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PREM 19/1805

Moratorium on Applications for Support and Innovation.

INDUSTRIAL POLICY

Part 1: Nov. 1984

Part 2: Feb. 1986

In attached folder

1) Report on 'SOFTWARE' A Vital Key to UK Competitiveness
2) Cabinet Office Report: Annual Review of Govt. Funded Research & Development 1986

PREM 19/1805

Referred to	Date	Referred to	Date	Referred to	Date	Referred to	Date
~~18.2.86~~							
~~11 Mar 86~~							
~~2.4.86~~							
~~10.4.86~~							
~~17.4.86~~							
~~16.6.86~~							
~~9.7.86~~							
~~21.7.86~~							
~~24.7.86~~							
~~29.6.86~~							
~~30.6.86~~							
~~13.8.86~~							
~~18.8.86~~							
PART 2 ENDS. Sept 86.							

PART 2 ends:-

SS/Emp. to SS/DTI September 1986

PART 3. begins:-

SS/DTI to SS/Emp. 13 October 1986.

TO BE RETAINED AS TOP ENCLOSURE

Cabinet / Cabinet Committee Documents

Reference	Date
E(A)(86) 2	15/01/1986

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

Signed J. Gray Date 1/10/2014

PREM Records Team

DM/11

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The Rt Hon Paul Channon MP
Secretary of State for Trade and Industry
1 Victoria Street
LONDON SW1H 0ET

September 1986

Dear Paul,

THE LINK PROGRAMME

I was very interested to see a copy of your minute to the Prime Minister of 11 August, in which you reported on the work of E(RD) and on the progress of discussions on the Pull-Through concept, and of her Private Secretary's letter to you of 18 August. I had also seen the earlier correspondence on Pull-Through in response to Geoffrey Pattie's letter of 25 July.

I gather that progress on the Pull-Through scheme is to be discussed again at E(RD) on Tuesday and I thought it might therefore be helpful to register the fact that, although my Department does not have a research programme of the kind the Scheme is designed for, I have a close interest in this initiative (which I warmly endorse as a concept) on two counts.

The first concerns the implications for skilled manpower. Given the difficulties we have experienced nationally in meeting the demand for IT skills, I can see a very important additional role any central coordinating machinery for the scheme in drawing to the attention of the partners (Government, industry and the academic world) the future requirements for additional manpower and new skills which would stem both from the research phase of Link programmes and from subsequent industrial exploitation.

The second concerns the way in which industry will benefit. I fully endorse the aims of increasing industry's own expenditure on R and D and of forging closer links between higher education and industry. At the same time I am aware that past major collaborative programmes of this kind

(particularly Alvey and Esprit) have been criticised by some people in industry for the bias they appeared to show against participation by the smaller firms in the industrial sector concerned. I can well understand why it is more difficult for small firms to stake their claim to a share in these programmes, especially where there is an international dimension, but we should recognise that they have a particularly important contribution to make in innovation and many, as you know, are spinning out directly from University departments. I believe the effectiveness of the Link Programme as a generator of enterprise and employment will be far greater if mechanisms can be established from the start to ensure that participation by small firms, in their own right or as partners with larger companies, is both encouraged and facilitated.

I should be grateful if these points could be taken into account in Tuesday's discussion.

I am sending copies of this letter to the Prime Minister, to the members of E(RD), to Sir Robert Armstrong and to the Chief Scientific Adviser.

IND Pol Support + Innovation PT2

PRIME MINISTER

DEFENCE R & D

You will remember that E(A) decided in February that Defence R&D should be reduced in line with the projections in the 1985 long-term defence costings.

I do not think MOD really believed that such a decision could have been taken or would stick and I am told that they did nothing to consider what they should be doing to live within the decision.

Predictably, the figures in the 1986 long-term costings are higher than those for 1985. (The 1985 figures even excluded EFA). Mr. Younger has accordingly proposed to E(RD), the Committee chaired by Mr. Channon, that E(A)'s decision should in effect be abandoned. He argues that it would mean either sacrificing capability or that we would have to buy off the shelf or manufacture under licence existing equipment from the US and Europe where the development costs have already been paid by somebody else. He recommends that instead of the specific decision taken by E(A) there should be 'a general ministerial directive to minimise R&D expenditure'. He would be prepared alternatively to work on the basis of the 1986 figures, putting off the evil day.

E(RD) has no authority to over-turn a decision taken by E(A) and this may well come back to you in due course. There is no need for you to intervene now.

It would surely be wrong to abandon the constraint set by E(A), as Mr. Younger wants. But it seems to me quite likely that in due course some increase in the figures will have to

be granted to Mr. Younger to accommodate the pressures on defence R&D coming even from procurement projects which are under way. However, Mr. Younger should be made to produce a full justification for this, and to put in place a proper management procedure to keep R & D in check.

DAVID NORGROVE

26 September 1986

SL2AIZ

P 02252

From: J B Unwin

Date: 26 September 1986

MR NORGROVE

DEFENCE RESEARCH AND DEVELOPMENT EXPENDITURE (E(RD)(86) 8)

You may like to see the attached copy of my brief for Mr Channon for next Tuesday's discussion by E(RD) of the above paper.

2. My very firm impression is that MOD have done nothing at all to implement the decision taken by E(A) last February that expenditure on defence R & D should be reduced in accordance with the projections in the 1985 Long Term Defence Costings. What has happened is that the 1986 Costings have thrown up higher figures (the main excuse being that the 1985 figures did not provide for the EFA) and the Defence Secretary is arguing that, although it might be possible to accept these as a compromise, he would prefer to have no quantitative constraint at all.

3. Mr Fairclough and I feel strongly that this is simply not good enough and I am so briefing Mr Channon. What MOD must now do is to put a proper management system in place which would be designed to enable them to live within the R & D figures imposed on them. If genuine problems arise, then the Defence Secretary is always free, of course, to come back to his colleagues. But a genuine effort must be made before he does so.

4. As you will see, I have advised Mr Channon that if E(RD) were minded to except the Defence Secretary's new proposal, the matter would have to be referred to E(A) for consideration under the Prime Minister's chairmanship

J B UNWIN

bc. Mr Norgrove

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SECRETARY OF STATE FOR TRADE AND INDUSTRY.

Defence Research and Development Expenditure
(E(RD)(86)8)

MAIN ISSUE

In this paper the Secretary of State for Defence in effect invites E(RD) to rescind the E(A) decision to constrain future defence research and development expenditure to the path showing in the 1985 Long-Term Costings. In practice such a decision could only be taken by E(A), so that E(RD) have in effect two alternatives:

(i) to endorse the Defence Secretary's recommendation that there should be no quantified restraint on future defence R & D expenditure but instead a general directive to minimise R & D expenditure in all defence procurement choices, for subsequent consideration by E(A); or

(ii) to reaffirm the need for a quantified framework for defence R & D, within which the Defence Secretary would be asked to prepare the best R & D programme he could, taking into account both military requirements and the implications for UK industry, while at the same time indicating how that programme could be improved if the quantified expenditure constraints were to be varied.

BACKGROUND

The reasons for the E(A) decision

2. Nothing has happened since last February to call into question the validity of the E(A) decision to limit future defence R & D expenditure. The case for that decision remains very strong indeed:

(a) defence absorbs a larger share of Government-funded R & D expenditure in the UK than in most other industrial countries;

(b) defence accounts for a larger proportion of total national R & D expenditure, public and private, than in other countries;

(c) although the Ministry of Defence now approaches procurement in a more business-like way than formerly, the attention of defence contractors remains focussed largely on defence sales, to the exclusion of any consideration of opportunities in civil markets;

(d) preemption by defence R & D of skilled manpower in the information technology/electronics field makes it more difficult for the rest of UK industry to secure the people they need most to improve their competitive position in international markets.

The intention of E(A), in endorsing the recommendations of the MISC 110 and MISC 119 Groups was to encourage a gradual reduction in the extent to which UK defence procurement relies on UK R & D directed exclusively towards defence purposes. The E(A) decision requires a gradual shift of resources out of defence R & D over an extended period of time, thereby minimising frictional costs in the redeployment of those resources elsewhere in the economy and avoiding disruption of the Ministry of Defence's procurement programme.

Ministry of Defence objections

3. The former Defence Secretary, while admitting the potentially important industrial impact of defence R & D, sought to resist the MISC 119 recommendation, on the ground that it would be premature to take any decisions which would constrain defence R & D until his programme, and all other Departmental R & D programmes, had been evaluated on the basis of common criteria from the standpoint of their contribution to the UK economy. (From this argument emerged the proposal to establish the Assessment Office.) The Ministry of Defence further argued that their R & D programme was vital to the strength of important sections of UK industry, and that there could be no guarantee that resources released from defence use would be applied more productively elsewhere in the economy. Although the uncertainty of the Long-Term Costing figures was emphasised by MOD, they did not argue that they gave a seriously misleading impression of the future trend in their R & D expenditure.

4. The case now made by Mr Younger is rather different. What it boils down to is that the 1985 costings made no allowance for the European Fighter Aircraft (EFA) project. MOD therefore now complain that they may not be able to find room for EFA and other desirable collaborative projects within an R & D programme constrained to last year's figures; that it is wrong to seek to put a programme directed towards military requirements into a financial straight-jacket; and that insisting on constraining future R & D expenditure means giving higher priorities to that objective than to minimising overall procurement costs. Mr Younger says that he does not want to be forced into a position where 50 per cent of UK defence hardware requirements are bought off the shelf overseas, and where the UK has to withdraw from desirable current and future collaborative projects with European partners. He proposes, therefore, that the Government should simply rely on a general directive in his Ministry to minimise R & D expenditure in all future procurement choices.

Implications of the MOD arguments

5. The arguments put by Mr Younger throw a very odd light on the Long-Term Costings. Their usefulness as a tool of management must be very questionable if they could be put forward last year with no allowance at all for a major item of RAF re-equipment (EFA) the need for which was clearly in everyone's contemplation at the time of the MISC 110 discussions. (The point appears to be that nothing can be allowed for in the Costings until it has some kind of Ministerial approval, so that the more distant years' figures inevitably have a strong downward bias attached to them.) It is clear that MOD have no management system in place to control future expenditure on development (future expenditure on research is projected to be broadly flat), and that no steps whatever have been taken to implement the E(A) decision.

6. MOD may argue that it is unreasonable to expect them to regard the volume of defence R & D expenditure as a policy objective; their system is designed to control the total costs of procurement, including both development and production. As part of their efforts to make defence contractors more efficient and competitive, they increasingly try to place fixed price contracts covering both development and production. The decision whether to purchase a new item of equipment off the shelf overseas, or to develop it collaboratively in Europe, or to develop it exclusively in the UK, at the same time

determines the UK R & D effort required. This is all very well: but it ignores the E(A) decision completely. Nor would be consistent with that decision to reduce apparent MOD development expenditure by lumping it all in with the production price by the means of 'cardinal point specification' contracts, correct though this approach may on occasion turn out to be. In principle there need be no incompatibility between the E(A) decision and a policy of cost-minimisation on defence procurement; and in practice decisions whether to take part in collaborative projects or to undertake exclusive UK development have invariably reflected factors other than cost-minimisation.

7. Given MOD's present policies and control methods, it is hard to believe that a general injunction to minimise development expenditure on new weapon systems would have any significant effect. Instead MOD need to install a system enabling realistic projections to be made of their UK R & D expenditure (including the development content of contracts whose price includes production as well as development and some allowance for projects not yet defined and approved by Ministers), taking into account the probable procurement arrangements for each item of equipment covered. A clearer view should then emerge on the scope for collaborative development and the need for off the shelf purchasing R & D expenditure within quantified constraints, so providing an adequate basis for decisions on the future content and shape of the programme. Such decisions would need to be based on an analysis of the military and industrial implications of all the projects within the MOD R & D programme, and on a considered judgment about their order of priority within that programme. (In practice it must be most unlikely that EFA is the marginal project which the Government would choose to sacrifice in order to keep MOD's R & D expenditure within a prescribed limit.) It cannot be excluded that it may at some time be necessary, on military and industrial policy grounds, to relax somewhat the constraints implied by the E(A) decision; but MOD have not yet begun to make a case which E(RD) could commend to E(A).

HANDLING

8. You will wish to invite the Secretary of State for Defence to introduce his paper. The Chief Secretary, Treasury will wish to respond, and the Minister for Industry and Information Technology will wish to make a substantial contribution to the discussion, reflecting on the one hand the claims of civil industry on the resources currently preempted by defence R & D, and on the other hand the need to maintain a strong and competitive UK capability in certain sectors of advanced technology which are heavily depended on defence. The other Ministers responsible for major R & D programmes may also wish to give their views, which will also reflect their sponsorship responsibilities for non-defence industries.

J B UNWIN
Cabinet Office
26 September 1986

10 DOWNING STREET
LONDON SW1A 2AA

From the Private Secretary

SIR ROBERT ARMSTRONG

Annual Review of the Government Funded R&D

This is to confirm that the Prime Minister is quite content for the 1986 Annual Revew to be published.

I am copying this minute to Mr. Fairclough

(MARK ADDISON)

1 September 1986

PRIME MINISTER

Could I confirm with you that you would be content for the Annual Review of Government funded R & D to be published, in the normal way. You saw the papers by way of background for your meeting with Sir Francis Tombs in July.

The summary of the Review and Sir Robert Armstrong's covering minute are attached.

Mark Addison

Yes MT

MARK ADDISON
29 August 1986

DG2 BID

cc BG

10 DOWNING STREET

From the Private Secretary

18 August 1986

Dear Tim,

The Prime Minister has seen your Secretary of State's minute of 11 August reporting on the work of the Ministerial Sub Committee on Research and Development. She was grateful for this and looks forward to the further report in September on the budget and detailed arrangements for the Pull-Through Scheme. She very much agrees with your Secretary of State that the Scheme will be an important signal of the Government's commitment to the research and development which will lead to greater wealth-creation. She expects E(RD) to give priority to settling the details of the Scheme and believes that, now that it has been agreed it should be a general initiative across Government, it will be necessary for a significant number of Departments to take part and for the total budget to be adequate to the task. In this context, she has commented that the figure of £15 million which is envisaged as the contribution from the MOD is smaller than she expected, and will be viewed as relatively insignificant. If necessary, she will be prepared to chair a meeting herself to ensure a viable Scheme.

As far as the announcement of the Scheme is concerned, she would prefer to defer a decision until we are closer to establishing its content.

I am copying this letter to the Private Secretaries to the members of E(A) and E(RD), to Joan MacNaughton (Lord President's Office), Tony Galsworthy (Foreign and Commonwealth Office) and Michael Stark (Cabinet Office).

Yours ever

Tim Flesher

Timothy Flesher

Timothy Walker, Esq.,
Department of Trade and Industry.

PRIME MINISTER

E(RD) REPORT ON PROGRESS

Attached at **Flag A** is the report by Paul Channon of the Ministerial Sub Committee on Research and Development. Also attached at **Flag B** is a note by John Wiggins of the Cabinet Office and **Flag C** is a comment by John Fairclough. As you will see, all three expressed a certain amount of disappointment on progress with the Pull-Through Scheme and recommend that in responding to Mr. Channon you should give Departments a nudge in the direction of providing resources from their research budgets.

Do you wish to respond as suggested in John Fairclough's minute? Yes MT

Mr. Channon hopes that you will announce the Scheme yourself, but John Fairclough and the Cabinet Office advise that a decision on this would be premature until we see what is actually produced. Wait to decide.

Agree to defer a decision on the way in which the Scheme is announced until the final report of E(RD) is available?

We may need another meeting chaired by me. for Defence MT

I'm for - RD

Be laughed to scorn

MT

Timothy Flesher

13 August 1986

DG2BIM

CONFIDENTIAL

PRIME MINISTER

I enclose the first report of the Ministerial Sub-Committee on Research and Development. I had hoped to be in a position to report agreement in detail on the Pull-Through Scheme but it is taking Departments some time to determine which of their programmes would best fit within the Scheme and therefore what sum to earmark for their contribution. In some cases the sums are not large but they may be significant in relation to Departmental R & D spend.

2 I think there is an element of dragging of feet but I judge it best to give colleagues the benefit of the doubt until September. Your endorsement of the Scheme at this stage would give support to our efforts to arrive at an adequate budget. It would also give support to the discussions we now need to have with industry.

PC

PAUL CHANNON

11 August 1986

DEPARTMENT OF TRADE & INDUSTRY

CONFIDENTIAL

DW4BGA

CONFIDENTIAL

PRIME MINISTER

WORK OF THE MINISTERIAL SUB-COMMITTEE ON RESEARCH AND DEVELOPMENT : E(RD)

The new Ministerial Sub-Committee on Research and Development was established in the spring in response to the work of the MISC 119 Group, with the remit to develop policies to enhance the contribution of R&D expenditure, public and private, to the development of the economy. E(A) at their meeting on 19 February (E(A)(86)6th Meeting) set the new Sub-Committee a substantial work programme, and asked for a first report by the summer.

2 E(RD)'s main tasks were as follows:

(a) to consider urgently Sir Robin Nicholson's proposal for a new scheme to 'pull-through' scientific and technological advances into marketable products and services;

(b) to secure more benefit for the economy from the resources devoted to defence R & D, in the light of E(A)'s decision to constrain defence R&D expenditure to the path set out in the 1985 Long Term Costings;

JF6AHG

(c) to reassess the shape and content of the Science Budget, with the objectives of sustaining the quality of the UK science and engineering base and securing greater economic benefits from exploiting the scientific research carried out within this framework;

(d) to devise further measures not involving direct Government expenditure to encourage additional private sector R&D;

(e) to explore ways of changing the objectives of Government R&D programmes so as to give much greater weight to their potential contribution towards strengthening the competitive position of UK industry;

(f) to oversee appropriate UK participation in European and international collaborative R&D programmes.

PULL-THROUGH

3 On ((a) above, E(RD) has concluded that there should be a single scheme capable of covering all the Departments with significant research programmes, and all the Research Councils. The fundamental purposes are to give new impetus to pull advances in basic science and technology through into goods and services of value to the economy, to forge more effective links between industry and research institutions on an inter-Departmental and cross-sectoral basis and hence to influence the programmes of those institutions in the direction of greater relevance to industrial needs. A hallmark of projects to be undertaken within the Pull-Through

framework is that industry will be expected to contribute at least half the costs over the lifetime of each project.

4 The present intention is that the largest contributions - from within existing resources - will come from the Science and Engineering Research Council, the major sponsor of 'strategic' research (i.e. work in areas with clear prospects of eventual application, but prior to the stage of specific commercial development) as part of the Science Budget, and from the Department of Trade and Industry, the principal source of Government support for applied research and development with the general objective of improving the efficiency and competitiveness of UK industry. In addition it is proposed that other Departments whose research programmes are primarily intended to serve particular objectives - procurement for defence, development of energy related technologies, the reduction of environmental pollution, and so on - will also contribute by identifying projects of significance to them which could better be carried forward within the Pull Through framework, and by earmarking the finance needed for the Government's contribution to these projects.

5 The participation of the Ministry of Defence will be particularly important both in amount (rising to £15 million a year when the scheme is in full operation) and in the contribution this will make to integrating defence R & D work more closely with the rest of the economy in accordance with the recommendations of MISC 110. The Chief Scientific Adviser's suggestion of a system of parallel defence and civil development contracts (see paragraph 6 of the Annex) is intended to contribute further towards this objective.

JF6AHG

6 As well as the Ministry of Defence, the Department of Transport and the Northern Ireland Office have agreed earmarked contributions. Other Departments, envisaged by E(RD) as having an important role in initiative, have yet to determine their contributions. Therefore we are signficantly short of the commitment needed, if we are to achieve establishment of a programme with an aim of building up Government expenditure to about £100 million in 1990/91. This figure would lead to a total expenditure of £500 million over 4 to 5 years, including industry's contribution of at least 50 per cent of the funding. My intention is to finalise the details, which includes continuing work by officials on the arrangements for implementing the scheme, consultations with industry, and report to you again by the end of September. I believe this scheme will be an important signal of the Government's commitment to research and development and I hope that you would feel able to make an announcement yourself.

DEFENCE R & D

7 On (b) above E(RD) has endorsed the conclusions of a further (and final) report from the MISC 110 Group of Officials. This made a number of recommendations with a view to ensuring that the potential wider benefits to UK industry and the UK economy are taken fully into consideration at every stage of decision making about defence R & D and procurement. These are set out in the Annex to this minute. They are designed to build on present arrangements for interdepartmental coordination; because they will involve not only senior officials and committees but also people at the level where proposals and specifications being to be formulated, they will mean a significant change in the decision-making environment. I therefore attach particular

importance to the remits to the Ministry of Defence (MOD) to prepare clear instructions for promulgation through the Department to ensure that the industrial dimension is taken fully into account at the formative stage, and to prepare an overview of international collaboration prospects from a UK industrial as well as a military standpoint. Meanwhile the Defence Secretary will be producing a paper for the Sub-Committee in September on the implications for his Department of compliance with the E(A) decision.

SCIENCE BUDGET

8 On (c) above, the Advisory Board for Research Councils (ABRC) are preparing a report on strategic research priorities (due early next year), which will include consideration of ways to enhance the wider economic benefits of the research work financed from that Budget. E(RD) has asked the Board to consider in particular:

(a) the case for a stronger centralised management of the activities of the Research Councils;

(b) the case for a different allocation of expenditure between the ABRC and the University Grants Committee (UGC) which would associate overhead costs more directly with research programmes, so allowing for a more effective concentration and selectivity of research effort;

(c) further steps to sharpen the management of research programmes and projects, providing for more stringent evaluation of progress towards pre-set objectives;

(d) increased participation by industry at different levels of decision making.

The ABRC report will also incorporate the UGC's ideas for improving the allocation of the funds they control, in the light of their recent initiative to improve the information base about the relative research capabilities of university departments. Meanwhile the Assessment Office have been asked to take the lead in the preparation of a paper, for consideration by E(RD), on possible steps to induce industry to contribute more to, and draw more effectively from, the work of Research Councils and universities.

PRIVATE SECTOR R & D

9 The question how to get more private sector R & D expenditure and activity (d) above, remains crucial - but difficult. The unsatisfactory performance of UK industry emerges clearly once again from this year's annual review of Government-funded R & D, which you discussed last week with Sir Francis Tombs, the Chairman of ACARD. The Official Committee on Research and Development (E(RD)(0)) will be reporting to E(RD) in the autumn, in the light of advice from the Advisory Council on Applied Research and Development (ACARD) and the DTI Technology Requirements Board.

OTHER DEPARTMENTAL R & D PROGRAMMES

10 As to the objectives of other Government R&D programmes ((e) above), E(RD) will be considering separate reports on the R&D programmes of Environment and Transport Departments this autumn, followed by reports on the R&D programmes of the Department of Health and Social Security, and of the

Department of Energy, before the end of the year. The R&D programme of the Ministry of Agriculture, Fisheries and Food is scheduled for early 1987.

INTERNATIONAL COLLABORATION

11 On (f) above, in addition to the further work on defence collaboration referred to in paragraph 7 above, E(RD) last month considered the UK's response to the European Commission's proposals for the EC Framework Programme for R & D and decided that we should aim to achieve agreement under our Presidency to a programme which represents only a modest increase above the current level of spending, and which is oriented more towards areas where there is likely to be early scope for exploitation by industry. It will be a difficult negotiation and the precise balance will only emerge as the discussions proceed; but we have already succeeded, with the support of France and Germany, in forcing the Commission to reduce significantly their opening bid. E(RD) will consider, as necessary, the implications for the balance between national and EC R&D programmes and for the allocation of Euro PES provision.

SUMMARY

12 E(RD) has made a start on what will need to be a continuing process if our objectives are to be achieved. Colleagues and their Departments have begun to give emphasis to the need to extract greater benefits for the economy from Government expenditure on R & D. But we have a long way to go and the proof of the pudding will be in the eating; much remains to be done to translate general objectives into detailed achievements on the ground. The first real test of this is the implementation of Pull-Through.

JF6AHG

i Some progress has been made in developing the Pull-Through Scheme, but there is still significant work to be done, especially regarding the earmarking of funds. A further report, including recommendations as to the timing of an announcement, will be made towards the end of September.

ii the recommendations in the final report from the MISC 110 Group of officials have been endorsed (see Annex) and the Defence Secretary will produce a paper for September on the implications for his Department of compliance with the E(A) decision.

iii the ABRC will complete its report on strategic research priorities, which will incorporate a section from the University Grants Committee and will also consider the case for stronger centralised management of research;

iv ACARD and DTI Technology Requirements Board are to advise on private sector R & D in September.

v Reports on the R & D programmes of Environment and Transport Departments will be considered in September, of Health and Energy before the end of this year and of Agriculture, Fisheries and Food early in 1987.

vi no more than a modest increase in the level of spending for the EC Framework Programme will be aimed for and its emphasis will move away from energy towards projects of relevance to industrial competitiveness.

JF6AHG

CONFIDENTIAL

13 I am copying this minute to colleagues on E(A) and E(RD), to the Lord President of the Council and the Foreign and Commonwealth Secretary, and to Sir Robert Armstrong.

PC

PAUL CHANNON

// August 1986

DEPARTMENT OF TRADE AND INDUSTRY

JF6AHG

ANNEX

RECOMMENDATIONS ON DEFENCE R&D

The Ministry of Defence should widen industrial representation (including civil as well as defence industry) on RE management boards and on other Committees advising the Ministry on defence R&D procurement questions.

2 The Ministry of Defence, in consultation with the Department of Trade and Industry and the Treasury, should prepare proposals for sharpening the incentives the REs have to promote industrial applications of their work, and report to Ministers by December 1986.

3 The Department of Trade and Industry and the Ministry of Defence should jointly commission the proposed case study by consultants of spin-off from defence R&D contracts. The results should be reported to Ministers as soon as possible; the objective should be to complete the work by the end of the year.

4 The Ministry of Defence, in consultation with the Department of Trade and Industry and the Assessment Office, should review means of encouraging industry to exploit MOD-funded R&D programmes and the intellectual property arising from them, and should consider other steps to improve the availability and flow of information, so as to facilitate the transfer of technology from defence into civil applications. A report should be made to Ministers as soon as possible after the case study at 3 has been completed.

5 Arrangements should be developed by the Ministry of Defence, in consultation with the Department of Trade and Industry, the Treasury and the Assessment Office, covering the nature, scope and timing of interdepartmental consultation in the ocurse of decision-making in defence procurement and the factors - including industrial impact, scope for civil applications and prospects for defence exports - to be taken into account in reaching decisions. A report should be make to Ministers by November 1986.

JF6AHK

6 Further consideration should be given by the Official Committee on Research and Development to the proposal by the Chief Scientific Adviser, Cabinet Office, for the institution of a pilot scheme for back-to-back defence and civil development contracts. A report should be made to Ministers in the same timescale as for 5 above.

7 The Ministry of Defence, in consultation with the Department of Trade and Industry, the Treasury and the Assessments Ofice should prepare a report for Ministers, again on the same timescale as for 5 above, oB prFspet UK defence requirements to be met by international, collaboration, and the considerations which will govern the UK's approach to them.

DEPARTMENT OF TRADE AND INDUSTRY
1 August 1986

JF6AHK

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W0187

MR ADDISON - No. 10

8 August 1986

E(RD): PROGRESS REPORT TO THE PRIME MINISTER

The Secretary of State for Trade and Industry will be sending this report to the Prime Minister today or early next week.

2. The working support of E(RD) is going reasonably well but it is disappointing that the Pull-Through scheme is not yet ready for announcement. You may wish to have some further background on this which, for understandable reasons, is not included in the report.

3. The original concept of the Pull-Through Scheme was that for the first one Government funding would be 25% each from the Science and Engineering Council (SERC) and the Department of Trade and Industry. The other 50% was to be found by a transfer from one or more Departments. Sir Robin Nicholson's proposal to E(RD) was that this should come from the fast reactor programme funds from the Department of Energy. It would be a matter for the CEGB to then decide whether they wished to make good those funds for the fast reactor programme.

4. This proposal was resisted by the Secretary of State for Energy and the alternative proposal of seeking contributions from a number of Departments was suggested. It was, perhaps, too easily accepted. The implications of this alternative concept are that

- the element of a real transfer of resources into Pull-Through is called into question

- the opportunity to transfer the R & D funding responsibility from the public purse to the industry which could be expected to benefit in the long term was lost

- by bringing a number of Departments into a general scheme the intention to develop a number of more narrowly targetted schemes is lost.

However this latter point could be turned to advantage in enabling more cross-Departmental topics to be tackled and in getting Departments used to working together rather more.

5. But despite enthusiasm for the principle of the scheme Ministers are showing a marked reluctance to name a figure which they will earmark from their own R & D budgets for the five year period. This is causing the Secretary of State for Education and Science some concern because if the full sum being aimed for (ie £100m by 1990/91) is not forthcoming the Research Councils, and in particular SERC, may well resist taking part because it will appear to them that their funds are being siphoned off into particular Departmental programmes.

6. In order to maintain pressure on Ministers to reach agreement on the budget by late September it would be helpful to have a strong endorsement for the Scheme from the Prime Minister. I attach a draft paragraph which might be included in her response to Mr Channon.

7. I am copying this minute to Brian Unwin and John Wiggins.

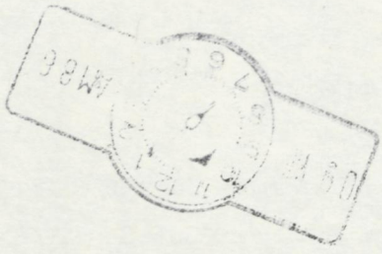
John

JOHN W FAIRCLOUGH
Chief Scientific Adviser

CONFIDENTIAL

DRAFT PARAGRAPH FOR RESPONSE FROM THE PRIME MINISTER TO THE SECRETARY OF STATE FOR TRADE AND INDUSTRY ON THE E(RD) PROGRESS REPORT

I look forward to receiving your further report in September when you will have agreed the budget and detailed arrangements for the Pull-Through scheme. I agree that the Scheme will be an important signal of our commitment to the research and development which will lead to greater wealth creation. I will expect E(RD) to give priority to settling the details of the Scheme and, now that it is agreed that it should be a general initiative across Government, it will be necessary for a significant number of Departments to take part and for the total budget to be adequate to the task. I will consider your advice about an announcement when you report in September.



CONFIDENTIAL

MR ADDISON

cc Mr Fairclough
Mr Unwin o.r.
Mrs Cunningham

WORK OF E(RD)

You should have received today Mr Channon's end of term report on the work of E(RD). However, because of messengerial delays, it did not get into Mr Channon's box last night, so that you will not receive it until next week. I am sorry about this; but there is not immediate time pressure, and it will not matter if a reply is delayed for a week or so.

2. The work E(RD) had done on defence and the science budget is straightforward and uncontroversial as far as it goes; Departments are all agreed on what needs to be done next, but translation of current efforts into a real improvement in the economy will only happen gradually over time, and as a result of sustained effort. E(RD) has also played a useful role in processing questions relating to the UK's approach to the EC R & D Framework Programme, but we are still only at the early stages of EC negotiations.

3. The difficult area is Pull Through - Sir Robin Nicholson's proposal for a new scheme to get industry, the universities and the public sector research institutions working together more effectively to translate the scientific and technological advances into marketable products and services. It was not possible to reach agreement on the basis proposed by Sir Robin, i.e. that 50 per cent of the funding should come from a reduction in the Department of Energy Nuclear Reseach Programme, with DTI and SERC providing the remainder. An alternative approach, which would have required smaller PESC transfers to DTI/SERC from a range of potentially interested Departments did not win support either - the other Departments simply do not have money they can afford to hand over. But the Ministry of Defence did offer to undertake a significant volume of the research in which they are interested within the Pull Through framework, which should have the effect of drawing in civil industry and ensuring that military and civil technology progress side by side. On this basis MOD would not actually transfer money to DTI, but would make funds under their own control available to support projects managed inter-departmentally and incorporating a substantial civil element. E(RD) agreed in effect to settle for this, on the basis that the other Departments with significant R & D programmes would participate in the same way.

4. Defence having offered £15 million a year (towards the target of £100 million, of which DTI and SERC would each subscribe £25 million), the DTI sought 'commitments' from the Departments of Energy, Transport, etc. I rather suspect that they were a bit flat-footed in pressing for 'firm' commitments to specified amounts of earmarked funds', with the result that the potential contributors feared that they were still trying in effect to secure PESC transfers by insisting on quantified commitments which exceeded the scale of the projects within the other Departments' programmes capable of being undertaken within the Pull Through Framework. As a result other Departments have been reluctant to commit themselves to specific figures. DTI further fear that other Departments, while proclaiming adherence in principle to the idea of

Pull Through, and to the E(RD) decision, will in practice change neither the make-up of their programmes nor the way in which they are run. SERC are disappointed at the scale of other Departments' contributions in relation to their own, and inclined to question whether the inter-departmental apparatus is worth having. Their reaction is understandable, but I think the answer is that the inter-departmental programme is worth having, if only to ensure that a substantial volume of defence-oriented research is carried out within the revised framework.

5. The best we can hope now is that the Department of Energy and other reluctant contributors will be ready to identify the broad orders of magnitude of their contributions to Pull Through over the next few weeks, so that there will be sufficient foundation for an announcement about the total size of the programme in September. It is, I am sure, a mistake to concentrate too much on the precise amounts - expenditure will in the end depend on projects being identified towards which substantial industrial as well as Government contributions can be attracted. This will only become clear gradually over time. However, given that the objective of the scheme is so clearly in the wider interest of the economy, we want Departments to approach it in as constructive a spirit as possible. It would therefore be very helpful if, in responding to the Trade and Industry Secretary's minute, the Prime Minister could make clear her support for the objectives, and her wish that other Departments should participate to the maximum extent possible, consistently with their own responsibilities and constraints. It would be helpful, too, if the inter-departmental and cross-sectoral character of the scheme could be endorsed, so as to restrict other Departments' scope for 'doing their own thing' without the participation of DTI and SERC.

6. I do not know whether Mr Channon will endorse Mr Pattie's wish that the Prime Minister should herself announce the scheme. This is not a point on which an immediate decision is needed, and it would be sensible to reflect further about it when discussions about other Departments' contributions have been completed. If there were an occasion - either a speech, or a seminar with relevant industrialists and academics - to which an announcement by the Prime Minister could conveniently be linked, this would undoubtedly help to get the scheme off to a better start. But it would be for DTI/SERC to handle detailed questions.

JW

A J WIGGINS
Cabinet Office
1 August 1986

CC/BG

NB attachment in PM's box 16.6.86.

WO178

MR ADDISON

1 August 1986

WORK OF E(RD)

I refer to Mr Channon's report on the work of E(RD) and John Wiggins' note to you on the same subject.

2. I feel I should express my disappointment with the pull-through proposal as it now stands. The identification of collaborative projects aimed at making an economic contribution is at the heart of the E(RD) process and responsibilities. I view the pull-through project as a test case of the E(RD) machinery and particularly whether the Departments can agree a common goal and make a contribution towards a realisation of that goal. I sense that a number of Departments are paying lip-service to the process by agreeing with the ideology, but at the same time expressing unwillingness to make the necessary financial contribution. I hope that the Prime Minister will find it possible to add her weight to the importance pull-through and to encourage the necessary financial commitments to make it happen.

3. I am copying this to Brian Unwin and John Wiggins.

JOHN W FAIRCLOUGH

Chief Scientific Adviser

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CQBG

Prime Minister (2)

Res information.

MEA 31/7

W0161

PRIME MINISTER

30 July 1986

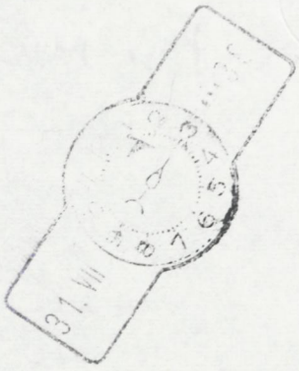
I am writing to thank you for agreeing to meet Sir Francis Tombs to discuss the comments of the Advisory Council on Applied Research and Development on the Annual Review of Government Funded R & D.

2. I know that Sir Francis was very pleased with the meeting, and went away reassured that the work which ACARD is undertaking still commands your interest.

3. One point which arose in the meeting which I promised to look into was the question of the contribution to GDP made by high technology industries. The latest figures available are those for 1983. In that year, high technology industries accounted for 3% of GDP; some 13% of the contribution to GDP by manufacturing industry which accounted for a quarter of GDP in total. If, however, we enlarge the definition of high technology industries to include computer services and telecommunication from the service sector, this increases the ratio to nearly 6%. However, as you can see from these figures, we are still dependent, to a large extent, on the more traditional industries and I share Sir Francis' view that it is the application of high technology to those industries which needs greater attention.

JOHN W FAIRCLOUGH

Chief Scientific Adviser



10 DOWNING STREET

LONDON SW1A 2AA

From the Private Secretary

MR FAIRCLOUGH
CABINET OFFICE

There is a slip in my record of the Prime Minister's meeting with Sir Francis Tombs on 25 July. On page 2, in line 7 of the penultimate paragraph "R&D expenditure" should read "defence R&D expenditure".

I am copying this letter to Rob Smith (Department of Education and Science) and Michael Stark (Cabinet Office).

(MARK ADDISON)

29 July 1986

file

SUBJECT cc MASTER

10 DOWNING STREET

From the Private Secretary

MR. JOHN FAIRCLOUGH
CABINET OFFICE

The Prime Minister held a meeting with Sir Francis Tombs, Chairman of ACARD earlier today. John Fairclough (Chief Scientific Adviser) was also present.

Sir Francis said he welcomed the opportunity to set out some of the thinking behind ACARD's comments on the 1986 Annual Review of R&D, and to explain some of the areas the Council were proposing to tackle in the future.

Sir Francis identified a number of encouraging developments in the R&D field:

(i) The establishment of a Science and Technology and Assessment Office, reporting to John Fairclough, to strengthen Ministers' ability to assess the economic returns to R&D.

(ii) The research councils were beginning to increase the emphasis they placed on the contribution research made to economic well-being.

(iii) ACARD's work, particularly their comments on the Annual Review were now being taken more seriously by departments.

Sir Francis believed however there was a lot more to be done. ACARD's main concerns at present were:

(i) Encouraging British companies. When considering the introduction of new regulations, for instance in pollution control, Government should have regard to drawing up a specification which would help British companies to meet it.

(ii) Over-specification. The Government tended to over-specify their procurement requirements, and this had the effect of discouraging British firms from investing in research and development. This had sapped industry's ability to undertake such research. The process needed to be reversed. Sir Francis agreed this was an area ACARD ought to consider further.

(iii) Government R&D expenditure on defence. The proportion of Government R&D spending on defence remained worrying. Overall, as a percentage of

GDP, UK R&D expenditure was not out of line with that of our competitors. But over half of that went on defence. Sir Francis urged that the Government should take steps to reduce this figure.

(iv) Cross-department issues. Occasionally scientific matters did not fall clearly to the responsibility of one department. Some way of dealing with this was needed. One approach would be for the Chief Scientific Adviser and ACARD to be allocated a small budget, say £250,000, to commission work which crossed departmental boundaries.

Sir Francis also identified two key points which ACARD would be looking at over the next year.

(i) Technology transfer. ACARD proposed to investigate ways in which the benefits of defence R&D expenditure found their way into industry more widely. It was too often the case that substantial investment in defence R&D had no commercial use, beyond its immediate procurement purpose. A way needed to be found to increase the scope for technology transfer.

(ii) Industrial spending on R&D. Only one-third of R&D expenditure was met by the private sector. Industry was making good profits but managements have tended to lack the technological awareness to know where and when to invest in research. Companies had, during the recession, cut back on training and R&D. Old habits died hard. This was an area ACARD was looking at.

The Prime Minister thanked Sir Francis for setting out ACARD's concerns and proposals so clearly. She shared his anxiety to improve the wealth creating potential of Government R&D expenditure, to improve the scope for technology transfer (particularly on defence contracts) and to encourage industry to invest more in R&D. She also noted ACARD's concern that R&D expenditure formed too high a proportion of Government R&D spending overall, and she said that steps were being taken to tackle this. She took note of Sir Francis' suggestion that a small sum be set aside for cross-departmental work; John Fairclough said that this might be part of the Assessment Office role, and he would be coming forward with proposals in this area in due course. The Prime Minister was glad to hear that John Fairclough would be co-ordinating a general response to ACARD's comments on the annual review of R&D.

The Prime Minister welcomed the creation of the new Assessment Office. She noted that there was now no shortage of advisory and co-ordinating bodies in Government to help secure a better directed research effort. The need now was not for more committees, but for action. She noted the difficulty of deciding what research in the longer term

might have a helpful economic impact, and it was vital that evaluation should not become a sterile and bureaucratic activity. John Fairclough said that his aim was that the Assessment Office would have a forward looking and stimulating effect; evaluation was certainly difficult, but not impossible.

I am copying this minute to Rob Smith (Department of Education and Science) and Michael Stark (Cabinet Office).

Mark Addison

MARK ADDISON

25 July 1986

PRIME MINISTER

MEETING WITH SIR FRANCIS TOMBS

You are meeting Sir Francis at his request, essentially to talk about ACARD's comments on the 1986 Annual Review of Government Funded R&D which has now been completed (Sir Robert Armstrong seeks your permission to publish this - Flag D). Sir Francis succeeded Sir Henry Chilver as Chairman of ACARD in November of last year. He is due to appear before the Lord's Committee on Science and Technology, and was particularly keen to see you beforehand. This will be the first occasion on which you have discussed ACARD's comments on the Annual Review with their Chairman. John Fairclough will also be at the meeting.

We have only been able to find three-quarters of an hour in the diary, and there is a good deal you can talk to Sir Francis about. It would probably be better as John Wybrew suggests (Flag E) to address a number of key general issues rather than to get too bogged down with the details of the ACARD Report and the Annual Review.

The key issues seem to be:-

(i) how can industry be encourged to invest more in R&D?

(ii) how can limited Government funds for R&D best be targeted?

(iii) how can we get more spin off from the funds allocated to military R&D?

Voluminous briefing from the Scientific Secretariat in the Cabinet Office is attached. You only need to look at a small proportion of this.

Flag A Letter from Sir Francis Tombs covering ACARD's comments (which you do not need to look at in detail).

Flag B A short and useful note from John Fairclough summarising the key points.

Flag C Detailed briefing from the Secretariat. (You do not need to look at this though you may wish to note that ACARD in the past three months has published the results of three recent studies: ~~exploitable areas~~ of science, software and medical equipment.)

Flag D Note from Sir Robert Armstrong seeking your permission to publish the Annual Review together with a useful executive summary.

Flag E A note from John Wybrew which identifies a number of discussion points.

Flag F A note from DTI explaining that Mr Channon is about to rule against the Engineering Council on a dispute they are having with the Society of Industrial Artists and Designers about a change of name for the latter.

MEA

Mark Addison

24 July 1986

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cc Blup
BC

D 1

Re Minute:
Agree to the publication of the review?
JN 27/7

Ref. A086/2157

PRIME MINISTER

Annual Review of Government-funded Research and Development

The fourth in the series of annual reviews of Government-funded research and development (R and D) expenditure instituted by Cmnd 8591 (Government observations on the report on "Science and Government" from the House of Lords Select Committee on Science and Technology) has now been completed, and I attach a copy, together with a summary ("Executive Summary"). The review has been prepared by the Science and Technology Secretariat in the Cabinet Office, working under the guidance of the sub-committee of Chief Scientists chaired by Mr John Fairclough.

2. The review is in three parts broadly following the format established in previous years. Part I contains a summary of past and projected Government R and D expenditure for the period 1983-84 to 1988-89 and a factual commentary thereon which summarises the R and D programmes by purpose and type. Other chapters in Part I summarise the R and D activities of the nationalised industries and the R and D expenditure of the private sector. Chart 5 of the Executive Summary shows in particular that the private sector are funding only just over one third of the R and D taking place in the United Kingdom. This rightly causes the Chief Scientific Adviser some concern, and is an item which he will be focusing upon in next year's review. Of special interest this year is the chapter describing manpower, the evaluation of R and D programmes and technology transfer, topics upon which Departments and Research Councils were requested by the Secretariat to provide detailed descriptions. Evaluation is something which the newly established "Science and

RTAABR

Technology Assessment Office" and the Chief Scientific Adviser may well wish to examine during the coming year. Finally, in Part I of the review are some international comparisons.

3. Part II of the review contains detailed information on the R and D programmes of the Departments and Research Councils which supplements the summary information in Part I. Part III contains various annexes relating to definitions and sources of data.

4. Under cover of his letter to you of 17 July Sir Francis Tombs, Chairman of the Advisory Council for Applied Research and Development (ACARD), sent you comments on this year's review; he requested a formal response to ACARD and Mr Fairclough's minute of 22 July gave you separate advice about this. You are meeting Sir Francis at 11.30 am on 25 July with Mr Fairclough.

5. ACARD's main concern continues to be the need for Government R and D programmes to contribute to wealth creation. This is the main focus of the work of the Ministerial Sub-Committee on Research and Development. Officials will be preparing a report for the Sub-Committee.

6. Previous annual reviews have been published and received a warm welcome from industrialists, the press and academics and others interested in the field. Favourable comments have also been received from both sides of the House. I suggest once again that it would be appropriate for the review to be published. If you agree, I will make arrangements for publication as soon as possible.

RA

ROBERT ARMSTRONG

23 July 1986

RTAABR

1986 ANNUAL REVIEW OF GOVERNMENT FUNDED R & D

EXECUTIVE SUMMARY

1. The 1986 Annual Review of Government Funded Research and Development is the fourth review prepared in accordance with the Government's statement in 1982 (Cmnd 8951).

Government R & D Expenditure

2. Total central Government expenditure on research and development in 1984/85 was £4.3 billion, which represents about 3% of total central Government expenditure.

3. Chart 1 shows the distribution of R & D expenditure by the different sectors of Government. The Ministry of Defence with 51% has by the largest expenditure on Research and Development, most of which is on development work.

4. In 1984/85 constant prices, expenditure on R & D is expected to decline in the period up to 1988/89 to a little over £4.1 billion. This is shown illustratively in Chart 2, where the decline in the civil departments R & D is quite noticeable. The detail in the Annual Review reveals that this is due in large part to a decline in DTI expenditure on R & D.

5. In the period up to 1988/89, the Ministry of Defence share of the total R & D expenditure gradually increases to 54% whilst the Research Councils and the UGC are expected to retain their proportional level (at approximately 12 and 15% respectively).Civil Departments' expenditure on R&D falls from 22% of the total in 1984/85 to 19% in 1988/89.

6. The primary purposes underlying Government expenditure on R & D are shown in Chart 3. Support for procurement (mainly by the MOD) is clearly the largest segment.

7. UK Government expenditure on R & D is about 1.3% of GDP in 1984/85.

Civil Expenditure on R & D

8. The results of the 1985 DTI survey of industrial R & D will be available in early 1987. The latest data therefore refer to 1983. The expenditure on R & D by industrial sector is shown pictorially in Chart 4, where the predominance of the electronics industry is clear.

Total Expenditure on R & D

9. Total expenditure in the UK on R & D amounted to £6.6 billion in 1983, approximately half was funded by the Government. Private industry, nationalised industries and monies from overseas financed the other half (illustrated in Chart 5).

International comparisons

10. Chart 6 shows total Government R & D financing as a percentage of GDP. The UK, France and the FRG are all above 1%. OECD data show the USA Government to spend a similar proportional amount, but Japan with only 0.5% of GDP spends proportionately less than the UK.

11. The USA, France and the UK all spend a significant amount of R & D in the defence field. As a percentage of GDP, the UK Government spends 0.7% on civil R & D which is similar to Italy, more than Japan (0.5%) and USA (0.4%), but less than FRG and France (both 1%).

12. In terms of total expenditure on civil R & D (that is both Government and private), the available data show that the FRG and Japan both spend about 2.5% of GDP, whereas USA, France and the UK all spend less than 2%.

Total R&D Expenditure 1984/85

Chart 1.

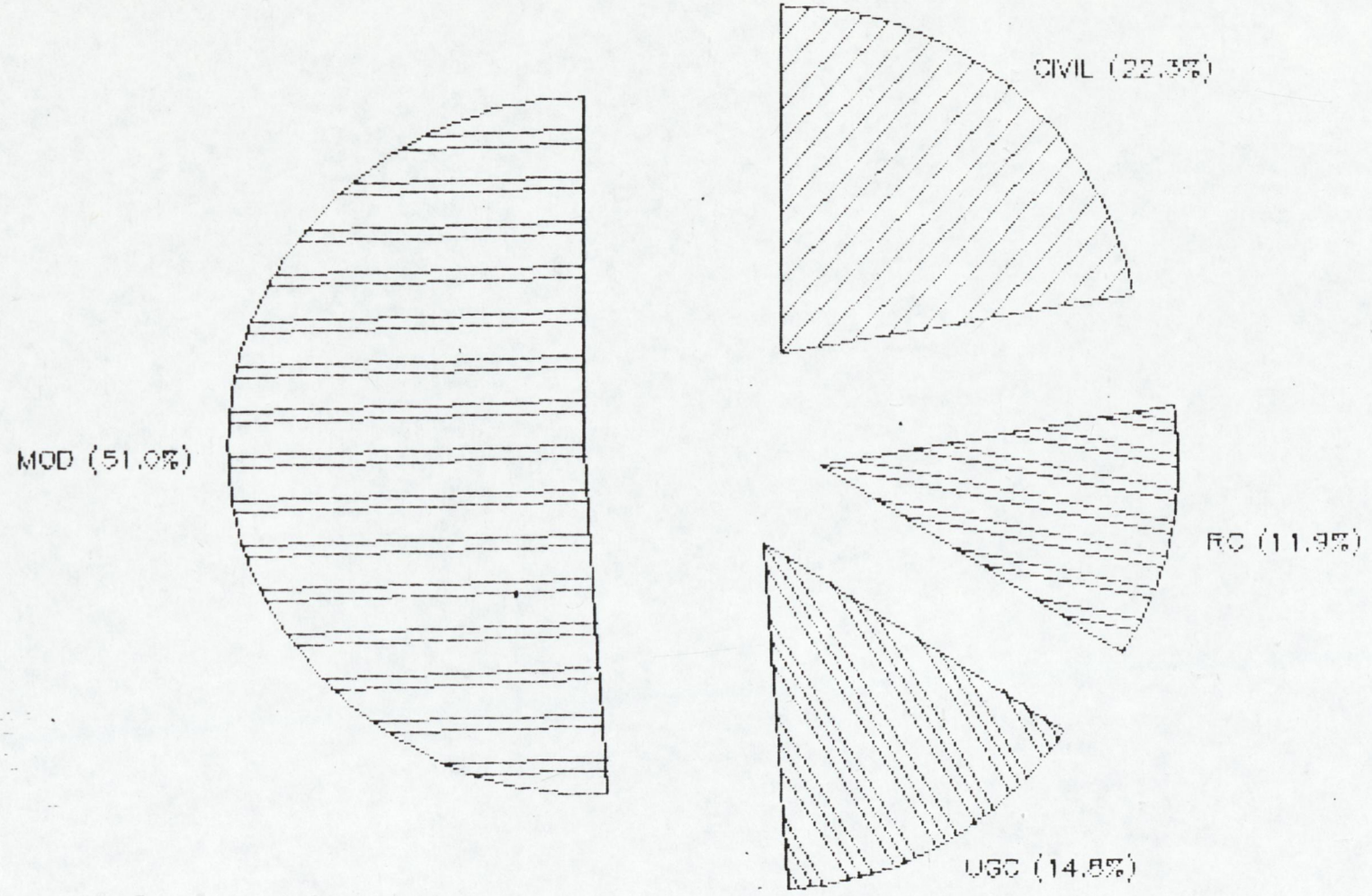


Chart 2

Total R&D Expenditure

1984/5 Constant Prices

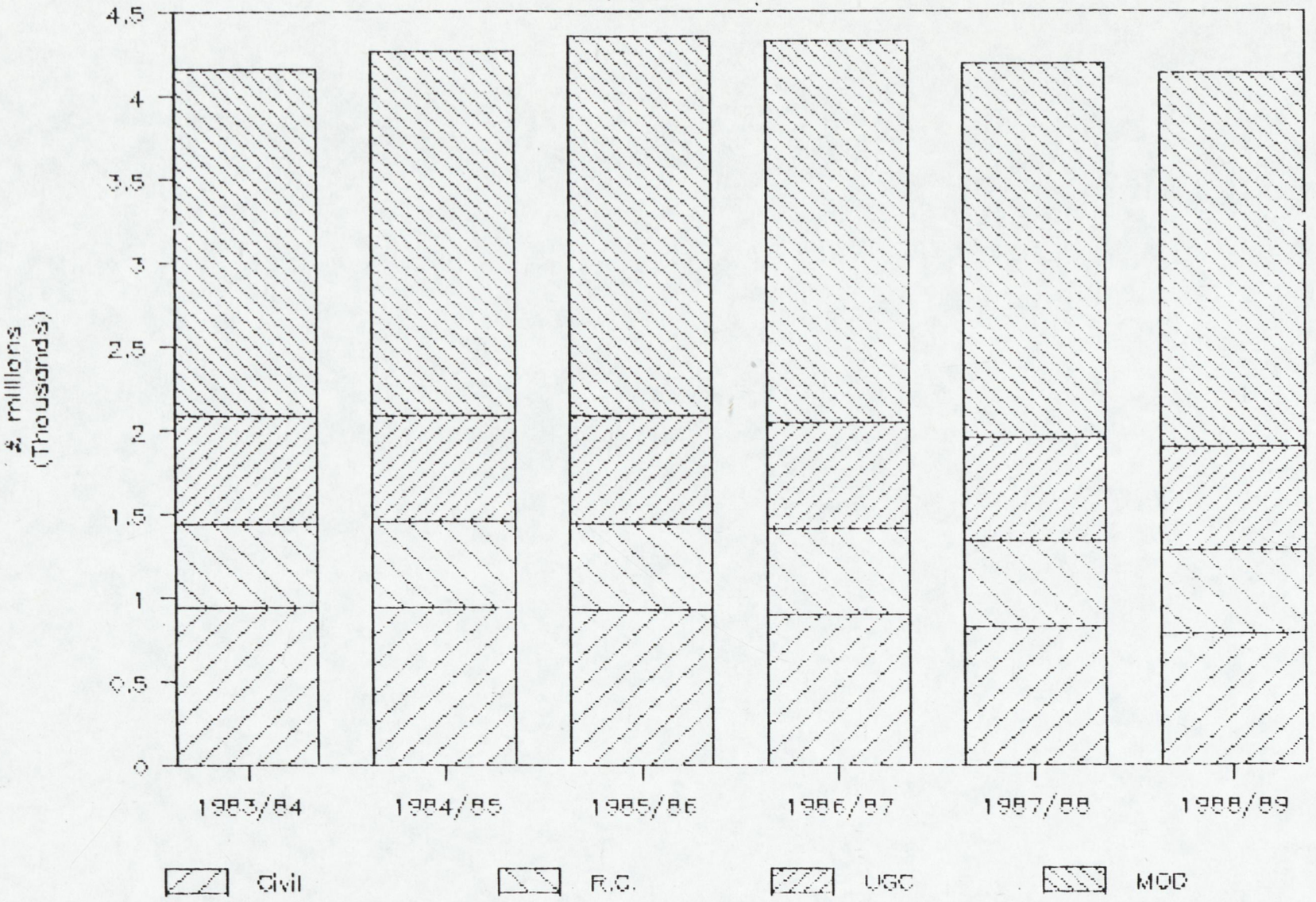


Chart 3.

PRIMARY PURPOSE OF GOVERNMENT R&D

1984/85

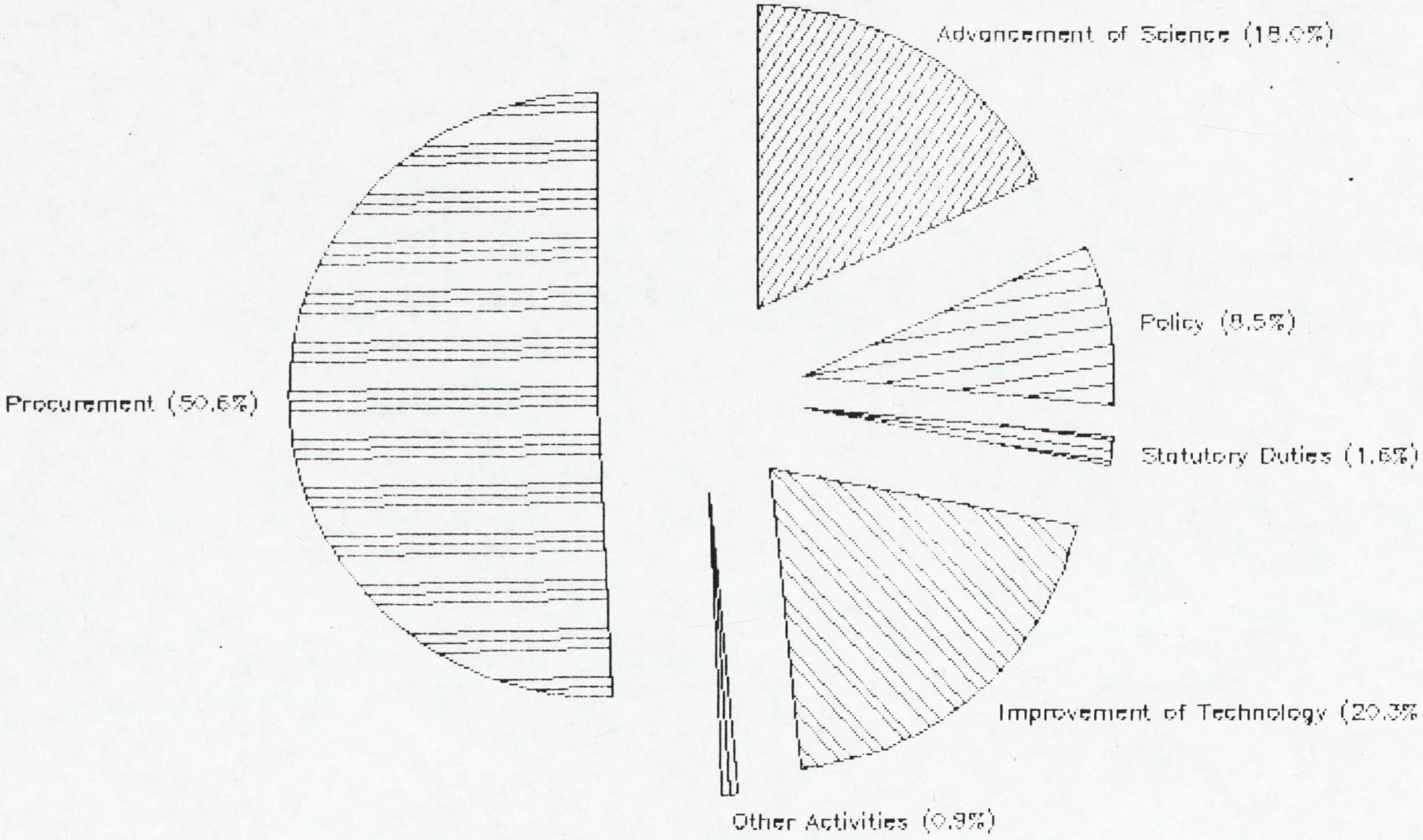


Chart 4.

INDUSTRIAL R&D BY SECTOR 1983

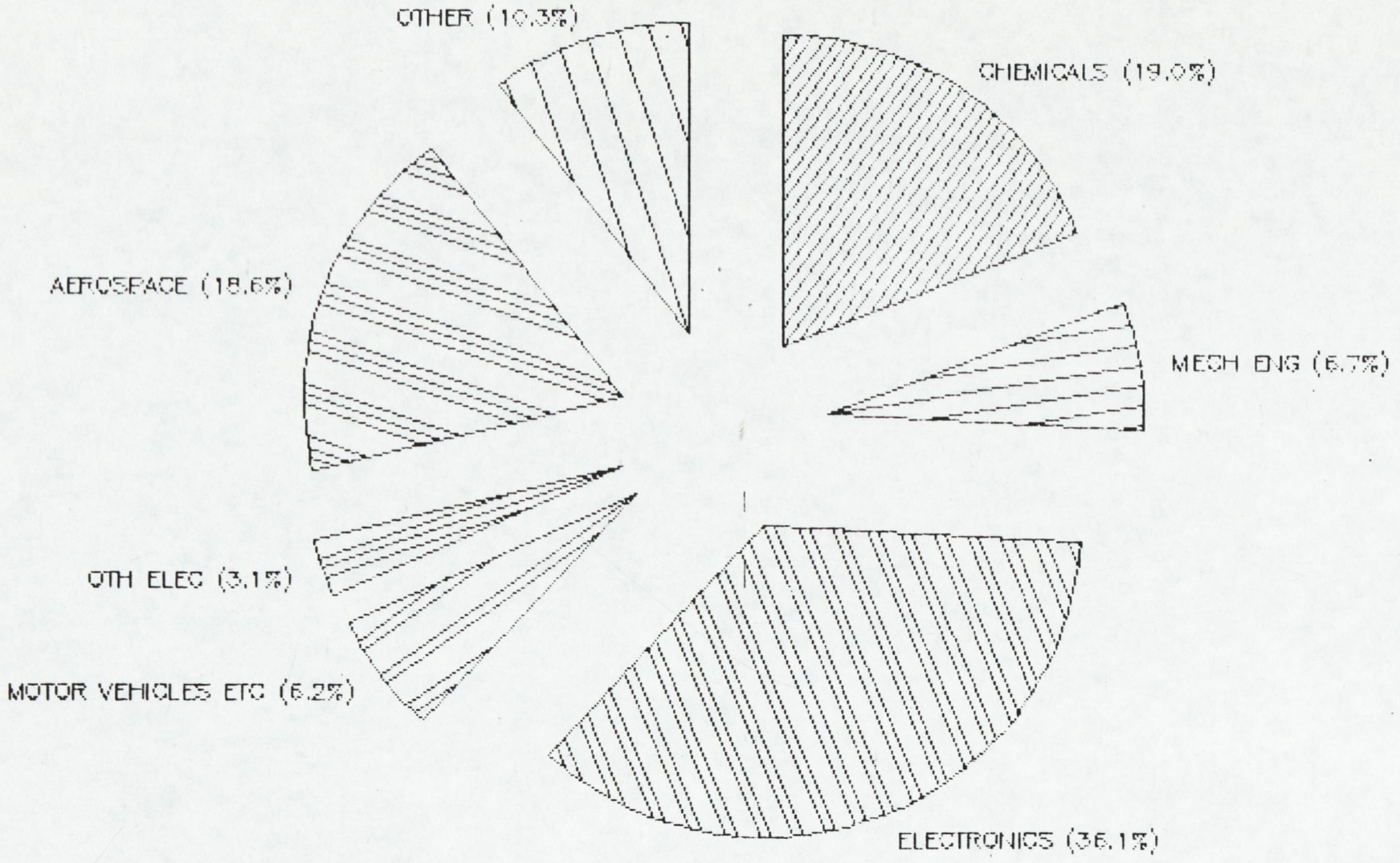


Chart 5

TOTAL R&D EXPENDITURE 1983

By Source Of Funding

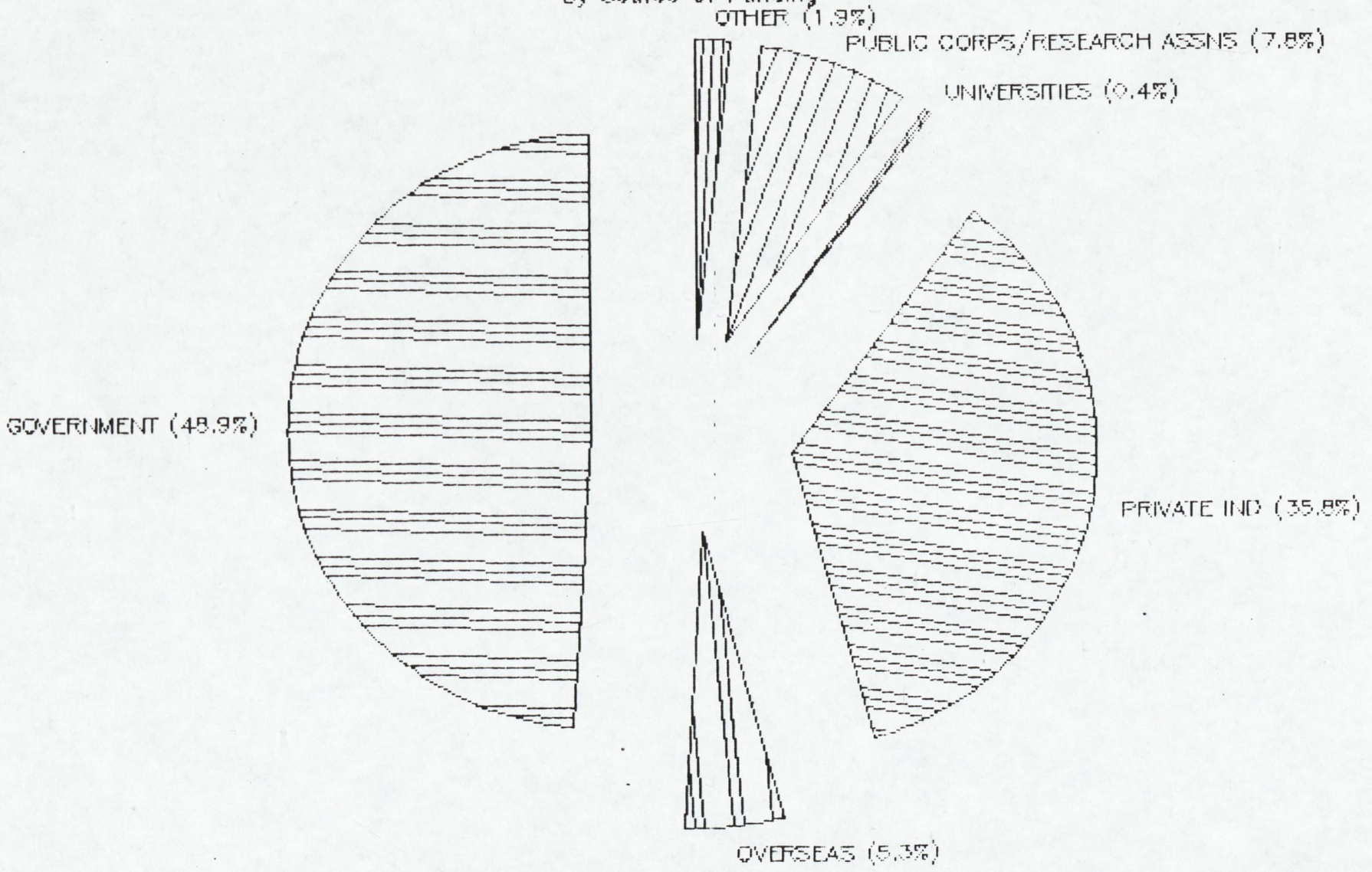
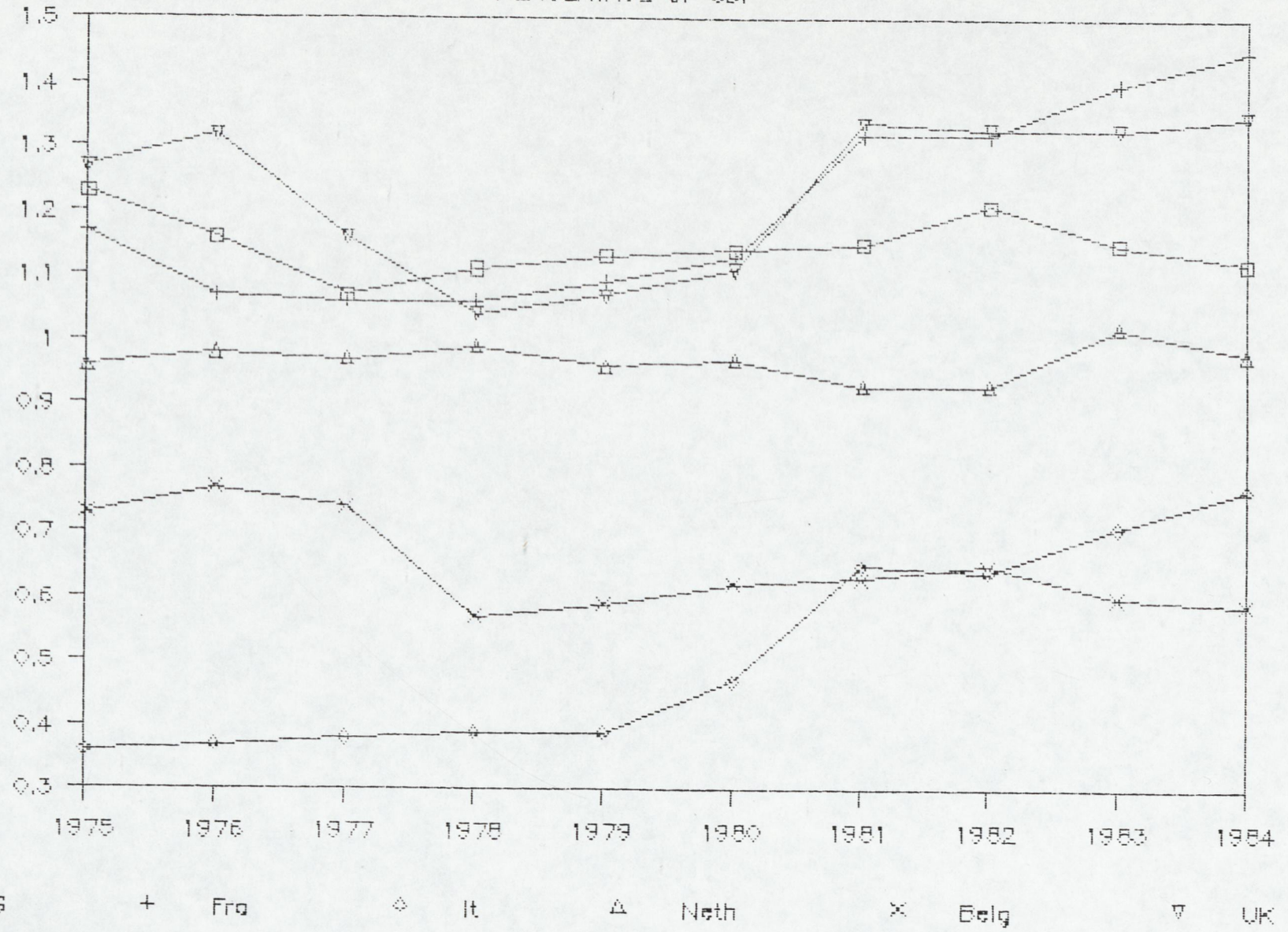


Chart 6

GOVRENMENT R&D FINANCING

PERCENTAGE OF GDP



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PRIME MINISTER 22 July 1986

BRIEF FOR THE MEETING WITH SIR FRANCIS TOMBS (CHAIRMAN OF ACARD) ON 25 JULY AT 11.30.

LINE TO TAKE

You will wish to thank Sir Francis for sending ACARD's comments on the 1986 Annual Review of Government Funded R&D and welcome this opportunity for discussing the points made in his covering letter.

BACKGROUND

Over the last four years the Advisory Council for Applied Research and Development (ACARD) has submitted its advice on the Annual Review of Government Funded R&D (further details of ACARD are at Annex A). The advice on the 1986 Review was sent to the Prime Minister by Sir Francis on 17 July 1986 with a covering letter noting the points which he will wish to discuss (this is attached at Annex B).

1. **ACARD's concerns on enhancing the wealth creation potential of Government Expenditure on R&D**

LINE TO TAKE

Although ACARD's advice on the Annual Reviews has not been the only influence on Government it has been an important influence. Government is vitally concerned to ensure that the R&D programmes undertaken by Departments are efficient and enhance the innovative capacity of the economy and ministers are now meeting regularly to review the priorities of Government sponsored R&D programmes - the wealth creation potential of these programmes is a major factor in assessing such priorities.

CONFIDENTIAL

The total amount of money spent by Government on R&D is enormous and there does need to be some redistribution of this spending which will feed through to sectors in line with their potential contributions to GDP.

So you see that ACARD's advice is taken seriously and we are grateful for the considerable amount of work members put in to produce Council's Comments on the Annual Review.

BACKGROUND

Command 8591 which set up the Annual Review process also stated that Government would look to ACARD for independent annual advice on Departments' research programmes and budgets. In accordance with this ACARD has reviewed the 1983, 1984 and 1985 and now the 1986 Reviews and made detailed comments on the last three of these.

In 1985 the main thrust of ACARD's comments on the Annual Review was that Departments' R&D programmes should be assessed against their relevance to wealth creation.

In July 1985 E(A)18th Meeting had a discussion on the issue of R&D priorities across Government (E(A)(85)19) and resulting from this MISC 119 was set up to: **review the R&D programmes of Government Departments, to assess the relative priorities of the different programmes, to consider the scope for change in the size, content and objectives of those programmes which could contribute to improving the efficiency, competitiveness and innovative capacity of the UK economy.** MISC 119 reported to E(A) in February 1986 6th meeting and E(RD) and its related official committee E(RD)(O) were formed (E(A)(86)2). E(RD) has met three times and the Chairman - the Secretary of State for Trade and Industry is due to submit his first progress report to you.

ACARD has been informed in general terms about this machinery set up to conduct the reviews of R&D priorities across Government.

The Science and Technology Assessment Office (the establishment of which was announced on 2 July) situated in the Cabinet Office and responsible to the Chief Scientific Adviser, will have as one of its tasks the evaluation of Departments' R&D programmes in terms of the contribution they make to the competitiveness and innovative capacity for the UK economy.

2. **ACARD's concerns on the levels of expenditure by Government on civil and defence R&D**

LINE TO TAKE

Expenditure on civil R&D

The statistics in the 1986 Annual Review show Government spends in total roughly the same proportion of GDP on R&D as France and more than the US and Japan. The total level of expenditure on civil R&D in the UK as a proportion of GDP is comparable with that of France.

I cannot accept that simply increasing Government expenditure on civil R&D will necessarily act as a motor to stimulate the competitiveness of UK industry. The reasons for the relative decline in the UK's ability to bring new innovative products to the market place are complex and not well understood. Industry itself must decide on the research it needs and be prepared to invest accordingly. The evidence shows that industry generally in the UK is not prepared to give R&D the same level of priority as industries in our competitor nations. I am pleased that ACARD will be advising on measures that could be taken to encourage the private sector to sponsor more R&D. I am sure that ACARD's report will make a useful contribution.

Expenditure on defence R&D

The question of the levels of Government expenditure on defence related R&D is a complex matter. The statistics in the latest Annual Review show that the greatest part of this expenditure is on development rather than on research and the equipment that the armed forces need is of course determined by the tasks

placed on them and these are becoming increasingly severe. I appreciate ACARD's concern about the level of expenditure on defence R&D.

It is right to see whether we can obtain defence equipment with less R&D investment by Government and in ways which offer better commercial returns both in defence exports and in civil products. The recent initiatives taken by MOD - in particular the Defence Technology Enterprises Company - will encourage the spin-off of technology from defence R&D to the civil sector.

BACKGROUND

In 1985 ACARD contested the statement made in Command 8591 that the level of UK's R&D expenditure as a proportion of GDP was sufficient. They urged that action be taken to secure an increase in the total investment in civil R&D from both Government and private sector sources. This year, ACARD urges Government to consider whether expenditure on civil R&D by Government should be given a higher priority (1986 Comments paras 1.5 and 2.1).

France and the FRG each spend about 1.0% of GDP on Government support for civil R&D; like Italy the UK Government spends about 0.7% of GDP on civil R&D; the USA and Japan each spend about 0.5%. (Ref Annual Review Table F1a).

OECD data shows that in the UK 60% of the expenditure on private sector R&D comes from industry itself whereas in France, US, FRG and Japan the figures are higher, ranging from 70% to 98%. (Annual Review Table F2)

ACARD has been requested to advise Government on measures that could be taken to improve the flow of private capital to pre-competitive R&D and to innovation (ARD(86)16).

In 1984 ACARD expressed concern at `the opportunity costs associated with current and projected levels of defence R&D'. These comments contributed to the decision to set up the Official Committee on Defence Research and

Development (MISC 110), as a result of whose work E(A) decided in July 1986 that defence R&D should be restrained to the declining profile given in the 1985 Long Term Costings. MISC 110 has submitted its second report to E(RD) (E(RD)(86)6). This report makes recommendations for increasing the economic benefits from defence R&D, including changes in R&D practices, procurement practices and the planning of the UK's approach to international collaboration. The recommendations were accepted by E(RD), and Departments will report to E(RD) on the follow up work. **THIS IS NOT KNOWN TO ACARD**

In 1986 ACARD is emphasising the need for methods to be found to ensure that technologies developed for defence are fully exploited in the civil sector (1986 Comments para 1.6). MOD have taken a number of recent initiatives designed to increase the civil spin-off from defence R&D: a joint initiative between MOD and a consortium of eight companies has led to the formation of Defence Technology Enterprises plc (DTE), a private sector company formed to transfer technology from MOD research establishments to civil industry; industrialists have also been invited to be members of the Controller Establishments Research and Nuclear (CERN) board with the express aim of enhancing liaison between MOD research and industry generally.

Mr P Levene - Chief of Procurement, MOD attended the Council's meeting on 1 May 1986 to discuss the influence of MOD sponsored R&D on UK industries generally (ARD(86)20).

Sir Francis Tombs and some members of ACARD had an informal evening meeting with Mr Younger on 10 June 1986 at which some of the above matters were discussed.

3. **ACARD's concerns on the level of technology transfer from Government R&D**

LINE TO TAKE

I would agree with ACARD that the wider economic benefits of R&D undertaken by Departments can be enhanced by appropriate technology transfer machinery being in place and used to advantage. Many departments are aware of this and have taken measures to promote technology transfer: DTI spends 14% of its budget on such activities and finds this a cost-effective means of promoting the beneficial uptake of technology by UK industry.

The level of technology transfer will of course be one of the factors used by the new Science and Technology Assessment Office when it evaluates the outputs from Government supported R&D programmes.

It is appropriate for Departments to review their approaches to technology transfer and I will ask chief scientists to consider and respond to ACARD's recommendation that a senior member of each Department be assigned responsibility for technology activities.

BACKGROUND

For the 1986 Annual Review, Departments were asked to provide more information on their technology transfer activities and ACARD has reviewed and made comments on their submissions.

ACARD's view is that Departments' efforts to encourage the transfer of technology from their programmes are rather narrow. (Comments para 3.8) They make recommendations that Government must give emphasis to technology transfer into manufacturing which will lead to enhanced international competitiveness (Comments para 3.9). They recommend that technology transfer must become a major issue for Government R&D and that responsibility for technology transfer should be assigned to a senior member of each Department (Comments para 3.11).

4. ACARD's recommendations concerning Government procurement practices

LINE TO TAKE

I agree that when Government is a dominant or major customer it should not lose sight of the need to help rather than hinder the supplying industries in becoming and remaining internationally competitive. It is essential that we obtain the goods and services we need at the cheapest possible price but not at the cost of having companies so geared to satisfying government customers that they are unable to meet the demands of larger, international markets. It is a difficult balance to achieve and one on which I welcome ACARD's advice.

BACKGROUND

ACARD in its Comments on the 1986 Annual Review recommends that public purchasing policies be modified to ensure more stimulus for technological advance. (Comments para 6.5)

In particular they say that DOE and DTp should ensure that their procurement practices stimulate the construction industries (Comments paras 4.13, 4.16).

Similar recommendations are made by ACARD's recent reports on the Medical Equipment and Software Industries.

The Government machinery which has been set up to review R&D expenditure and priorities will be examining the programmes of DOE and DTp as one of their first tasks and will be looking in general at the procurement issues addressed by ACARD.

5. **ACARD's recommendation to stimulate cross-departmental work**

LINE TO TAKE

I agree that it is important that Departmental boundaries should not get in the way of effective research and development but I believe that the measures we are already taking will help to prevent this and I am confident that Mr Fairclough will give this matter high priority.

BACKGROUND

ACARD has expressed a concern on what it sees as deficiencies in the mechanisms in place to initiative, control and co-ordinate programmes of R&D which involve or are of concern to more than one Department (Paras 1.4 and 3.5).

The Assessment Office will be in a position to do the type of work suggested by ACARD and should be able to assist ACARD with its own studies.

Cabinet Office
22 July 1986

ANNEX A

GENERAL BACKGROUND TO ACARD

The Advisory Council for Applied Research and Development (ACARD) was established in 1976.

It was given new terms of reference in 1982. These are as follows:

'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 Kindgom 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.'

Sir Francis Tombs (Chairman of Rolls Royce) succeeded Sir Henry Chilver as chairman of ACARD in November 1985. In April of this year the activities of the Information Technology Advisory Panel (ITAP) were subsumed into ACARD. ITAP's future work programme is to be taken forward within the Council.

ADVISORY COUNCIL FOR APPLIED RESEARCH AND DEVELOPMENT
70 Whitehall, London SW1A 2AS Telephone: 01-233 7140

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

17 July 1986

Dear Prime Minister,

The Advisory Council for Applied Research and Development has considered the 1986 Review of Government Funded R & D and their comments are enclosed.

I welcome the opportunity which I will have this year to discuss these comments with you.

The comments made by ACARD in 1984 and 1985 emphasised the need for the maximum contribution towards wealth creation to be gained from the full range of Government funded R & D programmes ACARD is very pleased to learn that Ministers are giving serious consideration to this matter and that the establishment of the Science and Technology Assessment Office reporting to your Chief Scientific Adviser, will strengthen their ability to assess the economic return to R & D. We hope that this process will lead to a reallocation of expenditure to maximise this return.

ACARD's principal comments on the 1986 Review concern the decline in civil R & D expenditure whilst that for defence continues to rise, (this concern applies particularly to DTI, DOE and DTp as sponsors and customers for industry); the lack of effective cooperation between Departments; the need to increase technology transfer activity and to make better use of the procurement 'muscle' of Departments to improve our international competitiveness.

ACARD believes that a modest central fund would enable primary investigations of R & D matters to be undertaken in order to stimulate more cross-departmental work. This is one of the aims of studies undertaken by ACARD and we would hope to underpin these on occasions with more detailed work.

I look forward to discussing these issues and others contained within the attached comments with you when we meet on 25 July.

Yours sincerely

Francis Tombs

SIR FRANCIS TOMBS

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ANNEX C

ACARD REPORTS

In the past three months ACARD has published the results of its three most recent studies into:

1. **Exploitable Areas of Science** (May 1986) - which considered how research could be organised in the UK to give greater economic returns. The report makes the point that in contrast with some other industrial competitor nations (notably US, Japan, France) the UK does not have a visible process for holding debates - involving industry, academia and Government - on the most appropriate directions for our national scientific effort.

ACARD concluded that such a process should be established in the UK. The process would take account of the potential market exploitation of branches of science and technology and recommend priorities.

A firm of consultants has been appointed to advise ACARD how this process could be established in the UK. These consultants will be reporting early in 1987. It is expected that ACARD will then put forward proposals on how the process can be set up, where it is to be located and the funding provisions that are necessary.

2. **Software** (June 1986) The ACARD report on Software was published on 16 June with the approval of the Prime Minister. It draws attention to the possibility that the UK was failing to win its expected share of world markets and that industry generally was failing to develop and apply software sufficiently rapidly and widely.

The main recommendations of the report for Government are that by appropriate co-operation Departments should use their public purchasing power to stimulate

new applications and development methods and that more attention should be given to technology transfer in the IT industries by the formation of an organisation whose aim would be to provide advice nationally on software applications, marketing, training and technology transfer. The Minister of State for Industry and Information Technology is co-ordinating the Government's response to this report of ACARD. The report and its recommendations were amongst the topics discussed at an informal meeting in March between the Minister, Sir Francis Tombs and other ACARD members.

This report has proved to be controversial with the software industry. Many companies have had a rapid rate of growth and have been very innovative but they have not made any inroads into world markets and show few signs of adopting trading strategies which will make them effective exporters.

3. **Medical Equipment Report:** (July 1986) The ACARD report on Medical Equipment was published on 10 July, with the Prime Minister's agreement. Its main recommendations are concerned with using the power of the NHS purchasng budget more effectively to encourage the UK industry to develop products which will be competitive internationally. There are also recommendations on primary health care services, Government R&D support, opening up the European market, and collaboration between industry and the health care professions, amongst other topics. The general thrust of the report is consistent with the policies of the Government, though some individual recommendations may prove difficult to accept. The Secretary of State for Health and Social Security is coordinating the Government response. Sir Francis Tombs and other ACARD members had a useful and positive meeting with him in June to discuss the report.

ANNEX D

Research and Development in the UK

Key Facts and Figures

1. Government funded R & D was valued at **£4.3 billion** in 1984/5.

2. Of this **£2.2 billion** (51%) is attributed to the Ministry of Defence.

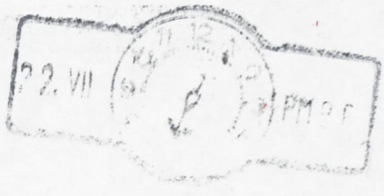
3. Largest expenditure by Civil Department is DTI - £346.7m in 1984/5. This is projected to decline to £252.1m in 1988/89 in current prices.

4. In 1983 (latest year for which full detail available) total expenditure in the UK on R & D was about **£6.6 billion** - of which about **half** was funded by Government. The combined expenditure of Private industry, Nationalised Industries, and monies from Overseas account for the other **half.**

5. UK Government spending on R & D represents about **3%** of Government budget.

6. UK Government spending on R & D is about **1.3% of GDP** in 1984/5.

7. Government employs at present (1984/5) about **57,000** people on R & D. Approximately **17,500** are degree level and **8,500** technicians (all figures include UKAEA).



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PRIME MINISTER 22 July 1986

ANNUAL REVIEW OF GOVERNMENT FUNDED R & D
COMMENTS FROM ACARD

You have agreed to see Sir Francis Tombs on 25 July to discuss with him ACARD's comments on the 1986 Annual Review of Government Funded R & D. This is the fourth such Review and the third on which ACARD has commented.

2. The Review, which was established by my predecessor, Sir Robin Nicholson, is proving to be a useful document in prompting discussion within Government on the balance of R & D expenditure and whether that balance might not be altered in a way which will create greater wealth, increased efficiency, innovation and competition.

3. The new machinery for Ministers to discuss Research and Development regularly, supported by an Official Group and the Science and Technology Assessment Office can be seen as logical developments stemming from the Annual Review process.

4. ACARD's role in this development has been important. In 1984 and 1985 ACARD's comments, which are confidential to Government, emphasised most of the main themes which Ministers are now addressing - namely the need

- to improve the contribution of Government funded R & D to wealth generating technology

- to press for greater spin-off from defence to civil industry and to question the balance between defence civil R & D

- to highlight the relative lack of funding for industrial R & D from industry itself

- to make Government expenditure on R & D more responsive to new market opportunities and technological advances.

5. The same themes arise in ACARD's comments this year but having already registered these as matters of general concern ACARD is beginning to look each year at particular Departments and areas of research in more detail. ACARD members undertake a considerable amount of work and it is their detailed work and questioning of Departments as much as the comments themselves which have led to greater appreciation of the need to establish clear objectives, rigorous monitoring of progress towards those objectives and a greater drive towards wealth generation.

6. ACARD have not so far received any formal response from Government to their comments. Sir Francis has now requested that they should and I am prepared, with your agreement, to arrange for this to be done through the Committee of Chief Scientists. In my view it is important to provide some feedback to maintain the energy and momentum of ACARD's work.

7. I hope you will feel able to welcome ACARD's comments and assure Sir Francis of their value.

JOHN W FAIRCLOUGH
Chief Scientific Adviser

hle JA

cc: Scientific Secretariat, CO

10 DOWNING STREET

THE PRIME MINISTER

21 July 1986

Dear Sir Francis.

Thank you for sending me the comments by the Advisory Council for Applied Research and Development, on the 1986 Annual Review of Government Funded R & D.

I look forward to discussing some of the issues raised by the Council when we meet on 25 July.

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Yours sincerely

Margaret Thatcher

Sir Francis Tombs.

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ADVISORY COUNCIL FOR APPLIED RESEARCH AND DEVELOPMENT

70 Whitehall, London SW1A 2AS Telephone: 01-233 7140

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

17 July 1986

Dear Prime Minister,

The Advisory Council for Applied Research and Development has considered the 1986 Review of Government Funded R & D and their comments are enclosed.

I welcome the opportunity which I will have this year to discuss these comments with you.

The comments made by ACARD in 1984 and 1985 emphasised the need for the maximum contribution towards wealth creation to be gained from the full range of Government funded R & D programmes ACARD is very pleased to learn that Ministers are giving serious consideration to this matter and that the establishment of the Science and Technology Assessment Office reporting to your Chief Scientific Adviser, will strengthen their ability to assess the economic return to R & D. We hope that this process will lead to a reallocation of expenditure to maximise this return.

ACARD's principal comments on the 1986 Review concern the decline in civil R & D expenditure whilst that for defence continues to rise, (this concern applies particularly to DTI, DOE and DTp as sponsors and customers for industry); the lack of effective cooperation between Departments; the need to increase technology transfer activity and to make better use of the procurement `muscle' of Departments to improve our international competitiveness.

ACARD believes that a modest central fund would enable primary investigations of R & D matters to be undertaken in order to stimulate more cross-departmental work. This is one of the aims of studies undertaken by ACARD and we would hope to underpin these on occasions with more detailed work.

I look forward to discussing these issues and others contained within the attached comments with you when we meet on 25 July.

Yours sincerely

Francis Tombs

SIR FRANCIS TOMBS

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COMMENTS ON THE 1986 ANNUAL REVIEW OF GOVERNMENT FUNDED R&D BY THE ADVISORY COUNCIL FOR APPLIED RESEARCH AND DEVELOPMENT

Introduction

In our comments on the 1986 Annual Review, Section 1 considers issues arising from our 1984 and 1985 Comments; in Section 2 we look at some expenditure patterns revealed by the statistics; we then consider some issues affecting the effectiveness of that expenditure; in Section 4 we comment on environment, construction, and transport R&D, with shorter comments on energy and defence R&D; Section 5 is a brief comment on how the Annual Review itself could be improved. Our conclusions are summarised at the end.

1 Issues arising from Comments on earlier Annual Reviews

1.1 This is the fourth successive year in which the Annual Review of Government funded R&D has been produced and ACARD has submitted its Comments to Government.

1.2 We are glad to be told that Government has now set up Ministerial and official machinery to assess R&D priorities across Government, and that the wealth creation potential of programmes is to be taken into account in this.

1.3 **We look forward to receiving evidence to show that these initiatives are achieving R&D programmes with an enhanced capability of contributing to our economic wealth.**

1.4 **We continue to be concerned that initiation and control mechanisms for large programmes of interest to more than one Department are inadequate - both in organisation and in funding.** (Exceptions are the Alvey programme and the British National Space Centre). **We recommend that a central fund of £250,000 per annum be established for enabling and primary investigations on R&D matters of wide interest.**

1.5 In our Comments on the 1985 Annual Review we questioned the statement in Cmnd 8591 `that the R&D expenditure as a proportion of GDP is sufficient'. We have not received any evidence that Government has considered whether its contribution to total UK civil R&D is adequate. We welcome Government intentions to encourage private sector R&D and we will be offering advice separately on this. We would urge Government to consider whether the potential contribution of civil R&D to the economy justifies giving it a higher priority in competing claims for public expenditure.

1.6 We welcome recent moves to improve spin-off and diffusion of technology from defence research. It is too early to judge the success of these initiatives but we question whether the scale of the effort is yet significant. We are told that the contribution from the export of defence technology is in excess of some £2 billion per annum and we recognise the contribution made by defence R&D to this. But technologies developed for defence must also be applied in the civil sector if the investment is to bring the fullest returns.

The 1986 Annual Review

2 Distribution and Trends in Expenditure

2.1 Table A.2 shows that the total Government R&D expenditure will decrease in 1988/89 by 2.9% from 1984/85. In this period, expenditure on defence R&D increases by 2.9%, for total civil R&D it decreases by 8.8% and for civil Departments there is a sharp decline of 17.3%. Expenditure by DTI declines over this period by 38%: from £346.7m to £215.5m, although the latter figure does not include any provision for new launch aid allocations. We are most concerned that Government expenditure on civil R&D is declining whilst that for defence continues to rise. The decline in civil R&D investment is contrary to our recommendations in previous years, and places the UK at a disadvantage in relation to our industrial competitors; we urge Government to take steps to ensure that the decline is halted and reversed. This applies

particularly to those Departments with a sponsoring role for industry or who are its major customers such as DTI, DOE and DTp.

3. Effectiveness of Government R&D Expenditure

3.1 We made brief comment last year on the evaluation of R&D programmes and on technology transfer. These topics are of central importance and this year we have looked in some depth at the methods being employed by Departments. Government R&D programmes are disparate and have a wide range of underlying aims. With such a wide range of aims it is impossible to formulate simple criteria against which the effectiveness of all R&D programmes can be assessed. Nevertheless, to ensure that limited Government funds are used to best effect, difficult choices will have to be made between competing programmes. Evaluation procedures for R&D programmes must play a necessary part in making these choices; and there must be mechanisms for wider exploitation of technologies developed as a result of publicly sponsored R&D. Evaluation must seek to be objective, results oriented, and to have common aims; among these must be an assessment of technology transfer possibilities.

R&D Evaluation

3.2 **The evaluation of R&D programmes is complex, difficult and costly, but its application will lead to great benefits: clearer definitions of the objectives and timescales of programmes, better progress control, closer risk and success assessment; and not least, better information to guide choices between contending programmes.**

3.3 Effective evaluation must have several constituent stages:

(a) The pre-project or `ex-ante' stage: when the project's objectives are set and the risk/benefit trade-off is assessed. Also to set timetables against which progress and achievement is to be judged.

(b) The continuous evaluation stage: to monitor progress against the objectives and time tables as set. Early recognition of project failure is an important aim here; as is a recognition of possible unexpected benefits.

(c) The final or `ex-post' evaluation to establish whether the programme objectives have been met; and to assess scientific technical, and economic achievements of the programme, including technology transfer.

3.4 Methods of evaluation currently used by Departments vary widely. Most Departments are using methods which are applied only retrospectively rather than combining ex-post with continuous evaluation. Many of the techniques in use are applied in an ad hoc and unco-ordinated way, and do not constitute a complete process of evaluation. For many Departments it is unclear where the responsibility for setting the procedures and conducting the evaluation lies.

3.5 **Where programmes involve co-operation between Departments, mechanisms must exist to ensure that objectives are clearly agreed so that effective evaluation can be made by the contributing Departments. We see little evidence of these mechanisms.**

3.6. **Departments and Government as a whole must use evaluation as part of the process of setting priorities for UK research. We recommend that Departments should give more attention to their evaluation procedures and ensure that they are applied.** Otherwise, Government R&D cannot be managed to best effect.

Technology transfer

3.7 **Technology transfer is of crucial importance in obtaining maximum benefit from R&D expenditure. All Departments should recognise this, and project formulations should always indicate who is intended to benefit from the work**

and how the results are to be transferred. DTI already reports some progress in this regard.

3.8 The interpretation by Departments of what constitutes technology transfer appears rather narrow and variable. Effective technology transfer will differ between programmes and Departments but it should encompass the following aspects:

(i) Communication and the promotion of the use of research results and new technologies both within Government and to industry, including groups who may need stimulation to see the relevance of results to their own field.

(ii) The examination of results to determine whether they have a potential in other application fields.

(iii) The interchange and transfer of people between Departments, and between Departments and industry. The benefits of this are twofold: staff movement is an effective means of transferring knowledge and it encourages researchers to involve themselves in the exploitation of their work.

(iv) The use of external organisations (such as the British Technology Group(BTG)) specialising in technology transfer.

(v) The monitoring of international R&D work so that technologies developed elsewhere may be recognised and transferred to the UK; and that opportunities for the sale of UK technology can be identified.

(vi) Machinery to assess the financial returns from Departments' technology transfer activities.

3.9 **Departments should require both internal and external applications for R&D funding to make a reference to the technology transfer potential of the**

work. Government must give emphasis to technology transfer into manufacturing, to stimulate advanced production methods which will raise the `added value' of products, and will lead to enhanced international competitiveness.

3.10 It should be considered how Departments that achieve effective technology transfer might benefit from their success by being credited with income arising from their R&D work.

3.11 **Technology transfer must become a major issue for Government R&D. We recommend that responsibility for technology transfer should be assigned to a senior member of each Department.**

4 Comments on Specific Sectors

4.1 We have selected environmental, construction and transport R&D for comment this year because **the management of the natural environment and an effective transport infrastructure have a wide economic importance and a direct impact on wealth creation, and because the level of R&D spending in these sectors by Government is fragmented and low compared with eg MAFF, DEn/AEA.**

4.2 The major proportion of Government R&D on environmental matters is through DOE and NERC, but several other bodies (eg HSC, MRC, MAFF) are sponsoring research which they classify as environmental. DOE and DTp are the principal bodies sponsoring R&D for the built environment.

Environment

4.3 The effects of agriculture, industry, transport, building and leisure activities on the environment are matters of wide importance and public concern. For many environmental problems the data are weak, and this makes it difficult to provide quantified arguments on risks and benefits. As a result decisions are often taken without enough facts. A central objective of environmental R&D must therefore be to generate adequate and robust data in advance of policy decisions. Departments (and DOE in particular) should ensure

that their R&D anticipates needs rather than only reacting to them, and that research on topics at the boundaries between Departments is not overlooked.

4.4 The control of environmental hazards can be extremely expensive. If environmental research can establish that the threat from a hazard is in fact limited or non-existent, the resulting financial saving may be considerable.

4.5 Many Departments are sponsoring R&D with an environmental component. But we have difficulty in discerning any direction of Government thinking on environmental matters, as the Departments concerned report their environmental research activities so differently. We perceive a lack of inter-Departmental co-ordination on environmental R&D. Where Departmental programmes have common aims it is wrong for them to be formulated and carried out in isolation.

4.6 There is moreover considerable overlap in Departmental activity and in their R&D. For example MAFF undertakes R&D to prevent flooding and waterlogging of urban and agricultural land and to maintain sea defences; whereas DOE's programmes are in support of the freshwater environment, the Water Authorities, and the rural environment. Nuclear waste management and acid deposition also involve many Departments, corporations and sections of industry and appear insufficiently co-ordinated.

4.7 **We question whether there is an adequate policy for R&D on environmental matters involving several Departments. We consider that the direction and effectiveness of such projects could be improved by setting up `national programmes' with well defined objectives.** Nuclear waste management research would seem a possible example.

Construction

4.8 The construction industry, broadly comprising building and civil engineering (including materials and components), contributes some 10% of GDP,

with R&D at only 0.7%* of construction turnover. In terms of international comparisons, UK Government support for construction R&D lags behind France, Germany and the US but is probably ahead of Japan. DOE's total support is only about £16.5m per year (which also covers relevant work on radioactive waste, housing and water supply). Much of the construction research in DTp (£9m) also makes an indirect contribution to the industry. About £1.5m goes to the industry from the DTI under the SFI scheme. Private sector R&D (£80m per year) is mainly carried out by individual manufacturing firms.

4.9 The DOE is the sponsoring Department for the construction industry, and is also through the PSA, a substantial customer. The policy which guides DOE R&D on construction is:

i. to do mainly what is needed for Government's own purposes.

ii. to leave it to the construction industry itself to do the research necesssary to maintain competitiveness, preferably in partnership arrangements.

iii. not to do what is the responsibility of local authorities

iv. not to do basic environmental research, which is left to SERC, NERC, ESRC etc

4.10 **DOE emphasis is therefore not to do research that other bodies `ought to do'. We believe this is inadequate. As the sponsoring body for the construction industry the Department should either perform or sponsor wealth creating research not adequately initiated by others.**

*Figures taken from the National Economic Development Office (NEDO) report: `Strategy for Construction R&D'

4.11 The conclusions of the NEDO report `Strategy for Construction R&D' taken together with the information in the Annual Review appear to show that DOE has not assigned enough priority and resources to construction R&D to help the industry to maintain its international competitiveness. **We consider that more resources should be allocated by DOE to encourage construction R&D, and the diffusion of technologies throughout the industry.**

4.12 The NEDO report recommends that a Construction Research Board should be established to co-ordinate private and public R&D. We agree with this, and we feel that DTp should be involved in this Board.

4.13 A theme of the recent ACARD study on the UK medical equipment industry is that public sector procurement practices do not encourage the production of advanced internationally competitive equipment. This applies equally to the construction industries. **As DOE (through the PSA) and other Government Departments are major customers of the construction industries, public purchasing policies should be modified to ensure more stimulus for technological advances which would enhance the international competitiveness of these industries.**

Transport

4.14 Both DTp and DTI support transport R&D. DTI sponsors R&D for the vehicle supply industry at about £12.0m per annum, maritime technology and shipbuilding £5.0m p.a and predominantly aerospace at £183.0m p.a. DTp expenditure in 1985/6 on R&D was: support for procurement £8.7m, support for statutory duties £7.9m and support of policy £8.2m, R&D for improvement of technology has been phased out in 1985/86 and DTp expenditure under this heading is now zero.

4.15 DTp's research programme is thus mainly oriented towards policy support, the framing of standards and the maintenance of technical efficiency.

4.16 **As the largest customer for civil engineering (notably highways and bridges) we would expect the Department to be particulary concerned with the health of these industries, for which the NEDO report cited earlier expressed concern. We consider that DTp as a major public customer should take a wider view of its responsibilities, and its R&D programmes should incude more - not less - direct support for the transport industries, to make them more competitive.**

4.17 The main contractor for road transport research is the Transport and Road Research Laboratory (TRRL), which spends about half of DTp's total R&D funds internally. This laboratory mainly supports the Department's policy responsibilities. This may be too narrow for the health of the industry which provides the transport infrastructure. It is regrettable that there has been no recent annual report issued by TRRL (its last report was published in 1979).

4.18 Although some transport related industries undertake high levels of R&D (e.g. aerospace) others appear to be niggardly e.g. R&D spending by British Rail (BR) and London Regional Transport (LRT) is woefully inadequate. Up to recently, this was jointly funded between BR/LRT and DTp, but these arrangements were terminated in 1985-86, with the R&D grant being merged into the total grant they get from the Department. This leaves BR and LRT to decide on their own allocations betweeen R&D and other forms of investment and expenditure. Such a change in the arrangements could seriously affect the level of R&D which is already low.

4.19 We also note that the R&D spend of British Shipbuilders has fallen over the last year to £2.7m which at 1.14% of turnover seems completely insufficient to maintain the industry.

4.20 Efficient transport systems are crucial to the effectiveness of all industries. The multiplicity of Government bodies and nationalised industries involved with transport research makes a co-ordinated policy almost impossible.

We consider that the case for a Transport Research Co-ordination Board (analogous to the Construction Research Board proposed by NEDO), should be explored.

Energy

4.21 The Advisory Council in Applied R&D for Fuel and Power (ACORD) is now considering a major appraisal of all the energy technologies that might be deployed in the UK. We believe that this would provide a useful foundation for the Council to examine energy R&D in its Comments on the 1987 Annual Review, and we therefore make only limited comment this year.

4.22 In 1985/86, UKAEA spent close on £380m on nuclear energy research, although half of this was recovered from "receipts" which the Annual Review does not break down by source or sector. Of the nett reported expenditure, £18m was for thermal reactors, £96m for the fast reactor.

4.23 **It is important for the UK to retain nuclear energy expertise, but we believe that the scale of expenditure on the reactor programmes is too high especially when contrasted with that of DTI which sponsors R&D for the whole of UK industry.**

4.24 Given the scale of expenditure on energy R&D, there should be high potential for technology transfer which can assist developments in industries not directly concerned with power generation. This should be given an adequate priority by all those benefiting from these funds.

Defence

4.25 In view of the importance of defence R&D within the total we consider it appropriate to return to this topic next year. We therefore make only limited comment this year.

4.26 **The impact of defence R&D on UK industry is considerable, yet it has often been difficult for technologies developed primarily for defence purposes to be transferred to benefit civil applications. Methods should be explored for incorporating the interest of the civil sector into suitable defence R&D programmes sufficiently early to facilitate the transfer of technologies.**

4.27 When equipment is bought at fixed-price terms, there is a fraction of the price paid, whether from UK or overseas sources, which must be attributed to R&D. For high technology equipment this fraction may be considerable. The figures given in the Annual Review may therefore underestimate the total expenditure on defence R&D. **We consider that the purchase of 'off-the-shelf' equipment from overseas will inevitably enhance the R&D capability of our international competitors and this applies not only to defence.**

5. Improvements to the Annual Review

5.1 The lack of detail in the Annual Review makes it difficult to provide an opinion on particular aspects of Departmental programmes. We shall consider whether in future years Departments should provide us with more programme background to aid in preparing these Comments.

5.2 It seems to us that in some Departmental submissions the text and tables in part II are inadequately correlated. The text often fails to refer to the levels of current expenditure, the trends or advance reasons for them. **We consider that the value of the Annual Review (both to ACARD and to Government) would be enhanced if Departments were to ensure full correlation between their text and tables.**

6. Principal Conclusions and Recommendations

6.1 We continue to be concerned that initiation and control mechanisms for large projects of interest to more than one Department are inadequate - both in organisation and in funding. We recommend that a central fund of £250,000 per annum be established for enabling and primary investigations on R&D matters of wide interest. (1.4)

6.2 Where programmes involve co-operation between Departments, mechanisms must exist to ensure that objectives are clearly agreed so that effective evaluation can be made by the contributing Departments. We see little evidence of these mechanisms. This applies particularly to environmental R&D. (3.5) (4.7)

6.3 We are most concerned that Government expenditure on civil R&D is declining whilst that for defence continues to rise. The decline in civil R&D investment is contrary to our recommendations in previous years and places the UK at a disadvantage in relation to our industrial competitors; we urge Government to take steps to ensure that the decline is halted and reversed. This applies particularly to those Departments with a sponsoring role for industry or who are its major customers such as DTI, DOE and DTp. (2.1)

6.4 Departments and Government as a whole must use evaluation as part of the process of setting priorities for UK research. We recommend that Departments should give more attention to their evaluation procedures and ensure that they are applied. (3.6)

6.5 Government must give emphasis to technology transfer into manufacturing, to simulate advanced production methods which will raise the `added value' of products; public purchasing policies should be modified to ensure more stimulus for technological advances. These actions will lead to enhanced international competitiveness. (3.9) (4.13)

IND PUL – Support + Innovation – Pt 2

TPH

6.6 The management of the natural environment and an effective transport infrastructure have a wide economic importance and a direct impact on wealth creation, but the level of R&D spending in these sectors by Government is fragmented and low compared with eg MAFF, DEn/AEA. (4.1)

6.7 As the sponsoring body for the construction industry the Department of the Environment should either perform or sponsor wealth creating research not adequately initiated by others. (4.10)

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6.10 Methods should be explored for incorporating the interest of the civil sector into suitable defence R&D programmes sufficiently early to facilitate the transfer of technologies. Technologies developed for defence must also be applied in the civil sector if the investment is to bring the fullest returns. (4.26 and 1.6)

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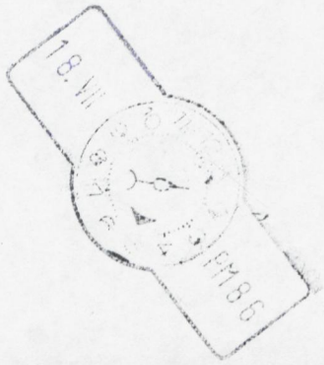

Prime Minister
MEA 14/7

From: Geoffrey Pattie, M.P.

House of Commons,
LONDON, SW1A 0AA.

CF

17th July 1986

Dear Prime Minister,

Some Good News!

1. The 'Pull through' programme is making satisfactory progress through ~~E~~ (RD) & if all continues to go well we could be in a position to invite you to take the lead in announcing this major initiative for industry & the scientific community. The programme is not only very necessary it is politically highly desirable.

2. It appears that after an intense & sustained campaign we have persuaded the Commission to reduce their bid for the R&D Framework Programme from 16 BECU to 7.7. This is still too high & we'll get it down but I thought you would like to know how this was going.

3. Eureka. It was very kind of you to open the Conference. We got a very good press throughout Europe for a job very well carried through.

Yours ever

John

Qn 0368

MR MARK ADDISON
10 Downing Street

9 July 1986

cc Dr Burdett
Mr Jones

Sir Francis Tombs, the Chairman of the Advisory Council for Applied Research and Development will shortly be sending to the Prime Minister a copy of the the Council's comments on the 1986 Annual Review of Government Funded R & D. We are delaying his letter until the Annual Review itself can be sent to the Prime Minister and this will not be before 17 July. I suggest that a brief letter to Sir Francis along the lines of the attached draft is all that is required in reply at this stage.

For your information and reference, a draft copy of these coments is enclosed. It is not anticipated that the final comments will differ from this draft.

Mr Fairclough will be forwarding, in due course, a summary of the main points in the Review and a short background brief to cover the points Sir Francis will raise when he meets with the Prime Minister on 25 July.

CATHY CUNNINGHAM

Enc.

DRAFT

COMMENTS ON THE 1986 ANNUAL REVIEW OF GOVERNMENT FUNDED R&D BY THE ADVISORY COUNCIL FOR APPLIED RESEARCH AND DEVELOPMENT

Introduction

In our comments on the 1986 Annual Review, Section 1 considers issues arising from our 1984 and 1985 Comments; in Section 2 we look at some expenditure patterns revealed by the statistics; we then consider some issues affecting the effectiveness of that expenditure; in Section 4 we comment on environment, construction, and transport R&D, with shorter comments on energy and defence R&D; Section 5 is a brief comment on how the Annual Review itself could be improved. Our conclusions are summarised at the end.

1 Issues arising from Comments on earlier Annual Reviews

1.1 This is the fourth successive year in which the Annual Review of Government funded R&D has been produced and ACARD has submitted its Comments to Government.

1.2 We are glad to be told that Government has now set up Ministerial and official machinery to assess R&D priorities across Government, and that the wealth creation potential of programmes is to be taken into account in this.

1.3 **We look forward to receiving evidence to show that these initiatives are achieving R&D programmes with an enhanced capability of contributing to our economic wealth.**

1.4 **We continue to be concerned that initiation and control mechanisms for large programmes of interest to more than one Department are inadequate - both in organisation and in funding.** (Exceptions are the Alvey programme and the British National Space Centre). **We recommend that a central fund of £250,000 per annum be established for enabling and primary investigations on R&D matters of wide interest.**

1.5 In our Comments on the 1985 Annual Review we questioned the statement in Cmnd 8591 "that the R&D expenditure as a proportion of GDP is sufficient". We have not received any evidence that Government has considered whether its contribution to total UK civil R&D is adequate. We welcome Government intentions to encourage private sector R&D and we will be offering advice separately on this. We would urge Government to consider whether the potential contribution of civil R&D to the economy justifies giving it a higher priority in competing claims for public expenditure.

1.6 We welcome recent moves to improve spin-off and diffusion of technology from defence research. It is too early to judge the success of these initiatives but we question whether the scale of the effort is yet significant. We are told that the contribution from the export of defence technology is in excess of some £2 billion per annum and we recognise the contribution made by defence R&D to this. **But technologies developed for defence must also be applied in the civil sector if the investment is to bring the fullest returns.**

The 1986 Annual Review

2 Distribution and Trends in Expenditure

2.1 Table A.2 shows that the total Government R&D expenditure will decrease in 1988/89 by 2.9% from 1984/85. In this period, expenditure on defence R&D increases by 2.9%, for total civil R&D it decreases by 8.8% and for civil Departments there is a sharp decline of 17.3%. Expenditure by DTI declines over this period by 38%: from £346.7m to £215.5m, although the latter figure does not include any provision for new launch aid allocations. **We are most concerned that Government expenditure on civil R&D is declining whilst that for defence continues to rise. The decline in civil R&D investment is contrary to our recommendations in previous years, and places the UK at a disadvantage in relation to our industrial competitors; we urge Government to take steps to ensure that the decline is halted and reversed.** This applies particularly to those Departments with a sponsoring role for industry or who are its major customers such as DTI, DOE and DTp.

3. Effectiveness of Government R&D Expenditure

3.1 We made brief comment last year on the evaluation of R&D programmes and on technology transfer. These topics are of central importance and this year we have looked in some depth at the methods being employed by Departments. Government R&D programmes are disparate and have a wide range of underlying aims. With such a wide range of aims it is impossible to formulate simple criteria against which the effectiveness of all R&D programmes can be assessed. Nevertheless, to ensure that limited Government funds are used to best effect, difficult choices will have to be made between competing programmes. Evaluation procedures for R&D programmes must play a necessary part in making these choices; and there must be mechanisms for wider exploitation of technologies developed as a result of publicly sponsored R&D. Evaluation must seek to be objective, results oriented, and to have common aims; among these must be an assessment of technology transfer possibilities.

R&D Evaluation

3.2 **The evaluation of R&D programmes is complex, difficult and costly, but its application will lead to great benefits: clearer definitions of the objectives and timescales of programmes, better progress control, closer risk and success assessment; and not least, better information to guide choices between contending programmes.**

3.3 Effective evaluation must have several constituent stages:

(a) The pre-project or "ex-ante" stage: when the project's objectives are set and the risk/benefit trade-off is assessed. Also to set timetables against which progress and achievement is to be judged.

(b) The continuous evaluation stage: to monitor progress against the objectives and time tables as set. Early recognition of project failure is an important aim here; as is a recognition of possible unexpected benefits.

(c) The final or "ex-post" evaluation to establish whether the programme objectives have been met; and to assess scientific technical, and economic achievements of the programme, including technology transfer.

3.4 Methods of evaluation currently used by Departments vary widely. Most Departments are using methods which are applied only retrospectively rather than combining ex-post with continuous evaluation. Many of the techniques in use are applied in an ad hoc and unco-ordinated way, and do not constitute a complete process of evaluation. For many Departments it is unclear where the responsibility for setting the procedures and conducting the evaluation lies.

3.5 **Where programmes involve co-operation between Departments, mechanisms must exist to ensure that objectives are clearly agreed so that effective evaluation can be made by the contributing Departments. We see little evidence of these mechanisms.**

3.6. **Departments and Government as a whole must use evaluation as part of the process of setting priorities for UK research. We recommend that Departments should give more attention to their evaluation procedures and ensure that they are applied.** Otherwise, Government R&D cannot be managed to best effect.

Technology transfer

3.7 **Technology transfer is of crucial importance in obtaining maximum benefit from R&D expenditure. All Departments should recognise this, and project formulations should always indicate who is intended to benefit from the work and how the results are to be transferred.** DTI already reports some progress in this regard.

3.8 The interpretation by Departments of what constitutes technology transfer appears rather narrow and variable. Effective technology transfer will differ between programmes and Departments but it should encompass the following aspects:

(i) Communication and the promotion of the use of research results and new technologies both within Government and to industry, including groups who may need stimulation to see the relevance of results to their own field.

(ii) The examination of results to determine whether they have a potential in other application fields.

(iii) The interchange and transfer of people between Departments, and between Departments and industry. The benefits of this are twofold: staff movement is an effective means of transferring knowledge and it encourages researchers to involve themselves in the exploitation of their work.

(iv) The use of external organisations (such as BTG) specialising in technology transfer.

(v) The monitoring of international R&D work so that technologies developed elsewhere may be recognised and transferred to the UK; and that opportunities for the sale of UK technology can be identified.

(vi) Machinery to assess the financial returns from Departments' technology transfer activities.

3.9 **Departments should require both internal and external applications for R&D funding to make a reference to the technology transfer potential of the work. Government must give emphasis to technology transfer into manufacturing, to stimulate advanced production methods which will raise the `added value' of products, and will lead to enhanced international competitiveness.**

3.10 It should be considered how Departments that achieve effective technology transfer might benefit from their success by being credited with income arising from their R&D work.

3.11 **Technology transfer must become a major issue for Government R&D. We recommend that responsibility for technology transfer should be assigned to a senior member of each Department.**

4 Comments on Specific Sectors

4.1 We have selected environmental, construction and transport R&D for comment this year because **the management of the natural environment and an effective transport infrastructure have a wide economic importance and a direct impact on wealth creation, and because the level of R&D spending in these sectors by Government is fragmented and low compared with eg MAFF, DEn/AEA.**

4.2 The major proportion of Government R&D on environmental matters is through DOE and NERC, but several other bodies (eg HSC, MRC, MAFF) are sponsoring research which they classify as environmental. DOE and DTp are the principal bodies sponsoring R&D for the built environment.

Environment

4.3 The effects of agriculture, industry, transport, building and leisure activities on the environment are matters of wide importance and public concern. For many environmental problems the data are weak, and this makes it difficult to provide quantified arguments on risks and benefits. As a result decisions are often taken without enough facts. A central objective of environmental R&D must therefore be to generate adequate and robust data in advance of policy decisions. Departments (and DOE in particular) should ensure that their R&D anticipates needs rather than only reacting to them, and that research on topics at the boundaries between Departments is not overlooked.

4.4 The control of environmental hazards can be extremely expensive. If environmental research can establish that the threat from a hazard is in fact limited or non-existent, the resulting financial saving may be considerable.

4.5 Many Departments are sponsoring R&D with an environmental component. But we have difficulty in discerning any direction of Government thinking on environmental matters, as the Departments concerned report their environmental research activities so differently. We perceive a lack of inter-Departmental co-ordination on environmental R&D. Where Departmental programmes have common aims it is wrong for them to be formulated and carried out in isolation.

4.6 There is moreover considerable overlap in Departmental activity and in their R&D. For example MAFF undertakes R&D to prevent flooding and waterlogging of urban and agricultural land and to maintain sea defences; whereas DOE's programmes are in support of the freshwater environment, the Water Authorities, and the rural environment. Nuclear waste management and acid deposition also involve many Departments, corporations and sections of industry and appear insufficiently co-ordinated.

4.7 **We question whether there is an adequate policy for R&D on environmental matters involving several Departments. We consider that the direction and effectiveness of such projects could be improved by setting up "national programmes" with well defined objectives.** Nuclear waste management research would seem a possible example.

Construction

4.8 The construction industry, broadly comprising building and civil engineering (including materials and components), contributes some 10% of GDP, with R&D at only 0.7%* of construction turnover. In terms of international comparisons, UK Government support for construction R&D lags behind France, Germany and the US but is probably ahead of Japan. DOE's total support is only about £16.5m per year (which also covers relevant work on radioactive waste, housing and water supply). Much of the construction research in DTp (£9m) also makes an indirect contribution to the industry. About £1.5m goes to the industry from the DTI under the SFI scheme. Private sector R&D (£80m per year) is mainly carried out by individual manufacturing firms.

4.9 The DOE is the sponsoring Department for the construction industry, and is also through the PSA, a substantial customer. The policy which guides DOE R&D on construction is:

i. to do mainly what is needed for Government's own purposes.

ii. to leave it to the construction industry itself to do the research necesssary to maintain competitiveness, preferably in partnership arrangements.

iii. not to do what is the responsibility of local authorities

iv. not to do basic environmental research, which is left to SERC, NERC, ESRC etc

*Figures taken from the National Economic Development Office (NEDO) report: `Strategy for Construction R&D'

4.10 **DOE emphasis is therefore not to do research that other bodies "ought to do". We believe this is inadequate. As the sponsoring body for the construction industry the Department should either perform or sponsor wealth creating research not adequately initiated by others.**

4.11 The conclusions of the NEDO report `Strategy for Construction R&D' taken together with the information in the Annual Review appear to show that DOE has not assigned enough priority and resources to construction R&D to help the industry to maintain its international competitiveness. **We consider that more resources should be allocated by DOE to encourage construction R&D, and the diffusion of technologies throughout the industry.**

4.12 The NEDO report recommends that a Construction Research Board should be established to co-ordinate private and public R&D. We agree with this, and we feel that DTp should be involved in this Board.

4.13 A theme of the recent ACARD study on the UK medical equipment industry is that public sector procurement practices do not encourage the production of advanced internationally competitive equipment. This applies equally to the construction industries. **As DOE (through the PSA) and other Government Departments are major customers of the construction industries, public purchasing policies should be modified to ensure more stimulus for technological advances which would enhance the international competitiveness of these industries.**

Transport

4.14 Both DTp and DTI support transport R&D. DTI sponsors R&D for the vehicle supply industry at about £12.0m per annum, maritime technology and shipbuilding £5.0m p.a and predominantly aerospace at £183.0m p.a. DTp expenditure in 1985/6 on R&D was: support for procurement £8.7m, support for statutory duties £7.9m and support of policy £8.2m, R&D for improvement of technology has been phased out in 1985/86 and DTp expenditure under this heading is now zero.

4.15 DTp's research programme is thus mainly oriented towards policy support, the framing of standards and the maintenance of technical efficiency.

4.16 **As the largest customer for civil engineering (notably highways and bridges) we would expect the Department to be particulary concerned with the health of these industries, for which the NEDO report cited earlier expressed concern. We consider that DTp as a major public customer should take a wider view of its responsibilities, and its R&D programmes should incude more - not less - direct support for the transport industries, to make them more competitive.**

4.17 The main contractor for road transport research is the Transport and Road Research Laboratory (TRRL), which spends about half of DTp's total R&D funds internally. This laboratory mainly supports the Department's policy responsibilities. This may be too narrow for the health of the industry which provides the transport infrastructure. It is regrettable that there has been no recent annual report issued by TRRL (its last report was published in 1979).

4.18 Although some transport related industries undertake high levels of R&D (e.g. aerospace) others appear to be niggardly e.g. R&D spending by British Rail (BR) and London Regional Transport (LRT) is woefully inadequate. Up to recently, this was jointly funded between BR/LRT and DTp, but these arrangements were terminated in 1985-86, with the R&D grant being merged into the total grant they get from the Department. This leaves BR and LRT to decide on their own allocations betweeen R&D and other forms of investment and expenditure. Such a change in the arrangements could seriously affect the level of R&D which is already low.

4.19 We also note that the R&D spend of British Shipbuilders has fallen over the last year to £2.7m which at 1.14% of turnover seems completely insufficient to maintain the industry.

4.20 Efficient transport systems are crucial to the effectiveness of all industries. The multiplicity of Government bodies and nationalised industries involved with transport research makes a co-ordinated policy almost impossible. **We consider that the case for a Transport Research Co-ordination Board (analogous to the Construction Research Board proposed by NEDO), should be explored.**

Energy

4.21 The Advisory Council in Applied R&D for Fuel and Power (ACORD) is now considering a major appraisal of all the energy technologies that might be deployed in the UK. We believe that this would provide a useful foundation for the Council to examine energy R&D in its Comments on the 1987 Annual Review, and we therefore make only limited comment this year.

4.22 In 1985/86, UKAEA spent close on £380m on nuclear energy research, although half of this was recovered from "receipts" which the Annual Review does not break down by source or sector. Of the nett reported expenditure, £18m was for thermal reactors, £96m for the fast reactor.

4.23 **It is important for the UK to retain nuclear energy expertise, but we believe that the scale of expenditure on the reactor programmes is too high especially when contrasted with that of DTI which sponsors R&D for the whole of UK industry.**

4.24 Given the scale of expenditure on energy R&D, there should be high potential for technology transfer which can assist developments in industries not directly concerned with power generation. This should be given an adequate priority by all those benefiting from these funds.

Defence

4.25 In view of the importance of defence R&D within the total we consider it appropriate to return to this topic next year. We therefore make only limited comment this year.

4.26 **The impact of defence R&D on UK industry is considerable, yet it has often been difficult for technologies developed primarily for defence purposes to be transferred to benefit civil applications. Methods should be explored for incorporating the interest of the civil sector into suitable defence R&D programmes sufficiently early to facilitate the transfer of technologies.**

4.27 When equipment is bought at fixed-price terms, there is a fraction of the price paid, whether from UK or overseas sources, which must be attributed to R&D. For high technology equipment this fraction may be considerable. The figures given in the Annual Review may therefore underestimate the total expenditure on defence R&D. **We consider that the purchase of "off-the-shelf" equipment from overseas will inevitably enhance the R&D capability of our international competitors and this applies not only to defence.**

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ACARD 6 / 86

Press Notice

ADVISORY COUNCIL FOR APPLIED RESEARCH AND DEVELOPMENT
70 Whitehall London SW1A 2AS

16 JUNE 1986

UK CAN INCREASE ITS COMPETITIVENESS BY USING MORE SOFTWARE, SAYS ACARD REPORT

The UK can increase its competitiveness by using more software says a report "Software - A vital key to UK competitiveness"* published today by the Advisory Council for Applied Research and Development (ACARD).

The report says that world wide, the manufacturing and service industries are increasing their competitiveness by applying software more widely. To apply software effectively, the UK industries require a better understanding of the nature and power of software; this understanding can only be achieved through increased in-service education and training.

The world market for IT products is large and growing rapidly. Major industrial nations are vigorously developing, promoting, and exploiting IT. Software is a key strategic element in the fierce economic competition between such nations.

ACARD's attention was drawn to the possibility that the UK might be failing to develop and apply software sufficiently rapidly and widely in all industries. A related possibility was that the UK was failing to win its expected share of the world market for software.

The report recommends forming an expert body to be called STARTING (Software Technology and Applications Review Team of Industry and Government), to monitor the implementation of the recommendations and their effectiveness in achieving the targets set. STARTING's main function would be to hold an annual, large scale, formal review meeting to consider a performance report of software users, appliers and suppliers.

*HMSO ISBN 0 11 630829 X £6.00

The main recommendations for Industry are:

* In-service training initiative for all users, appliers and suppliers.

* Increased application of software to increase the competitiveness of the manufacturing and service industries.

* Marketing initiative for UK software products and services.

The main recommendation for government is for inter-departmental cooperation on:

* Public purchasing to exercise demand side leadership.

* Technology transfer acceleration.

* Better R&D planning to avoid discontinuities in policy and funding.

* In-service training initiative for government employees.

Welcoming the launch of the report, Sir Francis Tombs, Chairman of ACARD said that he was pleased that the Prime Minister had agreed to publication of the report which ACARD hoped would stimulate public discussion of this key issue and lead to effective action.

Issued on behalf of ACARD by
Information Services, CABINET OFFICE
R57/G
Government Offices
Great George Street
LONDON SW1P 3AL

Tel: 01 233 6147

Notes for Editors

The ACARD Working Group was set up in January 1985 with the following membership:

Mr J Coplin (Chairman)	Director of Design, Rolls Royce Ltd
Miss S Bond	Royal Signals and Radar Establishment, Ministry of Defence
Mr D Collens	Technical Director, Software Sciences Ltd
Mrs J Connell	General Manager, F International Ltd
Prof C A R Hoare	Programming Research Group, Oxford University
Mr G W Holmes	Deputy Chairman, Systems Designers plc
Lt Col P Ost	Procurement Executive, Ministry of Defence
Mr D Robson	Controller, Software Support Services, National Westminster Bank plc
Dr M F Smith	Head of R&D, ISTEL Ltd
Mr J Whalley	Technical Manager, British Aerospace, Manchester
Dr C Whitby-Strevens	Microcomputer Support Manager, Inmos Ltd
Dr R W Witty	Deputy Director (Software Engineering), Alvey Programme

The Working Group's report was considered in February 1986 by ACARD, who endorsed its conclusions and recommendations. It is now published, with the approval of Government, to draw attention to the importance of software, to the concerns arising from the findings and to facilitate wider discussion of the Working Group's Recommendations.

The Advisory Council for Applied Research and Development (ACARD) advises the Government on applied research, design and development and the application of research and technology, together with the co-ordination of these activities with basic research. Its current chairman is Sir Francis Tombs, and the other members of the Council include senior industrialists, chairmen and technical directors of major companies, distinguished academics and other leaders in the field.

The formal terms of reference of the Council are -

"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."

ccBG

DEPARTMENT OF TRANSPORT
2 MARSHAM STREET LONDON SW1P 3EB

01-212 3434

Nicola Parkins Esq
Private Secretary
Secretary of State for Trade and Industry
Department of Trade and Industry
1-19 Victoria Street
LONDON SW1H OET

17 April 1986

Dear Nicola

ACARD Report 'SOFTWARE: A VITAL KEY TO UK COMPETITIVENESS'

Thank you for copying to Richard Allan here your letter to Tim Flesher of 10 April confirming your Secretary of State's willingness to take the lead in co-ordinating the Government's response to this report.

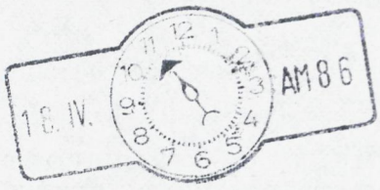
My Secretary of State would be grateful if you could ensure that officials of this Department are consulted on the formulation of the Government's response. We are particularly concerned with the suggestions in Appendix B for Safety Critical Software. If adopted these suggestions would have profound implications for all forms of transport, but particularly for air transport in view of its comparatively high dependence on computer systems for safe operation. It would be sensible for your officials also to consult the CAA directly on this very specialised subject to ensure that their expertise is fully brought to bear.

The contact in this Department will be David Rudd, who can be contacted on 212 7385.

I am copying this letter to Tim Flesher, to the Private Secretaries of other Cabinet Ministers and to Sir Robert Armstrong and the Chief Scientific Adviser, Cabinet Office.

Yours Sincerely
Jan Cunliffe

J CUNLIFFE
Private Secretary



Ind Pol: support +
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WO950

T Burgner Esq
H M TREASURY

15 April 1986

NBPM.

Dear Tom,

OFFICIAL COMMITTEE ON RESEARCH AND DEVELOPMENT

Thank you for your letter of 8 April. Both you and Brian Gilmore made the point strongly at the first meeting of E(RD)(O) that individual proposals could not be considered simply in isolation. My reading of the minutes (page 1, sub-paragraph a.) is that implicit note is taken of this.

I am sure that all present at the meeting understood what you were saying and accepted it to a large extent. I have to say, however, that E(RD), and hence E(RD)(O), have been given a clear set of initial tasks by E(A).

I don't think, however, that there is a real difference in our understanding of the situation. E(RD)(O) clearly must keep an overall view of the various initiatives on which it is advising Ministers; nevertheless, it must not be delayed by an inability to see the whole picture at any particular time.

I am copying this letter to members of E(RD)(O).

Yours ever,

Robin

SIR ROBIN NICHOLSON

Pa Norgrove

CABINET OFFICE

With the compliments of

J. B. UNWIN

70 Whitehall, London SW1A 2AS
Telephone 01 233

P 02003

SECRETARY OF STATE FOR TRADE & INDUSTRY

E(RD)(86)1st Meeting, 17 April 1986

I attach briefs on each of the items for discussion at E(RD) on 17 April.

2. Item 1 - the Work Programme: Your objective should be to avoid a discussion and have this paper noted only. The work programme has been discussed and agreed by E(RD)O and in any case only reflects the remits given to E(RD) by E(A)(86)6th Meeting of 19 February.

3. Item 2 - the Implementation of "Pull-Through": This is a Note produced jointly by the Secretary of State for Education and Science and the Minister of State for Information Technology. The substance of it was generally endorse by E(RD)O. It ought, therefore, to be possible to get E(RD) to agree to the principle of "pull-through", particularly in view of the support given to the idea by the Prime Minister at the E(A) discussion. The Treasury may raise the question of financing, but I recommend you to defer this for consideration under item 3 of the agenda.

4. Item 3 - Financing of "Pull-Through": This is in the form of a note by Sir Robin Nicholson. I fear it will be difficult to get agreement. The Secretary of State for Energy will almost certainly resist raiding his Vote for the remaining funds necessary for "pull-through". The Chief Secretary will be briefed to argue that a decision should be postponed until the relative merits of "pull-through" and other proposals for reallocating R&D resources can be considered in the 1986 PES. This would not meet the wish of E(A) for "immediate action" on these proposals and I suggest that you should press initially for the proposal recommended by Sir Robin Nicholson. If, however, as is likely,

this meets strong resistance, you may consider that your best bet would be to go for agreement on option (iv) of paragraph 9 of E(RD)(86)4 - going ahead with the proposal with a commitment now to find the additional funds necessary in the 1986 PES. If that fails, you will wish to reserve your position, perhaps with a view to reporting to the Prime Minister.

5. In steering the meeting you will wish to remember that time is limited since Cabinet is due to start at 10.30 am.

J B UNWIN

Cabinet Office
15 April 1986

AGENDA ITEM 1

Work Programme
E(RD)(86)2

BACKGROUND

In E(RD)(86)2 you invite members of the Sub-Committee to take note of the work programme of E(RD). As the paper makes clear, the first task of E(RD) were essentially set by the remit issued by E(A)(86)6th Meeting of 19 February. Moreover, E(RD)O has already had a protracted discussion of the work programme and its implications, and the references to the consideration of international (including EC) collaboration have been strengthened in response to the Foreign Secretary's (and your own) comments. There is therefore no reason why E(RD) should not simply take note of the work programme without further ado, and your aim should be to achieve this with the minimum, if any, discussion.

HANDLING

2. I suggest you introduce the note very briefly on the above lines and invite the Sub-Committee formally to take note of it. You will only wish to invite comments in a rhetorical manner. You may, however, wish to remind colleagues that the Prime Minister, in summing up the discussion at E(A)(86)6th Meeting of 19 February, invited the new Ministerial Committee to produce a first report within 3 months. This means that work will need to proceed swiftly and expeditiously, with the full backing of all Departments concerned.

AGENDA ITEM 2

Implementation of "Pull-Through"

E(RD)(86)3

BACKGROUND

In her summing up at E(A)(86)6th Meeting of 19 February, the Prime Minister said that the new Ministerial Committee on R&D "should give urgent consideration to the (then) Chief Scientific Adviser's proposal for a reallocation of resources so that immediate action could be taken to promote a "pull-through" of Government-funded R&D to improve the efficiency, competitiveness and innovative capacity of the United Kingdom economy". The Prime Minister also said the new Committee should aim to produce a first report within 3 months (ie before the end of May).

2. E(RD)(86)3 is a joint Note by the Secretary of State for Education and Science and the Minister of State for Information Technology suggesting how "pull-through" might be implemented. It is very much along the lines of Sir Robin Nicholson's proposals. The substance, though not all the details, of the paper was agreed at E(RD)O; and a separate paper from Sir Robin (E(RD)(86)4) makes proposals as to how the scheme should be financed.

Proposals

3. E(RD)(86)3 proposes that the DTI and the Science and Engineering Research Council (SERC) initiate a "pull-through" programme involving:

(a) an SERC/DTI Joint Programme Board (JPB) (comprising inter alios independent industrial representatives, members or nominees of the SERC Council and DTI Technology Requirements Boards, the Chief Engineer Scientist of DTI, and the Chairman of SERC) to consider proposals for specific programmes (a list of possibilities is at Annex 1 of

E(RD)(86)3) and to set critieria for "pull-through";

(b) public expenditure rising to £100 million pa by 1990 (comprising £25 million each from DTI and SERC with £50 million from other Government R&D expenditure), matched by at least an equivalent private sector investment;

(c) an expert task force of industrialists and academics for each programme to work out detailed research plans and programme management arrangements;

(d) retention of industrial property rights with the companies involved;

(e) evaluation and monitoring of the "pull-through" proposal by the new DTI Assessment Office.

Discussion

4. Except for the question of finance (see paragraph 6 below), the main substance of the proposal in E(A)(86)3 should command general acceptance. What is proposed draws on the experience which DTI and SERC have gained through collaborative R&D programmes such as Alvey and the Joint Opto-electronics Research Scheme (JOERS). It is recognised that the public sector contribution should be no more than is necessary to maintain an adequate programme with increasing industrial funding as projects move towards commercial exploitation; and that the programme should be properly evaluated and monitored. The main purpose of the programme is to address the UK weakness in developing successful industries from its outstanding scientific inventiveness. There would be side benefits in encouraging a greater interchange between industry and academe and helping reduce the current "brain drain".

5. The DTI believe it would be feasible to have some programmes running by 1990-91 with Government expenditure running at £100 million pa. At E(RD)O it was suggested that, in practice, the programme would take time to get underway, and that the maximum level of Government expenditure might be reached later.

Finance

6. This will provoke disagreement and the Treasury's reservation is noted in paragraph 6.4 of the paper. The Treasury do not believe that a firm decision to commit funds like this should be taken before the Public Expenditure Survey (PES). Financing of "pull-through" is however, the subject of Item 3 of the Agenda and I suggest you defer consideration until that item.

HANDLING

7. I suggest you try to secure the agreement of E(RD) to the substance of the "pull-through" programme as set out in E(RD)(86)-3; any detailed points (eg on refinements to the scheme) could be left to be settled between Departments at official level separately. In guiding discussion towards this end, you may wish to quote the Prime Minister's summing up of the discussion at E(A)(86)6th Meeting (paragraph 1 above); and to emphasise that a major virtue of this scheme is that it is simple and could be implemented quickly.

8. You will wish to invite the Secretary of State for Education and Science and the Minister of State for Information Technology to introduce E(RD)(86)3. The Chief Secretary, Treasury may wish to comment on the implications for public expenditure. The Secretary of State for Foreign and Commonwealth Affairs may have views on international aspects. Other Ministers may also wish to contribute to the discussion . Sir Robin Nicholson may also wish to comment in the light of the prior discussion by E(RD)O.

CONCLUSION

9. You will wish the Sub-Committee to decide whether the "pull-through" programme should be implemented along the lines suggested in E(RD)(86)3, subject to a separate decision on the financing.

AGENDA ITEM 3

Financing the Pull-Through Programme

E(RD)(86)4

BACKGROUND

E(RD)(86)4 is a Note by the former Chief Scientific Adviser, Sir Robin Nicholson, architect of the "pull through" proposal, in his capacity as Chairman of the Official Committee on Research and Development (E(RD)O). At its meeting on 26 March, E(RD)O gave general endorsement to the principle of the "pull-through" programme, but failed to agree on its financing. The DTI and the SERC have agreed to cover any expenditure in 1986-87 and to fund 25 per cent of the funds required in subsequent years. This means that the following amounts need to be found from elsewhere:

1987/88	1988/89	1989/90	Thereafter
£12.5m	£25m	£37.5m	£50m

Paragraph 9 of E(RD)(86)4 sets out 4 options for Ministers to consider, including that favoured by Sir Robin.

Proposals

2. The funding options identified in E(RD)(86)4 are:

(i) to provide the necessary funds by reallocation from the Department of Energy's fast reactor programme, by transferring part of the funding responsibility to the Electricity Supply Industry (ESI) as its potential customer (the option favoured by Sir Robin Nicholson);

(ii) to identify one or more other civil R&D programmes from which funds can be transferred;

(iii) to postpone a decision on "pull-through" until the relative merits of this and other proposals for reallocation of R&D resources can be considered in the context of the 1986 Public Expenditure Survey (PES) the option strongly favoured by the Treasury, who believe that no decision should be taken outside PES;

(iv) to go ahead with the proposals but to make a commitment now to find the additional funds necessary in the course of the Survey.

DISCUSSION

3. E(A)(86)6th Meeting on 19 February invited the new Ministerial Committee on R&D to "give urgent consideration to the Chief Scientific Adviers's proposal ... so that immediate action could be taken to generate a "pull-through" of Government-funded R&D to improve the efficiency, competitiveness and innovative capacity of the UK economy." There is therefore a strong presumption that decisions should be taken now.

4. Option (i) - to finance "pull-through" by raiding the fast reactor programme will be strenuously resisted by the Secretary of State for Energy, for the reasons in paragraph 7 of E(A)(86)4. The Department of Energy argue that, in the light of the decision at E(A)(86)6th Meeting that the total volume of resources devoted to defence R&D should be reduced, there is scope for increasing the total resources devoted to Civil R&D. Moreover, they see difficulties in reopening the arrangements recently reached with the CEGB for sharing nuclear R & D costs in the way implied; and point to difficulties this would cause in the international collaboration (France, Germany, Italy and Belgium) in fast reactor R&D on which the UK is engaged (a point which the Foreign and Commonwealth Secretary might make in support of Mr Walker). Mr Walker may also argue that, with the fast reactor now working at a full rate with high efficiency, and the prospect of electricity which can be generated by a fast reactor at a price competitive

with electricity from advanced gas-cooled reactors (AGRs) and from pressurised water ractors (PWRs), it would be unwise to put the fast reactor programme into jeopardy. The Treasury also contend that a transfer of costs to the CEGB of the amounts suggested would need to be matched by an increase in electricity prices of 0.5 per cent above what they would otherwise have been to ensure no net increase in public expenditure. But the Treasury should, in principle, be in favour of the ESI funding fast reactor R&D from which it stands to benefit; and they believe fast reactor R&D is the least cost-effective part of the Department of Energy's nuclear R&D programme.

5. You will need to invite views on these arguments. The objections seem to me to be greatly overstated. There is no proposal for a reduction in fast reactor R&D spending; merely that the ESI should provide the funding as the likely beneficiary of fast reactor R&D. This would be entirely consistent with the MISC 119 report which concluded (Annex 3 of E(A)(86)2):-

> "They (MISC 119) remained concerned that the Government continues to spend large sums in an area where no early direct economic return is expected. The Group noted that increased Central Electricity Generating Board funding had already been agreed for certain aspects of Atomic Energy Authority research, following the recent review of the Authority. They considered that efforts should continue to transfer more of the costs to the electricity generation industry as opportunity offers and to scale down the commitment of Government funds."

6. MISC 119 also concluded more generally that there was a need to "ensure that Government-funded R&D programmes are turned over to the private sector as far as possible to release resources for new needs"; and this proposal, accepting that the CEGB, though publicly owned, is a commercial trading body, is fully in line with this. If the Energy Secretary argues the case for the fast reactor programme on grounds of early economic benefit, this

strengthens the case for partial responsibility being assumed by the prospective user. If, however, the Secretary of State for Energy persists in resisting option (i), the views of MISC 119 notwithstanding, agreement on this option may not be possible at this discussion.

7. Option (ii) - to identify one or more other civil R&D programmes from which funds can be transferred. E(RD)O on 26 March did not identify any appropriate candidates.

8. Option (iii) - postponing a decision until the relative merits of "pull-through" and other proposals for reallocating R&D resources can be considered in the 1986 PES. The Treasury naturally favour this option and it fits in with usual PES orthodoxy. However, I think you have good reason for resisting it in this case. It would prevent the Sub-Committee making any effective progress, which is contrary to the wish of E(A) for early action and hardly in the Treasury's own interest since the prime object of the exercise is to improve the contribution of R&D to the economy. It would also be self deluding to imagine that some magical moment will come when all competing claims on R&D resources can be considered together; some decisions must be taken as they arise, especially if (as proposed here) offsetting savings can be found; and E(RD) is precisely the forum in which it ought to be possible to take this sort of decision.

9. Option (iv) - going ahead with the proposals, with a commitment now to find the additional funds necessary in the 1986 PES. The Treasury will oppose this also, but, if option (i) proves unacceptable to the Energy Secretary, it might be the best fall-back and you may wish to press the Chief Secretary hard to accept this in the spirit of making early progress. It would leave open the source of the offsetting savings. It would not rule out having a further go at the fast reactor programme; and given the agreement at E(A)(86)6th Meeting that the total volume of resources devoted to defence R&D should be reduced , there might in practice be scope in the 1986 PES round to appropriate

some of the savings from reduced defence R&D, though I should not be inclined to press this now. You will, however, wish to guard against any suggestion that the programme should go ahead at half the proposed level, funded only by the DTI and SERC. This would not meet E(A)'s request for urgent action on reallocation of resources; and would do little to change the emphasis of the Government's R&D programme. It is questionable also whether the scale of such a programme would be worthwhile, or whether DTI and/or SERC would in any case be willing to proceed on this basis. A further possible Treasury objection is that SERC will require extra resources from within the science budget, and that this also is a decision to be taken in PES. However, I understand that the Education Secretary has the power to decide on the allocation of resources between Research Councils within his total provision.

Defence R&D

10. The possibility of raiding the defence R&D budget may be raised; the Energy Secretary may offer this in place of his own programme. For the record, E(A)(86)6th Meeting concluded;

> "the total volume of resources devoted to defence R&D ... should be reduced in accordance with the projections in the 1985 Long Term Defence Costings. The implications of this decision, in particular how best the resources released could be exploited to the benefit of the civil economy, would need to be considered by the new Ministerial Committee, but the impact of this recommendation on the total defence budget was a separate question which would need to be settled in the public expenditure context."

Although it may in due course prove possible to reallocate some funds from the defence budget as a result of this (and I assume that the Treasury and the DTI will work towards this in the fullness of time), I think it would be premature to press this now. There is no formal authority for it; and you would risk provoking outright hostility from the Defence Secretary at this

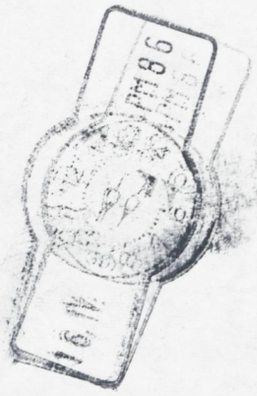
early stage in the Committee's proceedings. So although this must be a possibility for the future, I do not think you would gain any advantage in pressing it now.

HANDLING

11. You will wish to invite Sir Robin Nicholson, as Chairman of the Official Committee on R&D, to introduce his paper, and the Secretary of State for Energy to respond. The Chief Secretary, Treasury will wish to comment on the implications for public expenditure. The Secretary of State for Foreign and Commonwealth Affairs may have comments on international implications, particularly as regards fast reactor collaborative R&D. The Secretary of State for Education and Science and the Minister of State for Information Technology may also have views about the financing of "pull-through"; other Ministers may also wish to comment.

CONCLUSIONS

12. You will wish the Sub-Committee to decide which of the Options (i)-(iv) set out in paragraph 9 of E(RD)(86)4 - or which other option - it favours as a means of financing the "pull--through" programme. If no agreement proves possible, you may wish to say that you will reflect on how to take matters further; one possibility would be an immediate report to the Prime Minister for consideration in E(A) or a smaller group of Ministers.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JU982
Secretary of State for Trade and Industry

10 April 1986

Tim Flesher Esq
Private Secretary to the
Prime Minister
10 Downing Street
London SW1

Dear Tim,

Thank you for your letter of 1 April to John Mogg about the ACARD report 'Software - A vital key to UK competitiveness', pointing out that the Prime Minister has agreed that the report should be published.

As requested, I can confirm that my Secretary of State is willing to take the lead in co-ordinating with Departments the Government response.

I am copying this letter to the recipients of yours.

Nicola Parkins

NICOLA PARKINS
Private Secretary

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From the Minister of State
for Industry and Information Technology

GEOFFREY PATTIE MP

Rt Hon Sir Geoffrey Howe QC MP
Secretary of State
Foreign & Commonwealth Office
Whitehall
LONDON
SW1A 2AL

8 April 1986

Dear Secretary of State,

FRAMEWORK PROGRAMME FOR EUROPEAN COMMUNITY RESEARCH AND DEVELOPMENT

I know that you are well aware that discussion in the Community of proposals for a new Framework Programme for Research and Development will be one of the major issues for the United Kingdom Presidency later this year.

The Commission have already tabled their preliminary ideas and the Research Council will hold a first debate on 8 April. I shall be arguing, in essence, that the Commission's proposed expenditure (10 billion ecu over 5 years) is substantially too high and that any increase should be gradual and concentrated on programmes which will make an effective contribution to Europe's industrial competitiveness. This line was agreed in the Steering Committee on European Questions on 25 March where it was also recommended that I should send the text of the statement I intend to use at the Council meeting to you and to other colleagues with an interest in research and development issues for information. This is now attached.

I am copying this letter to the Chancellor of the Exchequer and to the members of E(RD).

T Bailes

AP2/AP2AAB

p.p. GEOFFREY PATTIE

(Approved by the Minister and signed in his absence.)

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DRAFT SPEECH

AGENDA ITEM 2 : FRAMEWORK PROGRAMME FOR RESEARCH AND DEVELOPMENT

MR PRESIDENT

I welcome this opportunity for an early discussion of the Commission's proposals for a new Framework Programme for research and development. I think we would all recognise that the size, shape and structure of the current Framework Programme are a legacy of the 1970s when energy was our central concern. This is not to disparage it. It has served us well. Of course we have tried through programmes like ESPRIT and BRITE to adapt to changing circumstances - and with some success - but the lineage of the current programme remains all too clear.

This is why I believe that, even though the present programme has another year to run, we must seek agreement now for a new and different approach which will equip the Community to deal with the challenge of the 1980s and the 1990s, which centres on industrial needs and competitiveness.

For us, as research ministers, the heart of the matter lies in the need to develop Europe's research and technology and to harness its scientific potential in order to meet those industrial needs and to ensure that Europe remains competitive in the world economy. The President of the Commission recognised this in a cogent and persuasive speech in Paris on 17 January. M. Delors then argued that the European Community could and should make a positive contribution towards meeting this challenge. I agree with him and I believe that the Framework Programme should be the vehicle to carry forward our ideas. But the decisions we take this year will set our course for the next five years. It is vital therefore that before we start we should be clear about where we are heading and how we plan to get there.

Recent Developments

Fortunately, Mr President, there are a number of signs that Europe is ready to respond to the challenge. The picture is by no means one of doom and gloom.

Within the Community the response to the challenge can be traced, Mr President, to the initiative of your own Prime Minister, Mr Lubbers, at the Dublin European Council in December 1984 when he tabled proposals for a new Technological Community. The Commission subsequently took up these ideas and developed them in a series of papers throughout 1985 which have culminated in the one which is now before us. Over the same period this Council agreed on ten new programmes to give substance and effect to the gradual shift in priorities away from energy and towards more industrially relevant programmes. Finally at Luxembourg in December last year the European Council agreed to incorporate a new chapter on research and technological development in the Treaties of the European Economic Community.

Outside the Community, in the area of basic science, we have seen agreement on the European Synchrotron Radiation Facility, on the Spallation Neutron Source and the opening of new astronomical facilities in the Canary Islands. In space technology we have seen the Ministerial Council of the European Space Agency agree on the construction of Ariane Five and on European participation in the Columbus space station and the emergence of ideas for possible future collaboration like HERMES and HOTOL. We have seen the consolidation of long standing industrial collaborations such as Airbus and the emergence of new ventures such as the Channel Tunnel. And of course we have seen the successful launch of EUREKA which has already generated twenty six new areas of collaboration involving both research institutes and industry.

I believe that all of these developments provide us with valuable pointers to the way in which we should proceed in future. I shall return to some of these later but I should like to concentrate now on the one which is perhaps the most significant for our purposes today, namely the new Treaty Articles on Technology.

Industrial Orientation

Article 130(f) of the Single European Act states explicitly and unambiguously that the Community's aim shall be to strengthen the scientific and technological base of European industry and to encourage it to become more competitive at international level. For the first time the Community's research and development programme has been given a clear objective. Moreover, and perhaps more importantly, the Article goes on to link the research and

development effort with the Community's wider aims and objectives, in particular the establishment of the internal market and the implementation of common policies as regards competition and trade.

For the United Kingdom the achievement of this objective should be the thread which runs throughout the Community's whole research and development proposals. And it should be bolstered by other linkages between research and Community policies, for example in the field of environment or health and safety. In these fields Community research should, in short, underpin Community policy-making. I am glad to say Mr President that I find substantial recognition of this thought in the Commission's proposals. We fully support the emphasis which has been given to programmes designed to promote the competitiveness of European industry. This must be the way forward.

Priorities

Mr President, against the background of those new articles we have attempted to assess the Commission's proposals for the new Framework Programme. I am happy to tell you our conclusions, though I should make it absolutely clear that this is entirely without commitment to either the overall level of resources or the size of individual programmes.

We accept that the seven areas identified are all legitimate ones for Community action. But we find a wide range of priorities across them. It will come as no surprise if I say to you that it is in Area 3 - Competitiveness of Industry and Services - that we believe the heart of the programme should lie. In particular we regard the effort on information technologies and telecommunications technologies, closely followed by technologies for manufacturing industry and materials science and technology as the sectors of highest priority.

Moving outside this sector there is a wide range of other programmes embracing Health, Safety, Environmental Protection, Science and Technology for Development, Stimulation and several of the general support programmes where we believe there is a substantial case for continuing Community action, though not necessarily with quite the same balance of content. The way in which these programmes develop in future must depend on the results the current efforts produce. Our preference will be to build on those programmes which can demonstrate their effectiveness.

There are, however, other sectors,Mr President, where we think there is already a need for reappraisal. Central to this is the management of energy. We recognise that although the commercial exploitation of fusion energy remains a distant objective, we must maintain the current commitment to the Community's JET programme. But as that comes to an end we shall need to think carefully about the volume of resources to be committed to its successor. Meanwhile in the areas of nuclear fission and new and renewable energy sources we believe that these programmes have now made an adequate contribution and that it should be possible to shift resources towards higher priority programmes. The same is true of the raw materials programme.

In a number of other sectors the Commission are proposing new or virtually new programmes or, as in the case of agriculture and fisheries, the implementation of programmes which have been under consideration without decision for a long time. It is clearly difficult to form a view of these proposals without any evidence of past performance. As more details emerge therefore we will want to look closely at the new proposals to identify their relationship to national and other international programmes and to see whether there is a clear Community dimension.

Our very preliminary assessment is that programmes in the areas of agriculture and marine science and technology might be potentially useful though the appropriate level of support would depend on the way in which they are developed. On Researcher's Europe the increase proposed is so large as to change the whole character of the present stimulation programme and we do have reservations. Not because of the desirable objectives but on grounds of priority and the undesirability of a new commitment of this scale before we have had any proper evaluation of current activities. In other areas such as the integration of information and telecommunications into new applications, or transport we believe that they may be better suited to collaborative programmes such as those in COST or EUREKA. In yet other such as space or aeronautics while there is a clear European dimension we do not believe there is a Community one.

JRC

While discussing priorities, Mr President, I cannot avoid mentioning the Joint Research Centre. We shall be dealing with the Centre fully under a later agenda item and so I will just make a brief reference at this stage because I believe it is essential to consider it in the context of the Framework Programme. The Commission paper is not very helpful in this regard and we would welcome greater clarity and precision on the way in which the Centre's work is integrated into the overall programme.

However, a certain amount is already clear. In 1986 expenditure on the JRC will amount to 28% of the total Community expenditure on research and development. At current rates of average expenditure the Community spends more in a year on the JRC than it does on ESPRIT; six times more than it does on BRITE, ten times more than it does on Biotechnology and thirty times more than it plans to spend

on advanced materials. If this is the signal we are giving to Japan and the United States of Europe's determination to compete for technical supremacy then I can only say Mr President that the Chairman of Mitsubishi or Hewlett-Packard must be sleeping peacefully in their beds. This picture must change and not simply by increasing expenditure on other areas. Every mecu spent on the JRC is potentially one less for other programmes which directly address Europe's current needs.

Evaluation

Finally on priorities Mr President, and to end on a less sombre note, there is one further area in the Framework Programme to which I would like to lend wholehearted support. By the standards of ESPRIT and RACE it is tiny but in terms of its significance on the way in which the programme is conducted it could be almost as important. I am referring to evaluation.

The absence of any effective evaluation of current programmes is a major handicap in our work this year, just as it was last year when we came to consider the raw materials and environment programmes. It is something with, regrettably, we must live with in the short term but which we must eliminate as quickly as possible. The only sound basis for developing an effective research and development programme is by a close assessment and evaluation of the extent to which it achieves its objectives. This is in the interests of the Member States who want to be sure they are getting value for money and of the Commission who want to demonstrate that their programmes are achieving results. I would therefore like to add evaluation to the short list of programmes of the highest priority which should have a share of any additional resources which might be available.

Resources

Mr President I think I should now turn to the question of the overall volume of resources which should be devoted to the new Framework Programme.

Successive European Councils have endorsed the concept of devoting a greater proportion of the Community's own resources to research and development. But that has implicitly assumed a transfer of resources from elsewhere in the budget. In current circumstances, I think we must all be realistic about the likelihood of achieving that. For our part we, in this Council, have agreed on the need for a gradual increase in resources spent on R & D. I remain fully committed to that. But I have to say Mr President that I do not believe that the Commission's proposal for expenditure of 10 billion ecu is consistent with the concept of a gradual increase. I believe that a programme of this size is neither necessary nor realistic; we must lower our sights substantially.

The Commission's argument rests in large measure on a comparison of Europe's performance in R & D with that of the US and Japan. This is the part of their paper which I find most questionable. It is easy to become mesmerised by statistics on the research and development expenditure of the United States and Japan. Indeed sometimes I think we are rather like a snake being mesmerised by the mongoose and we all know what happens to the snake. But the picture is more complex than that. The Commission have provided a lot of statistics. But they raise as many questions as they answer about the right level of R and D for any particular economy. They do not, in my view, provide a safe basis for the kind of conclusions that are drawn.

Of course we must be aware of what our competitors are doing and we should not close our eyes to unpalatable facts. But there are substantial differences between the situation in Japan and the USA and both have been successful. The US spends much more on basic science and on defence than Japan; the Japanese effort is much more centrally co-ordinated and directed. What conclusions should we draw? If we follow the American example on R & D we should be going down one road; if we follow the Japanese model we should follow an entirely different one. Where there <u>is</u> a substantial similarity is in the large domestic markets on which both the US and Japan base their industrial effort. This is

indeed something we must emulate through our efforts to establish a genuine European common market.

I cannot accept the implication that the European Community's R & D should be conceived largely as a matching response to US and Japanese efforts. What is right for the Community will depend on levels of national R & D expenditure and the alternative methods of international collaboration. It will be built up from a series of programmes whose Community dimension is thoroughly justified and whose economic effectiveness can be demonstrated. It will involve increases in some areas, but savings in others.

Community Dimension

Mr President, I would now like to return to the lessons to to emerge from the developments of the last eighteen months. One is that successful international collaboration takes place when the participants can identify a clear added value beyond that which would arise from going it alone. International co-operation carries inherently higher costs. If those are to be overcome then it must hold out the prospect of even greater benefits. Whether these arise from economies of scale, access to markets, agreement on standards, greater variety of skill and experience, or simply because the problem is trans-national in character, does not really matter. But the benefit has to be clear and tangible.

This means that the new Framework Programme will need clear and explicit criteria which are truly selective and help to establish priorities within the resources likley to be available. They should be rigorously applied to all proposals for action to ensure that there is a genuine Community dimension. Again I am glad to see the Commission paper recognises the importance of this, but the criteria suggested are framed too broadly to help with selection. When we come to look more closely at the content of the Framework Programme we will then need to consider carefully the precise terms of these criteria and the way in which they are applied.

Flexibility

A second lesson to emerge is the importance of flexibility. Many of the successful new developments, and some of the successful older programmes like COST, have at their heart a degree of variable geometry. Participants are able to opt into those programmes which reflect their interests and opt out of those which do not. The Commission will need to develop new modalities, consistent with the new technology Articles, which will recognise this wish for flexibility and reflect the diversity of interest of the Member States. These should include ideas for avoiding the automatic use of the 50% funding approach for shared cost work, particularly important if scarce resources are to be widely spread. This need is alluded to in the Commission's paper but so far the proposals have been disappointly short of ideas in this direction. I hope we

can see more in future.

Pre competitive Research

The third lesson to emerge is that there are already a wide range of instruments available both in the form of national programmes and international programmes. The Community should not be in the business of seeking alternatives or substitutes for these. Rather it should be identifying opportunities where can make a particular and unique contribution and where it has demonstrable competence. Experience shows this to be in the area of pre-competitive applied research. We need not be doctrinaire about this. But we should be clear about the main area of emphasis.

Cohesion

There is one further consideration, which I have not mentioned, but which is given prominence in the Commission's paper. This concerns the strengthening of the Community's economic and social cohesion. I entirely accept that that is a desirable objective, but it is not one we should explicitly set out to achieve through the research and development programme. In saying this I do not suggest for a moment that all Member States should not have the opportunity to benefit fully from the results of the research and development programme. But there are other parts of the Commission and other parts of the Community budget which have the strengthening of economic and social cohesion as their primary objectives. We should assist them with that task, but not try to do it ourselves.

Conclusion

Mr President, if I may summarise my argument it is as follows. The financial and human resources available to the Community are simply those of its Member States. They can only be used once. The Community should therefore concentrate on a limited range of programmes of the highest scientific and technological quality which have as their objective the strengthening of the competitiveness of European industry. This is where any increase in resources should go. We cannot afford increases on all fronts at the same time. Indeed we must achieve savings in areas which no longer central to Europe's needs. I believe we can do this and produce an effective Framework Programme at a substantially lower cost

than the Commission have so far proposed. I would like them to think again.

JOINT RESEARCH CENTRE (JRC)

Mr President, as I said in my earlier intervention I am glad that we have this opportunity to consider the role of the Joint Research Centre in parallel with our consideration of the future direction of the Community's research and development. It is right that we should do this because, as I said, the Joint Research Centre pre-empts at present some 28 per cent of the Community's R & D expenditure and this money is spent on activities which for the most part are no longer among the Community's highest priorities.

Mr President, in preparation for this debate we have carried out a careful survey of the whole range of the JRC's work as it is perceived by the Departments in the UK who work in the same field. The outcome is depressing. Almost 50% of the work is perceived to be of such low quality and relevance that Departments would be content to see it end. Only 10% is perceived to be of such quality and relevance that Departments would be prepared to sacriface domestic programmes to pay for it. These are not figures which are plucked out of the air; they represent the considered judgement of practitioners in the field.

This judgement appears to sit in stark contrast to that of the Scientific Council which comments favourbly on the quality of the Centre's work. Obviously I respect the honesty and sincerity of the Council's judgement and there will always be scope for differing opinions on scientific merit. But the differences are too great to be simply explained away like that. The fundamental difference is that the United Kingdom's analysis took into account not just the quality of the research, but also its timeliness, its utility and most significantly its value for money. As far as I can see the Scientific Council chose not to take these other considerations into account. This is a legitimate standpoint. But it is a luxury which I do not believe the Council can afford. The JRC is pre-empting resources which might otherwise be spent on other sectors of the Framework Programme and I believe the time is now right for a fundamental reassessment of its role.

I was heartened to read in the opening paragraph of the Commission's discussion paper that they too had reached a similar conclusion. The paper

states that the time has come "to re-examine the JRC without preconceived ideas beginning with the technological needs of Europe and with the EC role in satisfying them." I am sorry to say that the remainder of the paper did not live up to the promise of the opening paragraph. It very soon slips back into a justification of the status quo.

In brief the Commission's arguments for a new role for the JRC are:

1. Work on norms and standards needs independent technical competence within the Commission;

2. Some of this work is binding under Treaty obligations;

3. Nuclear safety work requires a central role;

The point about Treaty obligations obviously has to be taken seriously. But no attempt is made to present a serious case to support the assertion that work on norms and standards needs to be done at the JRC rather than, for example, by coordination of the work in reputable national laboratories. Nor does the paper address the fact that in the standards area which are most central to the Community's high technology effort - I am thinking of information technology and telecommunications - fall well outside the JRC's competence. The arguments about nuclear safety are of undoubted importance, but they relate to the present role of the JRC, not a new one.

The paper goes on to suggest that this new role would amount to a "transformation" of the JRC. But when we look at the figures in Annex 2 we find that the "transformation" amounts to a shift of effort of little more than 2 per cent per annum. Over five years only about 10% of total resources will be moved from nuclear to industrial and environmental work. If we agree to this proposal, even in 1991 fission, fusion and the high flux reactor will still account for 57 per cent of the effort of the JRC. And we must remember that much of the industrial programme has a decidedly nuclear flavour. By no stretch of the imagination can this be seen as a "transformation".

Even if one accepted the arguments over the future JRC role on norms and standards which, as I have indicated, I do not, the whole package would be too conveniently neat and tidy. It would be a remarkable coincidence if the growing demand in Europe for work on norms and standards should so exactly match the

declining requirement for work on nuclear fission. I am sorry, Mr President, but this simply does not add up to the kind of thorough, searching and rigorous examination of the role of the JRC which we have a right to expect.

What I think we must do Mr President is to take the opening paragraph of the Commission's paper at face value and institute a re-examination of the JRC's role that is truely without preconceptions. It should be a re-examination which consults the potential users of the JRC services in a systematic and comprehensive way. This means consulting the industries, the research institutes, and the governments of the Member States to establish precisely the scale and nature of the demand for direct action by the Community. It means exploring ways in which the Centre can become more cost effective, reduce its overheads and install better management systems.

Mr President what I am asking for may seem a lot. But it is no less than we have come to expect during the development of the ESPRIT and RACE proposals and, as I have said before, the JRC threatens to consume even more of the Community's resources than either of those two programmes. The task may appear more difficult and complicated because it involves an existing institution rather than a new proposal. But it will only be after a re-examination of this kind has been completed that we will be able to build up a picture of the kind of service the JRC should provide in future.

Mr President, it is these very strong doubts whether we have yet identified the future role of the JRC that leads me to the conclusion that it is unrealistic to expect to agree a new JRC programme this year. You will recall that, anticipating this potential problem, I requested at the last Research Council, that the alternative option of a revision of the present programme to be presented to us. I regret very much that the Commission has chosen not to do this. Article 3 of the 1983 resolution of the JRC is quite explicit that this decision is for the Council and not the Commission to take.

Mr President, the Commission paper puts forward three arguments for proceeding with the new programme. The first asserts "that a need has been identified" for direct action. It follows from what I have said that I do not accept that this "need" has yet been identified.

The second reason given is that the JRC programme should coincide with the

Framework Programme. I agree that this is a bureaucratic ideal, but it is not essential. There are many other programmes, some of equivalent size and of greater importance such as RACE which will also not be ready for decision in the course of this year.

The third reason given is that the changes recommended by the Scientific Council should be put into effect bearing in mind medium term objectives. This ia a truism. But first we have to be sure that the medium term objectives are the right ones and we are far from being sure of that.

Therefore Mr President I should like to repeat my request that for the next meeting of this Council we should have before us a proposal from the Commission explaining how the present JRC programme might be revised to carry on into 1987. This should set out clearly how the Commission propose to manage the remaining shortfall in budgetry provision and why they felt unable to find the additional 5 mecu savings in 1986 and 1987 that I suggested last December they should look for. In the meantime work should begin on the preparation of a more rigorous examination of the Centre's longer term role.

Mr President I do not wish to pre-judge the kind of re-examination of the role of the JRC which I hope this Council will agree should now be carried out. But I have to say that my impression is that the JRC is rather like a dinosaur which has grown up in an age when resources were plentiful, with its own carefully demarcated territory free from predators. Now the climate has changed. Resources are no longer plentiful. The dinosaur has to move out of its protected territory to look for new supplies. But the adjoining territories are alreeady inhabited by an altogether different species of beast, one which is much more nimble and flexible, with a smaller appetite and used to fighting for scarce resources. Unless it can evolve rapidly into one of the new species the JRC dinosaur will not survive.

file SH

cc CSO(CO)

10 DOWNING STREET

THE PRIME MINISTER

2 April 1986

Dear Sir Francis.

Thank you for your letter of 27 March and the Council's report on "Software: A Vital Key to UK Competitiveness". The Council has identified an important area for the future to which careful consideration needs to be given.

I agree to publication of the report. I have asked for arrangements to be made for the Government's written response and this will be communicated to ACARD in due course.

Yours sincerely

Margaret Thatcher

Sir Francis Tombs

SH

Pte SL3AOV ccBG

10 DOWNING STREET

From the Private Secretary

1 April 1986

Dear John

ACARD REPORT "SOFTWARE: A VITAL KEY TO UK COMPETITIVENESS"

The Prime Minister has received with correspondence from the Chairman of the Advisory Council for Applied Research and Development (ACARD) the Council's report on software and the competitiveness of UK industry.

A copy of the report is attached. The Prime Minister has agreed that the report should be published.

As is customary, a written response will be provided by Government and the Prime Minister has asked that the Secretary of State for Trade and Industry should take the lead in co-ordinating with Departments the Government response.

I am copying this letter and the report to the Private Secretaries of other Cabinet Ministers, and to Sir Robert Armstrong and the Chief Scientific Adviser, Cabinet Office.

Yours ever

Tim

TIM FLESHER

John Mogg, Esq.,
Department of Trade and Industry

ADVISORY COUNCIL FOR APPLIED RESEARCH AND DEVELOPMENT
70 Whitehall, London SW1A 2AS Telephone: 01-233 6139

Rt Hon Margaret Thatcher MP
No 10 Downing Street
London SW1

27 March 1986

R29

Dear Prime Minister,

ACARD REPORT "SOFTWARE: A KEY TO VITAL UK COMPETITIVENESS"

The Advisory Council for Applied Research and Development has recently completed a study of software. I have pleasure in enclosing a copy of the report on the study entitled "Software: A Key to Vital UK Competitiveness". The report and its recommendations have been endorsed by the Council who have invited me to submit it to Government and seek your approval for publication.

Impetus for the study came from a previous ACARD exercise concerned with the application of advanced manufacturing techniques. This suggested that the competitiveness of United Kingdom industry will depend not only on the effective use of the latest manufacturing technology but also on the adequacy of the software which controls such equipment. Indeed, it is becoming apparent that consideration of software needs is almost a prerequisite to the design and manufacture of products and provision of services.

The report is concerned essentially with two themes: the need for a rapidly rising use and application of well-engineered software in all sectors of the economy: and a more commercially vigorous, market-orientated software industry. Although the UK software industry has done well in recent years, growing at 20 per cent per annum, the world growth rate at 30 - 40 per cent is higher, and a very large and valuable world market for software is developing. The UK cannot afford to miss the opportunity in the fast growing market.

The report makes a number of recommendations aimed at increasing investment in software in proving its use in United Kingdom industries, and developing a more vigorous expert base from which to produce software products and services. With respect to software producers, it is proposed that the industry should itself address the problem of its fragmentation; larger, internationally competitive units are needed. A number of detailed recommendations are also made relating to an engineering approach to software production, marketing, quality and standards, education and certification, and demand-side leadership.
ACARD believes that it has identified important issues and made realistic recommendations which, if adopted by both the producers and users in industry and by Government will do much to improve our share of a rapidly expanding world market to, at the same time, increase efficiency in UK industry more generally.

Yours sincerely,

Francis Tombs

FRANCIS TOMBS

WO941

MR ADDISON

25 March 1986

ACARD REPORT "SOFTWARE: A KEY TO UK COMPETITIVENESS"

The Advisory Council for Applied Research and Development (ACARD) has recently considered a report on "Software: A Key to UK Competitiveness" prepared by a Working Group set up by the Council. ACARD approved the recommendations in the report and invited Sir Francis Tombs to submit the report to Government. He will shortly be sending a copy to the Prime Minister. For your information a copy is attached.

ACARD would like the report to be published and have invited Sir Francis Tombs to seek the approval of the Prime Minister. I do not foresee any difficulty as the conclusions and recommendations are uncontentious. By publication the report should stimulate further progress in this area and indeed could be of assistance in the discussions relating to the follow up to the Alvey Programme. I attach a draft reply for the Prime Minister to send to the ACARD Chairman.

The Council will expect the Government to provide a written response. Although the subject is of interest to several Departments it is more directly the responsibility of DTI and I would recommend that DTI is invited to coordinate the Government response. Other Departments with major interests are clearly MOD and CCTA and they will need to be closely involved in the follow up. The ramifications of software do extend to practically all Departments, for example, simply in dataprocessing and more complexly in the large systems of DHSS for social security, and the Inland Revenue for taxation. In my view, therefore, it will be necessary for all Departments to give consideration to the report and indeed implement some of the recommendations. Most important is that some way should be found to follow-up the main recommendation directed at industry, but with some Government involvement. It will be a matter for DTI to ensure that industry follows this up.

It would be helpful if the Prime Minister could draw the attention of her colleagues to the report and indicate to them how the report will be handled by means of a Private Secretary's letter. A suitable draft is attached. We shall supply you with the required number of copies.

RBN.

SIR ROBIN NICHOLSON

SL3AOY

DRAFT LETTER FOR THE PRIME MINISTER'S PRIVATE SECRETARY TO SEND TO PS/SECRETARY OF STATE FOR TRADE AND INDUSTRY

ACARD REPORT "SOFTWARE: A VITAL KEY TO UK COMPETITIVENESS"

The Prime Minister has received with correspondence from the Chairman of the Advisory Council for Applied Research and Development (ACARD) the Council's report on software and the competitiveness of UK industry.

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As is customary, a written response will be provided by Government and the Prime Minister has asked that the Secretary of State for Trade and Industry should take the lead in coordinating with Departments the Government response.

I am copying this letter and the report to the Private Secretaries of other Cabinet Ministers, and to Sir Robert Armstrong and the Chief Scientific Adviser, Cabinet Office.

Agreed MB

SL3AOU

DRAFT LETTER FOR THE PRIME MINISTER TO SEND TO SIR FRANCIS TOMBS

Thank you for your letter of 27 March 1986 and the Council's report on "Software: A Vital Key to UK Competitiveness". The Council has identified an important area for the future to which careful consideration needs to be given.

I agree to publication of the report. I have asked for arrangements to be made for the Government's written response and this will be communicated to ACARD in due course.

EXECUTIVE SUMMARY

E.1 World wide, the manufacturing and service industries are increasing their competitiveness by accelerating their use of computer software in end products, manufacturing processes and customer services. UK manufacturing and service industries can regain and enhance their competitiveness by applying software more widely. To apply software effectively, the UK industries require a better understanding of the nature and power of software; this understanding can only be achieved through increased in-service education and training. More knowledgeable manufacturing and service industries will be more able to pull through and take up new ideas from the supply side, which itself needs strengthening educationally.

E.2 The world software market is large ($40 billion) and growing rapidly (30% pa). The UK market is 5% of the world market. UK firms hold only 2-3% of the world market. In a period of rapid growth, the challenge for the UK software industry is to build a firmer foundation for other UK industries, and win a greater market share so as to reverse the emerging software balance of payments deficit.

E.3 Our recommendations are designed to help UK industry profit from the opportunities which software is creating, without recourse to government intervention. Our constructive approach has generated both strategic targets and detailed, tactical recommendations. Companies, government departments and educational establishments need clear visibility of the broad picture if they are to develop a coordinated approach to achieving the overall targets.

E.4 We recommend the formation of an expert body, provisionally called STARTING (Software Technology and Applications Review Team of INdustry and Government), to monitor the implementation of our recommendations and their effectiveness in achieving the targets we have set. STARTING's main function is to hold an annual, large scale, formal review meeting to consider a performance report of software users, appliers and suppliers. ACARD requires an annual summary report from STARTING in order to monitor its targets.

E.5 Our main recommendations for Industry are:

* In-service training initiative for all users, appliers and suppliers.

* Increased application of software to increase the competitiveness of the manufacturing and service industries.

* Marketing initiative for UK software products and services.

E.6 Our main recommendation for government is for inter-departmental cooperation on:

* Public purchasing to exercise demand side leadership.

* Technology transfer acceleration.

* Better R&D planning to avoid discontinuities in policy and funding.

* In-service training initiative for government employees.

TITLE

Cabinet Office

Advisory Council for Applied Research and Development

SOFTWARE: A VITAL KEY TO UK COMPETITIVENESS.

March 1986

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FOREWORD

The United Kingdom's manufacturing industries, service industries, defence, public services and domestic life are critically dependent on Information Technology (IT). IT is the construction and operation of information handling systems composed of microelectronics, computers, software and telecommunications. Of these constituents, software is the most complex, most costly and most difficult component to develop and bring to market. Software Engineering is the name given to the methods, skills and tools used to develop software.

The world market for IT products is large and growing rapidly. Major industrial nations are vigorously developing, promoting, and exploiting IT. Software is a key strategic element in the fierce economic competition between such nations.

The attention of ACARD was drawn to the possibility that the UK was failing to develop and apply software sufficiently rapidly and widely in all industries. A related possibility was that the UK was failing to win its expected share of the world market for software.

An ACARD Working Group with the following composition was therefore set up in January 1985 to investigate these concerns.

Mr J Coplin (Chairman)	Director of Design, Rolls Royce Ltd
Miss S Bond	Royal Signals and Radar Establishment, Ministry of Defence
Mr D Collens	Technical Director, Software Sciences Ltd
Mrs J Connell	General Manager, F International Ltd
Prof C A R Hoare	Programming Research Group, Oxford University
Mr G W Holmes	Deputy Chairman, Systems Designers Ltd
Lt Col P Ost	Procurement Executive, Ministry of Defence
Mr D Robson	Controller, Software Support Services, National Westminster Bank plc
Dr M F Smith	Head of R&D, ISTEL Ltd
Mr J Whalley	Technical Manager, British Aerospace, Manchester
Dr C Whitby-Strevens	Microcomputer Support Manager, Inmos Ltd
Dr R W Witty	Deputy Director (Software Engineering), Alvey Programme

The terms of reference of the Working Group were:

i. to identify measures to assist in the understanding and use of software engineering by industry and business through education and training;

ii. to report on the nature of existing and prospective management and organisation practices in software development, in the light of the changes being and likely to be brought about by software engineering;

iii. to report on current and prospective techniques and aids in the specification, design, integration and testing of software in the assessment of quality and correctness of product;

iv. to report on the international competitive position of the United Kingdom with respect to the above, including restrictions on international trade in software and its implications for UK industry and business;

v. to make recommendations.

Although the remit provided for the Working Group set down specific objectives for the study, it was considered necessary, in the event, to adopt a broader interpretation. The approach taken was to seek to identify the macro-economic significance of software to the United Kingdom; then to develop an understanding of the actions required to produce a better market performance; and how to develop the methods, skills and tools to achieve better software technology. Particular emphasis was placed on the users of software and on the collective behaviour of users, appliers and suppliers of software. This provided a framework within which the necessary steps to bring about the widespread use of software, and software engineering, could be achieved.

The Working Group's report was considered in February 1986 by the Council, who endorsed its conclusions and recommendations. It is now published, with the approval of Government, to draw attention to the importance of software, to the concerns arising from the findings and to facilitate wider discussion of the Working Group's recommendations.

The Council is grateful to the members of the Working Group for their contribution to ACARD's work, to the many individuals and companies who gave evidence to the Working Group, and the support of the ACARD Secretariat in the Cabinet Office.

CONTENTS

1. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

THE CHALLENGE TO THE UK'S COMPETITIVE POSITION

1.1 A vital opportunity exists for the manufacturing and service industries to improve their competitiveness by increasing their use of computer software in end products, manufacturing processes and customer services. A better understanding of the power of software is needed before it can be successfully applied more widely and effectively. Not enough understanding exists, at all management levels, of the opportunities for exploiting software in products and processes. Nor is there enough understanding of modern techniques for software application and development. These deficiences are mainly due to a lack of on-going, in-service education and training, at all levels of management and technical staff.

1.2 The software supply industry operates in a world market worth some $40 billion per annum, with a soaring growth rate of around 30% per annum. The UK domestic market is 5% of the world total. UK suppliers hold 2-3% of the world market. This share consists of about half of the UK domestic market plus only 0.5% of the rest of the world market. Many new UK software companies have been created in the last twenty years. Several have grown rapidly, at around 20% per annum, which compares very favourably with other UK industrial sectors. In spite of this relative success, the major UK software companies are much smaller than their major overseas competitors. Thus, in a period of rapid world market growth, the challenge facing the UK software industry is how to win a greater market share and build a firmer foundation from which to survive and prosper during the 'shake out' phase of market development which is now dawning.

1.3 In framing our conclusions and recommendations we were conscious of the following concerns

* The UK manufacturing and service industries (as well as defence, utilities and public administration) are now dependent on Information Technology (IT).

* Almost every aspect of business in the UK is open to international competition.

* In the economic struggle between America, Japan, the Far East and Europe, the use of IT is a major weapon.

* IT is critically dependent on software.

* The UK software market is dominated by foreign suppliers. This has three consequences:

  (a) the UK can no longer be sure of obtaining the software its manufacturing and service industries need to sustain their international competitiveness.

  (b) the increasing demand for imported software will bring about a major new source of balance of payments deficit.

  (c) the dominance of the UK and world markets by overseas suppliers is weakening the UK Software industry. The UK industry is not effectively fighting back.

* Should the UK be unable to afford, or not be allowed, to import foreign software needed to remain competitive, then the UK Software Industry will not be able to deliver competitive alternatives and so the whole of industry will be weakened.

1.4 While much ground has already been lost, prompt action can recover and improve the situation. If our recommendations are vigorously implemented, we believe no recourse to government intervention or subsidy will be necessary.

STARTING - A FRAMEWORK FOR ALL RECOMMENDATIONS

1.5 The widespread application of soundly engineered software can enhance the overall financial performance of the United Kingdom. To maximise this potential companies, government departments and educational establishments need clear visibility of the broad picture. Thus informed about national targets, and the general direction to be taken, they can then strive to achieve the overall targets by mutually coordinated actions.

1.6 We recommend the formation of an expert body, provisionally called STARTING (Software Technology and Applications Review Team of Industry and Government), to monitor the implementation of our recommendations and their effectiveness in use against the targets we have set. STARTING's main function is to hold an annual, large scale, formal review meeting to consider a performance report of software users, appliers and suppliers. ACARD requires an annual summary report from STARTING in order to monitor the effectiveness of the STARTING mechanism and the progress towards its targets.

MAIN RECOMMENDATIONS

1.7 Our main recommendations for Industry are:

* In-service training initiative for all users, appliers and suppliers

* Increased application of software to improve the competitiveness of the manufacturing and service industries.

* Marketing initiative for UK software products and services

1.8 Our main recommendation for Government is the formulation and implementation of a long term plan (TYPSSEA) for inter-departmental cooperation on:

* Public purchasing to exercise demand side leadership

* A new technology transfer initiative (BASSMATT)

* Better R&D planning

* In-service training initiative

1.9 The widespread application of soundly engineered software has the potential to enhance the national competitiveness of the UK. In Chapter 7, we make our main recommendations which we believe will maximise this potential. These main recommendations are divided between industry and government. In the three subsequent chapters we give more details about these main recommendations and make further recommendations. Chapter 8 contains the detailed recommendations for all industries and for the user, applier and supplier roles specifically. Chapter 9 contains the detailed recommendations for government; these are assigned to individual government departments. Chapter 10 contains detailed recommendations for the professional institutions. A 'routemap' of the organisation of our recommendations is given in figure 1. The Appendices contain detailed discussion of three topics: in-service education and professional qualification; the software implications for safety and standards; and product standards and certification.

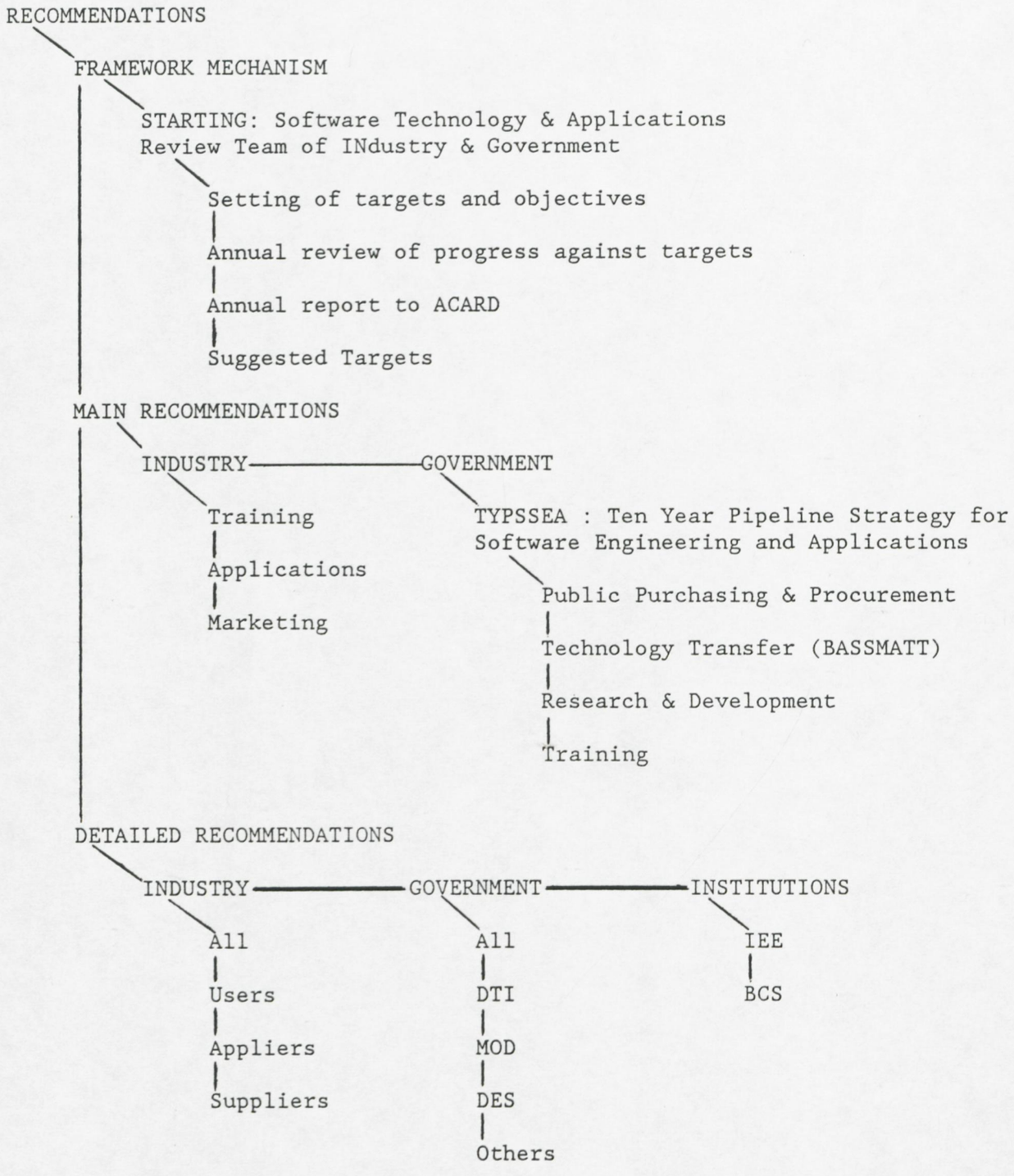


Figure 1. Structure of the Recommendations

2. INTRODUCTION TO IT, SOFTWARE, SOFTWARE ENGINEERING

2.1 Information Technology (IT) today affects almost every household and occupation in the United Kingdom. IT systems are at the heart of the financial services, the design of automobiles, the control of weapons systems, communications and many consumer goods.

2.2 IT is a combination of microelectronics, digital computers, software. computer programs, and telecommunications. The components of an IT system have to be brought together by systems engineering, and computer programs must be developed to enable the components to work, both individually and together, as a whole system.

2.3 Computer programs (software) are the sets of instructions, stored inside a computer's memory, which when fed with the appropriate data, control the computer (hardware) in a way which causes the computer to perform some desirable function such as predicting tomorrow's weather or computing the magnitude of an overdraft.

2.4 "Software is the entire set of programs, procedures and related documentation associated with a .... computer system."[1] Software Engineering is the collection of theories, methods, skills and tools used to produced software.

2.5 Computer programmers express their programs in a form which is readable by humans as well as computers. This is called 'source code' and is the generic name for programs expressed in such programming 'languages' as COBOL, FORTRAN, BASIC, PASCAL and ADA. Computer software in source code form (readable by humans) is analogous to an engineering blueprint. The actual value of a blueprint in terms of its physical components (paper and ink) is negligible. Blueprints, and software, are valuable because they capture the expertise of the designer who produced them; this expertise enables the end product to be manufactured.

2.6 The engineering blueprint needs a manufacturing process to realise the end product it represents. The 'end product' for software is called the 'binary form' because it consists of the '0's and '1's which are stored in the memory of a computer. It is this pattern of '0's and '1's which actually controls the hardware. Such a pattern is 'soft'; it cannot be seen or touched. It is this ethereal nature of software which makes it difficult to grasp exactly what software is, what it does and why it is so important.

2.7 In the same way that a blueprint can be readily reproduced by copying so can computer software. The key difference, however, is that turning a blueprint into an end product and mass producing that product is usually an expensive and time consuming process. With software the transformation from design (source) to product (binary) is done cheaply and quickly by the computer itself! It also explains why it is so easy to make changes to software - changing the design is just text processing, and so a revised product is simple and cheap to produce.

2.8 Mass production of software is as easy and cheap as reproducing blueprints. Thus 'piracy' of computer software, the illegal copying and distribution of someone else's software, is very easy to achieve and is widespread in certain areas of the world today. This explains why vendors are often reluctant to distribute the source code of their products.

2.9 In industrial terms, the development of software is a new activity. Today it is regarded as a 'craft activity' because it is labour intensive with programmers using craft level methods. Most programmers have not been professionally trained. They do not usually have a deep mathematical training but have developed skills 'by experience'.

2.10 Software Engineering is the application of science and mathematics, blended with experience, to the development of software. The theoretical basis of software engineering, whilst still in its infancy compared to some other engineering disciplines, has made steady progress. The pace of theoretical development is accelerating as the required mathematical principles are discovered and refined. The mathematics-led transition from a craft based industry to a mathematics based technology is gathering pace rapidly.

2.11 "Software can be divided into two generic types: systems and applications. Figure 2 shows examples of these types of software. Systems software helps the programmer by automatically controlling or managing the resources of a computer system. Applications software assists the user directly by performing specific tasks such as accounting or computer-aided design. Applications programs can be further divided into industry specific and cross industry.

2.12 Another perspective is the mode of delivery of software to users: packaged, bespoke (custom) or integrated systems. Packaged software generally refers to a standard program that can be used by a wide range of users with little or no modification. By contrast, custom software or bespoke programming is tailored to meet a particular user's need. Development of this software may take place on the user's premises or at the supplier's site on a contract basis. Integrated systems software is sold by systems integration firms which buy hardware from outside suppliers, add their own software and sell a complete system to users."[3]

2.13 Participants in the IT business may be divided into three types: the user, the applier and the supplier.

* The user is someone who employs an IT product to help him perform a task, but does not participate in the product's construction. For example, an accountant handling figures via a spreadsheet program is a user.

* The applier does not consider the construction of an IT product as a primary task. Appliers will typically tailor some general purpose product, such as a spreadsheet package or a differential equation solver, into a more specifically useful tool by exploiting or 'applying' their knowledge of say, the firm's accountancy procedures or the dynamics of an aeroplane. Appliers will have skills ranging from a simple understanding of the general tools (an experienced user) through to comprehensive programming skills (an 'internal' supplier).

* The supplier is primarily interested in the construction and development of software for users, appliers or suppliers themselves. The supplier should have a high level of technical skill.

2.14 Users and appliers are typically found in the manufacturing and service industries. Large companies and organisations will often have their own specialist computing or data processing departments acting as an 'internal' supplier. The external suppliers are formed from the independent software houses and the computer hardware vendors.

2.15 Users, appliers and suppliers form an international 'vertical' market segment. The nature of their interaction and interdependence, from the UK viewpoint, is now considered and some of the problems which we have identified are described.

Generic Type	Specific Type	Examples
SYSTEMS	Operating Systems	MVS/XA (IBM); CP/M (Digital Research); MS/DOS (Microsoft); UNIX (AT&T)
	Database Management Systems	ADABAS (Software AG) IDMS (Cullinet) IMS (IBM) RAMIS II (Mathematica Products Group)
	Telecommunications Monitors	ENVIRON / 1 (Cincom Systems) Softerm (Datasoft) VisiTerm (VisiCorp) CICS, TSO (IBM)
	Translators	Job Control Language Translator (DASD) Fortran Cross Assembler (National Semiconductor)
	Utitilies	Supersort (MicroPro International) Program Editor (Radio Shack)
APPLICATIONS	Cross - Industry	Lotus 1,2,3, (Lotus Development Peachpak 4 Accounting Series (Peachtree Software) VisiCalc (VisiCorp) Word Star (MicroPro International
	Industry - Specific	Life - Comm (Informatics General) BANKSERV 10000 (Anacomp), MUMPS - 1; (Digital Equipment Corp) Milliken Math Sequences (Milliken Publishing)

Figure 2. Types of Software[3]

3. THE PROBLEM

A CHALLENGE TO THE UK'S COMPETITIVE POSITION

3.1 The UK manufacturing and service industries (as well as defence, utilities and public administration) are now dependent on Information Technology (IT).

3.2 Almost every aspect of business in the UK is open to international competition.

3.3 In the economic struggle between America, Japan, the Far East and Europe, the application of IT is a major weapon.

3.4 IT is critically dependent on software.

3.5 The UK software market is dominated by foreign suppliers. This has three consequences:

* the UK can no longer be sure of obtaining the software its manufacturing and service industries need to sustain their international and domestic competitiveness.

* the increasing demand for imported software will bring about a major new source of balance of payments deficit.

* the dominance of the UK and world markets by overseas suppliers is weakening the UK Software industry. The UK industry is not effectively fighting back.

3.6 Should the UK be unable to afford, or not be allowed, to import foreign software needed to remain competitive, then the UK Software Industry will not be able to deliver competitive alternatives and so all manufacturing and service industries will be weakened.

3.7 While much ground has already been lost, prompt action can recover and improve the situation.

SOFTWARE: A CRUCIAL COMPONENT IN THE COMPETITIVENESS OF THE MANUFACTURING AND SERVICE INDUSTRIES

3.8 A basic question which we have considered is whether the manufacturing and service industries can achieve and maintain their competitive edge if our indigenous software industry declines.

3.9 The dependence of the UK's service industries, manufacturing industries, defence and public services on IT has already been stated. The UK's immediate and future trading performance depends crucially on the combination of the country's ability to compete in world markets for products and services based on IT and on the rapid, widespread and effective application of such products and services by industry and commerce.

3.10 The types of IT on which manufacturing industry is necessarily becoming ever more reliant include computer aided design and manufacture (CAD/CAM), robotics and office automation. Increasingly the knowledge, experience and skills which make up a company's competitive advantage are being expressed as and encapsulated into software. Companies which do not lead this trend will suffer, because such software will not be available for purchase. Instead it will be a strategic asset of their more successful competitors, for whom it will represent a considerable investment which will enhance future dividends.

3.11 Service industries are even more dependent on deploying advanced IT products to stay competitive; financial services now are almost pure IT activities. Japan and the USA have ambitions to rival the UK in the financial sectors and they are the major developers of key IT products. They will use this lever to try to offer better services than London's financial centres. Market forces, possibly aided by restrictions on the availability to the UK of key IT products, could lead to the loss of some important service industries.

FOREIGN CONTROL OF SOFTWARE USED IN THE UK

3.12 Information Technology is central not to just UK industry but to UK defence, public administration and utilities. The world and UK markets for IT hardware are dominated by the USA and Japan with the USA alone holding 70% of the world software market in 1983, and a predicted 75% in 1987[3]. The domination of the world IT market by one American company, IBM, is a special factor. IBM's dominance means that its products set de facto world standards. Most appliers and suppliers must comply with these standards and most users must operate within the limits defined by these standards. Therefore overseas governments and companies have the potential to influence major strategic aspects of the UK economy, defence and administration by manipulating the price or the availability of software.

3.13 Vulnerability to price increase is a consequence of lack of competition from UK software producers. A large part of the UK software market consists of the operating systems, compilers, database systems and communications packages supplied by the foreign hardware vendors who are mostly American owned. With very few exceptions, hardware vendors deliberately construct this software to be specialised to their own products. Customers build on top of this basic software and thereby become dependent on one vendor. The cost of this software, together with the cost of applications-orientated software built for use with it, and the costs of training staff to use it, ensure a complete dependency on the hardware vendor. The vendor may legitimately exploit this market dominance for commercial gain. Due to the scale of the market dominance, such software dependencies do give the foreign vendors a potential for strategic manipulation, beyond legitimate profit making, which is not controlled by normal market mechanisms.

3.14 The availability of software may be restricted in at least three ways to influence the UK strategically: temporally, totally or partially.

(a) Temporal restrictions refer to the potential for foreign suppliers to only sell 'last year's model' in the UK . This could ensure that the UK had a reduced competitive ability in important fields and markets.

(b) Total restrictions refer to deliberate decisions to prevent the UK purchasing essential software. For example, the USA's recent technology embargo has demonstrated that this tactic could be used to gain commercial advantage.

(c) Partial availability, such as supplying programs in binary but not source forms, is a common commercial practice. Strategically it means that, should a foreign supplier withdraw support and service from the UK, then the UK would not be able to maintain or develop the software on its own.

3.15 The UK, like many other countries, is thus dependent on American owned, developed and controlled software for the operation of most of the UK's computing power.

THE IT BALANCE OF PAYMENTS DEFICIT

3.16 The UK balance of payments deficit for IT (including software) was £928 million in 1983 and is predicted to worsen to £9 billion by the early 1990s, of which software will contribute a £2 billion deficit[2]. Figure 3 shows UK IT compared to other major UK loss makers.

3.17 Almost every aspect of business in the UK is subject to international competition. IT has intensified this competition. There is no escape from this competitive pressure. UK industry must enthusiastically and skilfully exploit the opportunities that IT offers or the UK economy will suffer.

3.18 The UK economy is dependent on IT and IT is dependent on software. Therefore software is critical to the economy.

3.19 The importance of software is reflected by the world market which is estimated at $40 billion for 1985, with an annual growth rate of 30%. The UK represents 5% of the world market. UK industry has only 2-3% of the world market; this share consists of about half of the UK domestic market plus only 0.5% of the rest of the world market.

3.20 UK software companies are growing at around 20% pa which is below the world rate of 30-40%. Thus the balance of payments deficit is going to increase if UK industry generally takes up IT at the rate required to remain competitive in world markets. This will drive the balance of payments deficit for software (all IT) from £200 million (£928 million) in 1983 to £2 billion (£9 billion in all IT) in the early 1990s. Two important questions are:

(a) Can the UK afford such a deficit?

(b) Can the UK afford to miss the opportunity which this fast-growing world market represents?

THE PACE AND COST OF SOFTWARE ENGINEERING

3.21 Now that the software industry is beginning to mature into a capital intensive, international industry, we are concerned that the cost and pace of technological development will be too expensive and too fast for UK companies to remain competitive.

ACARD

Some net deficits by industry

£millions in 1983

Road vehicles	3669.6
Fruit and vegetables	1555.7
Paper	1363.2
Textiles	1035.2
IT (inc software)	928
Software	**200**

Projected deficit for 1990

IT (inc software)	9000
Software	**2000**

Figure 3

8 NOV 1985

VML 29527

3.22 The world market for computer systems continues to grow rapidly. Success in microelectronics technology means that software development now is the most costly and difficult component to develop of most IT applications, often amounting to 75% of the overall life cycle cost of a large bespoke application.

3.23 World demand for software continues to soar.

3.24 Software development is labour intensive because it is essentially all design effort and no production effort. Therefore, there exists massive competitive pressure to find new ways to improve the productivity and quality of the software development process; to find ways to move from a labour intensive to a capital intensive process. All the major nations and companies have large R&D programmes seeking these goals. R&D itself, the pace of technical change and the consequential costs of capital equipment and staff retraining, together with the even greater costs of marketing and supporting new products, are forcing up the price of remaining a world class competitor in the software industry.

3.25 This big R&D push towards more capital intensive methods of software development is likely to weaken the UK software industry. The UK is likely to underinvest in R&D, underinvest in the capital equipment, underinvest in staff retraining, and underinvest in development and marketing. There are too many small companies which cannot afford this investment and too many large companies who will not make the investment unless forced to by public purchasing pressure or government subsidy. Too many companies are reliant on Government bespoke programming contracts (eg MOD work) which is somewhat sheltered from competition. Many such 'body shop' companies do not have revenue streams from software products to generate investment capital.

THE FUTURE OF THE UK SOFTWARE INDUSTRY IN THE 1990s

3.26 The indications are already present that the UK Software Industry is set to follow the pattern of the UK Computer Hardware Industry (and others). Pioneering innovation created a new UK market for computer hardware which grew rapidly to support a number of small companies. These failed to match the market penetration, and later the technical strength, of their overseas rivals. The UK companies therefore grew more slowly than their overseas rivals. When the UK market became just a part of a vast international market, the UK companies did not hold viable shares of this larger market. After government supported restructuring, through some unhappy mergers and takeovers, only one major UK company survives. The UK computer hardware market is now dominated by foreign suppliers.

3.27 Between now and the mid 1990s the UK software industry could evolve into one of three forms:

(a) A "net exporting" software industry contributing genuine wealth to the UK balance of payments and the economy generally. Other manufacturing and service industries benefit by exploiting the innovations of a dynamic, 'enabling technology' industry of world class.

(b) A "just enough" software industry servicing the needs of the UK manufacturing and service industries. This implies a major "net importing" software industry delivering foreign products to UK customers. A major balance of payments deficit on software products results.

(c) A "defence only" software industry, approximately keeping up with world developments, purely for strategic defence reasons. This implies a completely "net importing" industry with little or no innovation by UK firms who are totally dependent on MOD business. It also implies that as the overall UK software industry declines rapidly it will lose the non-MOD business to foreign competitors operating in the UK market.

3.28 The "man in the street" currently sees the UK software industry now and in the future as a high growth, export revenue-generating industry contributing significantly to UK employment and the balance of payments. This view is wrong. The recent USA study[3] confirms ACARD's view that the current trend is for the UK rate of growth to lag behind the world leaders, that the UK's world market share will decline, and that foreign companies and multi-nationals will dominate the world and UK markets in the 1990s.

3.29 The above decline will result from the action of current, international market forces. These include not only the normal commercial competition, but also political forces such as technology embargoes, import/export restrictions, tariff barriers, state subsidised development programmes and nationalistic procurement policies. The massive USA strengths of technical leadership, domestic market size, commercial vigour and investment, and government support will prevail in the world market. The remaining places in the world league will be taken by other countries such as Japan and France whose commercial vigour and government commitment exceed that of the UK.

3.30 The UK domestic market alone is too small to sustain a world class software industry. If the UK industry does not more vigorously compete in the world market, encouraged by Government action, then within 10 years only MOD supported firms will remain.

3.31 UK Industry and Government must together choose one of the options from para 3.27 and strive, jointly, to realise it. A 'window of opportunity' is still open but it is fast closing. The UK has the capability to build a long term success in the software business. We ask whether there is the will and the energy in the UK to succeed.

4. ANALYSIS : I. SOFTWARE USERS, APPLIERS AND SUPPLIERS

THE ROLE OF SOFTWARE

4.1 Since ACARD published its report on Information Technology in September 1980, the crucial role of software in IT has become even more apparent. It is now clear that software is vital to all sectors of the economy. The importance of software has been underlined, for example, by the difficulties encountered during the development of System X and the surveillance systems for Nimrod.

4.2 It must be emphasised that the service and manufacturing sectors are now highly interdependent. One aspect of the IT revolution has been to increase the common ground between various economic sectors. Some companies have seen this as presenting an opportunity to diversify their activities into new major areas of business.

THE SERVICE INDUSTRY

4.3 The service industry encompasses a spectrum of activities ranging from finance, banking and insurance; the retail trade; communications; entertainment; tourism and leisure; education; public administration through to the distribution and transport sectors. The industry is a major contributor to the country's wealth and now underpins practically all other sectors. Service industry exports, including invisibles, amounted to £19 billion in 1983. The service industry employs about 50% of the working population of the UK.

4.4 Part of the service industry has been involved heavily in IT for the past 20 years; for example, banking has 15-20,000 man years invested in software. Many service companies are totally dependent on IT. The service industries generate, by themselves, much of the applications software which controls their competitive edge and profitability. These applications, however, are usually based on hardware and systems software from the USA.

4.5 The consequential costs of software errors can be exceedingly high in sectors of the service industry. These sectors require software which is of comparable quality to safety-critical applications (see Appendix B). They need the best software engineering techniques to achieve this quality level at a reasonable cost. Not all companies in these sectors are using widely the most modern techniques.

4.6 The productivity of the software development process is important to the service industries. Much of the software in use is a problem to maintain. Emerging business opportunities and awareness of IT benefits have created an accelerated demand for new and enhanced IT based services. The maintenance problem and demand for new developments is placing an impossible burden on development resources and is causing a disappointing queue of unimplemented enhancements.

4.7 The ability to extend IT applications, without putting existing operations in jeopardy, is vital. This points to the need for an engineering approach to software production. Given the critical manpower shortage in IT, improved productivity of software development, by means of software engineering, is crucial to the continued good performance of the service industry.

THE MANUFACTURING INDUSTRY

4.8 The current trend of UK market share for the industry is alarming; manufacturing recently has become a deficit for the first time. Reversal of this trend is dependent, however, upon an increase of productivity and marketing effectiveness. The widespread application of software to the manufacturing industry's operations, especially those of design, manufacturing, and management, will play a key role.

4.9 To achieve the necessary gains in productivity, new manufacturing processes, advanced technology and traditional experience must be blended and encapsulated in reliable software.

4.10 Evidence shows that many overseas nations and companies have set productivity goals as high as the best UK manufacturing companies. There are strong indications that many overseas companies are well positioned to achieve their goals. The objectives of each industry and each company vary in detail, but their targets include:

* 50% reduction in timescale from design start to market entry for new products.

* 50% reduction in the cost to launch new products.

* Major improvement in initial reliability of new products.

* Increase model diversity so as to improve customer choice and satisfaction, without incurring unacceptable costs.

* To achieve these objectives within a decade.

4.11 The central importance of design in manufacture is receiving belated recognition. Prediction of both unit cost and the cost to prepare a new product now can be settled at the time the design is released for manufacture. Soundly based software, capable of aiding design analysis and optimisation, is a key to attaining timely design objectives.

4.12 Improved modelling of manufacturing processes and work flow is vital to achieving greater production efficiency. Better methods of design analysis are vital to match customer needs, designs and process capability. A good match is a major factor in achieving high productivity and control of costs.

4.13 A major development in recent years has been that major companies, for example Boeing and General Motors, are willing to do business only with those companies, large and small, who are able to adhere to their IT standards (eg Manufacturing Automation Protocol (MAP) and electronic data interchange). Effective software capability is the key to being able to meet these requirements. Companies not keeping pace with the technological standards of major companies may find themselves unable to trade in these sectors.

WORLD MARKET FOR SOFTWARE

4.14 Software has become an international commodity. There are large, world-wide business, domestic and industrial markets for general purpose software. World markets also are open for specialised software. In this section, we consider the world market for software in relation to the UK software industry and the software industries of other countries.

4.15 An estimate by the USA Department of Commerce[3] put the world market for software in 1985 at $40 billion. Growth was estimated to be about 40% compounded annually (figure 4).

4.16 The growth of the UK domestic software market is slow when compared to world market growth. The USA has 75% of the market, while the UK has only 3%. France, Germany and Japan each have about twice the share of the UK (figure 5). Only about 7% of the UK produced software is exported.

4.17 The world market currently is dominated by packaged software. The USA is dominant in such software, with packages contributing almost 60% of total USA software revenue, while the UK mainly produces bespoke, integrated systems. Computer users are buying more packaged systems to conserve their programming resources. The UK software industry would appear to be out of step with the trend of the world market.

4.18 Much of the market for software is 'invisible' because software often is embedded into products; companies develop applications software in the course of their business; and large numbers of people are engaged in preparing software for companies outside the IT industry. It is reasonable to assume that some of this effort is applicable to wider markets; it is important that the UK capitalises on this 'hidden' investment.

THE UK SOFTWARE INDUSTRY

4.19 The software business in the UK consists of suppliers, appliers and users. Many of the user companies are themselves important developers of software. A wide variety of companies are involved in the software business; from very large multi-nationals to very small local firms. These companies encompass a myriad of approaches to producing software.

Suppliers

(a) Overseas Computer Companies

4.20 At the top of the scale is IBM(UK) with revenue of £2.5 billion in 1984 (approximately 20% of that revenue was from software). Some 50% of total IBM(UK) revenues, including an estimated £200 million of software, is derived from exports. The size of this one company and the influence which it has on all software activities cannot be over-emphasised. IBM(UK)'s turnover matches that of the rest of the software industry. Consequently, consideration of the health of the UK software industry must include IBM.

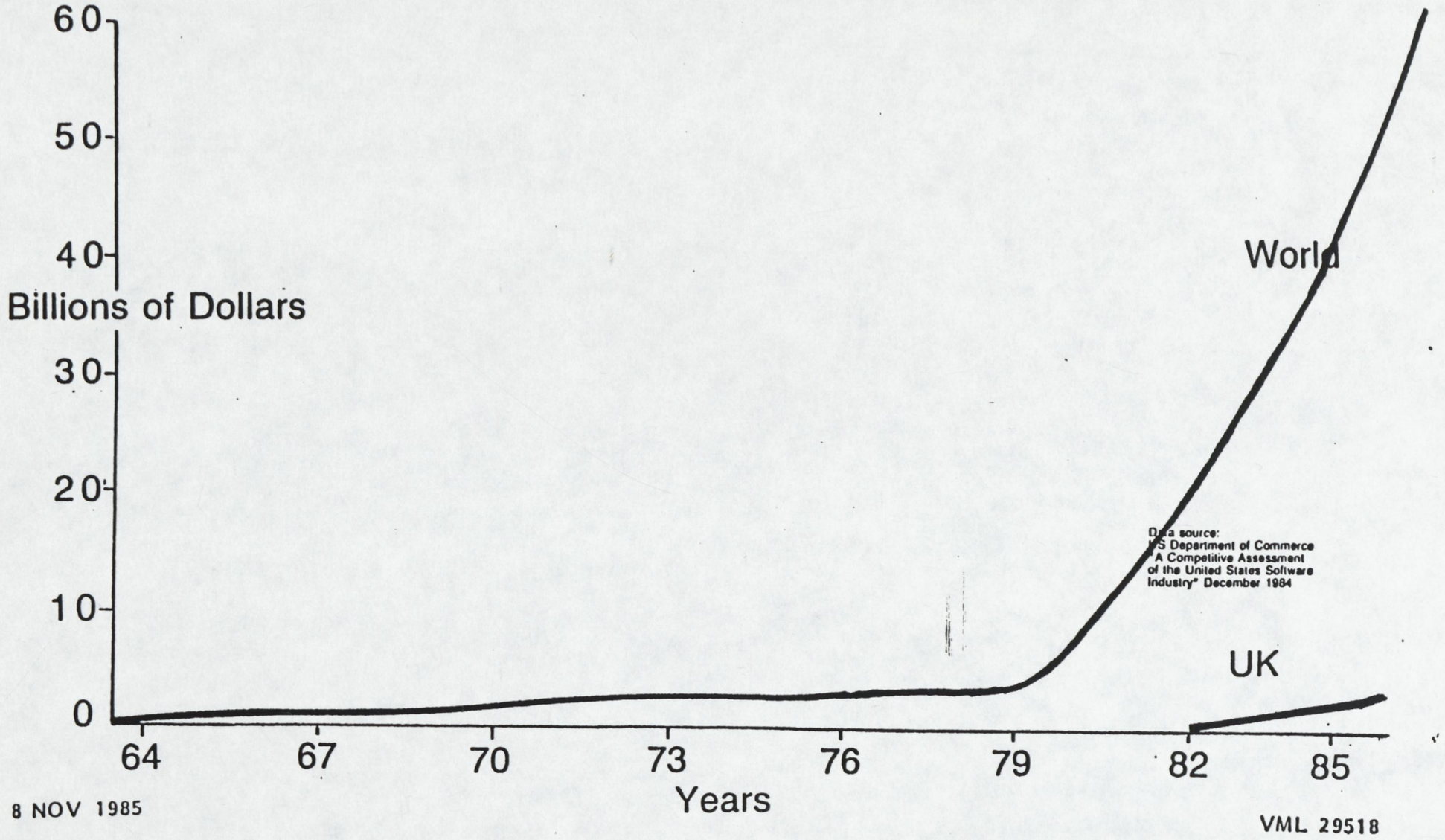
4.21 Also of great significance in the UK are other very large, American-owned, multi-national companies such as DEC, Honeywell, Hewlett-Packard, and Wang. DEC and Hewlett-Packard have set up major software development centres in the UK. Revenue figures are not available as a whole, but DEC, for example, had a 1985 turnover of £430 million in the UK.

(b) USA Software Companies

4.22 There are many software supply companies in the USA. The major product of these companies is packaged applications software in contrast to software revenues of hardware suppliers which tend to be from packaged systems software. Many of the products sold by software supply companies in the UK are imported from such USA companies. These USA companies are increasingly operating directly in the UK.

ACARD

Estimated world market for software



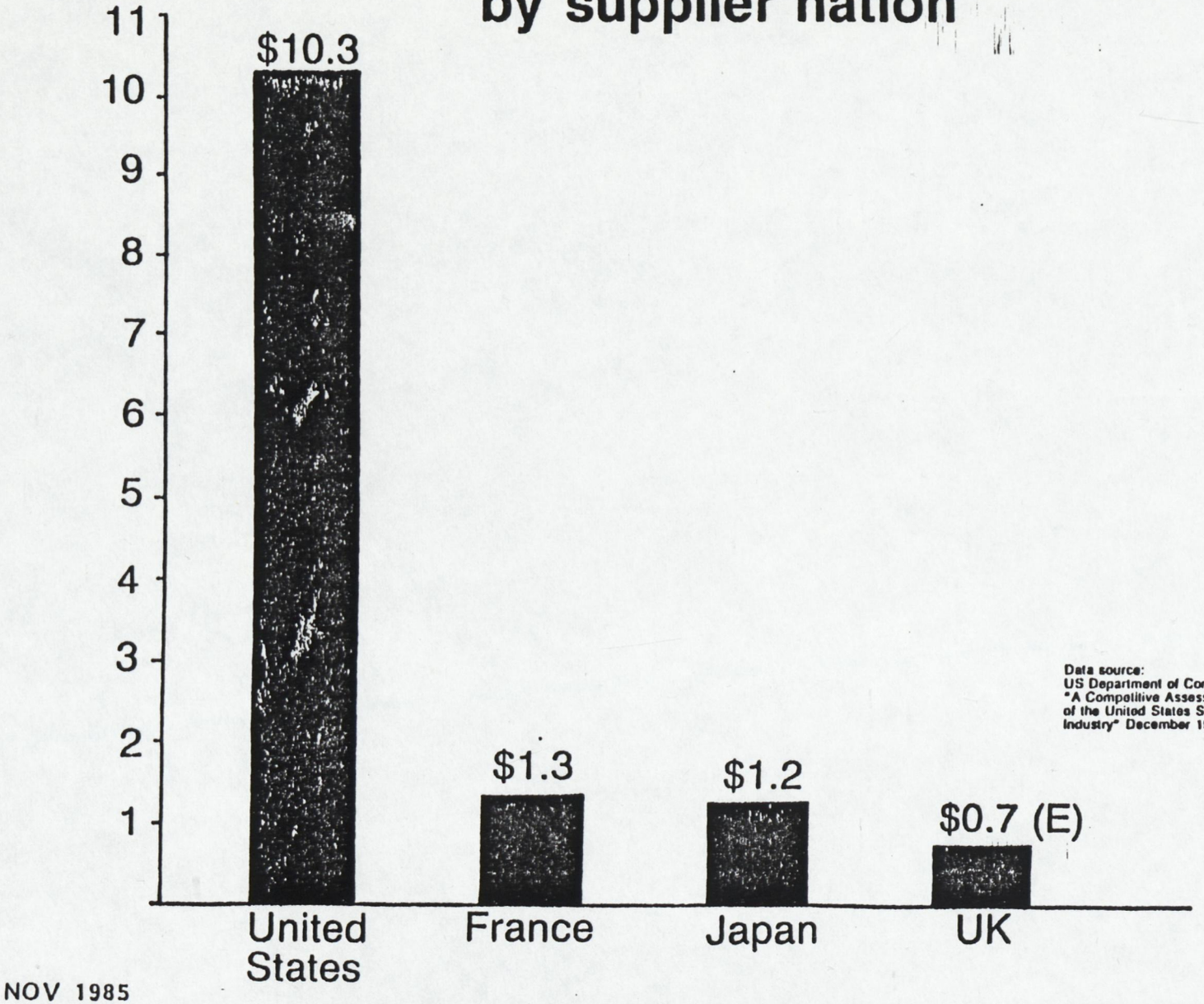
8 NOV 1985

VML 29518

Figure 4

ACARD

1982 Revenues of software industry by supplier nation



Data source:
US Department of Commerce
"A Competitive Assessment of the United States Software Industry" December 1984

Figure 5

8 NOV 1985

VML 29516

(c) UK Computer Hardware Companies

4.23 The UK has one major computer hardware company, ICL, which produces software for its range of hardware products. Recent years have also witnessed rapid growth of a number of other small hardware companies, based mainly on personal and home computers, for which a network of software supply firms has developed. A major consequence of the smallness of the UK hardware producer base is not only the loss of revenue on hardware sales but also on the systems software required to operate computer hardware.

(d) UK Software Houses

4.24 The leading UK computer software service companies are CAP, Centre File, Compower, Hoskyns, ISTEL, Logica, Scicon, Software Sciences, Systems Designers and Thorn-EMI. In 1984, these companies each had revenues in the region of £20-60 million. Collectively, these companies often are identified as the UK software industry, although, as indicated earlier, much software is produced by companies not identified as part of the UK software industry or is imported from the USA.

4.25 A major structural problem of the UK software industry is its fragmentation into many companies unable to generate sufficient revenues to undertake the development or marketing of new software products. Because of their small size, UK software houses are vulnerable to acquisition by major multinationals; two major UK software companies are now USA owned and more are likely to be acquired. We suggest that the sector is ripe for rationalisation into larger entities which are able to compete better with multinational companies.

4.26 The Computing Services Association, which includes most of the UK software houses, reported that in 1983 the computing services industry derived its revenues from:

28% processing (bureau)
18% bespoke (custom) software
18% total systems
12% consultancy
11% software products
13% other software

About 14% of the revenues of the software houses are derived from overseas sales.

4.27 The UK software industry has much to be proud of. It is growing faster and more profitably than almost any other sector in the UK economy (figure 6). Growth still is too low, however, if it is compared to the performance of the world software industry and the potential of the market to sustain higher growth. A combination of dynamism and protectionism by the USA, Japan and other nations poses a genuine threat to improvement of the UK's share of the world market. All of this emphasises the need for the UK software industry to rise to the challenge.

4.28 For the UK software industry to be profitable in the face of international competition it must:

* offer competitive prices, estimate development costs accurately, and deliver software on time and to budget - otherwise it will fail to win orders for bespoke developments or lose money on those orders it does win.

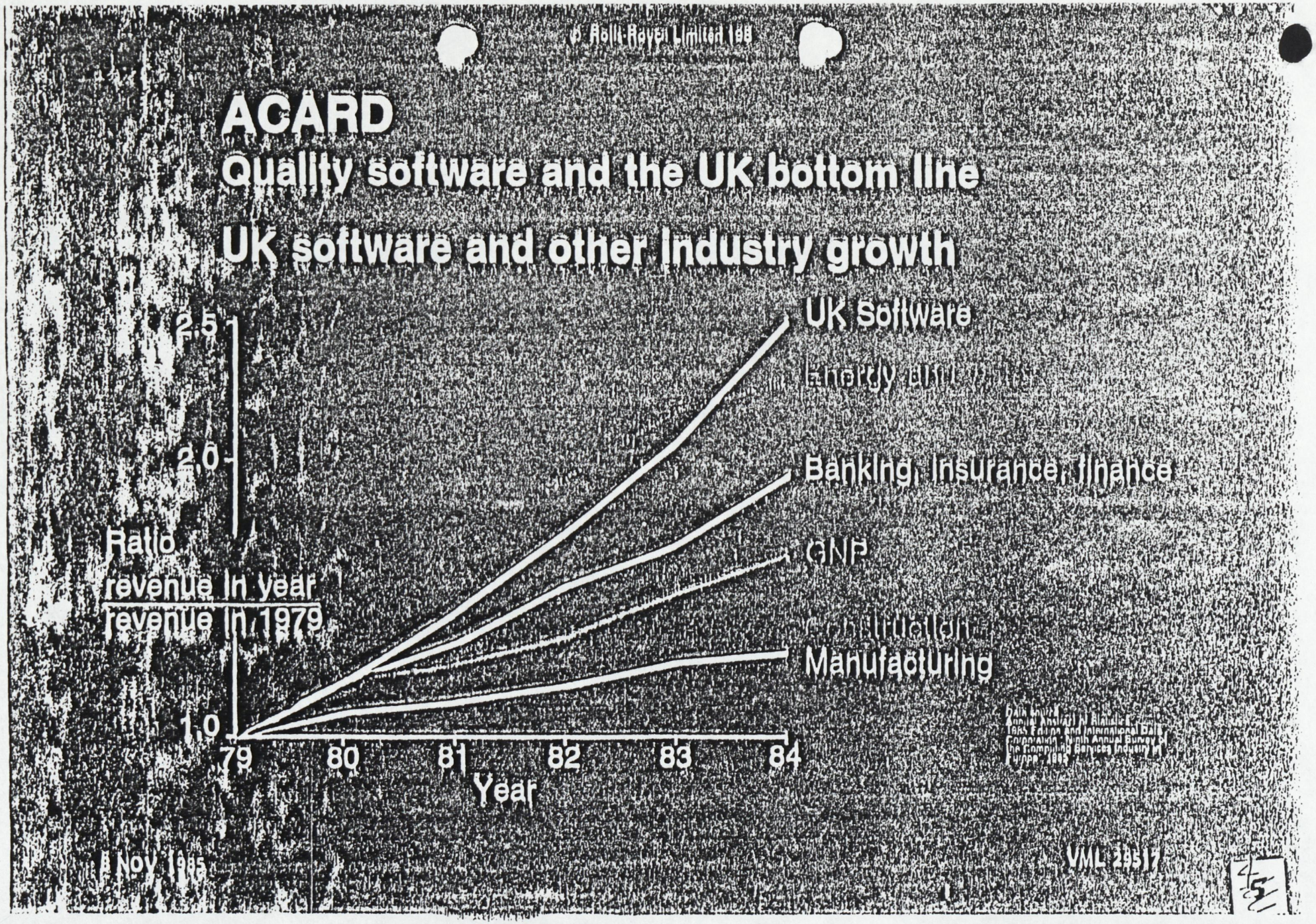

© Rolls-Royce Limited 198
ACARD
Quality software and the UK bottom line
UK software and other industry growth
UK Software
Energy and
Banking, Insurance, finance
GNP
Manufacturing
2.5
2.0
1.0
Ratio
revenue in year
revenue in 1979
79
80
81
82
83
84
Year
4 Nov 1985
VML 29517

Figure 6

* deliver software of high quality - otherwise it will fail to sell its products and fail to win orders for bespoke developments.

* respond quickly to changes in market demand for products.

4.29 Another problem of the UK software industry is that it does not collaborate sufficiently with hardware suppliers. In the USA, software companies keep close contact with computer hardware producers and, therefore, are in a position to offer ranges of products for new hardware in a timely fashion. UK software companies do not have this geographical advantage and one result is the heavy importation of USA software.

Appliers

4.30 The UK public and private sectors are customers for the software houses but are also major developers of applications software. Large electronics companies, such as GEC, Plessey, British Telecom, are a significant national force in the development of software. Other companies, eg Austin-Rover and BP, are significant spenders on software and have been instrumental in spinning off major software companies. Many UK companies appreciate the wider significance of their applications software but often have problems marketing it outside their normal operations.

4.31 Increasingly, companies with the capability to produce applications software, in-house, distinguish between strategic software which is necessary for their competitive edge and software of general applicability. General purpose software often can be developed more cost effectively from pre-written modules and packages than from 'scratch'. Opportunities exist for the software industry to produce these modules and the vital interface software.

Users

4.32 Practically all companies and organisations are software users. In the USA, major hardware and software companies show keen awareness of the needs of the user community in developing new products; for example, user groups and conferences are an important feature of the US industry. We consider that the relationship between user and supplier in the UK is not sufficiently close and recommend measures to rectify this problem.

4.33 In the case of small users of software, ignorance of methods for specifying, implementing, operating and maintaining systems is contributing to failure to benefit from small systems; this could become worse as users are driven to using more complex systems. The issues relating to the small producer and small user are, in some respects, a microcosm of the problem facing the whole industry. We commissioned a study by the National Computing Centre to focus on the issues relating to small users and suppliers of software. The NCC made a number of useful suggestions and proposals which we now urge them to follow up.

Customer Factors Limiting Innovation

4.34 The recent PREST report[4] about acceptance of new technology argues that "The structural and industrial implications of new information technology will be dependent on the willingness of consumers to accept the services they provide. It is apparent that acceptance is a gradual process in which consumers evaluate the performance and economic characteristics of IT."

4.35 "It is one matter for consumers to accept new IT products and services. It is quite another matter for these to be produced profitably by UK entrepreneurs. Acceptance is not a matter of consumer behaviour alone, but also a question of a balance between demand and supply. Effective supply depends upon a complex relationship between infrastructure, equipment and information services. The cluster of technologies and services which constitutes new technology contains within it several alternatives for satisfying latent needs for entertainment and information services."[4]

4.36 "A number of policy perspectives may be deduced:

* There is a need to stimulate a high rate of experimentation in the IT field

  In this context, the market mechanism is not only a means of allocating resources but also a framework for encouraging entrepreneurship by both consumers and producers. The high risks faced by initial entrepreneurs need explicit recognition as do the barriers to exploitation created by high and indivisible infrastructural costs. A policy of subsidy or support for experimental pioneers is necessary.

* Knowledge acquired by the consumer is the key to rapid acceptance

  Much can be done by Government to create awareness of IT services and technological opportunities. The analysis contained in this report[4] suggests the importance of identifying the needs of key innovatory groups and targeting campaigns specifically at them. A principal determinant of the relevant adopting population is the match between the performance requirements they impose upon a new technology and its level of technical performance.

4.37 Flexibility of policy should be the overriding concern if a framework for market experiments and consumer acceptance is to be encouraged. Policy makers must recognise the uncertainties inherent in technological competition to no lesser extent than the entrepreneurs on whose initiative the development of functional areas depends."[4]

User-Applier-Supplier Symbiosis

4.38 If a market is driven by technology push (supply side leadership) and customer pull (demand side leadership), then the rate of growth, innovation and application of innovation is driven by the technical expertise and vision of all three participants - users, appliers and suppliers. The UK has been slow to take up and apply IT innovations, even those which have been invented in the UK.

4.39 There is a need for improved communication and feedback between users, appliers and suppliers. The rate of circulation and spread of new ideas must be increased.

4.40 Only a technically aware market can demand innovation to set a pace commensurate with the rest of the world. Successful IT companies in the UK must be technically innovative, and supported by equally innovative, market demand at home.

4.41 Software companies need to become more product orientated. Market targeting requires symbiosis between users, appliers and suppliers.

THE UNITED STATES OF AMERICA

4.42 The USA software industry dominates the world; in 1983, it held 70% of the world market. Its leadership appears to be due to the predominance of USA hardware manufacturers, the entrepreneurial culture of the nation and the presence of a large internal market. USA hardware and software industries have restructured into large companies although there remain a significant number of small, independent companies. The small companies are constantly in flux; this may help maintain a dynamic industry which is responsive to change and willing to exploit innovations.

4.43 The USA software industry sees major opportunities for expansion. In spite of their dominance, they are making massive software investments in response to perceived threats from abroad, mainly from Japan.

4.44 Major USA software research and development initiatives have been established with public and private funding. Some are:

* The Microelectronics Computing Corporation (MCC), formed by twelve companies who have provided $120 million over five years, for a 15 year advanced software engineering programme.

* The Software Productivity Consortium (SPC), with about the same budget as MCC, was formed by twelve aerospace and defence companies to achieve technology transfer.

* The DOD Software Engineering Institute (SEI) is based at Carnegie Mellon University and will last at least 15 years with an initial $100 million over 5 years. SEI is 100% supported by the Department of Defense (DOD) and the major objective is technology transfer to DOD's suppliers; spin off into the civil sector is expected.

* The Strategic Computing Initiative which funds long term research.

* The ADA Joint Program Office which is concerned with promoting and controlling the ADA language.

* STARS activities which relate to software engineering technology for producing real time systems.

* The Strategic Defence Initiative (SDI) which will inject massive funding into computing and software.

JAPAN

4.45 Japan is following a strategy in software broadly similar to that used to achieve success in other markets, such as consumer electronics. Emphasis is placed on product enhancement in well-defined sectors; quality, image and competitive pricing are essential components to their products. Although the Japanese software industry started late, it is now the third leading supplier of software in the world.

4.46 A characteristic of Japanese software research and development is partnership between Government and industry. Duration of programmes is sufficiently long (10-15 years) to allow transfer of the results to industry; much of the research is carried out by subcontracting to industry. Japan has injected considerable public funds into software research and development:

* The fifth generation computing project has a budget of $450 million over ten years.

* The very high speed scientific computing systems project started in 1981 and will receive $200 million from MITI over five years.

* A major $100 million technology transfer programme, called SIGMA, to provide a national integrated project support environment for software producers.

FRANCE

4.47 The French software industry has become the leading software supplier in Europe and second in terms of world market share. Efforts have been made to ensure that the industry is export orientated and a quarter of total revenue is from export; the USA is their major customer.

4.48 An incentive to the software industry in France has been proposed by Government. This will allow increased depreciation of hardware used in the development of software and the accelerated write off of R&D expenditure.

4.49 Under the French five year Electronics Plan/Software Program, which started in 1983, $685 million will be provided by the French Government for research and development. The three year, $15 million, Mantis project began in 1983.

WEST GERMANY

4.50 The software and services market in West Germany was the second largest in Europe in 1984 at $2.4 billion. There has been a shift from bureaux services to software and systems; a number of new software houses have been established in this dynamic sector. Packaged software was the fastest growing sector at 34% accumulated growth in 1984 and accounted for 40% of the total software market.

SWEDEN

4.51 The Swedish IT industry was rationalised by the Government in the 1970s with subsidies of 450 million Swedish kroner. Reorganisation of the industry, identification of niches for exploitation and cooperation between government and industry have allowed effective competition with foreign competitors. For example, Sweden now is a world force in telecommunications.

4.52 In 1982 and 1984 the Swedish Government funded public computer awareness and literacy campaigns. A scheme was announced recently to allow 10,000 people per year to receive basic education in IT.

EEC

4.53 The countries of Europe have discussed ways of increasing collaboration to overcome the problem of fragmentation of the European industry and market. This is embodied in the Strategic Programme for Research and Development in Information Technology (ESPRIT). ESPRIT began in 1984, will end in 1989 and has a total budget of $645 million; $100 million has been earmarked for software development.

4.54 A European computer research institute was established recently in Munich through the collaboration of companies in the United Kingdom, France and West Germany. Initial funding is $15 million. Work will focus on software and networking techniques for fifth generation computer systems and is intended to complement ESPRIT.

OTHER COUNTRIES

4.55 It is known that other countries, for example, India, Korea, Taiwan and Singapore, are seeking to establish a presence in the world software market. A major advantage of such countries is lower labour costs in an industry which presently is labour intensive.

5. ANALYSIS : II. TECHNOLOGICAL DEVELOPMENT

THE ENGINEERING APPROACH

5.1 Software engineering is the application of sound scientific, mathematical, management, and engineering principles to the production of correct programs, on schedule, within estimated cost and at a competitive level of performance and price. An engineering approach to software must address all functions which relate IT to market needs and product support. Dependency on software is increasing in all sectors of the UK. Consequently, sound engineering practice, at all points in the software life cycle, is vital.

5.2 Software production is a difficult process to manage. Acceptable metrics for the productivity of software generation or for the quality of software products have not been devised. The difficulty of management reinforces the need for a sound engineering approach to software.

QUALITY

5.3 Computers are machines with a theoretical capability of performing perfectly. Their poor performance, in terms of quality and reliability, stems from the software which controls their behaviour. Software quality demands:

* fitness for purpose
* reasonable cost
* reliability
* ease of use in relation to those people who use it
* desirable maintenance and upgrade characteristics
* compares well against rival products.

5.4 High quality software presently demands labour intensive methods, such as formal review and exposure to the collective wisdom of experienced practitioners. Similar practices are essential in other engineering activities and their systematic application to software production would do much to improve software quality. Increased use of the best experience based techniques is vital.

5.5 Increasing use will be made of software modules and packages which will be integrated into specialised systems. Quality at this level is essential to ensure the quality of systems based on these components.

5.6 Mathematics promises a more rigorous and cost effective means of producing high quality software. The amount of science and mathematics which can be used to supplement human experience and reduce dependency upon human judgement is increasing. Many of the precise mathematical concepts appropriate to computer programming have been identified to the point where some classes of programs can be generated with the rigour of pure mathematics. The use of mathematically based techniques is likely to increase significantly in the next ten years as the accelerating research and development increase the rate of technology transfer. The take up of these techniques will be most profitably exploited by those companies who prepare their staff, in advance, with the appropriate mathematical education.

PRODUCTIVITY

5.7 In human terms, the investment in software is large; banks, for example, already have invested about 20,000 man-years of effort. With the existing burden of software maintenance and explosive growth in demand for new applications, massive improvements in productivity are required. The increasing cost of labour and shortage of skilled personnel suggests that requirements cannot be met by growth of staff.

5.8 Apparent increases in productivity are occurring already as users move to packaged systems, prototyping, 'fourth generation languages' and modular software. These approaches do not address productivity over the entire life cycle of software.

5.9 Significant and genuine increases in software productivity can be achieved only by an engineering approach.

5.10 Methods and tools have been created to assist software engineering; they are essential in large scale software projects. Benefits of using methods and tools, in any size project, are evident when specifying, producing, verifying and modifying systems. Methods and tools incorporate notations for describing the system, guidelines for producing descriptions and rules for verifying consistency and accuracy.

5.11 Current industrial use of methods and tools is not adequate. Many producers and users would benefit greatly from the immediate introduction of existing methods and support tools.

5.12 Integrated project support environments (IPSEs)[7] are a practical embodiment of accepted software tools and methods. The development and use of IPSEs should be encouraged. The IPSE concept is neither widely understood nor applied in practice. We believe that in-service education and training will help to address this deficiency and that IPSEs should form part of the UK's software research programmes.

5.13 Further automation of the development process is attractive as a valuable means of making better use of the available talent. This can be achieved by interactively checking the design details, and providing the designer with immediate analysis of the consequences of his design decisions. Important areas are mathematical techniques, measurement of software quality and estimation of software costs, timescales, and performance. These should be addressed by the UK's software research and development programmes.

5.14 Software developments and products must be documented. Correct, formal and complete documentation does not always receive sufficient attention from software developers. We believe that in-service education and training will correct this problem, in part. Tools for documentation should form part of the UK's software research and development programmes.

5.15 The Software Tools for Application to Real Time Systems (STARTS) initiative is intended to improve the quality of complex real time systems and to improve productivity of their productions. We believe that STARTS does not include enough participants from industry and government.

5.16 We welcome the work of the STARTS tools evaluation exercise but believe that this activity needs expansion. More cost-benefit studies are needed of the use of advanced software engineering techniques.

SKILLS, EDUCATION AND MOBILITY

5.17 Lack of understanding and awareness of software engineering principles in industry, at the highest levels, is a serious concern. "Some 10-20% of business expenditure (7% of GNP) is now for computers and software ... their optimum use is highly influential in the success or failure of an enterprise"[5].

5.18 We believe that widespread lack of competence in IT is a major cause of many of the problems associated with software in the UK. All staff involved with IT need a coherent appreciation of the subject. Experience, while absolutely necessary, is not sufficient in a technical field such as IT; education in the theoretical basis of the subject is necessary.

5.19 The UK has a well known shortage of IT skills at all levels. There is not time to wait for trained recruits to be produced by the education system. The only way to alleviate the shortage in a useful time frame (ie, 1990) is to educate and train members of the current IT population.

5.20 The UK tends to be poor at in-service training. Many firms are not prepared to spend any money on training; typical firms invest no more than one or two days per year per employee. In-service training tends to be only of immediate applicability.

5.21 Continuous and rapid technical change in IT means that those involved in the field require regular in-service education and training. Poor or obsolete technical skills and poor general IT awareness hampers not only the supply side; there is evidence to suggest that the demand side is constrained because users do not have the knowledge to exploit IT fully.

5.22 Employees need experience enhancement, as well as formal education and training. There is not enough interchange between academia, government service and industry. Mechanisms such as secondment and joint projects, used extensively in the Alvey Programme, are showing the benefits of this form of mobility.

5.23 Another skills problem in the UK is that of employee immobility. There is an underlying cultural reluctance to change jobs; this is damaging to a highly innovative industry. Immobility makes it difficult to obtain skills which may be available nationally, but not in certain areas, and makes it difficult for individuals to avoid technical insularity. Portable pensions, secondment and collaborative projects help reduce immobility.

5.24 It is essential that management understands the necessity of training and education in the IT field. Our message to management is:

* development of software, in terms of education, requires significant capital investment.

* computer professionals require frequent re-training because of the high rate of technical progress in software engineering .

5.25 The need for an engineering approach to software necessitates a fundamental change in approach which is not appreciated completely within the educational system. All levels of the system should emphasise software engineering in computer education.

STANDARDS

5.26 Regulations and standards may promote or inhibit growth of IT. Formulation of standards is a careful, detailed, tedious and time consuming process; it often is perceived as having little commercial value. The importance of standards often is underrated and the most competent people are not always involved.

5.27 Standards are vital to the UK IT effort. Other countries appear more adept at exploiting standards than the UK. This is done by promulgating national standards as international ones or by impeding foreign technology with counter-standards.

5.28 Commercial implications of standards can be considerable. Suppliers and users gain competitive leverage by intelligent and timely adoption or imposition of standards. Education can play an important role in achieving this goal.

5.29 Standards are a major technology transfer mechanism and contain considerable research content. Not enough support is given by the research community to standards nor do standards receive sufficient emphasis in educational curricula.

5.30 Increasing use is likely to be made of reusable software components which will be integrated into systems. Standards will be needed to ensure compatibility between software components and acceptability in the marketplace.

5.31 Support from all concerned is needed to ensure that UK representation is technically and politically successful in the standards arena. Industry must be prepared to play a leading role in standards making. Government must ensure UK strength in the international standards arena. Academics and researchers should be encouraged to participate in the development and teaching of standards.

5.32 Many IT standards have been based on a mixture of merely empirical knowledge and commercial self interest. Future standards should be based upon firmer scientific and mathematical bases, and with more consideration for the user of the standard and less for its supplier (see discussion in Appendix C).

6. ANALYSIS : III. THE ROLE OF GOVERNMENT

THE PUBLIC PIPELINE

6.1 The UK Government plays an influential role in all aspects of IT. Government influences:

* national IT policy
* national targets and expectations for IT developments
* national awareness and attitudes
* education and training
* public research and development
* public purchasing and procurement
* sponsorship and support of industry
* national and international regulations and standards
* the legal framework for the applications of IT.

6.2 Responsibility for these roles is split between many Government departments, including DTI, MOD, DES, DHSS, Home Office and CCTA. The IT roles played by government can be viewed as a pipeline which models the software industry (figure 7).

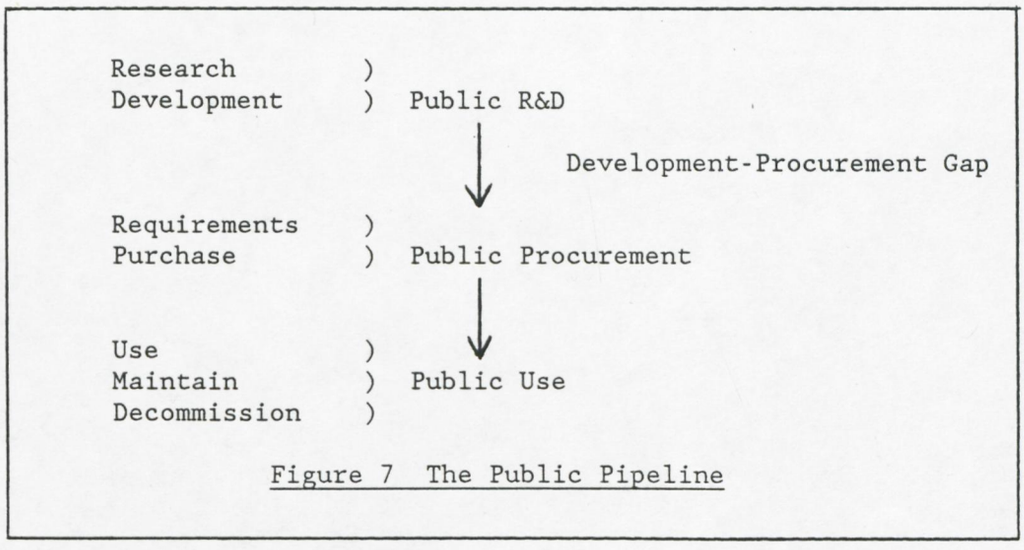


Figure 7 The Public Pipeline

6.3 Public funds finance almost all of the long term research in software engineering and novel applications. Thus government, directly or indirectly, controls the feedstock of the IT industry's pipeline. Much mention is often made of the rapid pace of innovation in software and IT. Some products often only have a lifetime of 2-3 years before they are superseded by some new innovation. It should be realised, however, that it often still takes 10-15 years for a novel idea to move from original conception to the product stage. The rapid product evolution is fuelled by the international scale and pace of the continuous Research and Development pushing through into the product domain.

6.4 This pipeline and the skills and infrastructure it represents take many years to build up; they need constant maintenance. If the flow is broken, by 'stop/go' funding of research for instance, then gaps in the product stream will occur. Such gaps cause firms to lose markets. These then cannot be recovered because it is either too expensive or impossible to win back these markets.

6.5 The need for long term continuity in research and development is recognised by America and Japan. In the UK there is a history of 'stop/go' funding and a fatal tendency to stop funding too soon after the initial stage of research. The UK tends not to push an idea far enough into development so that industry can have a suitable demonstration of the idea's worth, in order to justify further product development investment, or declare the idea demonstrably unsuitable for exploitation.

6.6 The Alvey Programme has been a major step forward in bridging the gap between academia and industry, between research and development. In 1983 Alvey was a 'go' force. Due to a lack of forward planning the momentum generated by Alvey is about to be lost as Alvey cannot fund new projects from 1986 onwards. Thus the feedstock of the pipeline is being 'stopped'. This is yet another example both of sporadic Government involvement and of UK inability to push research into development. Such discontinuities are extremely harmful to UK research and industry generally.

THE DEVELOPMENT - PROCUREMENT GAP

6.7 Government departments who sponsor research and development, such as DES and DTI, do not have major IT procurement requirements. Those departments who procure large quantities of IT, such as MOD and DHSS, do not sponsor much research which is not focussed on specific departmental requirements. There is no continuity of departmental support or involvement through the 'research and development to customer' pipeline. This discontinuity means that no one person or agency can 'champion' an idea from its conception through to commercial demonstration or availability. The formal and informal barriers between departments constitute the well known research-development and demonstration gap; they also form a development-procurement gap (figure 7). This renders impotent a major lever to help the IT industry; namely the imaginative use of public procurement to pull new ideas into the marketplace.

6.8 The Government's lowest compliant bid philosophy works against suppliers risking innovation, because innovation requires the costs of investment in tools, methods and training. Thus, stagnation and risk aversion pervade those sectors of the software industry which are dominated by Government procurement.

6.9 Lack of IT appreciation and skills is worse within Government than it is in Industry. This tends to make many Government attempts to support industry ineffective or even counter-effective.

6.10 There is neither widespread perception of a coherent UK IT policy nor of national targets. Views differ from forecasts of unlimited growth to forecasts of the UK becoming a 'slave' of international IT suppliers. National awareness of IT appears to lag behind other nations, in spite of action taken by government departments in recent years.

6.11 The UK's competitors are raising the stakes in the competition for the world IT market. Massive foreign government research and development programmes are backed by sensible public purchasing policies, effective technology transfer programmes, publicly assisted marketing and better educated populations. In the face of this competition, the UK must respond decisively if it is to meet these challenges.

7. RECOMMENDATIONS

STARTING : SOFTWARE TECHNOLOGY AND APPLICATIONS REVIEW TEAM OF INDUSTRY AND GOVERNMENT

7.1 The widespread application of soundly engineered software has the potential to enhance the national competitiveness of the UK. In this chapter, we make our main recommendations which we believe will maximise this potential. These main recommendations are divided between industry and government. In the three subsequent chapters we give more details about these main recommendations and make further recommendations. Chapter 8 contains the detailed recommendations for all industries and for the user, applier and supplier roles specifically. Chapter 9 contains the detailed recommendations for government; these are assigned to individual government departments. Chapter 10 contains detailed recommendations for the professional institutions.

7.2 Software is so important to the UK that the implementation and effectiveness of our recommendations must be regularly monitored against clear targets which we have provided. The organisations concerned must have a mechanism by which the recommendations and targets can be communicated. This mechanism must be responsible for performance evaluation on an annual basis. Feedback from the organisations must be part of the mechanism to allow adjustment of the recommendations and targets according to changing realities.

7.3 We recommend the formation of STARTING - the Software Technology and Applications Review Team of INdustry and Government. STARTING should:

* be comprised of outstanding individuals drawn from Industry and Government and academia, representing users, appliers and suppliers.

* submit to ACARD an annual report outlining progress towards the established targets and explaining any intentions to modify targets.

* convene a well-publicised, plenary annual general meeting of two days duration. The objectives of this meeting should be:

  - to provide an annual focus of publicity on the national importance of software

  - to report to the public on the past year's performance and overall progress towards the established targets

  - to communicate targets for the next year and the next 10 years

  - to invite papers and demonstrations pertinent to the goal of improving the UK's competitiveness by the development and application of software and software engineering

  - to provide an opportunity for formal and informal contacts between those involved in all aspects of software with a view to improving the user-applier-supplier, vertical market symbiosis and increasing the efficiency of the research-to-procurement public pipeline.

7.4 We recommend that the initial targets set by STARTING be:

* that the UK should have a software balance of payments surplus by 1995

* that UK-owned companies should, by 1995, supply:

  - 80% of bespoke/custom software produced in the UK
  - 50% of the new packages purchased in the UK
  - 30% of the systems software employed in the UK
  - 10% of the total world market for software

* that companies operating in the UK should, by 1990, increase their formal, in-service, software training to:

- Board and Senior Managers	1 week per year
- Middle Managers	2 weeks per year
- Technical IT staff	4 weeks per year
- Non-technical IT staff	2 weeks per year
- Other professional staff	1 week per year

MAIN RECOMMENDATIONS

7.5 Our main recommendations for Industry are:

* In-service training initiative for all users, appliers and suppliers

* Increased application of software to increase the competitiveness of the manufacturing and service industries.

* Marketing initiative for UK software products and services

7.6 Our main recommendation for Government is the formulation and implementation of a long term plan (TYPSSEA) for inter-departmental cooperation on:

* Public purchasing to exercise demand side leadership

* A new technology transfer initiative (BASSMATT)

* Better R&D planning

* In-service training initiative

MAIN RECOMMENDATIONS TO INDUSTRY

Training

7.7 The key to national success in both using and developing software is the effective education of those working with it. There is, at present, a low relevant educational attainment of most professionals involved in software. This problem has been recognised and measures have been taken to enable the UK educational establishment, in the long term, to meet the increasing needs of industry for staff trained in software technology and usage.

7.8 UK industry cannot afford to wait complacently for these recent changes in education to take effect. Industry must take responsibility for meeting its immediate needs. At present, UK industry makes insufficient investment in training those staff involved with software. Lack of training investment is blamed upon rapid obsolescence of training, perception of low cost effectiveness of training, high rates of staff wastage and those firms who "feed off" the training investments of others. Without the increased competence, effectiveness and productivity which training can provide, UK industry will find itself increasingly unable to deliver the software which it needs to compete.

7.9 We recommend that all sectors of industry using software increase their provision for in service training to meet the following annual targets:

* Directors, executives and senior managers receive one week of technical training.

* Managers receive two weeks of technical training.

* Technical IT staff receive three weeks of technical training; one week of business and marketing training.

Further discussion of the technical, business and marketing training is to be found in Appendix A.

7.10 There are significant benefits to be gained from following this recommendation:

* Many managers do not appreciate the importance of software to their businesses or understand the fundamentals of software; in-service training is a means of addressing this problem.

* Many programmers do not have an appreciation of the fundamentals of business, marketing or the importance of software to industry; in-service training can correct this.

* Many programmers and managers do not have an adequate mathematical and logical basis: unless this is remedied they will be unable to capitalise on the emerging software engineering techniques which are mathematically based. Such mathematical groundwork will be relevant for the rest of their careers and thus will bring a continuous, long term benefit.

* The rapid obsolescence of technical and managerial staff, even those properly educated at one time, is unavoidable in a dynamic field such as software; in-service training is a means of addressing this problem.

* The UK has a shortage of software skills at all levels; in-service training is a means for industry to "reskill" existing employees to meet this need.

* The scale of training requirements which the recommendations imply provide an opportunity to invest in producing cost effective training packages and delivery mechanisms.

Applications

7.11 In contrast to the technically competent base of indigenous software suppliers, UK industry has been slow to apply software to its business activities. Consequently, industry has lost considerable opportunity to enhance its competitiveness. As long as UK software efforts are led by suppliers, industry cannot realise the full benefits of IT. Industry must take steps to ensure that it is able to take advantage of software technology by applying it appropriately.

7.12 There is a close dependency between suppliers and users of software. Without the timely availability of suitable and cost effective applications software, many users will be unable to compete. Without user demand, software suppliers will not produce suitable products and, ultimately, will not prosper. It is unfortunate that UK software suppliers do not have effective collaboration with an indigenous, world ranked computer hardware industry. This means that they are not in the best position to offer new and timely software products based on new hardware. UK users are unable to capitalise on new hardware developments unless they turn to foreign software suppliers. Consequently, UK suppliers are in an inherently unfavourable competitive position. Because of this, application of software in specialist domains is particularly important to the health of UK software suppliers as well as users.

7.13 We recommend that the application of software by industry be accelerated. We believe that the following measures will be effective:

* In-service training will greatly assist the circulation of ideas and help create a dynamic climate of software application; a major goal of the training programme should be a substantial increase in the number of computer literate technologists who are capable of applying IT in their specialist knowledge domains. Details are given in para 8.1 and Appendix A.

* Increasing the rate of technology transfer and feedback between users and suppliers; this will be the task of the BASSMATT organisation (para 9.19).

Marketing

7.14 The marketing of UK software products and services is in urgent need of revitalisation. The success of some UK companies should not be depreciated, but such success often is related to exploitation of limited home market niches. Given the high technical competence and strong historical position of UK software suppliers, the present performance is disappointing. The increasing penetration of the UK home market by foreign suppliers is reason for extreme disquiet now that software is a vital part of the industrial fabric of the UK.

7.15 We have observed several problems:

* Comparatively healthy growth of some UK software suppliers obscures the fact that, overall, suppliers are losing international and home market share.

* The level of commitment and investment in marketing by UK companies falls far short of that of competitors.

* The UK has a poor image internationally.

7.16 UK software suppliers have not been notably successful in competitive international markets. This is because investment required to launch products is considerable, interaction with customers is difficult, costs of sales are high, competition is fierce and financial return results only from large sales volumes. As software becomes more of a commodity, both the cost and importance of marketing will increase.

7.17 The problems of marketing software cannot be solved easily but the rewards are high if they can be. The initiative must come from the software suppliers themselves but Government must show moral and financial commitment, as well. We believe that certain measures will be effective.

7.18 We recommend that UK software suppliers commit more effort and investment to publicity; this can be achieved by publications, public evaluations and participation in trade exhibitions; Government support is recommended for these activities.

7.19 We recommend that UK suppliers should collaborate in gathering market intelligence; the BASSMATT initiative (para 9.19) will be tasked with assisting this activity.

7.20 We recommend that UK companies should enter into partnerships with indigenous companies to penetrate foreign markets and to establish the necessary user-supplier relationships; Government support should be extended to such ventures.

7.21 We recommend that a sustained and substantial UK software image enhancement programme be launched at home and abroad; part of this should be the establishment of a "kite-mark" which indicates conformance to a high level of excellence (Appendix C); BASSMATT will be tasked with coordinating these activities.

MAIN GOVERNMENT RECOMMENDATIONS

TYPSSEA : Improving the Public Sector Software Pipeline

7.22 We recommend that government policies and actions on the promotion and development of software and its applications through awareness, education and training, sponsorship of industry, public purchasing, publicly funded research and development, legislation, regulations and standards should be coordinated by an inter-departmental, long term strategy. This strategy is provisionally named TYPSSEA - the Ten Year Pipeline Strategy for Software Engineering and Applications.

7.23 TYPSSEA should have four main elements:

* Public purchasing to exercise demand side leadership

* Technology transfer acceleration

* Public sector R&D continuity

* Public sector in-service training

7.24 TYPSSEA should be seen as a way of making the departmental interdependencies more visible, and of enabling all departments to see their roles in the public pipeline (para 6.1) as well as their own specific responsibilities.

7.25 TYPSSEA should be used as a way of representing a coherent government contribution to the STARTING mechanism.

Public Purchasing and Procurement

7.26 We recommend that all Government departments use their purchasing power to exercise demand side leadership. This should deliberately pull through new ideas already in the 'Public Pipeline' (para 6.1) and should help achieve the STARTING targets for the development and application of software.

7.27 We recommend that the principle of lowest cost bid for software development and purchase be replaced by a more flexible policy incorporating the following objectives.

* Whole life cycle costing instead of lowest construction cost bid

* Stimulus for product innovation

* Encouragement for the first use of new methods, tools and skills

* Export orientation

* Encouragement for the construction and use of re-usable software components

Technology transfer

7.28 Technology transfer is the vital stage in the public pipeline where new ideas sponsored by publicly funded R&D need to be helped across into the industrially funded product development and exploitation stages. The UK has created for itself something of a development gap which impedes the exploitation of good UK research. Further, both the industrial and government sectors have no obvious single place to which they can look for advice on emerging software technology. In contrast to the USA's SEI, MCC and SPC (para 4.44) and Japan's ICOT; the UK has no single organisation whose remit is technology transfer and which possesses the resources to do this vital job. The pace of technology transfer should be accelerated.

7.29 We recommend that Government set up a new technical organisation, provisionally named BASSMATT, which is to be a technology transfer organisation, similar in concept to the USA's Software Engineering Institute (para 4.44). BASSMATT should be a physical concentration of technical skills to give a national focus for software engineering and applications technology transfer. It should also provide DTI, MOD and other departments, with the much needed technical muscle to implement TYPSSEA.

7.30 BASSMATT stands for British Advisory Service for Software Marketing, Applications, Training and Technology transfer.

Public Sector Research and Development

7.31 The majority of software engineering research is public sector funded. R&D is an essential part of the 'public pipeline'; it is the source of new ideas and, vitally, it is the main source of intelligence about overseas research.

7.32 Individual departmental budgets are too small to compete with the massive funding of America and Japan. Only by inter-departmental cooperation, and informed selectivity, can UK research and development keep pace with our international rivals.

7.33 The need for long term continuity in research and development is recognised by our international competitors. The UK has a history of 'stop/go' funding which causes serious losses of efficiency, ideas, morale and highly skilled people.

7.34 We recommend that, through the TYPSSEA plan, coordination of research funding should:

* prevent discontinuities in funding, thus giving researchers enough lead time to plan properly for expansion, contraction or direction changes

* quickly answer the question 'what happens after Alvey?' to avoid another discontinuity

* increase collaboration on R&D between industry, government and academia.

Training

7.35 The public pipeline requires skilled manpower at all levels and in all roles if it is to function efficiently. The IT skills shortage in industry has drained the public sector of most of its skilled IT manpower. This lack of skill seriously affects the quality of work, advice and decision making in the public-sector today.

7.36 We recommend that the public sector implements a programme of in-service training similar to that recommended for industry and with similar targets.

CONCLUDING REMARKS

7.37 The manufacturing and service industries face stiff international competition. The wider use, application and development of software will enhance their competitiveness. The software supply industry, too, faces competition from large and dynamic overseas companies who are looking to dominate the UK and world markets. The continued high rate of growth in this market means that the 'window of opportunity' is still open for UK companies to grow further in world terms.

7.38 We believe that the prompt and vigorous implementation of our recommendations should give the UK a dynamic and efficient pipeline of software engineering and applications, allowing the UK's highly innovative technology 'push', to be 'pulled through' to win increased market shares by an enlightened demand-side leadership, facilitated by the skills acquired through in-service training.

8. DETAILED RECOMMENDATIONS TO INDUSTRY

IN-SERVICE TRAINING (USERS, APPLIERS, SUPPLIERS)

8.1 The primary industrial recommendation of this entire report is that industry initiates urgent action to update and enhance the skills of its existing workforce. This remedial action should be followed by a continuous programme of career-long, in-service training for all grades and types of staff.

8.2 The key to national success in both using and developing software is the effective education of those working with it. There is, at present, a low relevant educational attainment of most professionals involved in software. This problem has been recognised and measures have been taken to enable the UK educational establishment, in the long term, to meet the increasing needs of industry for staff trained in software technology.

8.3 UK industry cannot afford to wait complacently for these recent changes in education to take effect. Industry must take responsibility for meeting its immediate needs. At present, UK industry makes insufficient investment in training those staff involved with software. Without the increased competence, effectiveness and productivity which training can provide, UK industry will find itself increasingly unable to deliver and deploy the software which it needs to compete.

8.4 Our recommendation is that all sectors of industry using software increase their provision for in service training to meet the following annual targets:

* Directors, executives and senior managers receive one week of technical training.

* Managers receive two weeks of technical training.

* Technical IT staff receive three weeks of technical training; one week of business and marketing training.

Further discussion about in-service education and training is contained in Appendix A.

8.5 There are significant benefits to be gained from following this recommendation:

* Many managers do not appreciate the importance of software to their businesses or understand the fundamentals of software; in-service training is a means of addressing this problem.

* Many programmers do not have an appreciation of the fundamentals of business, marketing or the importance of software to industry; in-service training can correct this.

* The rapid obsolescence of technical and managerial staff, even those properly educated at one time, is unavoidable in a dynamic field such as software; in-service training is a means of addressing this problem.

* Many programmers and managers do not have an adequate mathematical and logical background; unless this is remedied they will be unable to capitalise on the emerging software engineering techniques which are mathematically based. Such mathematical groundwork will be relevant for the rest of their careers and thus will bring a continuous, long term benefit.

* The UK has a shortage of software skills at all levels; in-service training is a means for industry to 'reskill' existing employees to meet this need.

* The scale of training requirements which the recommendations imply provide an opportunity to invest in producing cost effective training packages and delivery mechanisms.

8.6 We recommend that the software producers in industry cooperate with the Department of Trade and Industry STARTS software tools initiative and the STARTS Public Purchasing Group to exploit the benefits of in-service training by using STARTS/PPG backed contracts to install and try out new tools and skills; and to report on and share the knowledge about their success or failure.

USE OF SOFTWARE (USERS, APPLIERS, SUPPLIERS)

Increased Rate of Application

8.7 In contrast to the technically competent base of indigenous software suppliers, much of UK industry has been slow to apply software to its business activities. Consequently, industry has lost considerable opportunity to enhance its competitiveness. As long as UK software efforts are led by suppliers, industry cannot realise the full benefits of IT. Industry must take steps to ensure that it is able to take advantage of software technology by applying it appropriately.

8.8 There is a close dependency between suppliers and users of software. Without the timely availability of suitable and cost effective applications software, many users will be unable to compete. Without user demand, software suppliers will not produce suitable products and, ultimately, will not prosper. It is unfortunate that UK software suppliers do not have effective collaboration with an indigenous, world ranked computer hardware industry. This means that they are not in the best position to offer new and timely software products based on new hardware. UK users are unable to capitalise on new hardware developments unless they turn to foreign software suppliers. Consequently, UK suppliers are in an inherently unfavourable competitive position. Because of this, application of software in specialist domains is particularly important to the health of UK software suppliers.

8.9 We recommend that the application of software by industry be accelerated. We believe that the following measures will be effective:

* In-service training will greatly assist the circulation of ideas and help create a dynamic climate of software application; a major goal of the training programme should be a substantial increase in the number of computer literate technologists who are capable of applying IT in their specialist knowledge domains.

* Increasing the rate of technology transfer and feedback between users and suppliers; this will be the task of the BASSMATT organisation (para 9.19).

Process Innovation

8.10 The manufacturing and service industries need to apply IT more to:

* the products they produce
* the services they offer
* the processes by which they design and produce goods and services

8.11 Process innovation covers a huge range from automated banking tellers, office automation, computer aided design and manufacture through to computer aided navigation for motor vehicles.

8.12 Technology transfer from the software research and development community into the applier/user community is of key importance in aiding the manufacturing and service industries to compete with nations such as America and Japan who have dynamic IT industries operating symbiotically with their other industries.

Product Innovation

8.13 The world market for software products and packages is the most rapidly growing sector of the software market. Only the income streams from ongoing sales will generate enough revenue to finance the R&D and capital investment needed to stay competitive in the world market. Thus we suggest that much more effort needs to be directed towards building software products and packages.

8.14 The best source of innovative ideas for new software products is to be found amongst the users and appliers in the manufacturing and service industries because they are best placed to recognise a generic problem capable of software solution.

8.15 Suppliers and appliers/users should cooperate much more. Those software services companies who have built up expertise in particular applications areas are well placed to move into the products market and should do so. Bespoke software should be built with reusability, product spin-off and export potential in mind.

Exporting

8.16 All software should be built with the possibility of export sales in mind. Designers can, for little increase in cost or complexity, make tailoring for overseas markets much easier by for example:

* parameter driven user interface dialogues so that the natural language of the user can be easily switched. (Don't build English error messages into the code!)

* parameter driven methods for such things as units, eg imperial and metric weights and measures.

* parameter driven handling of currencies so that packages may operate with any designated local and foreign currencies.

* parameter driven standards, eg design rule checker should be able to switch between BSI/DIN/ANSI/ISO versions of requirements if overseas market requirements are country specific, eg electrical regulations.

Several of the above suggestions are related to the human-computer interface. Much greater attention needs to be paid to producing software products with better end user interfaces than present offerings. Interfaces which are tailorable to different nationalities are one example. End users have differing levels of computer literacy, differing levels of application domain skills, differing educational and cultural backgrounds. Careful consideration of the end users' problems, requirements and skills will help software designers to produce more usable, and hence more successful, products.

Investment

8.17 The user/applier communities in manufacturing and service industries must increase their investment in software to stay competitive. This capital investment will only give a good return if it is accompanied by a proper level of in-service training and tools investment. Software is not a magic black box technology. It embodies the competitive edge for many activities and so requires continuous update and improvement.

8.18 The software appliers and suppliers will, in the next 10 years, see software engineering move from being labour intensive in the 1970s to being very capital intensive from 1990 onwards. Capital investment will be required to raise the amount of computer power per software engineer significantly. The UK is already behind the USA in this respect. Capital investment will be needed for the new software tools which are becoming available. The larger overseas suppliers are building Integrated Project Support Environments and Information Systems Factories[7] facilities; these are large investments.

8.19 Stocks of reusable software components must be built and maintained; this will require investment. The development of products from these components will require significant investment as will, most of all, the marketing of these products. Again, such investments will only be profitable if accompanied by a continuous programme of in-service education and training.

Report to Shareholders

8.20 We recommend that all user, applier and supplier companies, indicate, in their annual reports to shareholders, the progress they have made in training their workforces in IT skills; the investment made in improving their production processes via IT; the new products they have brought to market which exploit IT; and the overall investment made in software and IT.

MARKETING (APPLIERS, SUPPLIERS)

8.21 The marketing of UK software products and services urgently needs to be revitalised. Whilst the success of some UK companies should not be depreciated, such success is often related to the exploitation of a small market niche or sector. There are many such market opportunities, particularly in the international market-place. In general, the UK software industry is failing to take advantage of them.

8.22 The following problems need to be addressed in order to achieve the goals set out in our main recommendations:-

* An apparently healthy growth rate in the individual companies obscures the fact that the UK software industry is losing market share, both at home and abroad.

* Internationally, UK software products and services suffer from lack of image. International customers do not perceive any advantage to 'buying British'.

* UK software products and services do not satisfy the needs of the international market-place.

* The up-front investment required to introduce a new product into overseas markets is substantial. The costs of sales are significantly higher in the key USA and Japanese market-places than at home. Competition is fiercer, and return on investment results only from sales volume and follow-on business.

8.23 The problems for the software services industry are particularly acute, resulting from the obvious difficulties of interacting directly with overseas customers. This sector will need to become more strongly based on packages and reusable components.

8.24 We believe that the level of investment in marketing by UK companies falls far short of that of our competitors, and that the industry suffers accordingly. The following table, taken from a recent report by the US Department of Commerce[3], shows how USA personal computer software companies allocate their return on revenues.

Marketing	35%
Management	20%
Production	15%
R&D	15%
Profit	15%

8.25 UK software companies need to take a much more positive attitude to marketing, particularly in the international market-place. The initiative must come from the individual companies, but Government must show commitment to back this up with the support identified in our various recommendations.

8.26 We recommend that a sustained and substantial UK software image enhancement programme be launched at home and abroad; part of this should be the establishment of a 'kite-mark' which indicates conformance to a high level of excellence (Appendix C); BASSMATT should be tasked with coordinating these activities (para 9.19).

8.27 We recommend that more effort should be put into the support provided by UK embassies. The commercial and scientific attaches should be fully and regularly briefed, and should be made very aware of the new value and significance that the UK places on its software industry.

8.28 We recommend that UK software companies commit much more effort into creating product awareness. This can be achieved by placing technical and marketing articles in the international trade journals, by ensuring that third party reviews and evaluations are carried out and published, and by participating in international trade shows and exhibitions. UK software must be seen to stand up well to international competition.

8.29 We recommend that UK software companies should collaborate with each other in gathering market intelligence. BASSMATT (para 9.19) should help with this task.

8.30 We recommend that UK companies should enter into partnerships with indigenous companies to penetrate foreign markets and to establish the necessary user-supplier relationships; Government support should be extended to such ventures.

8.31 Special effort needs to be put into identifying new market areas. Government incentives should be provided to encourage the development of products in these areas. Such product development should be based on proven R&D, which is the subject of separate funding. The task is to bring a substantial idea (often embodied as a computer program) to the level of maturity and packaging that it becomes an effective and easy to use tool in the hands of the customer. It must also improve the customer's productivity in some way, and be competitive. Areas for the future include value added networks, man-machine interaction, the electronic office, process control software, integrated CAD/CAM systems, and on-line databases. Products which take a systems approach and exploit the new technology should be particularly encouraged. EUREKA and the DTI 'commercial demonstrator' (para 9.17) scheme should provide valuable stimuli to this objective.

8.32 It is our opinion that a disproportionate amount of effort is being applied to bespoke software, to the detriment of software products. The dependency on bespoke Government contracts can only make matters worse. The software industry needs to take a speculative approach by developing families of compatible modules, which can be assembled into products, or, with little extra effort, be tailored to fit bespoke requirements. Marketing has a significant role in the specification of such families and the de facto international standards they must meet.

RESEARCH AND DEVELOPMENT (APPLIERS, SUPPLIERS)

8.33 In our opinion industry must do much more short and medium term R&D. This increased activity, together with in-service training, will give a more vigorous and expert base from which to develop products, and to import new long term work from academia, thus greatly reducing the technology transfer gap.

8.34 Medium term work should be carried out collaboratively with academia and with other UK and European industrial partners to share the costs and make best use of limited, high calibre talent.

RESTRUCTURING (SUPPLIERS)

8.35 The UK supply industry is showing typical UK insularity in the way it remains fragmented. Small companies, though growing, are expanding less rapidly than the world market and are not generating the revenue to finance the right level of R&D and marketing.

8.36 Such companies show a marked reluctance to merge into larger units, be absorbed into larger industrial groups or to collaborate in attacking export markets. So divided, they will be conquered. The UK software suppliers must be prepared to cooperate more both between themselves and with the user/applier industrial sectors.

8.37 Most UK software houses are too small to tackle world markets. If they continue to compete with each other for the home market then we foresee that the large American companies will either take them over or just take over their market share until only the MOD market is available to the surviving UK companies.

8.38 The UK suppliers must restructure into larger internationally competitive units. We are not in favour of direct government action to achieve this; however, if this restructuring does not occur naturally, and soon, then our pessimism will likely be justified.

8.39 We suggest that the industry should see itself as the UK component of the European struggle against American and Japanese competition.

9. DETAILED RECOMMENDATIONS TO GOVERNMENT

THE NEED FOR INTER-DEPARTMENTAL COOPERATION AND COORDINATION

9.1 Previous chapters referred to the multiplicity of ways in which government affects the development and application of software, software engineering and IT generally. These include

* national policy
* national targets and expectations for IT development
* national awareness and attitudes
* education and training
* public sector research and development
* public sector purchasing and procurement
* sponsorship and support of industry
* regulations and standards, national and international
* the legal framework for the applications of IT

9.2 Responsibility for these activities is split between many government departments, including DTI, MOD, DES, DHSS, Home Office and CCTA. This spread of responsibilities for the advancement of developments and applications of IT does not seem to us to provide a coherent framework for policy making for such a nationally important subject. Decisions on one aspect of IT may have repercussions in a very different area. We believe that it is necessary that all factors which will influence the development and application of IT in the national interest should be studied together, and that Departments' plans and actions are co-ordinated and monitored.

9.3 There is also the difficulty that costs and benefits from the introduction of IT systems can fall to different government departments. Separate financial targets and accounting systems do not easily allow the redistribution of costs and benefits. Projects where the net national benefit would be substantial may not then come to fruition. There is need for a system of project cost and benefit distribution which can overcome departmentalism.

9.4 We believe that a focal point is necessary, in view of the number of organisations involved, to improve awareness in government, to promote a programme covering both projects and publicity, to improve internal communications and provide necessary couplings, to avoid delays, and to create a positive public consciousness of IT. There is a need to make existing United Kingdom efforts more coherent.

TYPSSEA: IMPROVING THE PUBLIC SECTOR SOFTWARE PIPELINE (ALL DEPTS)

9.5 We recommend that government policies and actions on the promotion and development of software and its applications through awareness, education and training, sponsorship of industry, public purchasing, publicly funded research and developmnet, legislation, regulations and standards should be coordinated by an inter-departmental, long term strategy. This strategy is provisionally named TYPSSEA - the Ten Year Pipeline Strategy for Software Engineering and Applications.

9.6 TYPSSEA should have four main elements:

* Demand side leadership through public purchasing

* Technology transfer acceleration

* Public sector R&D continuity

* Public sector in-service training.

9.7 These four elements are the major stages in the public 'research-to-customer' pipeline (para 6.1). TYPSSEA should be a long term strategy in which the departments associated with the pipeline form a series of joint targets and plans to increase the efficiency of the pipeline. Cooperation should occur through the use of public purchasing power to pull through new applications and development methods into commercial use; through the proposed technology transfer organisation to accelerate the pull through to commercial demonstration of new methods, tools and applications and push them towards commercial use; and collaboration on R&D planning to eliminate the discontinuities in R&D funding, whose 'stop/go' effect seriously damages the vital work of generating the staff and ideas which form the pipeline's feedstocks.

9.8 We suggest that the DTI take the lead in bringing TYPSSEA into operation as DTI has overall responsibility for the health of the manufacturing and service industries, and in particular the software and IT industries, ie most of the industries involved in the pipeline. Also, as a member of the Alvey Programme, DTI is well placed to help liaise with MOD, DES, industry and academia in the research and development areas.

9.9 TYPSSEA should be seen as a way of making departmental interdependencies more visible, and of enabling all departments to see their roles in the public pipeline as well as their own specific responsibilities.

9.10 TYPSSEA should be used as a way of representing a coherent government contribution to the STARTING mechanism.

9.11 TYPSSEA should be used by purchasers to plan their major projects with a better knowledge of the emerging technology; it should allow the R&D agencies the opportunity to recommend new innovations to the purchasers; it should allow purchasers to influence the R&D programmes so that relevant applications problems are tackled; it should allow various departments to improve long term manpower planning; it should allow the influence on procurement of education and training policies and curricula to be recognised (as when new recruits move up the management hierarchy to influence purchasing policy).

PUBLIC PURCHASING AND PROCUREMENT (ALL DEPTS)

9.12 We recommend that all Government departments use their purchasing power to exercise demand side leadership. This should deliberately pull through new ideas already in the 'Public Pipeline' (para 6.1) and should help achieve the STARTING targets for the development and application of software.

9.13 We recommend that the principle of lowest cost bid for software development and purchase be replaced by a more flexible policy incorporating the following objectives.

* Whole life cycle costing
  Software projects, especially large ones, take several years to develop a product which then stays in service for 10-20 years but undergoes continuous modification. For software the in-service maintenance costs can be much greater than the initial construction costs if the initial design is done on a lowest cost basis. An increase in effort at the design stage can have massive savings over the whole life cycle. The purchasing departments and the Treasury should therefore adopt life cycle costing for software. This will result in better 'value for money' overall.

* Stimulus for product innovation
  Purchasing departments should look beyond their own immediate requirements to see if their specifications can be used to pull through new ideas in the public pipeline which have a broader market than just the purchasing department.

* Encouragement for the first use of new methods, tools and skills.
  At some small additional cost the purchasing departments can pull through the emerging new techniques of software engineering and demonstrate their effectiveness. If such new techniques are encouraged by the purchaser then industry will be encouraged to invest in the new tools and training.

* Export orientation
  Purchasing departments should ensure that their specifications are not parochial to the UK thereby eliminating the export opportunity. Specifications should be explicitly formulated to deliberately encourage export, eg multiple currency facilities (£,$,DM) ISO not just BSI standards; multiple natural language version potential for NATO and European use; ADA not CORAL (see para 8.16 'exporting').

* Encouragement for the construction and use of re-usable components
  Purchasing departments should encourage the construction of software which can be re-used on later projects. This will require some additional cost on any specific project but over time will lead to the spin-off creation of a national asset base of re-usable components. Industry can then exploit these reusable components to reduce the cost of subsequent public contracts and win new non-public contracts. Re-use is an important software engineering technique which requires demand side leadership to pull it through into commercial practice.

9.14 We recommend that all government departments purchasing software should join the existing STARTS Public Purchasers Group. The STARTS/PPG should expand its term of reference to include all types of publicly purchased software. The STARTS/PPG should receive additional resources to improve on the good work already achieved. The STARTS/PPG should lead the drive towards public purchasing specifications for software projects which encourage:

* whole life cycle costing
* public pipeline pull through of new product ideas and process innovation
* export orientation
* re-usable component construction
* first use of new tools and techniques
* new in-service training courses to improve skill levels.

9.15 We recommend that the STARTS/PPG should work to improve the dialogue between customers (users and appliers), suppliers and researchers. This should improve the effectiveness of demand side leadership by giving early notification of public requirements, expanding on the long term targets set by STARTING. It should also improve the demand side's knowledge of what is in the research and supply side pipeline - the technology push component. A general improvement in the flow of information between the demand side and the supply side should improve the rate of development of both the supply industry and the user departments.

9.16 We recommend that the remit and resources of the STARTS Public Purchasers Group be expanded to allow the major private sector purchasers to join STARTS/PPG and that the STARTS/PPG's remit be widened to include all classes of software not just 'real time' applications.

9.17 We recommend that public purchasing power be used to fund two types of 'demonstrator' project: the research demonstrator and the commercial demonstrator (see figure 8). These demonstrators should increase the flow of the pipeline from research to product and help counter the UK tendency to fail to bring good ideas up to the demonstration stage.

9.18 We recommend that UK procurement be seen in a European context and be used to further the development of European software and IT industries.

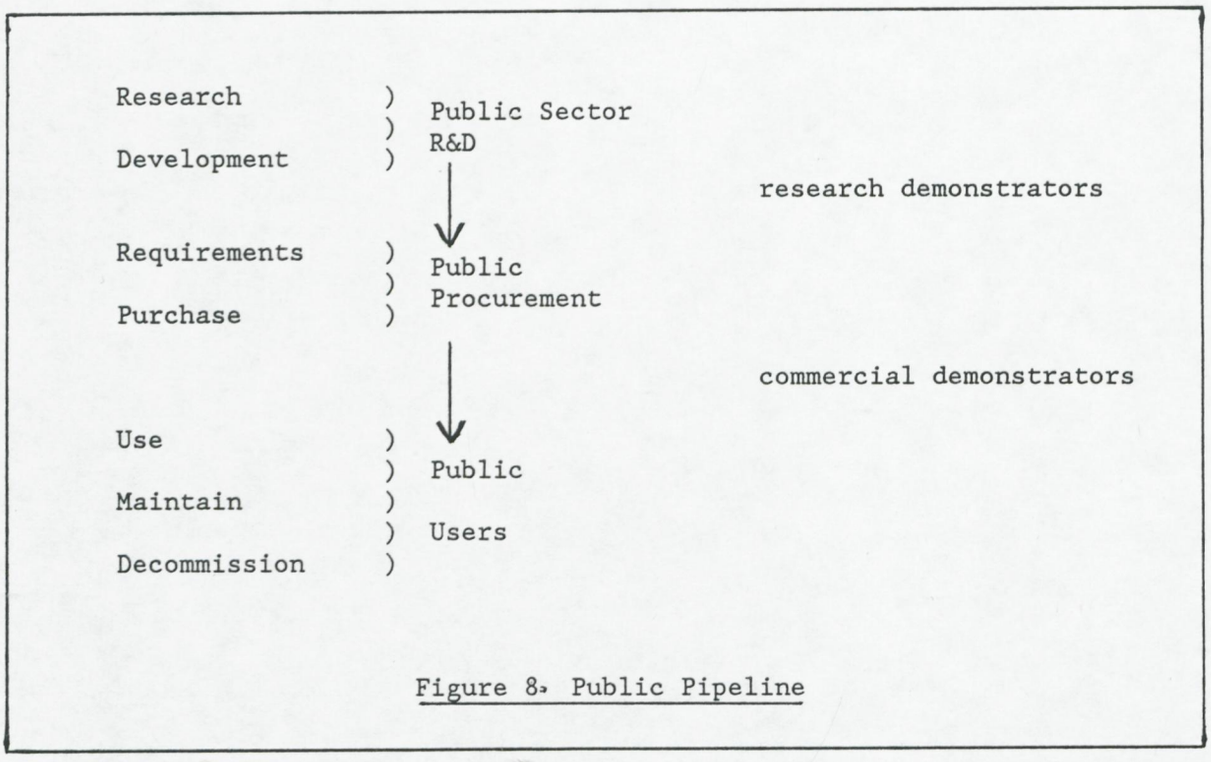


Figure 8. Public Pipeline

TECHNOLOGY TRANSFER (ALL DEPTS)

9.19 It is much more expensive to market a product internationally than just to develop it. It is much more expensive to develop a product than to do the originating research. Technology transfer is the vital stage in the pipeline where new ideas sponsored by publicly funded R&D need to be helped across into the industrially funded product development and exploitation stages. The UK has a development gap which impedes the exploitation of good UK research. Further, both the industrial and government sectors have no obvious single place to which they can look for advice on emerging software technology. In contrast to the USA's SEI, MCC and SPC (para 4.44) and Japan's ICOT, the UK has no single organisation whose remit is technology transfer and which possesses the resources to do this vital job.

9.20 We recommend that government set up a new technical organisation, provisionally named BASSMATT, which is to be a technology transfer organisation, similar in concept to the USA's Software Engineering Institute (para 4.44). BASSMATT should be a physical concentration of technical skills to give a national focus for software engineering and applications technology transfer. It should also provide DTI, MOD and other departments, with the much needed technical muscle to implement TYPSSEA.

BASSMATT: Technology Transfer Acceleration

9.21 One of our major recommendations to government is the formation of a technology transfer organisation, provisionally called BASSMATT, the British Advisory Service for Software Marketing, Applications, Training and Technology transfer.

9.22 BASSMATT should provide a national focus for software engineering and its applications. It should be modelled on the USA's SEI (para 4.44) in terms of scale and quality. It should be located in 'software valley' (the M4 corridor), the heart of the software industry.

9.23 BASSMATT's functions and effort should be as follows:

* (30%) Technology Transfer
* (25%) Independent technical advice
* (15%) Marketing Support
* (15%) Collaborative Research
* (10%) 'After Alvey' Programme support and collocation
* (5%) STARTING and TYPSSEA support

Technology Transfer (30%)

9.24 BASSMATT should speed the flow of technology transfer between the use/applier/supplier communities of manufacturing and service industries, the IT and software industries, government departments and academia. The following activities are suggested:

* Disseminate information via reports, seminars, newsletters, electronic databases, electronic-mail, bulletin boards etc

* Actively demonstrate state-of-the-art tools and products (the 'showcase environment'). BASSMATT should have an in-house Integrated Project Support Environment (IPSE) acting as a Software Production Centre (see below) and a Software Reusable Components Brokerage (see below) as suggested in the Alvey Report[7].

* The Software Production Centre (SPC) should not be a research project but the latest IPSE technology functioning as a working software factory. This will enable organisations to try out new techniques 'for real' in order to make a better selection and case for their own in-house investment. The SPC will be a 'showcase' of the best software engineering methods and tools.

* The Software Reusable Components Brokerage (SRCB) should be a database holding requirements, specifications, code, test data, documentation etc. Components should be collected from publicly funded projects and be made available to other such projects, thereby exploiting the benefits of the public purchasing recommendations encouraging the funding of reusable components (para 9.13). The SRCB's facilities should be made available via a communications network (this will be a driver to resolve various important issues such as security and licensing for such a new distribution technique).

* The SPC/SRCB/IPSE will be located at the 'software valley' site. The newly established software tools demonstration centre at NCC, Manchester, should become an outstation of BASSMATT. The Software Tools Demonstration Centre could be expanded to offer the same SPC/SRCB facility in Manchester. Other such outstations should be considered if a critical mass of companies can be identified to be served who are remote from the 'M4 corridor' but centred around a potential outstation.

* BASSMATT should be in touch with all the best UK R&D work to 'pull through' results.

* BASSMATT should seek out the best overseas work and transfer information about it to the UK community.

* BASSMATT should support the in-service training initiative by:

    - developing course material including distance learning material
    - tutorial use of the Software Production Centre
    - training the trainers
    - host short courses
    - investigate the quality of educational courses
    - investigate the efficacy of professional certification

Independent Technical Advice (25%)

9.25 BASSMATT should provide a focal point to which government departments, and industry too, can turn for impartial expert advice. BASSMATT's activities should include:

* evaluation of new software engineering methods, tools and products including helping STARTS/PPG tools initiative. Cost benefit studies.

* the development and assessment of new standards (Appendix C)

* an independent testing service to evaluate methods, tools and products. This should include work towards quality certification (Appendix C)

* contribute to the work on safety critical aspects of software engineering (Appendix B)

* act as a source of independent technical expertise for the STARTS/PPG public procurers

* offer general advice to the user/applier/supplier communities.

9.26 BASSMATT should build up expertise in the formulation and formalisation of software standards and designs. BASSMATT staff should participate in the work of standards bodies. A source of expertise in the application of formal methods for software engineering is going to be needed by both government and industry in the next few years, as software technology increases its mathematical basis. The need for better standards is discussed in Appendix C.

Marketing and Legal (15%)

9.27 BASSMATT should help identify world wide market opportunities arising from technical innovation, and give feedback from government users to suppliers. It should help disseminate information from market research studies (para 7.4). It should also help the DTI's legal side with technical advice relating to issues such as piracy, safety, warranties etc.

Home to the 'after Alvey' Research Programme (10%)

9.28 The management of the research programme taking up the Alvey role (as recommended in para 9.42) should be physically collocated with BASSMATT. This will ensure maximum pull-through from the research programme into the recipient industries by allowing excellent liaison opportunities. The research programme management will benefit from the technical environment and support which BASSMATT will be able to offer. Such collocation of research programme management and technology transfer organisation should provide a natural focus for orchestrating the UK participation in European scale programmes such as EUREKA and ESPRIT.

9.29 BASSMATT will also make a natural home for some 'research demonstrators' (para 9.17).

Research (15%)

9.30 A small internal research programme should be undertaken in collaboration with industry and academia. This will give BASSMATT people who are 'plugged in' to the research grapevine; these are the right people to pull innovations into BASSMATT. Research is also a vital career development mechanism, enabling staff to be rotated between research and technology transfer activities as part of their in-service training. The desirability of having, as a BASSMATT component, a research 'centre of excellence' should be investigated.

STARTING Support (2%)

9.31 BASSMATT should support STARTING by providing the technical effort needed to produce the annual report, the annual conference organisation and the organisation of the presentation of STARTING of evidence from industry, academia and government.

TYPSSEA Support (3%)

9.32 BASSMATT's primary function on behalf of TYPSSEA should be to speed up the flow of technology along the public pipeline, but BASSMATT should also support TYPSSEA by providing technical expertise and a common point of interdepartmental contact to help formulate objectives, strategy and tactics.

Organisation

9.33 BASSMATT should:

* have an initial 15 year lifetime with 5 yearly reviews

* be of similar size and quality to the USA's SEI or Japan's Sigma project (para 4.44)

* be located in 'software valley' between London and Bristol.

* have both permanent staff and secondees from government, industry and academia

* subcontract some of its work where appropriate

* as a national showcase, be staffed and equipped as well as rival national institutes such as SEI. The right quality of staff will not be easily recruited but a principle of 'top quality' should be initially established and maintained. If the quality of BASSMATT is not of world class then its next 5 yearly review should recommend its closure.

PUBLIC SECTOR RESEARCH AND DEVELOPMENT (ALL DEPTS)

9.34 The majority of software engineering research is public sector funded. R&D is an essential part of the 'public pipeline'; it is the source of new ideas and, vitally, it is the main source of intelligence about overseas research.

9.35 Individual departmental budgets are too small to compete with the massive funding of America and Japan. Only by interdepartmental cooperation, and informed selectivity, can UK research and development keep pace with our international rivals.

9.36 The UK R&D effort should be viewed as providing the feedstock for the UK contribution to the European community in which the major collaborative programmes should be executed.

9.37 The industrial, academic and inter-departmental cooperation exhibited by the Alvey Programme is an encouraging sign that the UK software community can work collaboratively at both technical and organisational activities.

9.38 We recommend that TYPSSEA be used to coordinate the research and development programmes of all departments to ensure that serious discontinuities do not occur as a result of either starting new programmes (which take time to become effective) or stopping existing programmes without adequately planning what should replace them (or not) so that enough time exists for the R&D community to cope smoothly with the change.

9.39 We recommend that the Alvey style collaboration on software R&D issues be continued and expanded to include those agencies and departments (such as UGC, DHSS) who are not currently involved.

9.40 We recommend that the 'what happens after Alvey?' question be resolved as soon as possible.

9.41 The UK must avoid a 'stop/go' approach to R&D. This causes loss of morale, loss of irreplaceable staff to overseas competitors, breakdown of collaborative working relationships, rundown of infrastructure and a large loss of momentum. With the ever increasing pace of international competition a smooth, continuous transition from the current Alvey Programme to its successor is vital. The plan for such a successor is needed urgently.

9.42 We make the following suggestions for the organisation of a successor to the Alvey Programme

* it must be collaborative between government, industry and academia

* it must have its own budget, derived from government departments, but under its own control

* it must have the ability to fund at a flexible level, say from 10-100% depending on the size of the company, the size of the project and the balance of research content versus product development. This could be achieved within an overall, bottom line budgetary constraint of a 50-50 split between government and industrial contribution.

* it should have the remit to fund research and commercial demonstrator projects (para 9.17).

* it should fund product innovation research as well as 'enabling' technology.

* it should be able to fund the development of advanced training courses and materials to speed the dissemination of new ideas.

* its HQ should be collocated with the BASSMATT to ensure adequate technical support and close cooperation between R&D and technology transfer.

9.43 We recommend that, in overall terms, industry should increase the level of its short and medium term R&D so that the academic community can restore the balance of its work in favour of the longer term work whilst maintaining the industrial collaboration links built up by the Alvey Programme.

9.44 The above set of recommendations should give the UK a balanced and efficient pipeline of software engineering and applications, with the highly innovative technology push, at which the UK is good, being pulled through by an enlightened demand side leadership, facilitated by the new skills acquired through the in-service training programme.

TRAINING (ALL DEPTS)

9.45 The public pipeline requires skilled manpower to all levels and in all roles if it is to function efficiently. The IT skills shortage in industry has drained the public sector of much of its skilled IT manpower. This lack of skill seriously affects the quality of work, advice and decision making in the public sector today.

9.46 We recommend that the public sector implements a programme of in-service training similar to that recommended to industry and with similar targets.

DTI RECOMMENDATIONS

TYPSSEA

9.47 We recommend that, as DTI has overall responsibility for the health of the manufacturing and service industries, and in particular the software and IT industries, DTI should be responsible for leading the formulation of TYPSSEA.

Demand Side Leadership

9.48 We recommend that DTI help organise the increase in demand side leadership called for in TYPSSEA. We suggest that this should be done by expanding the remit and resources of the STARTS Public Purchasing Group.

9.49 We suggest that DTI examines the potential benefits of inviting the major private sector purchasers to join the STARTS/PPG and that it's remit be widened to include all major software purchases not just 'real time' applications.

Technology Transfer

9.50 We recommend that DTI mounts a major exercise to improve the transfer of technology along the 'public pipeline' and between the user/applier/supplier communities. This exercise should encompass the following:

* Support for the in-service training initiative in industry

* Pull through of the research results of public sector R&D programmes, specifically Alvey and ESPRIT, including government support for 'research demonstrators' (para 9.17)

* Support for 'commercial demonstrator' (para 9.17) projects of innovative software engineering technology in real user applications to encourage take-up more widely

* Support for the creation of the technology transfer organisation, BASSMATT (para 9.19).

* Increased support for the STARTS/PPG software tools initiative.

* Continue support for 'awareness' programmes

* Support cost-benefit studies of new methods, skills and tools.

Support for Product Innovation, Marketing and Exporting

9.51 We recommend that the Software Products Scheme and Support For Innovation scheme be extended and enhanced to stimulate the software products industry and encourage user/applier companies to spin-off their bespoke developments into products.

9.52 We applaud the marketing and exporting aspects of the Market Entry Guarantee Scheme and Software Products Scheme and suggest that these mechanisms be enhanced to stimulate greater marketing efforts from industry, as marketing is the key to reaching the STARTING targets.

9.53 We suggest that DTI explore the idea of the Computer Services Association and National Computing Centre organising regular export marketing seminars to identify software export opportunities including the possibility of collaboration in overseas markets.

9.54 DTI should help UK firms participate in European initiatives such as EUREKA.

Further Study

9.55 We recommend that DTI conducts further studies of four important issues raised in the Working Group. We feel these issues require action within the next five years.

* the legal and technical issues surrounding safety-critical software, ie software products whose (faulty) operation could endanger public safety.

* the potential of software product quality certification (the 'software kite-mark')

* the role of new technical standards as a means of helping the UK industry tackle the world market

* the role for the certification of practising software engineers

These subjects are discussed further in Appendices A, B and C.

Fiscal and Legal Recommendations

9.56 We recommend that DTI examine the scope for fiscal measures, eg tax incentives, to support the main recommendations especially in-service training and investment in software tools.

9.57 We recommend that DTI examine what, if anything, needs to be done about copyright laws and software piracy; about the protection of Intellectual Property Rights to software innovations; about advising exporters on legal problems associated with selling software abroad.

9.58 We recommend that DTI examines the legal issues surrounding warranties and guarantees, disclaimers and the Trades Description and Health and Safety Acts in relation to software suppliers, their products and customers.

9.59 We recommend that DTI examines the problems facing UK companies arising from import/export controls such as COCOM to see what can be done to reduce the delays and frustrations which have been reported.

DES RECOMMENDATIONS

Research

9.60 We recommend that the DES and its agencies recognise that software engineering is an experimental engineering discipline requiring considerable equipment and technician resources. Planners and committees should recognise that software engineering is capital intensive. Teaching engineers and scientists how to apply software requires facilities comparable to industrial quality and sophistication. Rather than just acquiring the ability to create small programs 'from scratch', engineers and scientists today need to know how to solve applications problems by assembling and adapting software components, and how to maintain the solutions. This can only be done with facilities realistically comparable to best industrial practice. Software Engineering teaching and research require facilities of greater sophistication than current best industrial practice.

9.61 We recommend that SERC recognise the ever-increasing national importance of IT by elevating its Information Engineering Committee to be a full Board. SERC should continue its good work encouraging the collaboration between industry and academia, whilst maintaining a careful balance between that and its long-term work in IT research.

9.62 We recommend that DES strongly supports an 'after Alvey' research programme.

9.63 We recommend that DES, through its various agencies such as UGC and SERC, supports the academic participation in European projects by funding the necessary pre-proposal work and the additional costs of European collaboration.

Standards

9.64 We recommend that DES, through its agencies, supports the participation of academics in IT standards research, development, formulation and promulgation. It is vital that standards include the best work on the subject. (See Appendix C).

In-Service Training

9.65 We recommend that DES supports the industrial in-service training initiative (Appendix A). Much good work has already been done. Further help could be given by:

* encouraging the 'reuse' of teaching material by industrial trainers

* organising MSc courses to cater for day release students, evening classes, distance learning etc, so that students may pursue their studies whilst maintaining a relatively normal working life

* encourage the training of new trainers who will be needed by industry

Schools

9.66 We recommend that schools consider the following suggestions. Touch typing and 'mouse' skills should be taught as basic skills. The basic mathematics relevant to understanding IT should be taught. We suggest that Computer Studies for school children under 16 should be based on sound problem analysis and structured program development. The teaching of BASIC should be phased out as more powerful systems become available. A common core syllabus for Computer Science at A level should be constructed. This should include a good groundwork in the mathematical aspects of software engineering, as well as its practical application. The A level should be a suitable qualification for entry to a degree course in Computer Science.

MOD RECOMMENDATIONS

Procurement

9.67 We recommend that MOD strongly supports the STARTING and TYPSSEA policies and uses its vast influence and purchasing power to improve the quality of demand side leadership and its goals of technology pull through, export spin-offs etc. We welcome MOD's move to strive for more commercial spin-off. We look to MOD to use its procurement executive to encourage suppliers to work to the best software engineering standards and thus for MOD to strongly support the in-service education and training initiative.

Ada

9.68 We recommend that MOD takes strong and immediate steps to improve current UK Ada technology.

Research

9.69 We recommend that MOD continues to support collaborative research 'after Alvey'.

Technology Transfer

9.70 We recommend that MOD strongly supports the BASSMATT mechanism. We also recommend that MOD continues to improve its technology transfer efforts including 'demonstrator' projects, support for 'standards' development and the promulgation of the IPSE concept.

OTHER GOVERNMENT DEPARTMENTS

9.71 We recommend that other government departments such as DHSS strongly support the TYPSSEA and BASSMATT recommendations in view of their significant requirement for software and their considerable purchasing power.

9.72 We recommend that other government departments review their interest in the safety critical aspects of software discussed in Appendix B. The development of software controlled, patient monitoring and care systems means that we would expect DHSS to take an interest in the safety issue.

10. DETAILED RECOMMENDATIONS TO THE PROFESSIONAL INSTITUTIONS

10.1 The IEE initiative to boost software engineering within the Institution is welcomed and encouraged. The BCS Professional Development Scheme is also welcomed and encouraged.

10.2 We recommend that the IEE lead a study into the issue of professional certification of software engineers, safety critical software and quality certification as described in the appendices. The IEE should involve the Engineering Council, the BCS, industry, academia and government in these studies.

10.3 We recommend that the IEE and the BCS strive to encourage industry and government to implement the in-service training recommendation. (See Appendix A.)

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12. APPENDIX A

EDUCATION AND PROFESSIONAL QUALIFICATION

THE PROBLEM

A.1 The key to UK success in Information Technology is the appropriate and effective professional education of all who engage in it - from directors and managers, through systems analysts and programmers to marketing and sales staff.

A.2 A noticeable problem in the IT industry is the low relevant educational attainment of many practitioners. Even those with appropriate qualifications have little incentive or opportunity to keep abreast of the subject. Furthermore, the effectiveness of those qualified may be inhibited by the lack of education of their colleagues and of those occupying more senior positions.

A.3 We wish to distinguish carefully between 'education' and 'training'. Education is intellectual instruction which is of general and long term value. Most people perceive formal education as emanating mainly from schools, universities and the "educational system". Training is practical instruction which tends to be oriented towards specific goals, usually vocational. Most companies offer only in-service training to their employees.

A.4 At present, qualification tends to be based mainly on work experience. Low educational attainment is difficult to avoid in a discipline undergoing a high rate of development and rapid diversification of application area. In Britain this problem is compounded by several factors:

* The absence of a tradition of post-educational training for practitioners in the IT industry.

* High turnover of IT staff, which makes employers reluctant to invest in any but short term training of immediate applicability.

* A prevalent belief that education is the responsibility solely of government.

* A strong tradition of specialisation during and after formal education.

* Failure, in the IT industry, for individuals to obtain, through their own efforts or through those of their employers, necessary regular in-service education.

* Lack of common culture, experience and education in the IT industry.

A.5 Various bodies have made recommendations and taken action to increase the numbers of initially qualified entrants to professions associated with IT. We have not considered it our task to comment on the adequacy of these increases; rather, we must point out the well-known dangers of recruiting increased numbers of inexperienced engineers, when their senior colleagues and managers are not educationally qualified or competent to direct and supervise their activities.

A.6 As in other branches of engineering, it takes time to establish cadres of senior professionals with the right education, experience and personality to direct the work of others. To meet urgent needs, this process must be accelerated; and the quickest way to do this is to raise the educational level of those who already have the requisite experience and personality.

A.7 The British educational system and professional institutions have many merits and an enviable record of achievement in the established branches of engineering. It is essential that the development of engineering education in the IT industry should aim at the same high standards.

TOWARDS A SOLUTION

A.8 The precondition for a solution is to establish the principle that every responsible professional in IT will expect to supplement his formal education in software engineering more than once in his career. IBM probably is the most successful IT company in the world. Their investment in in-service education and training is outstanding. Employees are required to undertake several weeks annual training, no matter what their position in the company. IBM has implemented a policy, laid down some five years ago, that every programmer and manager of programmers should attend between two and six weeks of in-service education in the formal methods of software engineering. It is difficult to believe that a considerable part of IBM's success is unrelated to their commitment to in-service education.

A.9 As a nation we should set ourselves a similar target. Success in IT often requires, in a single person, technical competence, applications knowledge and business skill. In addition to the central core courses in programming methodology and software engineering, we also envisage more specialist courses on such topics as the needs of business and commerce, communications and protocols, process control, man-machine interfaces, knowledge engineering, management, marketing, programming language standards, other emergent standards, and safety-critical programming. None of these will compete with more specialised training courses in the use of proprietary hardware or software products.

A.10 Action has been taken by various groups (eg the IT Skills Shortages Committee) to encourage the educational system to increase the numbers of qualified entrants to the IT industry. Even if the output of professionally educated IT personnel should become adequate, it will be many years before those educated have acquired sufficient experience and seniority to have an effect on the industry as a whole. Attempts to increase the quantity of those issuing from the educational system, must not divert attention from the immediate need to improve the quality and effectiveness of existing practitioners.

A.11 We recommend, therefore, that a wide scale programme of in-service education be established by, and in, UK industry as a matter of high priority. The goals of this programme should be to improve the quality, flexibility and productivity of a significant proportion of those engaged in IT. The programme must not be confined to the insular aspects of software engineering and computer science, nor should it compete with specialised industrial training. Instead, the initiative should strive to impart appropriate familiarity with those subjects necessary for effective and professional conduct within the IT field. As such, the programme must be able to address the many levels of education required by such a diverse target population.

A.12 British professional institutions have an enviable record of success in establishing in-service education in many traditional branches of engineering. It is sensible to capitalise on the reputation and experience of the existing institutions. Success of the in-service education programme will require the cooperation of the Microelectronics Education Programme, universities, polytechnics, the Science and Engineering Research Council, the University Grants Committee and the Standing Committee for University Entry. The Government might participate both from a regulatory and an employer perspective. Above all, success will require commitment and participation from industry. The IEE and BCS have the necessary political experience to forge the necessary collaboration between the diverse organisations involved.

A.13 A prime mover in the setting of educational and professional standards for Certification of Engineers is the Engineering Council; in the case of Software Engineering, the Council works through the IEE and the BCS. Both these institutions are actively reconsidering their membership criteria for software engineers. Ideally, these bodies should collaborate on setting up or accrediting the required examinations, courses, and text-books, starting perhaps in the technically most demanding and most urgent area of safety-critical programming.

CURRICULA

A.14 It is unreasonable to expect that any formally approved syllabus and examination will in the foreseeable future keep pace with the rapidity of developments in Information Technology. It is therefore necessary to take more immediate steps to stimulate the development of new courses on offer from research and educational institutions, both public and commercial, for professional updating of programmers from industry and public service. By instituting an educational policy for programmers in public service, the Government could do much to stimulate demand; and the supply side can be stimulated by explicit commissions of course material, for example from the Open University and other sources capable of more rapid response.

A.15 The content of the new courses should be designed by those with the relevant practical and research experience, in close consultation with the organisations most likely to send students on the course. Each course should be given initially by those who have designed it.

A.16 Establishing curricula for an in-service educational programme of wide scope is not simple. The curricula must be accepted by all concerned as being technically robust and having long term viability. We believe that the institutions recommended (ie the IEE and the BCS) have expertise in establishing professional education schemes and will be able to accredit acceptable curricula. In-service education also would gain considerable prestige if it were acceptable as credit for traditional qualifications from professional and educational establishments. We recommend, therefore, that this be one of the goals for those establishing the programme. We recommend that the curricula should cover a wide range of subjects, but in no greater detail than necessary to provide a useful educational base. Some essential topics are:

* Business, finance, marketing and management.
* Communications.
* Computer hardware and associated technology.
* Data base design.
* Man-machine interfaces and knowledge engineering.

* Mathematics relevant to software; eg logic and set theory.
* Operating systems and programming languages.
* Software engineering and system design.

A.17 The goal of each new course development would be to obtain approval from the IEE and/or the BCS towards the accreditation of those who attend it. Accreditation should depend not only on approval of the syllabus and training material, but also on conditions, such as the following:

* There should be a reading list and a self-test procedure by which a professional can, without public embarrassment, check personal readiness to attend the course.

* There should be method for assessment of individual students, with explicit pass and failure grades.

* There should be advice and consultancy available for teams who find technical or other obstacles to putting into practice what they have learnt.

* There should be a follow-up, of students who have attended the course, to check the quality of the instruction, and its impact upon working practices.

* The courses may be taught as evening classes, short residential course, summer schools, or by distance learning techniques, whichever is most convenient for the students and their employers.

A range of professional examinations should be instituted, to check the efficacy of the education and record the achievement of those who pass them.

TARGETS

A.18 Targets for the in-service educational programme and performance monitoring should be maintained by STARTING, in collaboration with the IEE and BCS. We recommend also that the programme should assess the quality of education and its impact on working practices. The initial target of the programme should be that a significant (eg 50%) and representative proportion of companies and organisations using IT and operating in the UK should be committed to the in-service educational programme by 1990. By then, participants should have increased their formal in-service education to:

Board and Senior Managers	1 week per year
Middle Managers	2 weeks per year
Technical IT staff	4 weeks per year
Non-technical IT staff	2 weeks per year
Other professional staff	1 week per year

FUNDING

A.19 It is vital that in-service education does not constitute a hardship to those participating. Shortage of funding, qualified training staff and suitable courses is recognised. Consequently, considerable imagination must be applied to provide a cost-conscious programme of such wide scope

and availability. This, in itself, presents an opportunity and justification to develop innovative training techniques. We recommend that the IEE and the BCS consider novel methods of disseminating educational material (eg the Open University's distance learning and independent study techniques) and of examination (eg the Educational Testing Service of Princeton, New Jersey).

A.20 For companies, much of the cost of in-service education might be absorbed by some displacement of present in-service training; a national programme should allow economies of scale and lead to radically reduced costs. Government funding would be advantageous for rapid initiation of the in-service educational programme. Government should contemplate some direct or indirect training subsidy to support those setting up the new courses and the employers of those who attend them.

A.21 The in-service education programme is sufficiently important that those organisations making a significant contribution should receive public recognition.

13. APPENDIX B

SAFETY CRITICAL SOFTWARE

THE PROBLEM: NON-TECHNICAL

B.1 No computer software failure has killed or injured a large number of people. It is just conceivable that such a tragedy could occur. What steps should be taken to:

* prevent such a disaster,
* cope with it when it does occur,
* ensure such a disaster, having happened once, cannot recur?

THE PROBLEM: TECHNICAL

B.2 Stored-program digital computers must be amongst the most reliable mechanisms ever built by man. Millions of computers throughout the world are executing millions of instructions per second for millions of seconds without a single error in any of the millions of bits from which each computer is made. In spite of this, nobody trusts a computer; and this lack of faith is amply justified.

B.3 The fault lies not so much in the computer hardware as in the programs which control them, programs full of the errors, oversights, inadequacies and misunderstandings of the programmers who compose them. There are some large and widely used programs in which hundreds of new errors are discovered each month; and even when these errors are corrected, the error rate remains constant over several decades. Indeed, it is suspected that each correction introduces on average more than one new error. Other estimates offer the dubious comfort that only a negligible proportion of all the errors in these programs will ever by discovered.

B.4 New computers are beginning to be used in increasingly life-critical applications, where the correction of errors on discovery is not an acceptable option - for example industrial process control, nuclear reactors, weapons systems, station-keeping of ships close to oil rigs, aero engines and railway signalling. The engineers in charge of these projects are naturally worried about the correctness of the programs performing these tasks, and they have suggested a number of expedients for tackling the problem. Many of these methods are of limited effectiveness, because they are based on false analogies rather than a true appreciation of the nature of computer programs and the activity of programming.

B.5 The steps which ACARD has been considering in answer to the introductory question, are discussed under the following headings:

* Disaster Prevention
* Disaster Management
* Disaster Analysis

DISASTER PREVENTION

B.6 The initiative for disaster prevention must come from the UK Government and system customers. Current software is built, operated and maintained using methods and tools which are not keeping pace with the development of the hardware, nor with the increased sophistication demanded by new applications; nor do they take account of progress of research into

the reliability of programs. The necessary improvements in software engineering require investment in advanced development and production techniques, education, training and legislation. Legal obligations should be at least as stringent as those imposed by the Data Protection Act, and the care and time required for detailed drafting of legislation will be just as great. A start must be made immediately.

B.7 The remainder of this appendix outlines an imaginable solution that may emerge over the next fifteen years. It is intended to promote rather than to preempt a discussion of the details.

Registration

B.8 A Register must be established of those (software) systems which, if they fail, will endanger lives or Public Safety.

Operation (Demand Side)

B.9 Before any organisation can operate a life-critical computer system it must first obtain a Licence To Operate (LTO), which will only be issued when the operator can demonstrate that certain conditions (detailed below) have been met.

B.10 Each life-critical system must be operated by a Certified Software Engineer who is named as being personally responsible for the system. This Certified Software Engineer must have received the appropriate mathematical training in safety-critical software engineering.

B.11 A life-critical system must be adequately maintained; this must be one of the conditions of the LTO. Maintenance (ie Rectification and Development) must be the responsibility of a named Certified Software Engineer.

Construction (Supply Side)

B.12 Only approved suppliers may be allowed to build life-critical computer systems; thus suppliers must gain a Licence To Construct (LTC). A LTC will only be issued to suppliers who can show that they build systems to certain approved standards using methods which are mathematically sound, and using safety certified tools and staff.

Certification

B.13 A LTO must only be granted when a Safety Certificate has been issued. Certificates must be issued for limited periods, eg 5 years. Operational systems will thus need to be recertificated (relicenced) periodically (analogous to Certificate of Airworthiness).

Reliability Data Collection

B.14 To aid research into system reliability, and to assist Boards of Enquiry, all Registered life-critical software systems must supply operating data to the Licensing Authority.

DISASTER MANAGEMENT

B.15 In the past, the danger arising from failure of computer hardware and software has been limited by switching off the computer and reverting to manual operation if necessary. In future, there will be applications for which this fall-back procedure is not available. The computers will have to continue to run, and any necessary software changes and corrections will have to be inserted into the incorrectly running system. For these applications, specially stringent precautions are necessary.

Procedures

B.16 The Licensing Authority should require disaster management procedures to be laid down in advance of operation and practiced regularly during operation (ie 'fire drill practice'). The documentation of the system must meet a standard which would permit a team of experts/specialists to master it during the progress of an emergency.

Data Logging

B.17 The Disaster Management procedures should include the logging of data so that any subsequent Enquiry can ascertain the progress and cause of the disaster (analogous to the 'black box recorder' in an aeroplane).

Emergency Callout

B.18 There must be more than one Certified Software Engineer available to the operating company; and a duty rota should ensure that one of them is always available at short notice. Procedures must be set up for calling out a team of expert specialists in a longer lasting emergency.

DISASTER ANALYSIS

Collection of Reliability Data

B.19 During the normal (safe) operation of any life-critical system, data on its performance and reliability must be made available to the Licensing Authority. This data will be made available to any Enquiry. (This is additional to the data logging required in para B.14).

Board of Enquiry

B.20 Any disaster should be the subject of an official Board of Enquiry (similar to Rail, Air disaster enquiries). A Board of Enquiry must have the power to make changes to the system under investigation and/or the methods, tools, products and staff associated with the Certification procedure.

Any Error Triggers Board of Enquiry

B.21 Any error, no matter how 'small', in a software system which has been certified as being safe must be the subject of an Enquiry. This is the only way of discovering weaknesses in the Certification process itself, or misuse or misunderstanding of its application. Enquiries concerning non fatal errors should not have disciplinary implications, so that operators are encouraged always to give notification of minor faults.

Near Miss

B.22 Any serious 'near miss' must be reported to the Licensing Authority. An Enquiry should be held if the Licensing Authority is concerned at the incident's implications.

SAFETY CERTIFICATION

B.23 The UK must develop the ability to certify safety aspects of software system construction and operation. These include:

* certification of the mathematical soundness of the methods of construction.

* certification that certified methods are properly applied during construction and subsequent maintenance (rectification & development).

* certification of the tools used during construction and maintenance.

* certification of the software engineers who build and maintain the systems.

* certification of the end product, ie the software itself.

B.24 Methods should not be certified which are merely 'good practice'. Safety and reliability require more rigorous theoretical bases than existing good practice, so that system behaviour can be accurately and consistently predicted; hence the need for mathematical soundness to enable prediction to be based on mathematical proof.

B.25 Certification of a tool will only be given when it is shown that the tool preserves the mathematical soundness of the method it supports.

B.26 Certification of software engineers will only be given when they have completed an approved level of formal mathematical and methodological training together with an approved track record of experience. Certification should be of limited duration: recertification should require additional formal training both of the refresher type and new developments. Recertification should occur at regular intervals.

B.27 Certification of end products (and their components) implies proof obligations in addition to thorough testing. Proofs must be performed and checked by competent mathematicians or by a machine running certified software.

B.28 As in other branches of engineering, the rigour of the inspection procedures should be adjusted to the degree of risk, the severity of the danger, and the cost. For example we can imagine the emergence of several levels of certification.

(a) Disaster Level

Failure could involve more than ten deaths. The whole of the software must be checked by formal mathematical proof, which is itself checked by a competent mathematician. Further precautions required if damage limitation by switch-off is not feasible (para B.15).

(b) Safety Level

Where failure could cause one death, but further danger can be averted by switch-off. The whole of the software must be constructed by proof-oriented methods, checked by a competent mathematician. On occurrence of a fatality, the mandatory Enquiry must name the programmer and mathematician responsible, who might be liable for criminal negligence. Perhaps one error per 100,000 lines of code would be a realistic expectation, so that most shorter programs will contain no errors.

(c) High Quality Level

Appropriate for software sold commercially, where error could bring financial loss to the customer. By law, such losses should be reimbursed. All programmers involved should be certified competent in mathematical methods of software design and construction. Their use of the methods is checked by sampling. An acceptable error rate would be one error per ten thousand lines of code delivered. Each error corrected requires recertification at Safety Level. If the target error rate is exceeded, certification is withdrawn. Eventually, all software used to construct other certified software should be certified to this level; and the construction of 'disaster level' software should include independent checks on the correct working of support software used (eg check of binary code against higher level source codes).

(d) Normal Quality

Corresponds roughly to the best of current practice, (say one error per thousand lines of code). The methods used to construct software to higher levels of reliability may also be used to achieve normal reliability; and this should bring a significant improvement in programmer productivity and a reduction in the whole life cycle costs of the programs they produce.

14. APPENDIX C

PRODUCT STANDARDS AND CERTIFICATION

THE OBJECTIVE

C.1 This appendix discusses the opportunities and benefits of standardisation of the designs and interfaces of software products, for example programming language compilers, applications-oriented packages (graphics, statistics, etc), operating systems, word processors, spreadsheets etc.

C.2 The objectives of standardisation should be solely to benefit the consumer. A good standard should provide:

* Stability and protection of investment in the face of rapid technological obsolescence.

* Opportunity to mix and match components, services, and training, enabling purchase from suppliers who compete in providing the best value for money.

* Assurance that the selected product meets high standards of quality, reliability and fitness for purpose.

At present, the first point seems the most important: but in the future the second and third points should dominate.

C.3 Standardisation may also be used as a weapon in the commercial struggle between suppliers; and particularly between a dominant large supplier and its smaller competitors. This struggle does not necessarily contribute to the quality of the standard as perceived by the consumer.

THE PROBLEM

C.4 In a rapidly developing technology, it is extremely difficult to establish the first standard for each new requirement as it emerges. There is a choice of unattractive alternatives.

* The standard is promulgated before its first implementation. Such standards tend to contain oversights, misjudgements, and inconsistencies; they are unnecessarily expensive to implement and use. They are rarely appropriate to the technology that has emerged by the time the first implementations are available, and they cannot meet customer needs which come to light only after experience of use.

* The standard is designed after several rival products have reached the market place. In this case the standard has to be a compromise between the commercial needs of the rival manufacturers. Such standards will tend to be complicated, with many concealed inconsistencies; and they are unlikely to meet objective standards of quality as perceived by the customer.

C.5 There are many standards which are first drafted before implementations exist and finally completed after several competing products exist; such standards can combine the disadvantages of both the above alternatives. It is not surprising that the first standards promulgated for software products are no more satisfactory than the first standards (say) for physical measurement of space and time in the middle ages. Yet the need for standards in software is so great that they are welcomed and promulgated with an enthusiasm totally unrelated to their intrinsic quality.

TOWARDS A SOLUTION

C.6 In other branches of engineering, it is taken for granted that standards must evolve in the light of experience and of improved understanding of the relevant scientific concepts and principles. The improved quality of physical and engineering standards owes much to the goal-directed research and advance development conducted in the great National Laboratories of Physics and Engineering.

C.7 Improvement in standards for software products will require a similar devotion of effort both to the development and application of the relevant mathematical theories and to experimental confirmation of the parameters of cost, effectiveness, and customer satisfaction. Such an effort will require a central initiative and technical coordination on an international scale over a period stretching into the next century. It would be unrealistic to expect the effort to be wholly supported by the software supply industry, or by their customers.

C.8 This country has an outstanding record of achievement in the development of the mathematical concepts and theories relevant to the formulation of standards in Information Technology. However, there is at present an almost total gap between this theoretical work and the activities of standardisation committees, both at National and at International level. An equally dangerous gap is that which can arise between the standardisation committees and the experimental work necessary for design, validation, implementation, evaluation, and certification of proposed standards. To close these gaps will require a change in the expectations and policies of standardising authorities, and a very considerable increase in the amount of qualified technical effort expended on standardisation and on coordinated goal-directed research prior to standardisation. Attention must be paid not only to improvement of the quality of the standard, but also to the means by which customers and suppliers may migrate from existing to better standards. Furthermore, the body responsible for a standard must also devise and administer procedures for checking that products meet the standard, and perhaps issue a seal of approval like the BSI's 'kitemark' to products which meet measurable criteria of performance and reliability.

C.9 At present, suppliers are very busy in meeting the initial software standards which are now emerging, and customers are very busy in learning to live with them. Consequently, there is no immediate commercial pressure to improve the quality of standards for software products; there is even little realisation that such improvement may be possible. Indeed, the wide propagation of the first standard in each field is known to create considerable resistance to change, and even in the long term may prevent acceptance of improved standards. The layout of the typewriter keyboard is a good example of an improvable standard that has never been improved.

C.10 In spite of this risk, we recommend a policy of long-term, goal-directed research into software standards. This should be coordinated internationally, or at least on a European scale. If a single nation or group of cooperating nations can obtain a reputation for the quality of the standards they promulgate, this will give the local supply industry a head start in the international market place. If a national certification agency gets a reputation for the value of its seal of approval, even further advantages will obtain. Finally, the research towards standardisation will develop skills and techniques in advanced international market research, as well as specification, design, prototyping, and implementation of high quality software. If the standardisation research enterprise is properly managed, this technology will spin off to benefit local suppliers, not only of products but also of bespoke software, enabling them to secure a commercial edge in the international market place for all other products and services.

15. GLOSSARY OF ACRONYMS

BASSMATT.....British Advisory Service for Software Marketing, Applications, Training and Technology transfer

BCS.....British Computer Society

CAD.....Computer Aided Design

CAM.....Computer Aided Manufacture

CCTA.....Central Computer and Telecommunications Agency

DES.....Department of Education and Science

DHSS.....Department of Health and Social Security

DTI.....Department of Trade and Industry

IEE.....Institution of Electrical Engineers

IPSE.....Integrated Project Support Environment

ISF.....Information Systems Factory

IT.....Information Technology

MOD.....Ministry of Defence

NCC.....National Computing Centre

NEDO.....National Economic Development Office

R&D.....Research and Development

SPC.....Software Production Centre

SRCB.....Software Reusable Components Brokerage

STDC.....Software Tools Demonstration Centre

STARTING.....Software Technology and Applications Review Team of INdustry and Government

STARTS/PPG.....Software Tools for Application to large Real Time Systems/Public Purchasers Group

TYPSSEA.....Ten Year Pipeline Strategy for Software Engineering and Applications

UK.....United Kingdom

USA.....United States of America

18 February 1986

PRIME MINISTER

R&D PRIORITIES ACROSS GOVERNMENT

This is a disappointing Report about a lot of money - £4.4 billion of Government-funded R&D is planned for 1985-86. It focuses on the wrong problems. It fails to give practical examples. Its recommendation of a permanent Ministerial committee chaired by DTI - to second-guess the private sector is Heathite Corporatism.

There is no shortage of government-funded R&D in this country. In 1983, UK publicly-funded R&D was 1.33% of GDP, compared with 1.18% in the US, 1.14% in Germany and 1.40% in France.

The question the report needs to address is whether and why we are short of private sector R&D?

The real problems

The real questions on government-financed R&D, are:

a. Are we getting value for money on R&D expenditure? Indeed, how can we make "value for money" in R&D an operational concept?

- How much of the expenditure on Nimrod has been R&D?

- What has been the rate of return on DTI's expenditure on launch-aid?
- How can we justify expenditure on the fast-breeder reactor?

b. Do companies reduce internally-financed R&D or change the nature of this R&D as they receive more funds from government?

c. What is the hard evidence of benefits to the UK economy from DTI subsidies to individual firms?

d. Why is it that technology to exploit North-Sea oil and gas was developed without huge government R&D, but that our electronic industries consider such help crucial?

e. In a declining science budget, why is there so much spending on high energy physics, space research and astronomy?

Defence R&D

The crucial exam question is how does defence R&D contribute to the economy?

The one piece of evidence which sticks out like a sore thumb is defence R&D in the UK compared to other countries.

Defence R&D as % of GDP (1982)

(Source OECD)

UK	France	Germany	US
0.65	0.46	0.11	0.76

There is a case for saving money by cutting defence R&D. This could positively benefit the economy as highly skilled manpower would then be released for private sector product development.

Alternatives to corporatism

The rest of the Report is full of worthy intentions to push more research into the private sector.

But how? They propose setting up a permanent Ministerial committee with official support. This is nothing but an interventionist philosophy of picking winners applied to R&D.

A more useful approach would be to distinguish between applied research done by the private sector and pure basic research funded publicly. This leads us to recommend that:

1. Defence R&D should be cut.

2. Tax incentives should be used to encourage innovation and commercial risk-taking in privately-funded R&D.

3. Accordingly, public funds for R&D should be directed away from applied commercial research and towards basic research and initial support for diffusing information about new technology.

4. For grant-aided university research, a market-responsive system should be developed whereby the brightest talent is drawn to the most fertile areas, at the same time attracting private venture capital and industrial support.

BG

BRIAN GRIFFITHS

WO925

MR NORGROVE

18 February 1986

E(A) - MISC 119 REPORT

The further delay in the consideration of the MISC 119 report by E(A) only causes me to feel more strongly about the points I made in my minute to the Prime Minister of 17 January and I would be grateful if that minute could be included with her papers for the meeting.

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

RBN

SIR ROBIN NICHOLSON
Chief Scientific Adviser

CC B/UP

P 01916

PRIME MINISTER

CONFIDENTIAL

Report of the Ministerial Group on Research and Development Priorities Across Government (MISC 119)
(E(A)(86)2)

BACKGROUND

1. On 31 July 1985 E(A)(85)18th meeting FLAG B considered a report by the Official Group on Defence R & D (MISC 110) which recommended there should be a gradual and progressive reduction in the volume of UK resources devoted to defence R & D. The then Secretary of State for Defence refused to accept this, but agreed to consider it provided other Departments' R & D programmes were subjected to conmparable scrutiny. E(A) agreed that a small group of senior Ministers (MISC 119) should be established chaired by the Lord President to review the R & D programmes of Government Departments, to assess the relative priorities of the different programmes, to consider the scope for change in the size, content and objectives of those programmes which could contribute to improving the efficiency, competitiveness and innovative capacity of the UK economy, and to make recommendations to E(A). E(A)(86)2 is the Group's final report.

Proposals

2. The two most important recommendations of E(A)(86)2 are:-

(a) that a collective Government decision be taken to reduce the total volume of resources devoted to defence R & D (including any UK effort towards SDI) in accordance with the projections in the 1985 Defence Costings;

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(b) the establishment of a new Ministerial Committee under the chairmanship of the Secretary of State for Trade and Industry charged with the development of policies to enhance the contribution of R & D expenditure, public and private, to the performance of the UK economy. The conclusions of E(A)(86)2 list a number of topics the Committee should be invited to pursue, including proposals by Sir Robin Nicholson for a reallocation of resources to generate "pull through" of Government funded R & D.

MAIN ISSUES

3. The main issues are:

(a) the need to reduce the total volume of resources devoted to defence R & D;

(b) the establishment of the new Ministerial Committee on R & D Priorities;

(c) the task of the new Committee.

Defence R & D

4. UK public expenditure on R & D as a proportion of GDP is similar to that of other major industrial countries (except Japan, where it is much lower), but it is strongly skewed towards defence. Defence R & D in 1985-86 (at £2,300 million) accounts for 52.7 per cent of total Government R & D expenditure. The defence industrial complex appears to be largely insulated from the ordinary pressures of the market economy, and pre-empts scarce scientific resources, especially in electronics and information technology, to the detriment of the rest of the economy. Sir Robin Nicholson's discussions with electronics companies last summer suggested that the available resources of civil UK scienti-

fic and technical manpower (notably in electronics) were insufficient to meet all the demands on them. Moreover, as Mr Levene has openly admitted to the PAC, the spin-off from defence R & D, whether through exports of defence equipment or from civil applications of defence technology, is disappointingly small (10 per cent of current defence procurement expenditure of about £8 billion a year). France has secured double the volume of exports on the basis of a defence R & D programme on average at least 10 per cent smaller than the UK's, while Germany and Italy have achieved exports of major defence equipment not much smaller than the UK's on the strength of defence R & D programmes a quarter or less of the size of the UK's. The distortions produced by the pre-emption of scarce resources by defence could become worse with the additional demands of participation in SDI.

5. The new Secretary of State for Defence has not yet expressed a view on the MISC 119 recommendation. This recommendation does not ask him to do anything which his predecessor was not planning to do; the 1985 Defence Costings show a progressive reduction in defence R & D expenditure over the 10 year period to 1995 (offset by a parallel increase in expenditure at the production stage). He is simply being asked to validate this.

6. Mr Heseltine resisted being bound by a collective decision to constrain defence R & D within the 1985 Costings figures on the grounds that:

(a) the bulk of the expenditure is development not research, and so different in kind from most other Government R & D expenditure;

(b) the resources used in defence R & D would not necessarily be absorbed immediately into more productive work elsewhere in the economy (and they might migrate abroad);

(c) the requirements of national defence are such that arbitrary financial constraints should not be put on defence R & D expenditure;

(d) the imposition of such constraints could prevent the armed forces from having access to the cheapest and most cost-effective equipment.

However, he continued to offer to have defence R & D subjected to some process of comparative evaluation alongside other Departmental programmes, although in practice the work programme he suggested could be made (and was perhaps so intended) to continue indefinitely without ever producing any conclusion.

7. These arguments were all dealt with in the MISC 110 Report: the fact is that it can never be proved exactly and scientifically that the economy would perform better if scarce scientific resources vere not so heavily pre-empted by defence development work. But:-

(a) outside the MOD and those companies relying heavily on defence contracts there is universal agreement that the present concentration of R & D resources on defence is detrimental to the overall performance of the economy;

(b) the opportunity cost is undeniable whether the defence work is research or development;

(c) the need for time for industry to adjust to less concentration on defence R & D is acknowledged in the MISC 110 Report;

(d) the general starting point of the armed forces and the UK defence industry that all defence equipment needed by the armed forces should be developed and constructed in this

country to their exacting specifications leads to unnecessary expense and frequent serious waste. Nimrod appears to be an outstanding example of this, and more generally of failure to take wider considerations properly into account.

In practice the combination of real reductions in the defence budget, increased reliance on European or NATO collaborative development, and MOD's own plans to concentrate more on production than development expenditure seems bound to enforce a decline in MOD's R & D programme on the lines indicated in the costings, so that the new Secretary of State would have little to lose in accepting the majority of MISC 119's conclusion. The MISC 119 report also explicitly acknowledges that acceptance of this conclusion would not itself carry any implications for the size of the total defence budget. That would remain a matter for negotiation with the Treasury in the normal way.

New Ministerial Machinery

8. The central aim of MISC 119 was to improve the contribution of Government funded R & D to the performance of the UK economy. There is no overall Government R & D budget; and Government R & D expenditure reflects the priorities attached by individual spending Ministers to R & D relative to other parts of their own programmes. MISC 119 discussions have shown that most spending Ministers are willing to accept some form of collective discussion of their own R & D programmes, in the light of the overall Government interest in improving the performance of the UK economy. But this education of spending Ministers is bound to be a gradual process; and the discussion in MISC 119 showed that it could well prove counter-productive to rush fences for this reason. MISC 119 recommended that a permanent Ministerial Committee be set up under the chairmanship of the Secretary of State for Trade and Industry and including Ministers responsible for all the main Departmental R & D programmes, along with

representatives from the Treasury and Foreign and Commonwealth Office. The terms of reference of such a Committee might be (on the basis of paragraph 15 of E(A)(86)2):

> "To develop policies to enhance the contribution of R & D expenditure, public and private, to improving the efficiency, competitiveness and innovative capacity of the UK economy; to evaluate the contribution of Government-funded R & D activities to the Government's economic objectives; to assess the impact of the Government procurement policies on the shape and content of UK R & D activity in both public and private sectors; and to make recommendations on R & D priorities".

I have confirmed that Mr Channon would be content with these terms of reference.

9. We suggest that this Committee be established as a Sub-Committee of E, ie in a parallel position to E(A). It would still be open to you, in the event of the new Committee having to handle very difficult issues, to have these reviewed by E(A) under your chairmanship, or for you to take the chair of the new Committee yourself. An appropriate membership of the new Committee would be:

Secretary of State for Trade and Industry (Chairman)
Secretary of State for Education and Science
Secretary of State for Energy
Secretary of State for Defence
Secretary of State for Social Services
Chancellor of the Duchy of Lancaster
Minister for Agriculture, Fisheries and Food
Secretary of State for Transport
Secretary of State for the Environment

Chief Secretary, Treasury
Minister of State, Foreign and Commonwealth Office
Minister of State, Department of Trade and Industry (Mr Pattie)

The Chief Scientific Adviser, Cabinet Office will be in attendance. The Payaster-General has also asked to be a member of the Committee; you will wish to consider this. He may claim some involvement from the standpoint of skilled manpower; and his Department now has wide economic responsibilities. But the proposed list is already long enough and it would be desirable to avoid further requests, eg from the territorial Ministers. The Committee will need appropriate official support; Mr Channon agrees that this should be provided by a Committee chaired by the Chief Scientific Adviser; the Departments concerned would be represented by officials with economic and financial responsibilities as well as by their Chief Scientists.

Task of the New Committee

10. We envisage that the new Committee would have three main tasks:

(i) the formulation of recommendations on priorities for Government R & D expenditure;

(ii) the evaluation of Departmental R & D programmes, and the formulation of policies to secure greater economic benefits from those programmes; and

(iii) the promotion of other measures, not involving direct Government expenditure, to encourage additional private sector R & D.

R & D Priorities

11. The task of the Committee would be to keep the overall balance of Government R & D programmes under review. The Committee would consider, on a regular basis, whether the wider interests of the economy would point to the desirability of increasing some programmes and reducing others. The broad judgement about desirable changes in the level of defence R & D expenditure over time is probably the most important decision; but the proposed work programme specifically focusses on future Government R & D expenditure on the science budget, on agriculture and on nuclear energy. The work programme also includes early consideration of Sir Robin Nicholson's proposal (at Annex 4 to E(A)(86)2)) for Government funding to "pull through" applied research projects into new products and service to be sold profitably by UK industry, and for the redeployment of existing expenditure programmes to generate the necessary funds.

Evaluation of R & D Programmes

12. We contemplate that this part of the new Committee's remit would be underpinned by a "R & D Evaluation Unit" located in the DTI. This Unit, which would desirably include officials seconded from MOD, DES, the Treasury and preferably also the private sector, would be charged with discussing each programme in detail with the responsible Department and reviewing all possible ways of extracting more economic benefit from it. The proposal for a Unit in this form came originally from Mr Heseltine: we see it as potentially very important in providing an opportunity for - questioning continuously the size and direction of the defence R & D programme as a whole, and so enabling other Departments to relate defence procurement issues to each other and to the wider needs of the economy instead of having - as at present - to look at each one in isolation by reference only to defence requirements and the ambitions of the UK defence industry. The Unit should also be able

to contribute substantially to the development of international (particularly European) collaboration in both the civil and the defence fields. This area will, however, need to be considered carefully in relation to other R & D resources and priorities. There are, for example, likely to be great pressures for more European Community R & D spending, and there should be no question at this stage of unpicking the arrangements for handling them in relation to other public expenditure (the "Euro PES" arrangements) which were agreed (after protracted discussions with the Treasury) only some 18 months ago.

Measures to encourage private sector R & D

13. This is an area of unfinished business which could appropriately be tackled by the new Committee. Treasury and DTI officials have already done a considerable amount of work on topics like disclosure requirements relating to R & D in company reports. It is important to recognise the private sector dimension to the inadequate UK performance on R & D: it is not simply a question of throwing more Government money at the problem.

HANDLING

14. You will wish to invite the Lord President of the Council to introduce the Report of the Ministerial Group on R & D Priorities (MISC 119). You may wish to ask Sir Robin Nicholson to comment also.

15. Thereafter, I suggest you divide discussion into two parts. First, I suggest you ask the Sub-Committee to consider the recommendation of the majority of MISC 119 that a collective decision be taken to reduce the total volume of resources devoted to defence R & D in accordance with the projections in the 1985 Defence Costings. The new Secretary of State for Defence will wish to state his position on this central recommendation. The

Secretry of State for Trade and Industry and the Chancellor of the Exchequer and other colleagues may wish to comment. If it is not possible to secure a collective decision on this point at this meeting, you will wish to refer this question for further consideration by the proposed new Ministerial Committee on R & D Priorities.

16. Second, the Sub-Committee should consider the recommendation that a Ministerial Committee by established with appropriate arrangements for official support, with the task set out in paragraph 16 of E(A)(86)2. The Secretaries of State for Trade and Industry, Education and Science, Energy, Health and Social Services, Transport, Environment, the Minister for Agriculture, Fisheries and Food and the Chief Secretary, Treasury will wish to express views on this.

17. In his minute to you of 17 January Sir Robin Nicholson argued that it was possible for E(A) to take decisions now, at least in principle, on his recommendations for a research pull-through programme and an improvement of the industrial benefits from Departments' R & D programmes dealing with their statutory and regulatory responsibilities, without awaiting the formation of the new Committee. You may wish to test the views of the meeting on this. My own view, however, which I understand the Lord President strongly endorses, is that it would be counter-productive to press this now, and indeed would risk endangering the progress already achieved. It would therefore be better to remit this to the new Committee and to concentrate at this meeting on the crucial defence issue. However, you will wish to invite Sir Robin to state his views.

CONCLUSIONS

18. You will wish the Sub-Committee to reach conclusions on:

(i) whether or not a collective decision should be taken by E(A) to reduce the total volume of resources devoted to defence R & D (including any contribution towards SDI) in accordance with the projections in the 1985 Defence Costings; or whether this should be referred to the new Ministerial Committee for further consideration;

(ii) whether or not to establish a permanent Ministerial Committee as recommended in E(A)(86)2 (with the terms of reference and membership as suggested in paragraphs 8 and 9 above);

(iii) whether or not the task of the new Committee should be as set out in E(A)(86)2, or whether a decision in principle can be taken now on any of the MISC 119 non-defence recommendations (as advocated by Sir Robin Nicholson in paragraph 17 above).

J B UNWIN

18 February 1986
Cabinet Office

Prime Minister
But see paragraph 17
of Brian Unwin's
brief.
DRV
18/2

PERSONAL

MR NORGROVE

18 February 1986

E(A) - MISC 119 REPORT.

I have written the attached before I have seen a copy of Brian Unwin's steering brief for the Prime Minister. I have tried to persuade Brian, but I do not know with what success, to brief the Prime Minister to at least test views in the meeting as to whether some **action** on MISC 119 can be taken now as suggested in my minute of 17 January. Otherwise this will go on for ever.

2. The Lord President was due to report recommended actions in October. This became December because of Star Chamber meetings and February because of Westland. Now we have a new Ministerial Committee which will report in May (?) by which time nothing will be possible because of PES! And after PES too near the election?! Sorry, I must be getting cynical.

RBN.

SIR ROBIN NICHOLSON
Chief Scientific Adviser

10 DOWNING STREET

Prime Minister

You will remember that you agreed this should not after all be circulated more widely.

DHS

19/2.

PRIME MINISTER

R & D PRIORITIES

There is, to my mind, clear evidence that the resources devoted to defence r & d are excessive. The result is to leave us worse defended and to damage the civil economy.

The fact is that we try to do too much ourselves, maintaining a defence production capability across the whole range of our defence effort, which itself is wider than that of any other Western country apart from the United States.

This is becoming increasingly clear as weapons and weapons systems become ever more sophisticated and dependent on computers and computer software. Defence procurement disasters of the last few years include:

- Nimrod
- Foxhunter Radar (the radar for the air defence variant of Tornado)
- JTIDS (identification system for aircraft)
- BATES (an artillery targeting system)

Each of these - and one or two others about which you know - has run into trouble primarily through shortage of software engineers and lack of capacity for handling major software projects. The costs in terms of our defence capability are immense, and the result is to damage not only our computer industry but also our ability to apply sophisticated electronics to consumer products.

Part of the trouble is that governments and outside commentators are too easily seduced by industrial pressure groups using the argument that the UK needs such and such a

capability, or needs to preserve such and such a capability, if it is to stay in the forefront of technology. All the evidence shows that spin-off from military projects is limited, to put it kindly.

Peter Levene's efforts ~~at~~ will undoubtedly improve the situation by placing more of the risk with contractors. But the essential problem will remain.

To cut defence r & d would inevitably mean buying more defence equipment overseas, to a large extent from the United States, though the effects would not be felt for a number of years. At present we meet 95 per cent of our defence equipment needs through domestic production, of which about 10-15 per cent is in collaboration with others. That share would fall, at the cost in the shorter term, of lower employment in defence industries. But in the longer term our civil industries would gain, our defence industries would gain by concentrating on fewer products, and we would be better defended at lower cost.

This is another example of industries where shorter term change is needed in the interests of longer term prosperity, and, in this case, better defence.

David Norgrove

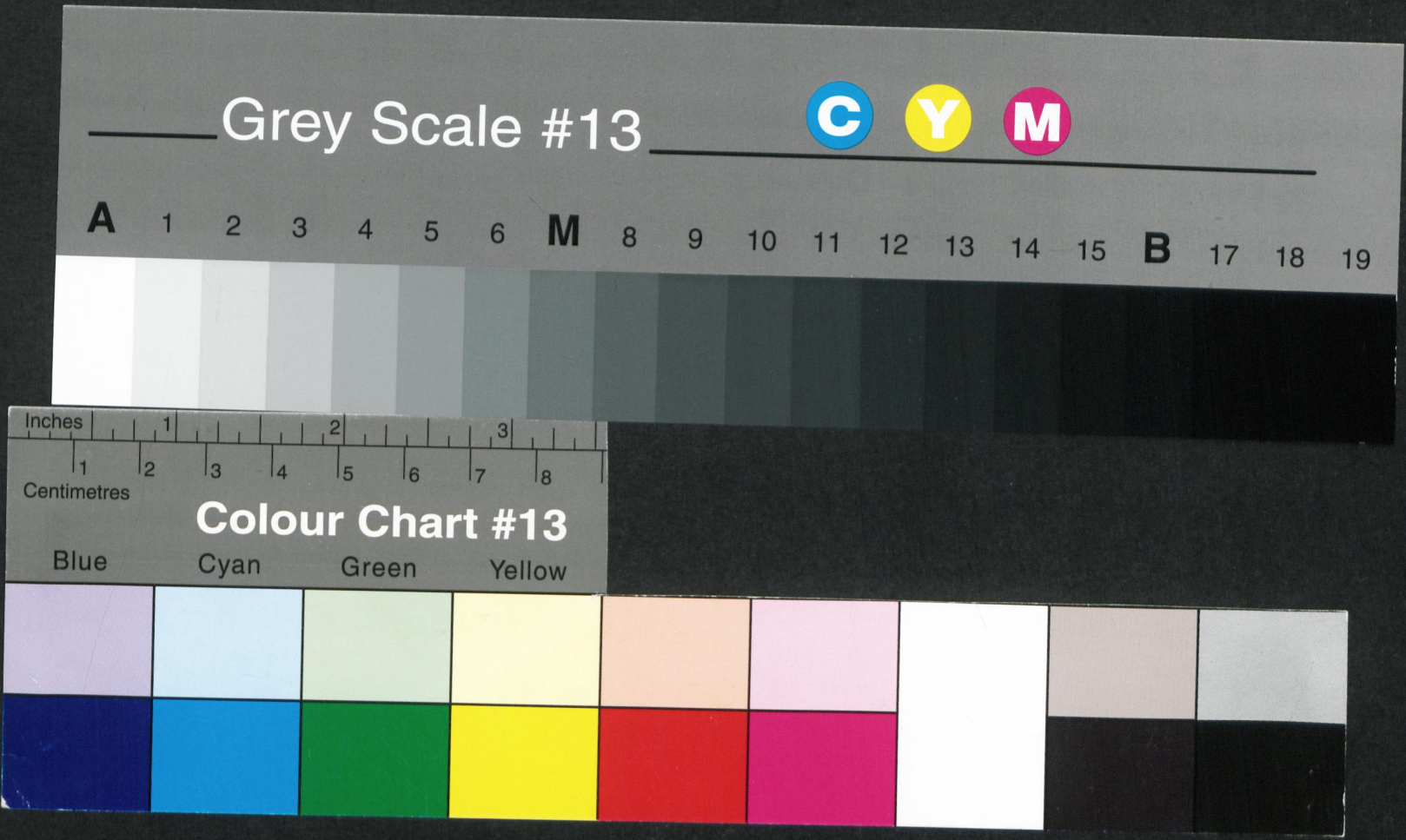
18 February 1986

PART 1 ends:-

DN ∞ PM 20.1.86

PART 2 begins:-

DN ∞ PM 18.2.86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