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SCIENCE AND TECHNOLOGY
COMMITTEE

First Report

TECHNOLOGY FORESIGHT

Volume II

Minutes of Evidence and Appendices

*Ordered by The House of Commons to be printed
29th November 1995*

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HC 49-II
[incorporating HC 794-i, ii, iii, of Session 1994-95]



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SCIENCE AND TECHNOLOGY COMMITTEE

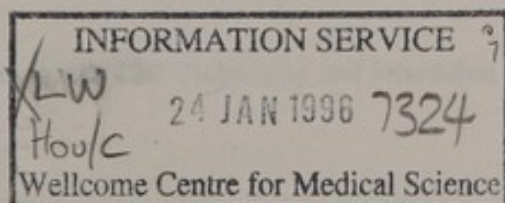
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The Science and Technology Committee is appointed under Standing Order No 130 to examine the expenditure, administration and policy of the Office of Science and Technology and associated public bodies.

The Committee consists of 11 Members. It has a quorum of three.

The Committee has power:

- (a) to send for persons, papers and records, to sit notwithstanding any adjournment of the House, to adjourn from place to place, and to report from time to time;
- (b) to appoint specialist advisers either to supply information which is not readily available or to elucidate matters of complexity within the Committee's order of reference;
- (c) to communicate to any other such committee and to the Committee of Public Accounts and to the Deregulation Committee its evidence and any other documents relating to matters of common interest; and
- (d) to meet concurrently with any other such committee for the purposes of deliberating, taking evidence, or considering draft reports.

Unless the House otherwise orders, all Members nominated to the Committee continue to be members of it for the remainder of the Parliament.

The following were nominated members of the Committee on 13 July 1992:

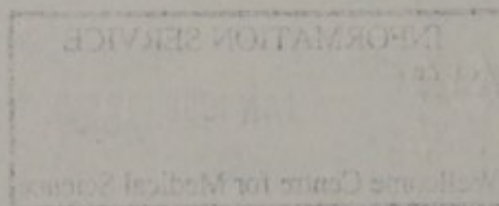
Mr Spencer Batiste	Sir Giles Shaw
Dr Jeremy Bray	Sir Trevor Skeet
Mr Malcolm Bruce	Dr Gavin Strang
Mrs Anne Campbell	Sir Gerard Vaughan
Cheryl Gillan	Dr Alan W Williams
Mr William Powell	

Sir Giles Shaw was elected Chairman on 15 July 1992.

On 9 November 1992 Mr Malcolm Bruce was discharged and Mr Andrew Miller added to the Committee.

On 16 November 1992 Dr Gavin Strang was discharged and Dr Lynne Jones added to the Committee.

On 7 November 1995 Cheryl Gillan and Mr William Powell were discharged and Mr Ian Bruce and Mr Patrick Thompson added to the Committee



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2. BACKGROUND AND CONTEXT

2.1 The White Paper on Science, engineering and technology, "Realising our Potential" was published in May 1993. It had the fundamental aim of exploiting better use of our scientific and engineering excellence and skills and making better use of those resources in pursuit of economic and social objectives. In particular, it proposed that closer partnerships between the science base and UK companies would assist substantially in improving wealth creation and the quality of life.

2.2 One of the key initiatives of the White Paper was the Technology Foresight Programme. The Programme commenced in the summer of 1993 with the appointment of a Steering Group to advise on the design and conduct of the Programme. In the autumn of 1993 a series of awareness events was mounted to inform the scientific and business communities about the Programme, and to elicit their views on how it should be undertaken. During 1994 Foresight Panels were appointed to undertake analyses in 15 sectors, looking ahead at developments over the next 10-20 years. The Steering Group continued to oversee progress on the programme plans in the Foresight process. In early 1995 the Steering Group received five draft reports from the 15 Foresight panels and conducted hearings at which the Panels were questioned about their findings. Foresight panels also provided final draft reports which were published in March and April 1995. The Steering Group's assessment of the 15 panel reports, together with its views on the general position to be drawn from them, were published in a report on 22 May 1995.

2.3 Ministers have made clear that these reports were only a first step in achieving the aims of the Foresight Programme. It was stated that the Foresight process would continue in being and that the next steps would be to disseminate Foresight findings and work to address real advances in wealth creation and quality of life through their implementation.

2.4 On 20 July 1995, following CMT's report in 1994, Sir Ian Taylor, MP, made a policy statement on science, engineering and technology. The Minister endorsed the Government's commitment to following up Foresight, in particular by utilising additional funding available to underpin Foresight dissemination and implementation.

A 10% welfare through Challenge Fund administered by the CMT, all of which would be matched by industry.

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MINUTES OF EVIDENCE

TAKEN BEFORE THE SCIENCE AND TECHNOLOGY COMMITTEE

TUESDAY 24 OCTOBER 1995

Members present:

Sir Giles Shaw, in the Chair

Mr Spencer Batiste
Dr Jeremy Bray
Mrs Anne Campbell

Dr Lynne Jones
Sir Trevor Skeet
Sir Gerard Vaughan

Memorandum from the Office of Science and Technology (TFC 61) (2 October 1995)

1. INTRODUCTION

1.1 In July the Clerk to the Science and Technology Committee wrote to both the Office of Science and Technology (OST) and the Department of Trade and Industry (DTI) requesting information on the Technology Foresight Programme. The specific questions asked were:

What action has been taken or is planned on each of the recommendations contained in Chapter 5 of the Report from the Steering Group of the Technology Foresight Programme, and on the infrastructural priorities identified in pages 79-83 of Chapter 4. The Committee would also like to know what OST staff resources were devoted to Foresight in the period when the exercise was being carried out, and what resources will be devoted to it in the future.

Is there a Minister responsible for ensuring the Technology Foresight Programme is implemented within the Department?

Is there a particular official responsible for ensuring the Technology Foresight Programme is implemented within the Department? If so, at what grade and what are his or her other responsibilities?

What mechanisms (e.g., working groups) have been put in place to ensure that Technology Foresight is implemented?

What effects has Foresight had on the plans published in the Forward Look?

2. BACKGROUND AND CONTEXT

2.1 The White Paper on science, engineering and technology, "Realising our Potential" was published in May 1993. It had the fundamental aim of making better use of our scientific and engineering excellence and skills and making better use of these resources in pursuit of economic and social objectives. In particular, it proposed that closer partnerships between the science base and UK companies would assist materially in improving wealth creation and the quality of life.

2.2 One of the key initiatives of the White Paper was the Technology Foresight Programme. The Programme commenced in the summer of 1993 with the appointment of a Steering Group to advise on the design and conduct of the Programme. In the autumn of 1993 a series of awareness events was mounted to inform the scientific and business communities about the Programme, and to elicit their views on how it should be undertaken. During 1994 Foresight Panels were appointed to undertake analyses in 15 sectors, looking ahead at developments over the next 10-20 years. The Steering Group continued to oversee progress on the successive steps in the Foresight process. In early 1995 the Steering Group received first draft reports from the 15 Foresight panels and conducted hearings at which the Panels were questioned about their findings. Foresight panels then provided final draft reports which were published in March to April 1995. The Steering Group's assessments of the 15 panel reports, together with its views on the generic priorities to be drawn from them, were published in a report on 22 May 1995.

2.3 Ministers have made clear that these reports were only a first step in achieving the aims of the Foresight Programme. It was stated that the Foresight process would continue in being and that the next stage would be to disseminate Foresight findings and seek to achieve real advances in wealth creation and quality of life through their implementation.

2.4 On 20 July 1995, following OST's move to DTI, Mr Ian Taylor, MP, made a policy statement on science, engineering and technology. The Minister confirmed the Government's commitment to following up Foresight. In particular, he noted the additional funding available to underpin Foresight dissemination and implementation:

— A £40 million foresight Challenge Fund administered by the OST, all of which would be matched by industry.

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[Continued

- £70 million additional funding for DTI to support innovation and Foresight, part of which would be matched by industry.
- The matching sums from industry would provide a total package worth some £170 million.

2.5 Mr Taylor also noted several other responses to Foresight, including new LINK programmes (see paragraph 4.2); and the *Information Society Initiative* designed to spread awareness of the opportunities and benefits that an information-based society can bring about. The Minister further announced that part of the Foresight Challenge Fund would be directed towards the components of EQUAL—an initiative to *Extend Quality Life*, which aims to take forward several foresight priorities, particularly in the health and medical field, under one umbrella.

2.6 The OST and DTI welcome this opportunity to provide the Committee with an early insight into progress with the Technology Foresight Programme. The key objectives of the current phase of the Programme are:

- Dissemination of the ideas contained in the reports of the Foresight panels and the Technology Foresight Steering Group.
- Sustaining and extending the Foresight networks which are building partnerships between science and business.
- Urgent consideration of Foresight recommendations.

The OST, which leads the Programme, intends to provide an interim report on progress in pursuit of these objectives in December 1995, as announced in the 1995 Forward Look; and a first annual report in May 1996 with the 1996 *Forward Look* on Government-funded science, engineering and technology (SET). This memorandum, therefore, provides the Committee with a preview of how Foresight objectives are being taken forward.

2.7 The Government's general strategy for taking forward Foresight is in two parts:

- (i) First, the Foresight panels themselves have been given a remit to disseminate their findings and to encourage the take-up of their recommendations in the public and private sectors. Where appropriate the Government will seek to broker joint action by panels in furtherance of priorities which envisage similar outcomes.
- (ii) Second, the Government collectively and individual Departments of State will seek to respond to Foresight priorities where a leading role for the public sector is required, for example, in reviewing policy and regulatory frameworks.

Apart from the this general strategy a multitude of entirely voluntary actions by both public and private sector bodies are being undertaken. The Foreign Programme has encouraged a wide range of independent concerns—professional institutions, learned societies, trade associations, universities and firms—to review their strategic thinking and to initiate their own Foresight analyses.

2.8 The Government intends to encourage these developments. As the Steering Group recognised in its report (paragraphs 5.10 and 5.11) one of the main aims of Foresight is to promote Foresight activity at several levels in the economy. In due course, the Foresight "habit" will thereby become deeply embedded in the culture of our institutions.

2.9 The remainder of this memorandum reflects the Committee's interests as stipulated in paragraph 1.1. Section 3 summarises the recommendations in Chapter 4 and 5 of the Steering Group's report; Section 4 sets out how the priorities in Chapter 4 of that report are being taken forward with reference to Forward Look plans; and Section 5 describes the mechanisms being put in place to ensure that those recommendations are being addressed. Two concluding sections provide details of the resources devoted to the Programme (Section 6) and look to developments over the coming months (Section 7).

3. PRIORITY RECOMMENDATIONS IN CHAPTERS 4 AND 5

3.1 The Steering Group identified two sets of priorities in Chapter 4 of its report. First, *twenty-seven* generic SET priorities were identified, ranging from work on the effects of demographic change to life cycle evaluation in relation to sustainable technologies. Second, *eighteen* generic infrastructural priorities were listed in respect of skills development, the science base, the communications infrastructure, finance, and the policy and regulatory framework. Annex A gives summary details of the Steering Group's priorities.

3.2 In Chapter 5 of its report the Steering Group made *sixty-four* recommendations, detailing action to be taken by the OST, Departments of State, Research Councils, Universities, Higher Education Funding Councils, and private industry. These recommendations are given in full in section 5.

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[Continued]

4. ACTION ON GENERIC PRIORITIES

4.1 There are three main mechanisms whereby *generic SET priorities* are being addressed by public sector bodies.

4.2 First, Government Departments and Research Councils are considering the implications of Foresight for their SET portfolios. Within Government Departments, Foresight priorities are being taken into account in formulating future SET spending plans. An account of each Department's present Forward Look plans and future SET priorities, including the effect Foresight has had on them, will be given in the 1996 Forward Look. In addition to addressing spending plans, DTI is promoting Foresight through a wide range of its existing activities which promote industrial innovation.

4.3 Within the Research Councils an interim report on the response being made to Foresight was published by the Director General of the Research Councils in June.¹ This report provided many examples of relevant initiatives; just three of them are:

- A new *bioinformatics* research programme jointly funded by the BBSRC and EPSRC with £10 millions funding over four years.
- An *environmental diagnostics* programme, within an emphasis on pollution and waste, funded by NERC.
- EPSRC's intention to set up one or more *centres of excellence*, perhaps based upon existing interdisciplinary research centres.

The Research Councils and Foresight Panel members will discuss the scope for further shifts in research portfolios to reflect Foresight priorities during the autumn. This dialogue should allow the Councils better to understand the range of Panel concerns contributing to generic SET priorities identified by the Steering Group. Councils will also be able to review, and perhaps quantify, the impact which Foresight initiatives are likely to have on their programme spending over the next three years (1996–97 to 1998–99).

4.4 Second, LINK programmes have been devised in an early response to Foresight priorities. By the end of August 1995 a total of five new LINK programmes with Foresight credentials had been announced. These were:

- (i) Applied biocatalysis.
- (ii) Waste minimisation through recycling, re-use and recovery in industry.
- (iii) Integrated approaches to healthy ageing.
- (iv) Genetic and environmental interactions in health.
- (v) Earth observation.

In addition, extra money has been injected into two existing LINK programmes to support new Foresight-relevant projects. In all of these programmes the Departments and Research Councils are active partners and are therefore standing ready to encourage the academic-industry partnerships which are fundamental to Foresight thinking. Annex B to this memorandum provides further details of these seven LINK programmes.

4.5 Third, the Foresight Challenge, which was first announced by Ministers on 22 May, was launched on 25 September, 1995. The Challenge is intended to pump-prime the response to Foresight and to encourage science-business collaborations. It will offer funding, on a competitive basis, to collaborative projects which take forward either generic or sectoral priorities. A wide range of bodies will be eligible to lead and participate in Challenge consortia. Outline bids are required by mid-November 1995, while detailed bids may be submitted up to January 1996. Successful Challenge consortia are expected to commence operations in 1996–97. OST funds for the Challenge amount to £40 million; with matching funds from the private sector the Challenge should initiate programmes worth in excess of £80 million. The terms and conditions of the Foresight Challenge Fund are at Annex C of this memorandum.

4.6 The *infrastructural priorities* in the Steering Group's report are being addressed in three ways. First, the OST has set up a *Whitehall Foresight Group* with a specific remit to co-ordinate responses to the infrastructural priorities in the Steering Group's report.

4.7 Departments are represented on this Group by their *Foresight Action Managers*. The full terms of reference of the Whitehall Foresight Group are:

To review the recommendations relevant to government arising from the Technology Foresight reports; to identify the further actions required and to co-ordinate and report those actions with an interim report to Ministers at the end of 1995 and an annual report in May 1996.

¹ Cabinet Office (OPSS, 1995) *The Research Council's Response to the Recommendations of the Technology Foresight Initiative*, 29 June 1995.

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[Continued

It is expected that the Group will focus particularly on those areas where Government has a particularly strong locus, namely, in the areas of *communications, education and training, finance* and the *policy and regulatory framework*. The Group met for the first time on 12 September 1995.

4.8 Second, the Research Councils have a role in providing new incentives for multidisciplinary research, in looking again at the incentives for academics to work with industry, and in maintaining research excellence. In the Research Council's Response to Foresight document, the BBSRC noted that it is:

- Maintaining the skills base through strong studentship and fellowship schemes aimed at identifying the best supervisors, departments and research programmes.
- Maintaining support for truly excellent research, whether or not in a Technology Foresight priority area, through the peer review process.
- Providing incentives for multi-disciplinary research through workshops, co-ordinated programmes, Interdisciplinary Research Centres, research groups, Institutes, LINK programmes and joint programmes between Institutes and universities.
- Providing incentives for universities to work with industry through LINK, ROPA, CASE, the Teaching Company Schemes, equipment-with-industry initiatives and workshops between academics and industrialists.

The Research Councils will thus focus particularly on the first *eight* infrastructural priorities identified by the Steering Group, dealing with "the skills base" and "research in the science base".

4.9 Third, the Higher Education Funding Councils will also keep in view Foresight infrastructural priorities. For example, the Scottish Higher Education Funding Council (SHEFC) is canvassing the views of organisations, institutions and individuals who have an interest in the role of higher education in Scotland as to how SHEFC might respond to Foresight. It has asked for views on whether recurrent research grants might be affected by a Foresight "priority factor"; it is considering whether Foresight might affect funding for physical infrastructure; and it is discussing a wide range of related issues. The SHEFC will submit an action plan to the Secretary of State for Scotland by the end of 1995 which will detail the way forward.

MAINTAINING NETWORKS AND PANELS

1. We recommend that the sector panels be maintained by OST and that a focus of their work, at least over the next 12 months, should be to ensure communication of the results.
2. We recommend that action be taken, wherever and whenever appropriate, to implement the recommendations of the various panels and the generic priorities we have identified.
3. We recommend that the Steering Group, chaired by the Chief Scientific Adviser, be continued in its overarching capacity.
4. We recommend that the 15 sector panels be retained but that the composition of each panel be shaded to take account of the need to communicate and promote implementation of the results.
5. We recommend that Research Council representatives be added to the membership of appropriate sector panels, and that Departmental representatives with expertise in policy and regulatory matters continue to be in membership of each panel.
6. We recommend that the panels develop close working links with professional bodies, learned societies and trade associations.
7. We recommend that senior personnel from industry, relevant trade associations and professional bodies be recruited by OST to serve as the links between the sector panels and the relevant community.
8. We recommend that sub-groups of individuals drawn mainly from different panels should be established to address cross-sectoral issues.
9. We recommend that further foresight work on Marine Science and Technology be undertaken, as recommended by the Agriculture, Natural Resources and Environment panel.

5. SPECIFIC STEERING GROUP RECOMMENDATIONS

5.1 For ease of reference each of the 64 recommendations made by the Steering Group is given alongside the accompanying text on the actions taken subsequently.

5.2 **Maintaining Networks and Panels.** Most of the Foresight panels are to remain in being for the foreseeable future. Two of the former panels, namely, *Communications* and *Information Technology* and

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[Continued]

Electronics have been merged in view of the convergent technologies in these sectors. One panel—*Agriculture, Natural Resources and Environment*—has been divided into two. A new panel for the *Marine* sector is also being formed to bring together a variety of marine market interests spread across several sectors (recommendation 9). A full list of the panels is attached at Annex D.

5.3 The Foresight panels have been given terms of reference which reflect the Steering Group's recommendations that they should focus on disseminating and seeking implementation of their findings (recommendations 1 and 4). These terms of reference are attached here at Annex E.

5.4 The terms of reference (see Annex E, paragraph 7) give panel chairmen a wide degree of latitude in recruiting new members for the next phase of the programme. Panel chairmen have been allowed to assess their needs to establish links with professional bodies, trade associations, Departments and Research Councils where they do not already have such links (recommendations 5, 6 and 7).

5.5 The Technology Foresight Steering Group is to remain in being, under the chairmanship of the Chief Scientific Adviser (recommendation 3). The composition of the Steering Group is being changed somewhat to reflect the need to focus on dissemination and implementation in a wider community. An announcement of the full membership of the new Group will be made shortly.

PUBLIC SECTOR ACTIONS

10. OST should continue to support and co-ordinate the overall programme including the panels and their networks.

11. The OST should take the lead in co-ordinating implementation across Government via the official Committee on Science and Technology and the Science and Engineering Base Co-ordinating Committee.

12. The OST's co-ordination should be exercised through the annual Forward Look. Foresight findings provide ingredients for a way of assessing the national portfolio of science, engineering and technology, the central purpose of the Forward Look. Government must ensure that Foresight messages are received loudly and clearly by appropriate programme managers in the Departmental system.

13. Where recommendations for a shift in the portfolio have been made, it is important that systems of oversight are specifically deployed in order to trace progress, both in Departmental-sponsored expenditure and elsewhere. The OST provides the natural base for such an activity.

14. In addition to contacts through the panels and the Steering Group, links with industry should be made through professional and industry bodies such as the Chemical Industries Association, The Royal Society of Chemistry, the Institute of Physics, the Association of British Pharmaceutical Industries, and through senior industrialists belonging to appropriate professional bodies. The latter should be appointed specifically to lead on implementation and to serve as the link between the OST Foresight team and industry.

15. Links with industry should not become confined to SET specialists but must extend also to those with general management and marketing responsibilities in industry.

16. The Technology Foresight team within the OST should be strengthened. While the Steering Group fully accepts the need for efficiency in the use of resources, we believe that building up the team for the implementation phase is essential.

17. We recommend that an even stronger co-ordination mechanism for SET be established across Government to optimise interaction, to minimise unnecessary duplication and to improve efficiency in the use of necessarily limited resources.

18. We further recommend that the Annual Forward Look on SET be used pro-actively as a strategic planning statement to take forward actions resulting from the Foresight process.

19. We recommend that other Departments follow the lead of the DH, DOE, DFE, AND DTI in setting up specific arrangements to take forward Foresight findings relevant to their area of responsibility. It is important that there be close liaison between these new groups and the national Technology Foresight panels.

20. We recommend that the Government's Public Understanding of Science campaign should include a Foresight dimension.

5.6 Public Sector. The OST will continue to support and co-ordinate the Foresight Programme, including maintenance of the Panel Secretariat. The panels, in turn, will devote resources to maintaining links with their respective communities (recommendation 10).

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5.7. The official Committee on Science and Technology and the Science and Engineering Base Co-ordinating Committee (SEBCC) will continue to monitor the progress of Foresight and, where appropriate, seek to encourage implementation of Foresight findings (recommendation 11).

5.8 The *Forward Look* will review Foresight progress annually and will provide a central assessment of the shifts in the SET portfolio which result from it (recommendations 12, 13 and 18).

5.9 Departments have established very good working relationships with their appropriate sector panels (recommendation 19). Within DTI, the sector divisions have direct links to the panels through senior officials' membership of 12 of the Panels. Regular meetings of these officials and others responsible for Foresight follow-up are held to ensure co-ordination of effort. As a result of the transfer of OST to DTI, the Foresight panels now have an additional resource on which to draw in the form of DTI's sector divisions and the Government's Regional Offices, which have extensive knowledge and contacts with industry and related organisations. Close working practices have been established to improve efficiency and effectiveness and to ensure maximum synergy in promoting the Foresight message in industry. DTI sector divisions and Government Offices are actively working with panels to arrange specific events, such as workshops, and to promote wide industrial involvement in taking forward Technology Foresight.

5.10 Other Departments also work closely with the Foresight panels. For example, the Department of the Environment has been involved with the construction panel since its inception, and is seeking to dovetail the priority recommendations of that panel with the Whole Industry Research Strategy (WIRS) which the Department has formulated in collaboration with industry bodies. Some Departments have devised new arrangements since the Steering Group's report (for example the Ministry of Defence, see below, paragraph 5.12) in order to co-ordinate responses to Foresight. The Whitehall Foresight Group will keep these emerging arrangements under review.

5.11 Recommendation 20 proposed that the Public Understanding of Science (PUS) programme should have a foresight dimension. A major opportunity to follow this up will arise during Science Week early in 1996. In the meantime, the British Association for the Advancement of Science (BAAS) supported by OST mounted "The Foresight Experiment" during early September. This event contrasted the views of people over the age 40 with young people as they view emerging trends and opportunities in the food and drink sector. On the same day, the BAAS (with OST and private sector support) launched "Visions of the Future", an explicit response to the Steering Group report and an important contribution to the public understanding of science. This initiative will encourage young people to assess future trends through a nationwide series of briefings, presentations and debates. Universities will be selected as regional debate centres for the topics identified in the Technology Foresight Programme. Other ideas, including national competitions and interactive discussions over telecommunications networks, are under discussion.

DEFENCE

21. We recommend that the R&D base in the defence area must sustain and enhance its cutting edge R&D capability.

22. We recommend that the MoD continues to take steps to access leading edge R&D in industry, and in the civil sector, as well as in-house.

23. We recommend that new initiatives should have wealth creation as a priority. These initiatives should be funded jointly by the DTI, OST, civil industry and defence in areas of underpinning technology.

24. We recommend that the civil-defence forum work closely with the Defence and Aerospace Foresight Panel.

25. We recommend that technology Demonstrators should be included when joint DTI, OST civil industry and defence priorities are being considered.

26. We recommend that LINK be developed as a mechanism to establish these new civil, defence and industry partnerships.

27. We recommend that substantially increased attention be given to the co-funding of defence projects on a European basis.

5.12 **Defence.** The main actions in this field are for MOD to pursue (recommendations 21-27). The Trade and Industry Select Committee has recently received evidence from the former Defence Procurement Minister (Mr Freeman) to the effect that MOD is vigorously following up Foresight on a Departmental basis. In particular, two initiatives may be noted. First, MOD has announced the preparation of a Technology Strategy to the Managing Directors of the UK Defence Industry. It is envisaged that this will in future meet the MOD need for

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Science and Technology advice, particularly where it concerns the equipment programme, as well as looking at wealth creation and the maintenance of the UK defence industrial base. The OST welcomes this development. Further to this, the MOD intends to launch a programme, under the provisional title *Beacon*, to encourage greater international collaboration, primarily in Europe, involving both government and industry. Second, the Joint Working Forum on Civil/Defence Collaboration meets regularly to assess the scope for collaborative projects which might respond to Foresight priorities. The full terms of reference for this Group are at Annex F. In addition, MOD has for some time held regular meetings for the major defence suppliers at which likely future trends in technology requirements are reviewed. Other collaborative initiatives include the Civil Aeronautics Research and Development (CARAD) programme, Pathfinder, Strategic Alignment, Dual Use Technology Centres and DERA support to Industry.

THE SCIENCE BASE

28. We recommend that the Higher Education Funding Councils address how the funding allocated to different subject areas (at present largely driven by historical factors) should be adjusted to reflect Foresight findings and the real cost of supporting Foresight priority areas.

29. We recommend that the Funding Councils consider whether the other components of their funding formulae could be better used to reward and encourage academic researchers who take forward Foresight findings, and promote collaboration with industry, between departments and between universities.

30. We recommend that Funding Councils consider how the capital funds which they allocate should be used more selectively to respond to Foresight findings; and

31. We further recommend that Funding Councils fully assess the skilled manpower implications of the Foresight analyses.

32. We recommend that a main focus should be in support of innovative research, discovery and international excellence whether in basic, strategic or applied areas.

33. We recommend that the Technology Foresight priorities should be integrated by the Councils into their decision making processes.

34. We recommend that priority areas identified, whether by Foresight or not, should be fully funded, even if this means more selectivity in the awards made.

35. We recommend that each Research Council contributes positively to an expanded LINK scheme.

36. We recommend that the Research Councils seek further opportunities for joint funding, of research within the science and engineering base.

37. We recommend continued support for the ROPA scheme and for the jointly funded science budget equipment scheme.

38. We recommend that the research training support grant for consumables and related recurrent research expenditure should be increased further as a priority item from within the Science Budget, as circumstances permit.

5.13 **Science and Engineering Base.** The role of the Higher Education Funding Councils (HEFCs) and the Research Councils (RCs) in taking forward Foresight (recommendations 28-36) has already been addressed above (section 4). The Foresight dialogues in the autumn will provide an opportunity to consider the progress made by individual RCs in integrating Foresight into their decision-making processes.

5.14 The then Chancellor of the Duchy of Lancaster, David Hunt, announced the Realising our Potential Awards (ROPAs) on 24 May, two days after the launch of the Steering Group's report (see recommendation 37). A total of 473 awards costing £46.7 million were made. A report on the ROPA scheme will be published shortly by the OST. It is worth noting here that ROPAs are not funded at the expense of responsive mode science; the essence of ROPAs is that they are awarded to fund curiosity-driven, speculative research which is at the heart of our great tradition and achievement in fundamental science.

INFRASTRUCTURAL ISSUES

39. We recommend the various skill deficits identified by panels in areas like IT competence, chemistry, mathematics, and finance should be discussed with the Education and Employment Departments, the relevant training and further education bodies and the professional institutions with a view to developing a co-ordinated response.

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40. We recommend that action to address the various regulatory issues identified by panels as influencing the competitive scope of sectors should be taken forward by the DTI Deregulation Unit and relevant Government Departments. The recent Deregulation Act should assist in obtaining a responsive follow-up.

41. We recommend that the increasing and welcome involvement of women in scientific research is recognised and encouraged where possible.

42. We recommend that further research be undertaken into the factors which led firms to locate their intellectual and strategic headquarters in particular countries, and to understand better the factors which create new clusters of business activity (such as Silicon Glen in Scotland) which could underpin a future strategy for attracting inward investors.

43. We recommend that further research be undertaken to understand the managerial and financial approaches to the containment of business risks associated with innovation.

44. We recommend that the Council for Science and Technology address the issue of the strategic framework for research in the UK: the roles of different forms of research support and organisation . . . and the infrastructures which their work requires.

5.15 **Infrastructural Issues.** A variety of bodies were invited by the Steering Group to address a diverse range of infrastructural issues (recommendations 39-44). As already noted, the Whitehall Foresight Group has been set up to co-ordinate Government action on infrastructural issues. Some of these issues are clearly more complex to address than others—for example, skill deficits in IT competence—and will require careful co-ordination by Governmental and professional bodies which have complementary roles to play in bringing about useful results in this area. Other recommendations may require further discussion before specific work can be initiated.

5.16 The Steering Group's recommendation to encourage the involvement of women in science (recommendation 41) was quickly responded to by Government. Ministers announced a doubling of the Government's contribution to the Dorothy Hodgkin fellowship scheme, which aims to encourage post-doctoral scientists to stay in science (90 per cent of applications for this fellowship scheme are made by women). In addition, the Development Unit on Women in SET (OST) and Opportunity 2000 will shortly be producing a brochure about the business benefits of retaining women in scientific posts.

THE PRIVATE SECTOR

45. We recommend that indigenous and inwardly investing companies in this country be treated equally with respect to Foresight involvement, diffusion and implementation.

46. We recommend that companies of global excellence located in the UK be underpinned by a public sector SET infrastructure.

47. We recommend that every company in the top 1,000 companies be targeted to become fully involved in Foresight, both within the company and as part of the national programme.

48. We recommend that Panels develop targets for R&D intensity in the sectors by reference to world competitors, and together with trade associations and other bodies, publicise the targets compared with actual performance widely in their sectors and amongst key decision makers.

49. We recommend that mechanisms be established whereby large companies with extended supplier chains convene Foresight groups to address mutually beneficial future areas for enhanced collaboration, needs, likely markets and technology trends.

50. We recommend that the Association of Independent Research and Technology Organisations (AIRTO) supported by Government should be invited to diffuse Foresight findings to SMEs in their sectors.

51. We recommend the appointment of leading industrialists to serve as "Foresight Champions", liaising with the Foresight Panels, with the relevant industrial base, and importantly with relevant professional organisations. The specific remit of the "Foresight Champions" should be to foster dissemination and implementation.

52. We recommend that existing DTI schemes for supporting industry be sustained and expanded, for example SMART, SPUR and the Teaching Company Scheme.

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53. We recommend that the LINK scheme should be broadened and expanded, and the OST science base industry schemes such as ROPA be sustained.

54. We recommend that Business Links, Business Connect (Wales) and Business Shops (Scotland) be fully involved in promoting Foresight at the regional and local levels.

55. We recommend that universities be supported to serve as local pan-sectoral foci for anticipating local and regional business and social change.

5.17 **Private Sector.** The biggest challenge to the Foresight Programme is to encourage private sector concerns—including inward investors, who tend to invest chiefly in high technology fields, and who are expected to pay a full part in Foresight—to perceive that Foresight is fundamental to their competitiveness (see recommendations 45-55). The natural focus for work on this front is the Foresight panels which can tailor the Foresight message to individual target audiences in their sectors. DTI sector divisions and regional offices are assisting the panels in this task. They are playing a key role in disseminating the Foresight results to the private sector, and encouraging take-up of priority recommendations. Ministers have set aside a budget of £2 million for this activity, largely targeting SME concerns, and a substantial programme is now underway.

5.18 But the task ahead should not be underestimated; it will be difficult to promote long-term issues, such as Foresight, onto the main Board agenda of our leading corporations without hard evidence that Foresight can influence the "bottom line." A number of necessary conditions for progress in this area might be:

- Successful Foresight examples from the private sector.
- Evidence that Foresighting companies tend to outperform stock market average trends.
- The clear grounding of Foresight analyses in expected market trends.

5.19 Some work on all of these areas is ongoing. For example, a leading investment bank is putting together an experimental "Foresight Portfolio"; the portfolio will represent companies who are known to employ Foresight in their strategic planning. The Centre for the Exploitation of Science and Technology (CEST) has published a business guide to exploiting the outputs of the Foresight process¹ and mounts interactive Foresight workshops designed to show how the Foresight "habit" can be incorporated into strategic company thinking. The Confederation of British Industry (CBI) is promulgating Foresight both at a national and regional level. The Association of Independent Research and Technology Organisations (AIRTO) is assessing how best it can deliver the Foresight message to its client companies.

5.20 Territorial departments and agencies—for example, the Scottish Office, Scottish Enterprise, and the Industrial Research and Technology Unit in Northern Ireland—are mounting a series of events to highlight the work of particular Foresight panels which have considerable importance for the local company (e.g., food and drink in the Northern Ireland economy).

5.21 Professional institutions and learned societies—for example, the Institution of Electrical Engineers, the Institute of Physics, the Royal Society of Chemistry, the Institute of Materials, the Royal Society, the Royal Society of Edinburgh and the Royal Academy of Engineering—also have a key role to play in particular sectors. Many of these have already organised dissemination events which tailor the Foresight message to their members. The focus on the particular rather than the general in this work is clearly right for the business audience. It is likely that Government is not best equipped to deliver Foresight ideas to corporate targets; and it will increasingly look to non-governmental deliverers (including business schools, the universities, CEST, RTOs and other consultancy organisations), with a direct financial interest in selling Foresight as a useful strategic tool, to convey the Foresight message to business.

INTERNATIONAL ISSUES

56. We recommend that the Government takes a fully pro-active role in shaping EU policy on SET strategy and regulation, emphasising the need for an open market, customer focus and global competitiveness.

57. We recommend that EU programmes and national programmes continue to be established on the basis of complementarity.

58. We recommend that the Government does more to place UK scientists, engineers and technologists in key areas of influence in Brussels.

59. We recommend that more attention be given to developing appropriate global partnerships and alliances in the areas of SET. Collaboration can be more influential than competition.

¹ *Acting on Foresight* (CEST, London, 1995).

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5.22 **International Issues** (recommendations 56-59). OST officials gave a presentation on UK Technology Foresight to senior officials from EU member states on 20 July, 1995. This marked the start of a process by which the results of Technology Foresight will be used to influence and support the UK position on EU R&D programmes, including the work of the recently created R&D Task Forces. Mr Taylor has given Foresight particular emphasis in international presentations—for example, at the OECD ministerial meeting and in discussions with his German counterpart during September. Bilateral discussions with countries that have themselves carried out Foresight exercises, and with whom there are reasonable prospects for future collaborations, are also planned.

5.23 Individual panels are also exploring the scope for collaborative partnerships in Foresight priority areas which match the programmes announced in the EU's Fourth Framework Programme for R&D. Annex G to this memorandum provides an illustration of the portfolio mapping which the OST has undertaken in order to assess the extent of the fit between Foresight priorities and the current EU Framework programme. It is clear that while some Foresight panels, such as Health and Life Sciences, have fair prospects of encouraging partnerships in Framework Programme areas, other panels—for example, chemicals, construction, financial services, food and drink, and retail and distribution—will have to look elsewhere where they have partnership ambitions.

PARTNERSHIPS AND REPORTING

60. We recommend that DTI private sector partnerships should be enhanced.

61. We recommend that the Research Council schemes such as ROPA and CASE studentships be enhanced.

62. We recommend the LINK should be broadened to serve as an umbrella organisation to assist public sector-private sector partnerships in any areas related to Foresight, be these R&D programmes or infrastructure.

63. We recommend that the LINK funding base be sustained and expanded, including exploring the potential involvement of new funding sources such as venture capital.

64. We recommend that Government co-ordinate the production of a Foresight progress report by the end of 1995.

5.24 **Partnership** (recommendations 60-63). DTI Ministers have taken steps to encourage more private sector partnerships as recommended by the Steering Group. On 22 May 1995 an additional £70 million of DTI funding was announced to underpin innovation and Foresight initiatives. Some £11 million of this funding is to be devoted to an expansion of LINK, which is based upon a partnership concept, over the years 1995-96 to 1998-99.

5.25 The ROPA scheme, which rewards academics working in partnership with industry, has already been expanded once since its inception. As noted by Ian Taylor on 20 July¹ Ministers intend to keep under review the case for a further expansion of ROPA in the light of experience with the current wave of awards. The Research Councils are employing CASE studentships as a means of directly addressing Foresight priorities.

5.26 Mr Taylor's policy statement also noted that some universities are particularly successful in combining excellence in scientific and engineering research with excellent connections to business:

"We need to learn how they do it, and help others to do the same ... OST and the Council for Industry and Higher Education (CIHE) are studying successful academic-industry interactions which are already happening; they will publish the results later this year."

The lessons from this study will clearly have more general relevance for all partnership schemes operated by DTI, as well as those partnerships specifically following up Foresight priorities.

5.27 As noted in paragraph 4.2, and at Annex B, the LINK scheme is contributing significantly to the implementation of Foresight priorities. The independent LINK board—established in March 1995 in anticipation of the Foresight reports—will take a strategic overview of the contribution that LINK is making to delivering Foresight priorities.

5.28 A number of improvements are being made to the LINK scheme, in line with the recommendations of a review published in March 1995. For example, greater operating flexibility has helped to encourage sponsors such as the MRC and NERC to increase their commitment to LINK, thereby broadening the funding base. In parallel, closer links are being made with other schemes such as the Teaching Company Scheme in order to improve the overall impact of Government-supported partnership schemes in taking forward Foresight.

¹ Policy Statement on Science, Engineering and Technology by the Minister for Science and Technology, DTI, 20 July 1995.

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6. RESOURCES

6.1 Table 1 below gives details of the staff resources in DTI devoted to the Foresight Programme. As recommended by the Steering Group there has been a strengthening of the OST core team. This partly meets the need to devote more clerical resources to the Panel Secretariat; but also reflects the need for a secretary to assist the new Marine sector panel and some temporary assistance with work on the Foresight Challenge.

6.2 There has also been a strengthening of resources within DTI divisions, where a number of officials in regional offices and sector divisions are working to carry forward the dissemination and implementation of Foresight (see Table 1). Mr Alistair Macdonald, Deputy Secretary and head of DTI's Industrial Command, has overall responsibility for ensuring that Technology Foresight is implemented within DTI, other than OST. This is part of his responsibility for seeking to identify the needs of UK business through a close dialogue with individual sectors and an understanding of what influences competitiveness at home and abroad.

6.3 Expenditure by OST on the Foresight programme over the years 1993-94 and 1994-95 amounted to £2.33 millions. The following table provides details of spending to date and over the remainder of this financial year:

£ millions		
1993-94	1994-95	1995-96
0.38	1.94	1.91

OST will keep under review such spending in order to ensure that the objectives of the Programme can be delivered while seeking to obtain maximum value for money at all times. The above figures represent spending on OST core team staff, core team general administrative expenditure, Foresight panel secretaries, and the Foresight panel budgets (for travel and subsistence, publicity, building hire, consultancy fees, etc.).

6.4 In addition (as noted in paragraph 5.17), DTI Ministers have also set aside resources to help disseminate Foresight to industry and encourage networking activities. These sums amount to £2 million over the two years 1995-96 to 1996-97. Government Offices in the regions and DTI sector divisions will be the main channel through which these supplementary networking resources will be put to use.

TABLE 1
DTI staff resources devoted to foresight

Grade level	1994-95	1995-96
<i>OST</i>		
G3	0.3	0.3
G5	0.5	1.0
G6	1.0	0.5
G7	9.5	10.5
Other grades	4.0	7.0
Sub-total	15.3	19.3
<i>DTI</i>		
G3	0.1	0.1
G5	0.1	0.1
G7	0.5	0.5
HEO	0.5	0.5
Sub-total	1.2	1.2
Total	16.5	20.5

Note:

In addition, 11 regional offices and five sector divisions are devoting approximately one to two man years each to Foresight activities between 1995-96 to 1996-97.

7. FUTURE DEVELOPMENTS

7.1 Each of the Foresight panels has developed a forward diary of commitments to present their findings to a wider community. There will be an opportunity to review these and take stock of achievements later this year. Some events which will be important for all panels over the coming months are as follows:

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September:	Foresight Challenge Launch
October:	Foresight dialogues (Panels and Research Councils) CBI/AIRTO Conference on Foresight
November:	Deadline for Challenge bid outlines
December:	Progress Report on Foresight
January:	Deadline for Challenge full bids

1996

March:	Challenge winners announced
May:	Forward Look Foresight progress review.

7.2 Looking further ahead, it will be important to maintain the momentum of Foresight over the medium term. It will be important to build upon the lessons learned during the first phase of the Foresight exercise. To assist in this it would be helpful to obtain evidence on the merits and shortcomings of the Foresight analyses undertaken in the first phase. Rather than rely on the selective recall of Foresight Programme participants in 1999 the OST is taking steps now to obtain such evidence. A questionnaire is being circulated to all Foresight panellists during the autumn asking for their views on each element of the Foresight process. OST and Manchester University are jointly sponsoring a CASE student to analyse these responses and undertake further evaluation tasks. In due course, it may be appropriate to supplement this work with an evaluation conducted by a fully independent external concern.

OST

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ANNEX A

STEERING GROUP GENERIC SCIENCE AND TECHNOLOGY PRIORITIES

Steering group science and technology priority

Broad area	Generic priority	Recommendation	Priority grouping
<i>Social Shaping and Technology Impact</i>	1 Demographic change	Informing health care, retail, financial services, leisure and learning markets; and underpinning assessments of health care effectiveness	Emerging
	2 Risk assessment and management	In finance, food, health, travel, the environment, etc., includes psychology of risk perception, and study of behavioural responses to risk	Intermediate
	3 Workplace and home	Social acceptability of new technology in the home and workplace. Changing patterns of work and leisure resulting from multimedia, etc.	Intermediate
<i>Communications and Computing</i>	4 Communicating with machines, including software	Interfacial software for the information superhighway; virtual reality (e.g., in learning, leisure, shopping, banking and architecture); image analysis, speech recognition, and other technologies. Applications: Multimedia comms, vehicle guidance/control	Key
	5 Design and systems integration	Integration of technologies, sub-systems and software; CAD/CAM; concurrent engineering; requirements and system models; rapid prototyping; interoperability; life cycle cost/performance/quality trade off	Intermediate
	6 Information management	Databases, security retrieval etc; information flows and reservoirs in large organisations, protecting the security and integrity of information, and validation of remote transactions	Intermediate
	7 Modelling, simulation and prediction of complex systems	Software and mathematical techniques for modelling complex systems and events in areas such as product design, risk analysis, behavioural analysis, the environment, and financial products and markets	Intermediate

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Broad area	Generic priority	Recommendation	Priority grouping
	8 Optical technology	Optical display technology (including 3-D displays) and other areas including optical sensors, optical information storage, optical computing and signal processing, optical comms	Key
	9 Software engineering	Safety critical software; safety critical systems for real-time applications; techniques for reducing cost of safety critical systems; verification techniques; management of large complex software projects to ensure reliability, security and effectiveness	Key
	10 Telepresence	Design, management and organisation of data gathering and distribution systems. Multimedia products (including voice, image and text) particularly for tele-learning, tele-medicine, interactive skill development and entertainment	Key
	11 Bioinformatics	Simulation and visualisation of biological processes, gathering and processing data from biological processes and the study of information flows within biological systems	Key
	12 Biomaterials	Self-assembly of complex materials and design (by genetic manipulation) of new biological materials for specific applications; biocompatible materials; materials with properties similar to biological materials (e.g., synthetic muscle)	Intermediate
<i>From Genes to New Organisms, Processes and Products</i>	13 Genetic and Biomolecular Engineering	Production of design plant and animal tissues, drugs, proteins, etc., through genetic modification	Key
	14 Health and Lifestyle	Diet/health interface, preventative health care, fitness, the genetic approach to individually tailored health care programmes, and technologies for healthy ageing	Key
<i>Better Materials, Synthesis and Processing</i>	15 Catalysis	Full range of heterogeneous, homogenous, asymmetric and bio-catalysis; analytical and applied aspects of surface science, catalyst modelling, design manufacturing; includes catalysis for high selectivity and efficiency, high performance molecules, colloids	Intermediate
	16 Chemical and Biological Synthesis	Applying chemical and biological materials and processes to energy production, food synthesis, etc.	Intermediate
	17 Materials	Electronic, optical, lightweight, high temperature, super-conducting, reusable/disposable, durable, clean materials	Intermediate
	18 Materials Processing Technology	Materials assembly and combination, reducing materials processing costs, understanding and controlling the behaviour of advanced materials during processing (including joining)	Intermediate
<i>Getting it right. Precision and Control in Management</i>	19 Management and Business Process Engineering	Process re-engineering, management science, "just in time" (JIT), lean processes, processes for the control of credit and debt	Key
	20 Automation (including robotics)	Automated technology in manufacturing, process and service industries; includes work underpinning robotics applications in the home, agriculture and marine environments	Emerging
	21 Process Engineering and Control	Control and optimisation of all continuous processes in manufacturing	Intermediate

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Broad area	Generic priority	Recommendation	Priority grouping
<i>A Cleaner and Sustainable World</i>	22 Sensors and Sensory Information Processing	Chemical, biological, mechanical, electromagnetic sensors and measuring instruments, data fusion techniques and data processing	Key
	23 Security and Privacy Technology	Secure communications, information storage and encryption, behavioural and transaction pattern analysis, smart cards, detection and prevention of financial fraud, customer verification and recognition techniques	Key
	24 Clean Processing Technology	Production of more efficient processes via waste minimisation, reduced emissions, discharges and solid wastes; interactions between regulatory systems and the science base; and integrated monitoring and control of pollution	Emerging
	25 Energy Technology, including combustion, monitoring and control	Combustion monitoring and control; air-breathing aircraft engines, control and minimisation of emissions; maximising fuel efficiency; storage and transmission technology	Emerging
	26 Environmentally sustainable technology	Alternative, sustainable energy technologies and resource conservation; energy efficient machines and systems; social issues relating to energy usage; marine environment; appropriate technologies for developing countries	Key
	27 Product and Manufacturing Life Cycle Analysis	Life-cycle evaluation in relation to sustainable technologies, environmental impact, changing use and lifelong support, manufacturing evolution, product evolution and incremental improvement; disposal and decommissioning	Emerging

STEERING GROUP GENERIC INFRASTRUCTURE PRIORITIES

Steering group generic infrastructure priority

Broad area	Generic priority	Recommendation
<i>The skills base</i>	1 Training better SET teachers	Including use of interactive learning to bolster the skills base in universities and FEIs, with particular reference to maths and physics
	2 Communications skills	To develop these skills in SET managers, scientists and engineers in explaining SET development and potential
	3 IT competence	To develop IT competence at all levels: the schoolroom, degree courses, in the workforce and amongst middle and top managers
	4 Public understanding of science	Active promotion of science to engender widespread understanding of scientific achievements and dispel unwarranted fear of leading-edge possibilities
	5 Business awareness	Develop business awareness in education and training institutions and in the content of HEI SET science courses
<i>Research in the science base</i>	6 Maintain support for truly excellent basic research	Whether in a Foresight priority area or not, to maintain excellent basic research on a selective basis
	7 New incentives for interdisciplinary research	To encourage universities and Research Councils to develop more multidisciplinary research activity

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Broad area		Generic priority	Recommendation
	8	Universities and Research Councils to work with industry	Incentives for universities and Research Councils to work with industry
Communication	9	Promotion of the information superhighway	Promote the rapid and extensive development of the information superhighway by education, regulatory and technological means
	10	Science-watch function	To monitor and disseminate SET intelligence from overseas
Finance	11	Development and encouragement of long-term finance for R&D and innovation	Development and encouragement of long-term finance for R&D and innovation, including the continuous review of fiscal measures
	12	Special incentives for SMEs	Special incentives for SMEs, including setting-up networks (regional or supplier chains) and technological incubators
	13	Enterprise architectures	To define, articulate and support the infrastructures which promote successful business clusters (e.g., Silicon Glen, the City)
<i>The following need to be continuously developed and made more sensitive to European and international regulations and standards</i>			
Policy and regulation	14	Intellectual Property Rights	Particularly copyright and data protection in new electronic media
	15	Procurement by Government	To stimulate leading-edge technology
	16	Regulations on the environment, finance, communications, etc.	To make regulations more sensitive to the speed of innovation in markets and technologies
	17	A continuously updated scientific basis for standards	To scientifically update standards in the environment, in genetic manipulation, health and safety, etc.
	18	Demonstrator projects (applications oriented)	To catalyse market development and focus resources on areas of high potential. Examples are the Foresight Vehicle and energy efficient buildings. Demonstrators could cover business processes to focus on best practice

ANNEX B

HOW FORESIGHT IS BEING TAKEN FORWARD THROUGH LINK

Programme	Announced	Sponsors	Description
<i>New LINK Programmes</i>			
Applied Biocatalysis	March 1995	BBSRC/DTI	The programme aims to facilitate the broader application of biocatalysis in UK industry by supporting research to improve both the understanding and the usability of biocatalytic processes.
Waste Minimisation through Recycling, Re-use and Recovery in Industry	May 1995	EPSRC/DTI	The programme aims to develop and implement cost effective technologies for recycling, re-use and recovery of materials within the manufacturing and process industries, thereby reducing waste and input and disposal costs.
Integrated Approaches to Healthy Ageing	August 1995	MRC	The programme aims to improve understanding of psychological, physiological and social factors affecting good or ill health in old age. It also aims to develop new ways of supporting healthy ageing and independent living, and to develop new approaches to the prevention, management and rehabilitation of disorders affecting the elderly.

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[Continued

Programme	Announced	Sponsors	Description
Genetic and Environmental interactions in Health	August 1995	MRC	The programme aims to develop collaborations between academia and industry in genetics, molecular/genetic epidemiology, pharmacogenetics and complementary disciplines technologies.
Earth Observation	August 1995	BNSC/DTI/ NERC/DoE	The programme aims to support innovative pre-competitive earth observation applications research on a collaborative basis targeted on end user needs emerging from Foresight.
<i>Boosts to existing LINK Programmes</i>			
Hydrocarbon Reservoirs	June 1995	DTI/NERC	Additional funds are being allocated to research directed at more accurate identification and assessment of new oil and gas fields; and technological improvements to increase yields from existing oil and gas fields.
Surface Engineering	July 1995	EPSRC/DTI	The programme supports collaborative research into new and improved surface treatment and coating systems and their associated process technologies. Additional funds are being allocated to new projects that address relevant Foresight priorities.

ANNEX C

TECHNOLOGY FORESIGHT CHALLENGE

Terms and Conditions for Competitive Bids

1. INTRODUCTION

1.1 The White Paper on science, engineering and technology—“*Realising Our Potential*”—was published in May 1993. It took as its main theme that the UK is potentially very strong in science and technology and that:

“... steps should be taken which, on the basis of other countries’ experience, will help to harness that strength in science and engineering to the creation of wealth in the United Kingdom by bringing it into closer and more systematic contact with those responsible for industrial and commercial decisions. Such a systematic interchange between industry, scientists, engineers and science policy makers (both in the public sector and the significant charitable sector from which the United Kingdom derives such benefit) would improve mutual understanding and allow each group to make its decisions against a better-informed background.” (Cmnd 2250, paragraph 1.16).

To that end, a number of initiatives were set in place, including the *Technology Foresight Programme*.

1.2 The first phase of the Technology Foresight Programme has now been completed. Reports from 15 Foresight sector panels and the Technology Foresight Steering Group were published in the spring of this year. We are now entering the second phase of the Programme in which dissemination of findings and implementation of priorities will be the key objectives.

1.3 In the House of Commons on 22 May the Chancellor of the Duchy of Lancaster said:

“The key to success will be to get industry and the science and engineering base working in partnership to address the opportunities which Foresight has identified. To stimulate this, I am announcing today a Foresight Challenge. This will be financed through an extra £40 million of public money which I will make available over the next three years, for collaborative initiatives which address Foresight priorities.”

1.4 Ministers undertook to consult the academic and business communities on the detailed terms and conditions of the Foresight Challenge Fund. This undertaking was discharged during July and August and the following paragraphs reflect the findings of that consultation.

2. FORESIGHT CHALLENGE AWARDS

2.1 The ultimate objective of the Foresight Challenge is to increase wealth creation or the quality of life by implementing Foresight priorities. Thus, the objective of the Challenge is consistent with the 1993 White Paper on Science, Engineering and Technology and the Technology Foresight Programme.

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[Continued]

2.2 Projects undertaken as Challenge projects will be expected to have strategic objectives consistent with the objective of the Challenge; and Challenge projects will be expected to address one or more Foresight priorities. For the purpose of the Challenge a Foresight priority may be identified in any of the reports of the 15 Foresight panels or the report of the Technology Foresight Steering Group ("Progress Through Partnership").¹ It is intended that part of the Foresight Challenge Fund should be directed towards the key strategic aim of extending the quality of life of our ageing population (EQUAL) to which a wide range of science and engineering disciplines have a contribution to make (see attached statement by Ian Taylor MBE, MP, Minister of Science and Technology). A large number of the priorities identified in the Foresight reports are relevant to EQUAL.

2.3 Challenge bids may employ the existing architecture of partnership schemes sponsored by public sector bodies. For example, partnerships may wish to propose a collaborative research project under the LINK rules, perhaps with associated Teaching Company Scheme programmes to facilitate the exploitation of the results of research. The use of existing partnership schemes is not a mandatory condition of the Challenge, but existing schemes provide useful indications of how the contributions from different partners within EC state aid rules (where applicable) and intellectual property rights might be handled.

2.4 Challenge projects will be assessed on a competitive basis. Those projects which best meet the Challenge criteria will be made the subject of Challenge Awards.

3. GENERAL CHALLENGE CONDITIONS

3.1 **Type of projects.** The Foresight Challenge is expected to bring forth a wide range of imaginative proposals. Illustrative examples might include:

- Collaborative research with a specific technological output in prospect.
- The establishment of a postgraduate training course in a multidisciplinary field.
- The setting up of a centre of excellence in a single or multidisciplinary field.
- The development of specialist technological equipment.

In all cases, bidders are urged to consider the use to which project outputs can be put in order to serve the objectives of the Challenge Fund. Hence, specific provision for dissemination and use of project outputs should feature in project submissions as an integral part of the project design.

3.2 **Project size.** The Challenge Awards will be a mix of relatively large and small projects. The main emphasis of the Challenge Fund will be on helping to resource projects with a total annual project cost within the range £1-2 million over three years 1996-97 to 1998-99. However, this condition will not rule out awarding Challenge funds to projects below the indicated threshold size if they score highly in terms of the Challenge criteria. There will be an upper size limit on the total public sector contribution of £4 million.

3.3 **Eligibility.** The Challenge will be open to a very broad spectrum of partnership leaders and members. It is hoped that the following organisations will be encouraged to lead and participate in partnerships:

Manufacturing and service businesses in the UK.

Research Councils and Research Council institutes.

Trade Associations.

Research and Technology Organisations.

Universities.

Learned Societies and Professional Institutions.

Charities.

Technology Clubs.

Public sector bodies (including trading funds and agencies).

For the purposes of the Foresight Challenge a collaborative partnership will mean: a non-incorporated group, with two or more members, formed to undertake a programme of work in a Foresight priority area. Challenge partnerships must involve at least one member from the science base (academic establishments and Research Council bodies) and one private sector business.

¹ Available from HMSO bookshops. Summary leaflets for all sixteen reports are available from the OST: facsimile number 0171 271 2015.

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[Continued

4. CHALLENGE FUNDING CONDITIONS

4.1 Challenge Fund resources must be at least matched by a contribution from one or more private sector partners.

4.2 The public sector contributions to a Challenge project must not exceed 50 per cent of the total, except as stipulated under 4.3 below.

4.3 For Challenge projects in the field of training—e.g., postgraduate training courses or new skill centres—condition 4.2 will not apply.

4.4 For the purposes of the Challenge, universities proposing to contribute towards project costs from sources other than Research Council awards and Funding Council income will be treated as private sector contributors.

4.5 All contributions towards project costs, whether by public or private sector partners, may be made in cash or equivalent material resources (henceforth "kind"). Partners who propose to contribute resources in kind will be expected to express such resources in their equivalent cash value in the submitted bid (see below section 7), and demonstrate that those resources will clearly promote the work to be undertaken.

4.6 The total of the public sector contribution to a Challenge project may not exceed £4 million over the life of the project.

5. ASSESSMENT OF BIDS

5.1 Partnership bids will be assessed by a *Challenge Awards Group*. The Group's membership will consist of: the Chief Scientific Adviser (Chairman), the Director General of the Research Councils, the Chairman of the LINK Board, and two representatives of the Technology Foresight Steering Group.

5.2 The Challenge Awards Group will be charged with assessing partnership bids in terms of the *Challenge criteria* set out below in section 6.

5.3 The Group will have discretion to seek advice outside its membership on any aspect of a bid which bears upon a Challenge criterion. The Group will also have discretion to interview partnership representatives on any aspect of a submitted bid.

5.4 The Challenge Awards Group will provide the *Technology Foresight Steering Group* with a short list of partnership bids.

5.5 The Challenge Awards Group, in the light of advice from the Technology Foresight Steering Group, will provide DTI Ministers with advice on a short list of Challenge bids and provide recommendations on the final list of awards.

5.6 Ministers' decisions on the successful Challenge bids will be final.

6. FORESIGHT CHALLENGE CRITERIA

6.1 Foresight Challenge bids will be assessed against a set of five standard criteria. The fundamental Foresight criterion is that the objectives of increased wealth creation or improved quality of life will ultimately be served. In addition, the Challenge Awards Group will assess:

- (i) The extent of the match between an identified Foresight priority and the proposed project.
- (ii) The quality of the science, engineering and technology featuring in a proposal, in particular the research excellence of the proposed academic partner(s).¹
- (iii) The expected ability of the consortium to deliver the project outputs on time and within cost.
- (iv) The attractiveness of the project outputs in relation to project costs.
- (v) The degree to which traditionally low investors in technology and small and medium sized enterprises are encouraged to participate—either in generating or using project outputs.

¹ As the *Forward Look* 1994 observed:

"The science and engineering base must concentrate on its proper role: the training of highly skilled men and women and the conduct of research at the frontiers of knowledge. However, in the setting of priorities and the allocation of resources, appropriate recognition should be given to the relevance as well as the scientific excellence and timeliness of research."

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[Continued]

6.2 The multidisciplinary nature of many Foresight priorities is drawn to the attention of potential partnerships. Hence, under criterion (i) above, it should be noted that if the Foresight priority specifies a multidisciplinary approach this will need to be fully reflected in the Challenge proposal.

7. FORM AND STRUCTURE OF CHALLENGE BIDS

7.1 Partnership consortia are required to submit an outline of the proposed bid by mid-November. This outline should be no more than 1,000 words in length. Partnerships will be advised within three working weeks on the suitability of an outline of the bid for a Challenge award. Guidance provided by Foresight Challenge officials will not be binding upon the Challenge Awards Group.

7.2 Full Challenge bids, will be expected to take the following form:

- (i) **Preamble:** Stating the rationale and objectives of the partnership project.
- (ii) **Foresight context:** How the project addresses a priority action identified by the Foresight Steering Group or a Foresight Panel.
- (iii) **Proposed partners:** Specifying the leading organisation and members of the partnership.
- (iv) **An outline project plan:** An exposition of the project activities, those undertaking the activities, and the timescales for achievement.
- (v) **Expected expenditure:** The cash spending profile over time and the sources of funding; this should include explicitly a line detailing project management costs. Challenge funding will be available for three years only, commencing in April 1996.
- (vi) **Milestones and deliverables:** The intermediate outputs to be generated during the project's life, the expected achievements of the project, and the intended paths for dissemination and exploitation of projects results. Bidders must specify how the *intellectual property rights* arising out of the project will be allocated between partners.
- (vii) **Project manager:** The named individual who will be responsible for monitoring and reporting on progress to partners and Challenge sponsors.

7.3 Submitted bids may provide supporting material. However, brevity is urged upon all bidders; and a maximum size of 30 pages of A4 material will be mandatory under the Challenge.

7.4 Please address bids and other correspondence to: *Foresight Challenge Manager, Office of Science and Technology, Albany House, 84-86 Petty France, London SW1H 9ST, Fax: 0171 271 2015.*

8. TIMETABLE

8.1 The forward timetable must allow for the submission of project outlines and full bids prior to the next financial year. Accordingly, partnerships are invited to submit bids according to the following timetable:

- (1) Foresight Challenge Launch: September 1995.
- (2) Outline bids submitted: September to mid-November 1995.
- (3) Full bids submitted: Up to 17 January 1996.
- (4) Challenge Awards announced: Early March 1996.
- (5) Challenge projects underway: April to June 1996.

8.2 There will be a second call for projects in June 1996. The second round call will seek to satisfy the demand for:

- (a) A slightly less ambitious timetable in fields where collaborative partnerships are comparatively novel.
- (b) A timetable which accommodates organisations whose budgetary planning cycles have made it difficult for them to participate in the first round.

At this stage, no decision has been taken on the relative proportions of the Challenge Fund which will be devoted to the First and Second round calls for projects.

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ANNEX D

**TECHNOLOGY FORESIGHT PROGRAMME SECTOR
PANELS AS OF SEPTEMBER 1995**

Panel	Chairman
1. Agriculture	Professor John Hillman, FRSE
2. Chemicals	Dr John Beacham
3. Construction	Mr Herb Nahapiet
4. Defence and Aerospace	Mr Anthony Edwards
5. Energy	Mr Gerry Clerehugh
6. Financial Services	Mr Michael Hughes
7. Food and Drink	Professor Peter Lillford
8. Health and Life Sciences	Professor Mark Ferguson
9. Information Technology, Electronics, Communications	Dr John Taylor
10. Leisure and Learning	Mr Peter Wallis
11. Manufacturing Production and Business Services	Dr David Grant
12. Marine	Mr David Goodrich
13. Materials	Dr John Campbell
14. Natural Resources and Environment	Professor Kerry Turner
15. Retail and Distribution	Dr Graham Winfield, CBE
16. Transport	Mr Stephen Gibbs

ANNEX E

**TECHNOLOGY FORESIGHT PANEL REMIT:
JUNE 1995-1996:
DISSEMINATION AND IMPLEMENTATION**

INTRODUCTION

1. As agreed at the meeting of Panel Chairmen on 22 May, the purpose of this note is to provide guidance on the general remit of panels for the next phase of the Foresight Programme. It outlines the key tasks, the resources available to panels and wider co-ordination issues.

KEY OBJECTIVES

2. The key objectives for panels over the next twelve months are as follows:
 - (i) To disseminate panel findings throughout the relevant industry sector.
 - (ii) To continue to develop the networks on a regional and national basis.
 - (iii) To promote implementation of findings by brokering partnerships between firms and with Research Councils, Departments and Universities.
 - (iv) To monitor progress with Research Councils and Departments as appropriate; and
 - (v) To keep panel recommendations under review and assess them in the light of community views.

WORKING METHODS

3. As during the main Foresight analysis phase panels will not be constrained by a detailed, centrally-imposed methodology. It is expected that the main work towards the above objectives can be undertaken by panel sub-groups (composed of panel and associate members) with plenary meetings of panels devoted to monitoring progress. In addition to this general framework

- (i) Panels will be expected to involve appropriate professional and industry bodies in the setting up of regional workshops and other dissemination events. Such events will also provide the opportunity for validation of panel recommendations.
- (ii) Panels should seek to participate in and take advantage of the dissemination network resourced by DTI sponsor divisions, regional offices and Business Links.
- (iii) Panels should seek, partly through the firms represented amongst their own membership and through other key firms in the sector, presentations to firms in "supply chains". Such presentations may be particularly useful in reaching small and medium-sized businesses.

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[Continued

- (iv) Some personal, small group communication exercises with key players may also be appropriate.
- (v) It may be appropriate to present panel findings and discuss prospects for implementation directly with Research Councils and Government Departments. In this case, to avoid possible duplication, it will be helpful if arrangements were made via OST.
- (vi) Rather than pursuing all recommendations simultaneously, panels might choose to tackle two or three "flag ship" recommendations during 1995.
- (vii) In considering action to take forward particularly R&D projects, panel should bear in mind two main mechanisms: (i) the existing LINK scheme and (ii) the Foresight Challenge Competition. OST will arrange briefing for panels on (i) from the LINK Secretariat and will provide guidance on (ii) following on from consultations with academia and industry about the general features of the Foresight Challenge Competition.
- (viii) OST will similarly arrange briefing for panels on international collaboration, in particular the European Framework Programme of collaborative research and other relevant S&T international agreements.
- (ix) OST will compile and circulate to panels a regular diary of foresight related events drawing on information from panels, research councils, departments, trade and professional bodies.

BUDGET AND RESOURCES

4. OST will make available up to £40,000 to each panel for running costs over the financial year 1995-96 including regional workshops, other events, panel member travelling expenses and subsistence. In addition, as noted, support is available from DTI to pursue specific dissemination events with industry. Bids are to be channelled through OST.

5. OST will also provide a panel secretary (one per two panels) whose job will be to support the panels in achieving the tasks outlined. Where appropriate, panels should also seek to gain support from professional bodies, industrial associations and individual companies to help co-fund and organise dissemination events.

OVERALL CO-ORDINATION, CROSS SECTORAL LINKAGES AND GENERIC ISSUES

6. Through the work of the panel secretaries on a day-to-day basis, and through periodic meetings with panel chairmen, OST will secure overall co-ordination. *OST will also take the lead on the generic S&T priorities and on the generic "infrastructural" priorities identified in the Steering Group's report.* Progress here will be reported back to panels. Where appropriate, OST will form sub-groups consisting of members from different panels to address generic/cross sectoral priorities.

NEW PANEL MEMBERS

7. Panel Chairmen are free to recruit new panel members (on a full or associate membership basis) as they see fit in order to discharge the above remit. The OST stands ready to provide Panel Chairmen with names of potential members from the original Conomination exercise conducted in 1994-95, should they wish to employ Conomination as a quarry. It might be thought appropriate to conduct preliminary consultation about new members among existing panel members and/or among key sectoral organisations (e.g., trade associations, professional bodies, universities). It would be helpful to bear in mind the need to draw new members from as wide a community as possible, and address issues of balance in respect of age, gender, business and academic representation, and regional interest in extending invitations to potential new members. Panel secretaries should provide contact details for all newly recruited panel members.

MILESTONES

8. OST to arrange briefing on (vii) and (viii) in paragraph 3 above during *July/September*. Panels to produce a short report outlining their broad strategy and events to date by *mid-November* to feed into the OST/Steering Group's first progress report on implementation by the end of the year. Panels to provide fuller account of progress to date by *end-February 1996* for OST to provide *Forward Look* assessment.

OST

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[Continued]

ANNEX F

JOINT WORKING FORUM ON CIVIL/DEFENCE COLLABORATION

TERMS OF REFERENCE

1. To advise Ministers on further opportunities for the development of a co-ordinated approach to the planning of civil and defence S&T, informed by the priorities identified by the Technology Foresight Programme.

2. The Forum will:

- Develop, wherever possible, a co-ordinated response to Foresight, combining defence and civil objectives and will have oversight of any necessary lower level groupings.
- Identify new opportunities for civil and defence S&T collaboration, together with the likely cost to each of the key participants. This should be carried out in conjunction with the private sector, building on existing mechanisms and responding to Foresight.

3. The new Forum will make an initial report back to EDC on the progress it has made by the end of September, 1995.

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[Continued]

FOURTH FRAMEWORK PROGRAMME

[illegible]CORRELATION BETWEEN EU
FOURTH FRAMEWORK
PROGRAMMES AND
FORESIGHT SECTOR PANELS

Very good/strong match

Good to medium match

Weeker match

Chemicals

Construction

Financial Surv

Health & Life Science

Transport

Communications

Food & Drink

IT/Electronics

Manufacturing, Production & Business Processes

Materials

& Environments

Defence & Aerospace

Energy

Leisure & Learning

Retail & Distribution

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[Continued]

Examination of witnesses

RT HON IAN LANG, a Member of the House, President of the Board of Trade, MR IAN TAYLOR, a Member of the House, Parliamentary Under Secretary of State for Science & Technology, PROFESSOR ROBERT MAY, Government Chief Scientific Adviser, SIR JOHN CADOGAN, Director General of Research Councils, were examined.

Chairman

1. President of the Board of Trade, good afternoon, and you are most welcome. You are most welcome in your new capacity; you are most welcome because at the opening of your speech on Friday you gave us news that this Select Committee has a future, and we are very grateful to have that confirmation so firmly given at the first opportunity that occurred. And we welcome, too, our good colleague, the Parliamentary Under-Secretary, Mr Ian Taylor; we welcome, too, Sir John and Professor May, in his first appearance before the Committee, and you two are particularly welcome.

(Mr Lang) Thank you very much, Chairman. Can I, in turn, express my satisfaction and pleasure at the opportunity to meet the Select Committee so relatively early in the tenure of my office as President of the Board of Trade, although I am conscious that the average life of the President in office has been not much more than 12 months in recent years. However, I am very pleased to have this chance to meet the Committee and also to have had the opportunity to do so against the background of last Friday's debate, which I hope was a useful opportunity for the subject we are concerned with to be aired; and also against the background of—in my view at any rate, although the matter is, of course, in other hands as well as mine—that the Select Committee on Science and Technology should continue in place. And I am glad to be able to bring the Chief Scientific Adviser, Professor Bob May, with me for the first time to the Committee; Sir John Cadogan you have seen before; and Ian Taylor, as Minister for Science & Technology, is well-known to you.

2. President, do you wish to actually say a few opening words, or should we proceed with the questioning?

(Mr Lang) It might be helpful, Chairman, if I just said, at the outset, how I see the importance of Science and Technology in the context of the Department of Trade and Industry.

3. Please do.

(Mr Lang) This is a change that took place at the same time as my appointment and I instinctively welcomed it because I did feel that there was a potential synergy between Science and the Department of Trade and Industry. I was immediately anxious to reassure the scientific world that the future of basic research would not be put at risk in this context, that I did not see it as a threat, and also that I was persuaded that there was no hidden agenda, and indeed there is none. The importance of basic research will continue, OST retains its discrete entity within the Department and I believe that, far from suffering by Science coming into DTI, the prospects for basic research, or

blue skies research, are as good as ever they were. And, indeed, the need to get closer to market research, better aligned with industry, which is something that was identified in the White Paper and I think to which we would all subscribe, is something that should act as a spur also to the future of basic research. So I believe that this is a good step forward. I noted that the former Chief Scientific Adviser, once he had left the position, wrote of the decision as being a "shrewd move", to quote his words, and was entirely complimentary about it, and certainly it is my intention that that should be the case.

4. Right; well, thank you for those opening words. You will be aware that the transition, from the OST location in Cabinet Office to become, although a discreet and ring-fenced, part of the DTI has caused a considerable amount of controversy, and indeed this was one of the themes of last Friday's debate, as you are well aware.

(Mr Lang) Indeed.

5. Could I open the questioning, therefore, still seeking assurances. For example, in your very busy role, how much time can you give to Science and Technology as a singular part of your representation; and perhaps you might also combine that with how far you consider your role is to act as the advocate of Science and Technology in the Cabinet itself, can we have a little bit of assurance that this kind of aspect, this particular aspect of your role, will be undiminished?

(Mr Lang) Yes, Chairman, I can certainly give the Committee that assurance. I do regard it as an important priority, in my role as President of the Board of Trade, to advance and to represent the interests of Science in Cabinet. As to how much time I can give to it, I will give as much time as I can and as much time as is necessary. I was particularly anxious to take part myself in the debate last Friday, although I do not yet feel myself fully up to speed on some of the detailed aspects of the overall range of Science activities. In that context, however, I am very comfortable indeed to have Ian Taylor as Minister for Science and Technology, exclusively dedicated to those activities, and already coming from a background with considerable ministerial experience in some of those areas; and, of course, we have the two distinguished scientists on either side of us to constantly keep us up to speed on the importance of Science. The role of the Director General of Research Councils is entirely unchanged by the transfer of OST into DTI, and so indeed is the role of the Chief Scientific Adviser, whose remit runs right across Government, who has access to the Prime Minister, as well as to me, and who will, I am sure, pursue the role with vivid determination.

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RT HON IAN LANG, MR IAN TAYLOR,
PROFESSOR ROBERT MAY and SIR JOHN CADOGAN

[Continued]

[Chairman Cont]

6. If I were to ask who is now the Minister for Science, what would your answer be?

(Mr Lang) In Cabinet context, I am; in the day-to-day Government context, Ian Taylor is.

Chairman: Right. Dr Bray.

Dr Bray

7. Against the general background of industrial policy, the Government has some reason for being pleased with itself on the record of inward investment. Would you feel that that has been as successful in the research and development of foreign companies as in production activities in the UK?

(Mr Lang) Yes, I do, Mr Chairman. I think that one of the reasons that inward investment has been attracted to this country is the strength of our science base. I have more experience in the Scottish context of this, where I was able to use as a selling point to many of the electronics companies that we sought to attract to Scotland the access to the universities, the science parks and the academic institutions; with that there came the encouragement to locate R&D facilities in their investments and not just assembly shops. The calculation, when I left the Scottish Office, was that something like half the inward investment in Scotland had some R&D component with it; now the quality and strength of that R&D component would vary, but it is a trend that we were encouraging and which I continue to encourage at DTI, because, quite clearly, inward investment takes root more deeply and in the longer term if it has strong links to the science base in the country where it is located. I think Ian Taylor may like to enlarge on that.

8. Thinking of precisely those companies which you and I both know well, one feature of their research and development in the UK is that it is very much thinner than their corporate average intensity of research and development, in other words, their base lies heavily overseas, and this shows up when it comes to resiting production?

(Mr Lang) It is, of course, only natural that a company that is building plants in other parts of the world to serve the market and manufacturing and selling products that have originally been developed in the home base, should start from a standpoint of having all its R&D at home; the important thing is that the R&D is attracted into the new location and takes root there and sometimes spins off other new developments, which can indeed inform future development back at the base of the parent company. It is that taking root of the R&D in this country that we regard as important, and it is increasingly happening.

9. If you compare pharmaceuticals, electronics and engineering, the foreign interest in research and development is heaviest in pharmaceuticals, less in electronics and least in engineering, and the foreign investment has been greatest in engineering, considerable in electronics and not very big in pharmaceuticals, apart from research and development. Do you think that that has any lessons for the overall balance of Government industrial and research policy?

(Mr Lang) I am sure there are lessons to be learned from it; I hope we are learning them. But I

think one of the reasons is that the pharmaceuticals industry for example, is one in which we are very strong ourselves and on which our own scientific base is very strong, and therefore that may make it less likely that we will attract science-orientated pharmaceutical development from other countries.

10. Looking at the particular practice, is it not the case that the pharmaceutical industry is supported not only by the strong science base but also by the procurement practices on drug pricing by the National Health Service?

(Mr Lang) That may be so, but it is not within my remit so I do not feel I can answer authoritatively.

Chairman

11. Could I bring in Mr Taylor, because I think you had something to offer?

(Mr Taylor) I do not want to interrupt the flow, but I just wanted to add one very interesting point. If you look at the Siemens investment, for example, in Tyne & Wear, over the last few months, one of the points they made to me was the accessibility of our research. We often praise the German research system—I have been to talk to them in Bonn, and I am not being critical about it, as such—I think the accessibility of our universities and their research excellence is actually rather attractive for companies coming in from Germany. Certainly in the semi-conductor business, we have got the chance of having very interesting relationships between the universities and the new industry that is now seeming to want to place itself in the UK. You mentioned electronics, and there is no doubt that the electronics industry—Sharp, Sony, Hewlett Packard, Motorola—have all done a very considerable amount of their research in the UK, which has then led to very considerable exports; I think Motorola is one of our largest exporters.

Dr Bray

12. Have you looked at the Sharp labs in Tokyo and compared them with that in Oxford?

(Mr Taylor) I agree with the President, in the sense that as it is a Japanese company, you would expect them to be rather well equipped and developed there; but I think the point is that we are looking to bring intellectual know-how and research and development in with the investment, and even a company which is less down the hi-tech field, Samsung, has actually followed its massive inward investment with an R&D base in the UK. So that is a welcome development, because, wearing my hat as Technology Minister, I am well aware that if you get the R&D here, you are likely, in the development phase, to precondition who is going to be supplying the ultimate product.

13. This is the background which has been necessary background for DTI and the Government's industrial research policy generally. The score on inward investment is broadly that, some, we are glad of that, but there could be more. If you look at the balance of what has been happening on research and

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[Dr Bray Cont]

development expenditure, DTI's expenditure has been plunging whereas the science base has stayed just about level as a proportion of GDP?

(Mr Lang) There have been some changes, of course, to DTI's budget, not least because the receipts from Launch Aid have been very considerable and also because of the withdrawal from the fast breeder reactor programme; those have made a very substantial—

14. But will those account for the continuing fall in the next two years?

(Mr Lang) I think, to a large extent, they will. Of course, the next two years, we are still in the Public Expenditure Round at present, for the next three years, but I anticipate that there will be further falls from that. Sir John may be able to give us more details of it.

(Sir John Cadogan) When you start pulling out of something you cannot do it overnight, it takes a period of years, so we have got the decline curve still to come.

Chairman

15. That will last, perhaps, to—?

(Sir John Cadogan) Two to three years.

16. To three years?

(Mr Taylor) It is distorted by Launch Aid; it depends on how you calculate it really. Because there have been no real investments under Launch Aid for some years, of course, we are now getting the receipts, because it was a risk/reward arrangement. But, going back to Dr Bray's point, I believe that Sharp has actually invested in R&D at a faster rate than it originally intended, because of the excellence of the relationships it has been developing. We are talking about inward investors starting from virtually a standing start and I believe that we should take a lot of pride and credit, and so should our research base.

(Professor May) Just to sharpen the point about Launch Aid, before we move on from it, it is attributed as support for research from DTI when it is putting out money, and it counts as negative income when it is actually getting money in. In 86/87, for example, £96 million went out, and thus counted in the Science and Technology figures; in 95/96, the inward receipt was £40 million, and in 97/98 the inward receipt looks to be £120 million. So that is the continuing fall, with the continuing rise in receipts from Launch Aid: it is a distorting thing.

Dr Bray

17. Is this not set to continue, for example, say, at the National Engineering Laboratory; is it not likely that the incoming purchaser will put very much less money into it than the Government had done when it was functioning as a National Engineering Laboratory?

(Mr Lang) I do not think that is necessarily so. Private sector spend on science has been rising; the private sector now contributes something like 70 per cent to the overall total of all public and private R&D expenditure in this country and, of course, it is our purpose to encourage the private sector to increase its spend. Clearly, it would be unwise to calculate these things solely on the amount of money that is being

spent without taking account of the demands upon that money. If the fast breeder reactor programme is in decline and the money is no longer needed for that, then, clearly, that has to be taken into account, not just within the Science Budget but within public expenditure overall. But the Science Budget is 30 per cent above its 1979 level in real terms; there has been a very substantial increase over that period.

18. The Science Budget: first of all, as a proportion of GNP, it is just about level, that is in terms of the number of scientists it is just about level?

(Mr Lang) That is because the GNP has risen more rapidly.

19. Yes, but the number of heads doing science is just about the same; what it basically represents is an increase in scientists' pay.

(Mr Lang) Is that a bad thing?

Dr Bray: Oh, no; it would be even better if their pay went up more than the rest of the country, so that it was a higher proportion of GDP.

Dr Jones

20. We have just established the importance of Government spending in levering-in other investment, and this country is well behind other countries in terms of its business investment; is this the time to actually be seeing a fall-off in these programmes?

(Mr Lang) I think that one has to recognise the fact that overall spend has risen by 6 per cent since 1986 and the private sector contribution is a very substantial proportion of that, and growing, and that is highly desirable. What matters is the outputs that are achieved, rather than the inputs, and the use to which the money is put. A lot of the resources that we are putting in now are designed to lever-in private sector resources, for example, in the ROPA scheme and in—

Chairman: Can I just bring Sir Gerard Vaughan in on this.

Sir Gerard Vaughan

21. It will not surprise you that we have got a great many questions to ask you on this area but, before we go further down this road, can I take you back for a moment to the responsibility for policy-making. We were asking you about your role in the Cabinet. What is the position of the former Committee on Science and Technology, which the Prime Minister is to chair; is that still a significant part of the policy-making structure, or not?

(Professor May) My understanding is that it has been subsumed, as others have, into the larger Cabinet Committee on Competitiveness, EDC. On the other hand, the Committee of officials—if you will pardon my use of the jargon, the taxonomy of which I am slowly mastering—the Committee of officials that served the Committee to which you refer, which were the Chief Scientists in departments, chaired by my predecessor, that continues and I continue to chair it, so that it feeds into the Competitiveness Committee, on which I sit.

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[Sir Gerard Vaughan Cont]

22. Just so that I can be clear on this, does that mean that the Prime Minister's direct role, if you like, other than through the Cabinet, has now been withdrawn and that that Committee, under his chairmanship, is no longer part of the procedures?

(Professor May) That Committee, under his chairmanship, has now transmogrified itself, along with some others, into the Competitiveness Committee, under the Deputy Prime Minister's chairmanship.

Chairman

23. So it is chaired by the Deputy Prime Minister?

(Professor May) Correct.

Chairman: So that the transmogrification is not entirely without merit.

Sir Trevor Skeet

24. But, surely, Professor, if Competitiveness is the new Committee, the precedent is going to be subservient to the wider requirements, and therefore pushed further into the background is going to be basic science?

(Mr Lang) No, I do not see that as being the case at all. It is always possible to take a negative view. I take the positive view that it creates a new opportunity for Science to be brought into the foreground, and that is up to myself and to Ian Taylor to achieve, with the help of Professor May.

(Mr Taylor) Could I directly answer that. I think one of the problems is that too often the science base has looked a little bit apart, very much lauded and respected but actually not seen as a big contributor to the long-term benefit of the quality of life and competitiveness of the country. I do not think there is any danger in bringing, let us say, Professor May into the heart of the debate about competitiveness, because he is going to bear in mind the contribution the science base can make. And as I said on Friday, a strong science base can benefit from a strong industrial base, and pretty well any strong industrial base will need a long-term, strong science base to underpin it.

25. Yes, but, Mr Taylor, in 1993, the new Ministry, OST, came into being; within two years it was demolished. And also we find, too, that the Cabinet Committee in its old form is demolished, it ceases to be independent and directly under the Prime Minister, becomes under the Deputy Prime Minister and becomes re-termed a "new Committee". Are you still saying that this Committee is going to have an independence?

(Mr Taylor) I am going to say it is likely to be even more productive, and I am not going to get into an arcane dispute about outputs between the Prime Minister and the Deputy Prime Minister, in terms of the time spent on decision-making. But what I am saying is that the OST, when it was brought together in 1993 after the White Paper, was in a sense a new venture and that venture has been successful. Now change is inevitable in those circumstances, and indeed should be regarded as positive; and the fledgling, as Sir William Stewart put it, the fledgling had now got

the strength to go out into the wide world, and the wide world is effectively represented by the DTI.

26. It could be construed, in the other light, could it not, of dilution and extending it too broadly, that Science might suffer? What one is primarily concerned with is, particularly in the importation of these companies from abroad and bringing their scientific work here, that we will be expanding still further; but we find, on the one hand, we have the alteration of the structure, on the other hand, as we have learned today, a lot of the expenditure has dropped drastically?

(Mr Taylor) You raise several points. I do not accept that there is a direct comparative fall-off in expenditure in the sense of the science base; there are clearly fall-offs in certain aspects of both civil and military expenditure, certain aspects of DTI expenditure, for the reasons that we have gone through in detail.

(Professor May) May I just add that, perhaps as a newcomer to this highly structured world, it seems to me that to sit as the only non-Cabinet Minister in the Competitiveness Committee is an upgrade in the job from sitting in the important but somewhat more narrowly defined Committee that dealt just with S&T. This may be a delusion on my part, but it seems to me a chance to air my views on a wider range of things which I think bear directly and indirectly on Science and Technology.

Chairman

27. President, can I come back on a matter which we should perhaps clear up before we move on. OST expenditure, we are told, is to be ring-fenced from the DTI. Can you guarantee that Research Councils and the OST would not be under pressure, as it were, to try and subvert DTI funding by altering their priorities?

(Mr Lang) Chairman, we have not used the word "ring-fence" as such. We have said it would have a separate budget heading, and obviously all expenditure in the Public Expenditure Round has to come under review. But, certainly, there is no objective—indeed, the reverse is the case—to allow Science expenditure to suffer in that context. I shall be doing my best to ensure that Science expenditure remains as high as we can afford it to be.

28. So that there will be, in your mind and in fact, a separation of OST budget and DTI budget and never the twain should coincide, or coalesce?

(Mr Lang) They would come under the same overall heading of the Department but they would be separately discernible, I would expect, at all times.

29. And separately negotiated, perhaps?

(Mr Lang) These are deep waters, Chairman, when it comes to negotiating with the Treasury.

30. But you are an admirable negotiator.

(Mr Lang) I think I am revealing no secrets, when I say that in negotiations that I have been involved in, I have been extremely conscious of the importance of the Science Budget and determined that it should not suffer unduly.

31. You do recognise, I am sure, your inheritance, Mr President, is of a Science Department and a

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Science Budget which have produced a significant impact in a very short period of time. We would hate to think that there might be any reduction in that, due to the overall involvement of the DTI as a greater budget than that for Science?

(Mr Lang) There would be no reduction as a consequence of the changes in the governmental structure.

Chairman: I will cling to that straw.

Mrs Campbell

32. Can the President of the Board of Trade tell us if the difference between the cost of the Framework Four and Framework Three programme, which I think is around £100 million, is this year going to be borne by the DTI, or will there be an attempt to pass that on to the OST?

(Mr Lang) I will ask Mr Taylor to deal with this one.

(Mr Taylor) I think Mrs Campbell is referring to the Euro-PES problems. It is not necessarily the time for me to be too clear about that because we are in the middle of some rather complicated negotiations in preparation for the Budget. The treatment of Euro-PES is immensely complicated and one of the problems faced by spending departments with a European connection, as opposed to some of the spending departments in other Governments in the European Union, because of the accounting treatment. So it is a very delicate issue and negotiations are in full flight. I cannot, therefore, say what exactly will be the outcome of the Budget and how the Euro-PES settlement will actually impinge.

33. But I think that, with respect, Chairman, we are talking, I think the answer that I got reflected some concern about the level of contribution to the European Framework Four programme. But what I am concerned about is how the cost of that will be borne internally by Government and whether it will be borne by the DTI, as it has been done in the past, or whether an attempt will be made yet again to pass it on to another department, and whether the OST might be at a disbenefit from that?

(Mr Lang) It will be separately attributable and there is no difficulty that we have in discerning the distinction; OST bears a share and DTI bears a share.

(Professor May) In the initial presentation of it, the Treasury has broken it into components. I am told it is the envy of Europe, the ability thus to identify expenditures with such precision. But it has identified a MAFF component, a DTI component, this component, that component and, separately, an OST component.

34. Can we then ask the question as to how that compares with previous years and whether the whole of the cost in previous years was borne by the DTI, as I understand to be the case: last year, for example?

(Mr Lang) No, it was not borne by the DTI. The DTI bears by far the largest share, with I think OST coming second and then MAFF and other departments very far behind, but there is a clearly discernible narrative running through the last year and into the

present year, and the restructuring of OST within DTI will not undermine that position.

Sir Trevor Skeet

35. The English are known for their competence and for having very intricate situations and getting through them. But, you know, what many of us are concerned about is policy, and in policy I have noticed three things: that the expenditure on the research and development of the higher education spending councils has fallen, the expenditure by Government Departments on R&D has fallen, and DTI, as my colleague mentioned a moment ago, has slumped very severely. The figures for 1991 to 1995/96 confirm this and I think you have indicated today that this is going to be the ensuing result until certain matters are cleared up. Can we have your assurance that there will be a change and that a more positive role will be taken?

(Mr Lang) Chairman, I have already answered, I think, for DTI and I am not really the appropriate person to answer for other Government Departments. However, Professor May does, of course, in his office as Chief Scientific Adviser, straddle these departments, so I will invite him to comment on Sir Trevor's remark.

(Professor May) With the greatest respect, we are going a bit wide here beyond, but I am very happy so to do.

Chairman

36. But we are very generous-spirited.

(Professor May) I am very happy so to do. I would distinguish between what I would call the science base, which would be the OST, Office of Science and Technology spend, primarily the Research Councils, and that fraction for the Higher Education Funding Councils which is attributed under the rubric of research, which in total is about £2.3 billion, something like that. It has 1 or 2 per cent of fluctuation, depending on exactly how you do the calculation, but that funding for the Science Base broadly went up by an overall total of something like 10 per cent in real terms over the last ten years or so and is slated in the published Forward Look to undergo a slight decline. And of those two components, OST has done better than has the research component of HEFCE etc. Then, separately, there is another heading for departmental spend, and that is something which, as you observe, has just gone down in a precipitous fashion, to about 50 per cent of what it was ten years ago in real terms. Some of that, in my opinion, represents, under stringency and cost-cutting, a real loss. However, the greater component of it, I think it is fair to say, are these tactical details, the fast breeder, the Launch Aid complexities, where getting money in counts as a loss in the Science and Technology budget. This departmental R&D spending is a relatively small component anyhow. And then there is the Defence component, which is the trickiest of the lot, in a sense; it is often counted as about £2.5 billion of R&D, but of that only about £0.6 billion—I say “only”—only about £0.6 billion is, in my opinion, real R&D and the rest is undergirding purchasing, and thus changes in

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purchasing policy can have a grave effect on it. At the same time, again in a regime of stringency, I do worry, and I have expressed my worries, that from the perspective of the Ministry of Defence, if you are having to meet economies by slowing down purchasing then that is an argument for differentially greater spending on long-term research, because the long term is going to be more relevant if you are buying things more slowly. So, in short, it is a very complicated picture.

Sir Trevor Skeet

37. So you see the era of stringency now ending?
(Professor May) I am speaking out of turn here.

Chairman

38. I think Sir Trevor is a bit out of turn.
(Professor May) I would regard the entire western world, as a result of the rise of Asia and the Asian tigers, to be in a time of greater competitiveness and a time when greater efficiency and greater cost-cutting, and thus stringency, is incumbent upon all of us; and I speak in that broad historical sweep, I had no intention to convey any sense of the immediate goings-on of this PES Round. That is something that has been true for the last ten years and is going to be increasingly true for the next ten years.

39. Thank you, Professor May, for that *tour d'horizon*. President?

(Mr Lang) No, it is Mr Taylor.

(Mr Taylor) Having recently been at the OECD and listened to the various Science Ministers there, talking about the problems they are facing, and having recently had talks with my European Union colleagues, there is no doubt there is going to be stringency right across the board and within the European Union, not least to meet the Maastricht criteria. Therefore I do not think that we are any different from the pressures that are placed on others. What we need to do is to improve the output of research, and that is one of the targets we have got.

Chairman: We must now move on. The LINK programme. Sir Gerry Vaughan.

Sir Gerard Vaughan

40. Can we ask you now about the role of the technology demonstrator programmes, and particularly perhaps ask you to expand a bit more on where you see the LINK programmes have got to, and how you are going to pursue these, is there going to be extra money, which we understand there is going to be, for these programmes, will it go up year on year—we can go on with a lot of questions on this—has the bureaucracy really gone down? Some of the LINK programmes are reported very favourably, but as one travels round the country other ones, one hears, are not at all satisfactory. It is a rather broad question?

(Mr Lang) Yes. Chairman, perhaps I can start. Obviously, we cannot anticipate the outcome of decisions yet to be taken in the present Public Expenditure Round, but the SMART and SPUR

schemes, which I think are the ones amongst those that Sir Gerard is interested in, have an enhanced budget of £76 million over three years, and the LINK programme in the current year has an extra £6 million, including matching funding from the private sector; it is a very useful piece of our overall scientific infrastructure. I cannot anticipate, I am afraid, decisions yet to be taken for next year.

41. Many of the LINK programmes have been widely criticised as being ineffective and overbureaucratic?

(Mr Taylor) There was some criticism about it, but I think that the criticism was looking at the system before we reassessed it this year. At the time of the Forward Look it was announced that we were going to realign some of the aspects of the LINK programme and that was at precisely the time we announced that there would be more funding, certain more targeted approaches. The figure of £6 million is, of course, a matched funding with industry. I think that the LINK programme is a very interesting one; it is certainly one of the key parts of the delivery mechanisms for the Technology Foresight process, and therefore it is a crucial part of what we are attempting to do and the relationship between DTI and the OST fits very neatly with that. The SMART and SPUR projects, which I was responsible for the year before I became Science Minister as well, are also crucial to the development of new ideas, many of which come out of the universities; as I award the prizes, it is Professor this and Professor that who is coming up to collect them. So I am very much in favour of them and we have now got the SMART, the SPUR and the SPUR-plus awards.

42. Are you expecting to be able to progressively channel more money into this type of programme?

(Mr Taylor) I do not think I would wish to be drawn on future commitments, but I can say that we have actually relaunched it this year and I think, over several years, we are now talking about £70-odd million that we are putting into it for the three categories. There is the large unit size of grant, which is SPUR-plus; SPUR, which is for companies that are employing, I think, above 50; and SMART, which is the first stage, and for smaller companies. It has been widely welcomed as a fairly integrated package and now we are backing it up with resources through the Business Links, because the companies that succeed and some of those that do not succeed will be getting ongoing advice from our Business Links network.

Chairman

43. Thank you for that. Can we move on, and, if I may, President, I would like to address a couple of questions to your two Chief Advisers, Professor May and Sir John. What do you consider—and welcoming you to this, your first appearance—to be your prime responsibilities, as CSA?

(Professor May) To answer in the broadest terms, I would say my primary responsibility is to be aware across the entire spectrum of Science and Technology in the UK, arguing the case for its central importance in our future and the wealth of the country and the

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quality of life in the country, and looking in more detail for gaps, overlaps and deficiencies. If I could single any one thing out of the agenda of initiatives I inherited, it would be the Foresight programme. To go back one step, I would say our science base still is, by a variety of objective measures, exceptionally strong. It creates wealth; a lot of that wealth, in the more successful industries—pharmaceuticals, chemicals—is captured in this country. A not inconsiderable fraction of that wealth is captured outside this country. Part of my job is to make sure that we do a better job, while preserving the strength of the science base and in no way distorting fundamental research to product development; that we do a better job of connecting all the players so that we capitalise on things better. I do not see my job as replete with further great initiatives. I see I myself as inheriting the White Paper, the Foresight programme, greater attention to careers in science, greater attention to careers of women in science (as part of a larger attention to women in the workforce) greater attention in a systematic way to public understanding of science; and I see my job as the rather undramatic task of carrying these things forward that have been begun well.

44. Right. If I can pick you up on the Foresight programme, could I ask, to both of you, what are the relative roles which you play, both yourself, as CSA, and Sir John, as Director General, in this Foresight programme; you divide it up, obviously, by virtue of the offices you hold, but what are the contributions you expect to bring to the Foresight programme, each of you: perhaps we could ask Sir John first?

(Sir John Cadogan) Perhaps I should just say what I think my role is. You have heard what the Chief Scientific Adviser says; he has this enormously difficult job, if I may say so, of looking right across Government, and indeed outside, to the strength of the science base and, as I think I said to this Committee two weeks after I took my job, I see it as looking after the shop. I have to advise Government on how the Science Budget should be distributed amongst the Research Councils, the Royal Society, and so forth, and I have to keep an eye, a functional eye, on the strength of the science base on the other side of the dual support divide, without of course having any control over it; and, crucially, I have to ensure that the science and engineering base continues to be world class. And I have another duty, which is to ensure that the science and engineering base is well connected with the users; that does not necessarily mean industry, it means the Department of Health, and everything else, without being the servant of the user. That is my first job. Now, where does Foresight come into this: well, Foresight, of course again, is across the piece. The Research Councils, because they lead, have in their hands and distribute on our behalf £1.3 billion. They, in fact, are very important movers in changing directions, and my job is specifically to see that all the Foresight recommendations and the Foresight processes are fed into the Research Councils' planning, both tactical and strategic. We want them to take Foresight into consideration. They will not be dominated by Foresight, Foresight is one of the factors, but it is an important factor and it is my job to see that

it is fed into the Research Councils. It is not at all difficult, I should say; the Research Councils have been very proactive in coming forward and are pushing hard. They are very, very keen to get connected.

45. And your confidence that by pushing the Foresight programme in this way, and indeed without much reluctance on behalf of the Research Councils, do you consider that that will materially affect the quality of the science base?

(Sir John Cadogan) If there is any suggestion that the quality should fall then that would be very, very serious; I do not accept that quality should fall at all. Whatever happens, we are looking, at the end of the day, for real, increased quality—increased quality—wherever it is possible. There is no question about this at all, because if something is seen as Foresight-related, if it turns out to be third rate science and rubbish then they just do not fund it.

Dr Jones

46. Sir John and Professor May, how will you assess for yourself in a few years' time how successful you have been in these aims that you have set yourself?

(Professor May) In Foresight?

47. In all the things that you said you currently will grow responsible for?

(Professor May) Both the narrower and the wider question are difficult to answer, obviously. Let me take the narrower, but important, one of Foresight. We have a variety of intermediate measures of progress, as it were. One can look to ask are the Research Councils being responsive; as John just said, one can look and ask are departments being responsive, what specific effect on spending, for their plans for spending next year are governed by Foresight; one can turn to the Higher Education Funding Councils and ask how is it feeding into that process? Then you can imagine there are markers there on responsiveness, one can look out to various sectors of industry and ask for quantitative measures of dissemination of the message. These are obviously necessary but not sufficient measures. The ultimate measure of the success of Foresight is not going to be any short term, such easy thing, but the longer-term question of whether, across the board, our industry is doing a better job than it has of taking up the fruits—the unintended, unforeseeable fruits—of basic research. On the wider question, of how am I going to measure whether science will continue to flourish as it has so long in this country, again one can construct way-stations down the road which are a secondary measure. But ultimately it is going to be asking; are we attracting the brightest young people into the subject; are we creating a structure that, while it looks after research broadly, is properly and—Bill Stewart's word—democratically elite; differentially looks and seeks out the disproportionately important, very, very best and creates career structures for them that recognise their singularity, while at the same time

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[Dr Jones Cont]

being sensitive to the changing career structures of the larger numbers of people.

Mr Batiste

48. Can I come in on that, with the science base. In the context of talking about the science base and career structure, I think you have rightly put your finger on the point that, if we do not have an adequate supply of bright young graduates coming into science, in the medium and the long term we are going to have serious problems within the science base. Now, I think many people were quite surprised by the OECD figures, which suggest that Britain has far more science graduates than any of our competitors in the age range 25-34, but that a very large proportion of them do not pursue science careers. Now, when we were looking at our first Report, we felt that that was not necessarily a bad thing, because it is right that bankers and others should be science literate and should be trained in the skills—

(Professor May) And would that more of them went into the House.

49. And would that more of them came into the House. But, nevertheless, the part of the equation whereby such a large number of our science graduates are going into non-scientific routes tends to suggest that there may be an inherent unattractiveness in a scientific career for a fair proportion of our science graduates. Now, do you see that as a problem at the moment?

(Professor May) I do not. I would like to know more. One of the things I would like to know more about is why the only country that does better than us, graduating people in science and engineering in the age range 20-25, is France, but we beat, as you say, Japan, the United States, Germany. However, when you look at the numbers per thousand in the workforce, we are back in the middle of the pack. I would dearly like to know more about where our science and engineering graduates go; the conjecture is, differentially, a lot of them go into the City. But if I look at the best younger people who are taking up, for example, the Royal Society University Research Fellowships—a start to a career better than an Assistant Professorship at Harvard or Yale—they are the brightest and the best. I relapse into anecdote but I can only speak from that not inconsiderable number I am familiar with, and they are extremely good.

50. If you were in a position where you felt, when you analysed this issue, that there were significant problems, there were barriers, for example, in relation to the prevalence of short-term contracts for young scientists, do you feel you would be in an effective position to be able to carry that argument to other departments and to create a cross-Whitehall approach to this type of problem?

(Professor May) I simply do not know. I would be in a position to carry it and I would. But I have not been doing the job long enough to know how effective I will be.

Dr Bray: Is it not the case that it is widely remarked upon in universities, not just in this country but, interestingly enough, in the tigers as well, that, of

young people, whereas ten years ago the brightest would go into science and engineering, now they want to go into business studies?

Chairman

51. Is that known?

(Professor May) All I can say is, it is not my experience. Talking about inward investment, we still attract some of the brightest and the best from elsewhere in Europe and the United States. In my own department at Oxford—the graduate students, post-doctoral students, more than half of them are from around the world and some of them are people of exceptional quality, and there is certainly a net inflow of these best people from within Europe. My own group is half German, Austrian, Indian, United States and Canadian.

Dr Bray: I am sure individual eminent researchers like yourself will continue to attract the very best, but the net effect, as observed, in, say, the tigers, who contribute a very large number of students, post-graduate students, to the United States as well as to this country, is that, their observation is that the quality of student going into the basic sciences and engineering is lower than it was ten years ago. Can you account for that?

Dr Jones: Certainly, the A level qualifications, I know, in my own university, of students going into science and engineering, has actually fallen.

Chairman

52. Observed, or not?

(Professor May) I wish to pass this question on, knowing nothing about A levels.

Chairman: We will keep that for later. Sir Gerard Vaughan.

Sir Gerard Vaughan

53. Much of what you say sounds very satisfactory and rather reassuring, but if you look at the 1995 Forward Look there are comments there about the science base, saying that, for example, in important scientific and engineering areas there is a lack of up-to-date facilities and equipment and, further on, there is a lack of depth and breadth of expertise and, further on, there is an absence of coherent integrated programmes of sufficient size. So there is a lot to be done, is there not; all is not quite as well yet as we would like to think?

(Mr Taylor) I do not think the purpose of the Forward Look is to disguise the problems. One of the issues that came up when I was giving a lecture at the Royal Institution yesterday was the problem about equipment in universities, and it is a problem, particularly as science becomes more complex and therefore you need to renew your equipment at regular points.

54. Forgive me; that will not get us far if we do not recognise it as a series of problems?

(Mr Taylor) No; my point is the Forward Look should recognise where the problems are as well as where the strengths are.

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[Continued]

[Sir Gerard Vaughan Cont]

55. Agreed.

(Mr Taylor) And, Sir Gerard, the point I was about to make was that this raises a very interesting question, which may well be the subject for another day, about the relationship between centres of excellence and centres of study, and the spin-off areas of teaching and distribution of the knowledge. Because, clearly, we have to look at the challenges which are facing our very best centres, in terms of access to the latest equipment, not only for research purposes but, of course, one of the factors we must never forget is that one of the objectives of universities is to teach our bright young people and then for them to go out into the wide world, particularly into industry.

(Mr Lang) If I could just add, Chairman, I hope that the first few words of my colleague, my Honourable Friend's remarks, were caught by your microphones. He did not say that it was the purpose of the Forward Look to disguise problems: he said that it was not the purpose to disguise. I just sense that might not have been picked up.

(Mr Taylor) If I was ambiguous I will repeat it. I absolutely think the Forward Look needs to be clear about where the weaknesses are as well as where the strengths are.

(Mr Lang) But it is important for the Funding Councils and the Research Councils to look at the infrastructural issues, and that is what we look to them to do.

Chairman

56. But you would agree, would you not, President, that it is part of the DTI's role in life to, in fact, secure a favourable climate for innovation anyhow?

(Mr Lang) Oh, indeed, yes.

57. And that is, indeed, one of your prime objectives and may involve pursuing issues with other Government Departments: perhaps you would care to comment on that?

(Mr Lang) Yes, indeed. As part of the restructuring process, we have strengthened the innovation side within DTI and that is something that we seek to inject into Government thinking as a whole through, for example, the Competitiveness White Paper and through the other work of that unit.

58. Could I ask you a question, to Sir John at this point. You have suggested, I think, several areas in which improvements to the science base need to be made and, might we ask, is it going to be necessary to concentrate scientific effort in order to ensure resources are not too thinly spread, under the present circumstances; if so, in which areas should the UK be content to be less than world class, but provided it has the expertise to pick up the technology developed in other countries?

(Sir John Cadogan) It is extremely important that we recognise which of the key areas of science and engineering are crucial to the competitiveness of the nation. Science and technology have to be at the heart of anything to do with competitiveness, which incidentally is why I thoroughly approve of the OST being in the competitiveness arena. I think it is crazy

to have science and technology separated from competitiveness. We cannot be super in everything but we do know the areas where we are good and we know the areas where we would want to be better; what we would hope to do is to see that the underpinning science and engineering base is strong in those areas. But you do not do it just by throwing money at it; if you do not have good people with good ideas they do not get the money. It is quite a tricky problem; it is the chicken and the egg. We do have certain areas where we have islands of excellence, but they are not very large islands. Those are the areas where, of course, we look for good ideas and good suggestions coming forward so they can be supported. Let us say that widgetry is the latest thing; if you do not have any widget-makers in the country you just do not put \$10 million into it; getting good people is the important thing.

Sir Trevor Skeet

59. It is quite right that we should not spend the money over too broad a field. You want £40 million for Foresight Challenge and £70 million for the DTI to support innovation and Foresight. Had it occurred to you that a lot of money is being spent on CERN now, which would pay for some of these bills, and also the ESA, which I regard as being important but others do not, also consumed a lot, and you cannot generate further money; do you have to take it from these other accounts?

(Sir John Cadogan) You have very nicely illustrated the problems that come with my post, because we have CERN and ESA, who together, in two cheques, consume £110 million. Now, we are in ESA and we are in CERN, I say nothing for the moment about the quality of the science or—why do I not say it, the science is outstanding in these areas, terrific—but the point is we are in there by treaty, but we are in there, and it is right that this country should participate in these great experiments. What is problematical for us, of course, is that if you choose to be in a great experiment, which is located in Geneva and you pay in Swiss francs, you are at the mercy of changes in currency. Now, a year ago, you will recall that we had a tremendous negotiation with CERN about reducing their costs, so that we could get the same science for less money, and we were successful, and that saving went straight into the science base.

Mr Batiste

60. Yes, but in these negotiations with the European Union on funding—

(Sir John Cadogan) It is not actually the European Union, CERN and ESA; CERN—

61. Yes, but I must raise it because I want to come to ESA in a second, separately, because I think they are interconnected in rather important ways. We seem to face a constant difficulty in that we have priorities that we would set in the UK and we have the first layer of priorities to see to what extent those same priorities are shared within Europe, and therefore a proportion of European funding reinforces the priority areas that

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[Mr Batiste Cont]

we have. How confident are you that you are actually able to achieve that commonality?

(Sir John Cadogan) We do achieve it because, of course, you have to get agreement in ESA, and the Minister will know much more about ESA than me; but we have to get agreement right across the piece, all the participants have to agree on the content of the programme, and indeed on what experiments you fly. Indeed, if a particular nation does not want to participate, it does not.

62. Let me come back specifically. The question I addressed to you was in the wider context of European funding rather than specifically in relation to ESA, but let me deal with the ESA one because we face the very difficult problem in ESA that, as far as our space expenditure is concerned, if you look at the figures over the last three or four years, the national spend on what we would identify as our domestic priorities has been hammered very hard, whilst the treaty commitments through ESA have been maintained. And the problem for us there is that ESA is funded by an entirely different mechanism from European Union R&D expenditure, and the Space Agency is obsessed with *juste retour* as its only method of financing, whereas if, in fact, ESA spending, if Space spending were subsumed in the larger European R&D budget British industry, on competitive terms, would have an enormously larger share of this very important industry. In terms of the development, we have already established that our science base has to be integrated within Europe to a great degree, but here we have an infrastructure issue which is mitigating very significantly against British industry. How do we address that?

(Mr Lang) I really just wanted to try to allow Ian Taylor to catch your eye, Mr Chairman, because he was at ESA negotiations last week and did secure quite a satisfactory outcome, which I think he might share with the Committee to good effect.

(Mr Taylor) Mr Batiste is raising some long-term changes which might take place, or at least possibilities, because there is not a complete similarity of membership between ESA and the European Union, etc. Where he is absolutely right is that the concept of *juste retour*, which is that if you put X in you are going to get X out, is actually a nonsense, and I said that, translated into several languages, during the ESA Ministerial last week. I am beginning to win the battle, but it will be a slow process and we have agreed to review it again. The difficulty for the UK on one hand is a budgetary difficulty, in terms of how it is calculated, and on the other a perception difficulty. The budgetary difficulty is, for example, that for Germany, under the current financial arrangements within Germany, the subscription to ESA comes out of a different pocket from the Science expenditure in its national budget. So if the subscription to ESA goes up it is of very little to concern to the Minister for Science; whereas in this country if the subscription to ESA goes up it squeezes more out of what we have available, through PPARC, for the national Science programme. This is precisely why we got squeezed on the Integral experiment, which obviously dismayed scientists at the University of Southampton, for

example. Now, that balance has to be addressed. I cannot overnight change it because the pressures on other countries are different from here. What we did at ESA last week was really, I think it is fair to say, quite remarkable, because we agreed and we all smiled, but I was actually one man out when I started negotiation. We have effectively secured a flat budget for five years in cash terms, assuming that inflation is at 3 per cent or below. There is an adjustment for anything that is above 3 per cent. Now, that is a remarkable settlement, and the point I wanted to make to them was that if we did not tackle it now what would happen is that in a year or two's time, as the Maastricht criteria bite on other Governments, they would have said, "We can't afford it, let's take this element out of the Horizon 2000 programme", whereas by tackling it now we have got a chance of delivering the Horizon 2000 programme, which I believe in strongly.

63. What is the implication of that agreement going to actually be, in relation to the Budget, because if we have a flat level of spending for the European Space Agency we are talking in the range, between '94 and '96, of about £77.8 million to £80 million for ESA, in terms of the projections and estimated outturns, and that in turn has reduced the national Space programme to about £6.4 million. If you are able to keep the ESA expenditure flat, does that mean there is now going to be more money available for national priorities within Space?

(Mr Taylor) What it does is, over a five-year period it is estimated to reduce the cost to the UK of the ESA Science programme by £15 million, which I think is a very important achievement, and that therefore gives some headroom for continuing activities in science. Professor Ken Pounds, the Chief Executive of PPARC, welcomed the deal at the end of the week and he added, "It will enable us to work for a more stable base in seeking to maintain our traditionally active role in the ESA programme, starting with participation in the next major mission, Rosetta." Now, I think that it will be very warmly welcomed by British scientists and indicates what you can do from a tough negotiating position, but a supportive one. The final point I would make, because I know you do not want me to overrun, is that we depend upon collaborative programmes in these areas; there is no way that Britain is going to have a Space interest or an interest in a large hadron-collider by itself, but we have got to try and get our colleagues to realise that we have got to have discipline in the budgets.

Chairman: Right; well, I take collaborative evidence as being very important, Mr Taylor. And we now turn to relations between Government Departments, where I trust the collaboration is even at a higher level.

Dr Bray

64. I am anxious to get on and see how far you are satisfied that other Government Departments are, in fact, addressing the right priorities in research, but can I first clear up a question about DTI. There is a

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[Dr Bray Cont]

question on the Order Paper today, from Mr David Shaw, to ask the President of the Board of Trade if you will make a statement on the sale of the National Engineering Laboratory. It is in the light of that question that I earlier asked whether there are any specific developments in relation to NEL in forward productions?

(Mr Lang) An announcement has not yet taken place, Chairman, is all I can say to that.

65. The written reply to that will be in the Library by now, it may not have been earlier?

(Mr Lang) In that case, the written reply will probably say just that, but an announcement may take place soon.

Chairman: But it is not available today; right.

Dr Bray

66. The general picture is that DTI expenditure is reaping the harvest of past activity, for example, in the return of Launch Aid now; so, because of the cuts, there is no future harvest to be looked forward to, in terms of future contributions, to DTI or other departmental budgets. Now, when you come to other departments, we have had, for example, the Report of the Royal Commission on Pollution, making very sweeping recommendations about transport policy; we have the Report of the Intergovernmental Panel on Climate Change, coming up for a review at the end of its decade; we have a number of major issues arising in the field of genetics that we have been looking at in this Committee. Against all this, there seems to be a need for Government to have a very active view of what are the research issues that other departments ought to be addressing. Now, how far is the Chief Scientific Adviser really effectively able to get in to other departments to beef up their own research competence and ambitions?

(Professor May) Let me begin by outlining some of the formal things we do and then turn to some of the specifics, and then ultimately say, and I will try and be quick about this, that being something like seven weeks into the job I cannot really foresee how effective I am going to be in discharging the job I should be doing. Firstly, the whole purpose of publishing the Forward Look, for example, is deliberately to take a view across all departments of the whole notional £6 billion of public spending on S&T, looking at the strategic implications of that and looking, department by department, at how one believes the stated mission matches what is happening. For Technology Foresight, there is an intergovernmental departmental panel that is monitoring, again, as I said earlier, the responses to that. We have a specific working forum on making the most of civil and defence links in science, engineering and technology, that is dealing with a series of specific detailed things. And then I also have a handle on the question you asked, in the fact that I chair or participate in a number of, as we discussed earlier, interdepartmental committees that are concerned with particular SET areas, like marine science or, as you mentioned, global environmental change; or the responses to your own Reports on, for example, human

genetics. That is the mechanism. If you take the specifics, as you know, I have a personal interest in Global Change and in the Biodiversity Action Plan, and things like this, and I continue that interest; I meet regularly with the other Chief Scientists and I have identified bits and pieces where I think, if I had the power simply to act not to persuade, I would do things slightly differently, and I am in the course of conversation. I expect in some instances I will persuade people to the view that I believe is right and in others I will not.

67. Can you say specifically, does this involve your visiting particular institutions within other departments?

(Professor May) Yes.

68. Forming a common view with those Chief Scientists in those departments, providing a brief to your own Ministers, the Minister for Science and the President, so that they can meet the departmental Ministers, with yourself and their Chief Scientists, to try to make the case?

(Professor May) This is what Bill Stewart did.

69. He tried to do it; he did not sustain it?

(Professor May) I am not in a position to bandy impressions, I am afraid. I have the impression that in some instances he was quite effective in doing just that, and one of my first conversations with the President of the Board of Trade and with Ian Taylor was to say, "You do realise that later in our relationship there will be occasions when I come to you to say I am not altogether in favour of what you are doing in DTI, and do we understand that?" and they both said, "Yes", although we have not yet had an instance.

70. Can I ask the President of the Board of Trade, is it his intention to have a regular annual meeting with ministerial heads of other major departments on their science programmes?

(Mr Lang) That is not actually my overall responsibility. Professor May has a transdepartmental role; I do not, as such. But, quite clearly, if there are any issues involving the Science Budget and the science activities of other departments which I consider, given my responsibility in Cabinet for Science, justify a meeting then I will seek it. It is not a matter of—

71. But that was the role of the Chancellor of the Duchy, when he was doing the job?

(Mr Lang) Not an automatic meeting every year regardless; he would pursue matters on a—

Chairman

72. It would happen, presumably, President, if there were disagreements which Professor May, in his CSA role, would come to you and say, "Resolve it"?

(Mr Lang) Certainly.

(Professor May) I would see my coming to the President and saying, "Would you please do such and

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such" and I am encouraged to believe that he would do it.

Mrs Campbell

73. Could I just deal with the move of the OST to the DTI, because it seems to me that a lot of this is about signals, and what that is signalling to many scientists is that the Government do regard science as being there purely for wealth creation, quite ignoring the aspect of quality of life. And I wonder if you feel that the right signals have been promoted to the scientific community and to the public in general by that move and whether there is going to be encouragement from the DTI, which is now the main department, in encouraging research into environmental factors, into health, and so on, in the same way as there is towards specific industry help for wealth creation?

(Mr Lang) If I can answer this, to start with. So far as the quality of life is concerned, I have repeatedly made it clear that I regard that as an important component of scientific activity, and indeed I said so in a number of interviews and I also said so in my speech on Friday. Nothing has changed in terms of the priorities and the policies set out in the White Paper in that context. Science is not simply there as an aid to wealth creation. Again, I hope I have said often enough and clearly enough the importance that I attach to basic research, to blue skies research, to curiosity-driven research; the ROPA programme, which we have not actually discussed yet, is a programme geared to achieve that sort of outcome.

74. President, I think scientists are hearing your words and I think in some cases there is not a belief that there really are policies behind those words that will actually match what those words are saying, and I think we are seeing scientists, for instance, working for the Medical Research Council, who have had a number of very large grants turned down this time, who feel that because of the concentration on wealth creation then those projects which are intended to improve health and quality of life are simply not getting funded?

(Mr Lang) I do not think that is correct. There will always be anecdotal cases of individuals unhappy because their own grants have been turned down, but there is no question of prioritising our expenditure in such a way as to preclude quality of life type issues. And, so far as the question of other Government Departments are concerned and their expenditure, for example, I think Environment was mentioned, if I became aware of any difficulty arising over scientific commitments in other Government Departments I could either raise the matter directly, bilaterally, with the Secretary of State concerned, or I could discuss it with Professor May and he could raise it, or I could raise it at the Competitiveness Committee and have the matter thrashed out there. So that a number of avenues are open to us.

(Sir John Cadogan) It is purely factual. Personally, I do not think there is any difference between wealth creation and quality of life; if you do not create wealth you cannot get quality of life: talk to

the Ethiopians about quality of life. You have to be a wealthy nation to do the things you want to do, the important things; you want people to live longer, you want education, and so on. But the facts are that, of course, two of our Councils are dominated by quality of life considerations, the Medical Research Council and the Natural Environment Research Council. We have two Councils devoted to it; so there can be no question that it is not looming large in the scheme of things. And, of course, at the last allocation the Medical Research Council leaving aside PPARC, who got the biggest increase, because of the fluctuations, MRC actually got the biggest increase; so there has been no question of MRC getting less money, or NERC getting less money, far from it. Between them those two Councils dispose of getting on for £450 million.

75. But can I put it that wealth creation is actually necessary for quality of life but not sufficient and perhaps that is something that Sir John would like to—

(Sir John Cadogan) I think wealth creation and quality of life go together, I do not think they are two separate things.

Mrs Campbell: I think, if you consider carefully what I have said, you will see that there is actually a very marked difference between what I am saying and the statement that you have just made, and I am putting that to you as a proposition.

Chairman

76. I think Professor May also would like to comment?

(Professor May) If I can just quickly come back to Dr Bray's initial point, just to say one more time, to clarify my understanding of the procedural apparatus for implementing my vision of my responsibilities across departments. Whether it is a quality of life issue or creation of wealth or a fundamental science issue, if I saw things which I felt ought to be configured differently or given different priorities then I would turn to Mr Lang, in his capacity as representing the transdepartmental interests of S&T in the Cabinet. So there is a certain element of schizophrenia essentially vested in his role. He is, on the one hand, President of the Board of Trade, but he has a transdepartmental role for S&T in the Cabinet; just as there is an element of schizophrenia in my own position, as Head of OST, reporting to Mr Lang, and Chief Scientific Adviser, reporting to the Prime Minister. And that was taking the debate back a moment to answering your question, and I imagine there will be just such instances as when I have been in the job longer.

Dr Bray

77. Can the President of the Board of Trade confirm that that is his view; I am sure he can?

(Mr Lang) Yes, I can; I do.

78. So what is the role of the Prime Minister then?

(Mr Lang) The Chief Scientific Adviser has access to the Prime Minister, the Prime Minister himself

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[Dr Bray Cont]

continues to take a close interest in Science, although he no longer chairs the committee, which has been subsumed into the Competitiveness Committee, and I would also have responsibility to report to the Prime Minister any anxieties I had over Science, not just in DTI or OST but across Government, and would do so.

79. Would it be fair, to sum it up, that with the Prime Minister the role of a Chief Scientific Adviser is on the broad strategic issues; with the President of the Board of Trade, in his interdepartmental role, which you described, that it is on the practical implementation, in relation to budgetary questions and specific programmes, and so on?

(Mr Lang) I do not think it is necessarily as clear-cut as that, but I would not particularly quarrel with that definition.

Chairman: Right. Could we now move on. Dr Jones.

Dr Jones

80. Can I pursue this schizophrenia on a slightly different tack. Earlier on, when we were talking about budgets, President, you talked about the importance of output measures, and in our 1994 Report on the Forward Look we recommended the development of output measures and the OST responded in that they were currently working with the Government Departments to develop performance measures. In the 1995 Forward Look the list of the sorts of output measures that might be looked at were: dissemination of research results, patent activity, commercial licence agreements, royalty income. Now, whilst I would agree with Sir John that wealth creation and quality of life go hand in hand, that list could perhaps be seen to exclude perhaps long-term issues of wealth creation. I actually think that quality of life considerations could actually have great potential for wealth creation, that certainly came out of our Human Genetics inquiry. But there is a suspicion, that sort of list that is coming out does seem to give the impression of short-term considerations, not the considerations of quality of life, long-term wealth creation, issues such as those Professor May raised about quality of scientists and people coming into science, and that does give a suspicion that the whole aim of the Foresight exercise is to redirect Government research spending to the use of the short-term needs of industry. And I think that that is symbolised, to some extent, by people, by the move into the DTI, and really I am seeking some assurances about this issue and also how you are developing output measures, is that actually possible, will you, for example, be looking at the issues which we raised in our earlier Report, about the importance of R&D to GDP growth, for example, that is on a long-term basis, rather than these sort of short-term considerations which seem to be coming out of what is happening to the assessment of projects at the moment?

(Mr Lang) I agree, this is an important subject and it is one which the Committee have themselves, in their Report last year on the 1994 Forward Look, said that they strongly supported. It is an area where there are now many examples of departments taking steps to

address the potential spin-off from science and technology, for wealth creation and quality of life improvements, and OST is monitoring progress in this area. The position of departments against an agreed framework of performance measures will provide a bench-mark against which further progress can be assessed. I do not see a particular distinction between long term and short term nor a particular problem arising there. Dr Jones mentioned some of the measures, but there are others; the Research Councils have a Framework of Performance Measures, consisting of process measures, primary outputs and research outcomes, and we have agreed with departments a whole range of measures suited more to the kind of work that they are engaged in rather than to a question of whether it is long term or short term. I do not think the distinction is one that need cause concern.

(Sir John Cadogan) I do not believe there is any evidence that great benefits only come from long-term research. I am a committed believer in long-term research, I am still involved in a long-term research project, but my experience in industry shows me that often you can draw on the long-term research with a very short, fixed piece of research to come out with something that really works and pays off and can move forward. It is too simplistic to say there is long term and there is short term research. We need a combination for tackling particular problems. I do want to emphasise that there really cannot be a difference between wealth creation and quality of life, and the Minister, when he introduced his portfolio earlier in the year, did draw attention to the idea of extending quality life as a major target. If you think about it, if we could extend quality life in the nation this would have tremendous ramifications; it would make a difference to this nation almost more than anything. We have people who live longer. What our epidemiologists from MRC have shown, for example, is that ladies live longer than men but they actually have a shorter quality life; part of this is genetic. One would have to integrate engineering, technology, genetics, small molecule medicines, new working practices, new leisure practices and hopefully keeping our ageing workforce active. I think the day of the youngster has gone, the day of the middle-aged and elderly person is coming. I am glad to say, more and more activity can come out of older people if you can extend quality life, and it would really make a difference to this nation in a unique way. And that is through a combination of science, engineering, medicine, technology, social studies, and of course out of it would come uncountable commercial and wealth-creating benefits.

81. But, so far, in terms of the measures which Professor May was talking about earlier, we do not seem to have been doing very well, in terms of scientists, the performance of our industry, and there is a worry that what we have been doing well, in terms of our basic research, which as you have been saying earlier has attracted overseas investment and it has attracted students to want to come and study, could be undermined by this whole emphasis in terms of the kind of criteria which I just read out. And it is very

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[Dr Jones Cont]

important that as part of the Foresight exercise it should be industry that are actually using the results of Foresight as well, with help from Government, as appropriate: how confident are you that industry will use that? Now, business investment is still not up to the level that it was in 1990, there is a temptation to just use, to shift Government funding; how are we going to encourage industry to invest more? In March 1994, for example, the former Economic Secretary to the Treasury, Stephen Dorrell, began to set up a wide-ranging review of financial structures and flow of savings in the economy into investment; now that was dropped. That is worrying to some of us. What is going to be done to ensure that industry actually invests?

(Mr Lang) The whole Technology Foresight programme is geared, to a large extent, to engaging the commitment of industry. The involvement of 15 panels, consulting with 10,000 people in identifying sectors for which there is a promising area of research of value to industrial progress, is geared to engage the commitment of industry to investing in new technology, using modern methods, and applying research. Business Links, the initiatives we are sending round, are designed to help small and medium size enterprises get into this area; and I do not accept that we are not making progress there, as Dr Jones mentioned earlier in her question. If you look at the productivity figures of this country, although our productivity levels may still not stand comparison with the best, we have closed the gap quite dramatically in recent years with an average productivity growth of somewhere around 5 per cent per annum. That is the reason we are so competitive and attract so many inward investment companies to this country; it is the reason why our exports are performing so well. So we see the benefits of science and technology already delivering very considerable progress, but we are in no sense complacent and we recognise that we have to continue to be competitive; the whole Competitiveness White Paper is geared to building on what we have achieved and moving further and faster. That is why these initiatives, including the whole of the Technology Foresight initiative, are so relevant and important. As to funding, which I think was another point raised, there is the Foresight Challenge, which is designed to lever in, pound for pound, from the private sector, the resources that the Government is putting into it.

82. I will not go into that because we want to raise it later, but, with respect, our exports are not doing well and our balance of payments in manufacturers is in deficit and—

(Mr Lang) With respect, our manufactured output is higher than it has ever been before and our manufactured output exports are higher than they have ever been before in our history.

83. We believe that exports have not been impressive and we will have to do a lot better than we are at the moment.

(Mr Taylor) I just want to add, actually that if you looked at what I announced yesterday in terms of our increased exports to Japan, I think you would have fewer doubts about the excellence of very considerable

parts of British industry. We would like more to be as excellent; that is why we are bench-marking.

84. Exactly; there is no—

(Mr Lang) Up 82 per cent in six months.

(Mr Taylor) For heaven's sake, I really do think it is more constructive, Dr Jones, to look at where we are excellent, because the whole thrust of what the DTI is trying to do is to bench-mark the long tail of those not as good against those that are the best; that is the point of the Competitiveness White Paper; that is actually why the Forward Look is so broad-ranging. And yesterday, at the CBI, in another speech, I set out in very clear detail, which will avoid my having to do it again today—not because the Select Committee is not important but to save time, because you can read my speech—the seven Foresight visions that I have, one of which has got Sir John quite worked up, which is the extending quality life, and also the delivery mechanisms that we are looking to to make sure that industry takes to heart the messages in the Foresight process.

Chairman: Right. Thank you, Mr Taylor. Can we move on now to, Sir Gerry Vaughan.

Sir Gerard Vaughan

85. I think Mr Taylor will agree that industry will only be able to implement Foresight if it can fund its research needs adequately, otherwise they will not be able to implement it fully. Can I ask you, are there discussions in the City about changes in the private financing of research and is the Government involved in an initiative of this kind?

(Mr Taylor) First of all, I think that our initiatives are actually leveraging in a lot of money; in the ROPA scheme, which we may come back to, we reckon there is about £260 million of backing by industry for curiosity-driven projects. We have seen that businesses are matching funds for the Foresight Challenge. There are a lot of things that industry are putting money into which unless we were taking action would not have been levered in. That is very important. The point about looking at ways of financing or changing the cultural attitude of the financial community to research and development is a key one and I do not think we have yet found the answer to that. You simply cannot just tell institutions in the City that they have got to change their normal parameters; so it is a process of education. This, of course, was one of the conclusions which came out of the Foresight Panel chaired by Michael Hughes. It is a very important series of introspective and wise judgements that Panel made about the difficulties the City is going to face. In terms of the Government, I clearly cannot anticipate the Budget; I have seen recommendations about tax credits.

86. But you have a Director of the Bank of England on your Steering Group, do you not?

(Mr Taylor) Yes. Well, that is a deliberate attempt to integrate.

87. And, presumably, from that, you will be hoping that discussions on greater City involvement in funding will emerge?

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[Continued]

[Sir Gerard Vaughan Cont]

(Mr Taylor) Yes. Pen Kent's arrival is important; Michael Hughes' position is important. One of the key things that came out of the Panel's reassessment of risk and risk management is that these are crucial themes for the future of British industry. I have had talks only in the last week in the City about how we might go further, looking to encourage and stimulate financial backing for companies that upgrade the status of research in their development programmes; and with Michael Hughes was discussing very clearly the important point that the City should look rather carefully at companies that are not investing in R&D because of the way that the world economy is changing. This will not happen overnight, but we have got to do a bit of proselytising, and that is one of my tasks.

Mrs Campbell

88. I think the difficulty I find is that, the real problem is that industry or the financial institutions will not allocate the money for research and development; indeed, what we are finding is that companies pay out twice as much in dividends as they pay towards research and development, which is quite the reverse situation of what we see worldwide. Now, however much you engage companies with academia or with Government and get them interested and involved in the research, if they cannot fund it, or are not prepared to fund it at the end of the day, the whole thing fundamentally falls?

(Mr Taylor) Mrs Campbell, can I just raise one point. If you go back to the Competitiveness White Paper in the summer, one of the key themes there is to try to unblock funds to help the hi-tech sector. Now, the Innovation Unit of the DTI is working closely with the City and companies to try and look at the pre-financing evaluation of a project, which is a real problem in many cases, because the evaluation of a hi-tech project is often disproportionate to the amount of funds required for it. We are looking at these problems very actively, but there is no simple solution because you cannot force the investment community to reassess or re-rate stocks overnight. They are in a very competitive world too; nor can you guarantee that all hi-tech stocks are going to perform according to their plan, and therefore it is not for the Government to tell the investment community how they should rate any particular investment. But there is a culture change, in which we can participate, and I am participating.

(Mr Lang) Can I just add to that, Chairman. I think it is dangerous and a mistake to generalise in this way and imply that the whole of industry is failing to engage in research and spend money on it. Something over £9 billion is being spent by the private sector in research and I mentioned earlier that there had been a 6 per cent real terms increase. Just to give one example, I had the opportunity, when in the St Helen's area recently, to visit Pilkington's, a world leader in glass technology and yet a company which still invests every year 2 per cent of its sales, not its profits, 2 per cent of its sales every year in scientific research. There are many other companies doing the same sort of thing, so we should not generalise and, by implication, knock

our industry too hard. But I do agree that there are other companies that are not doing it and those are the ones we want to encourage, and that is why we have these schemes that we have talked about.

Mrs Campbell: But one of Mr Taylor's predecessors did actually undertake, I think, to carry out a review of the efficacy of tax incentives in encouraging industrial research and development. I would like to know if that review is taking place and whether, is any work going on in Government at the moment, either within your own Department or within the Treasury, to carry out a review of the case for fiscal incentives for research?

Chairman

89. I think, before you answer that, I might remind you that the Committee did publish, in its Report on Innovation, in the routes from innovation to technology, this particular information from the most recent United States research, which suggested there was indeed a beneficial correlation between tax incentives of a given percentage and a return in terms of investment in research.

(Mr Taylor) In the DTI we have been looking at this very closely, not just leaving it to the OST, because it is a big problem and it is a competitive advantage problem too, in terms of inward investment, so there are many aspects to it. I am not going to anticipate what might or might not happen in the Budget in a week or two's time; you would not wish me to do that, I know. But there are, in fact, more tax reliefs for industrial research and development than many people realise and indeed the Scientific Research Allowance possibly is the best kept secret around, except to some of the best accountants; total tax subsidy is £2.5 billion for that.

Dr Bray

90. That is just ordinary, that is just limited to what is available for advertising?

(Mr Taylor) I do not think it is perhaps as widely used as possible, and there has been pressure by my predecessor to get the Inland Revenue to draw more attention to it and to clear up any uncertainty over coverage.

91. With respect, is the Minister not confusing the ordinary allowances available, for example, for advertising expenditure and research, on the one hand,—

(Mr Lang) No.

(Professor May) No.

92. And the research and development capital expenditure, on the other, which has a higher rate of allowance; it is the latter which is not sufficiently known?

(Mr Taylor) I repeat, exactly what I said; I am not going to anticipate the Budget. There are a very considerable number of discussions that have gone on. What I am also saying is that there are certain things that can be used, and my predecessors have pushed the Inland Revenue and the Department of Trade and Industry has pushed the Inland Revenue to clarify

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[Dr Bray Cont]

those, and I think that that is something that is worth noting.

93. Can Professor May comment on the contrast between the US context in which the scientist taps the venture capital market and what he observes in the UK, particularly with regard to the very early stages of conceptualisation of a scheme?

(Professor May) It is my impression, and it is only a personal impression, that venture capital is more venturesome in the United States, and it is equally my impression that universities in the United States were more aggressive in a managed way in reaching out to such venture capital. The USA is a culture in which people are more comfortable putting everything at risk. It is a cultural difference and one that I think I happen to find attractive; it goes right from the faculty to the people prowling the corridors of Universities looking for investment opportunities. I found at Princeton my problem, in a way, was holding people to the clearer recognition that their job in the university was fundamental research, and we had rules against product development, and in a sense keeping at bay the people who wanted to try and invite them to invest in this; venture capitalists, as it were, prowling the corridors. I think this is something that does represent to an extent a cultural difference. It is something that lies at the heart of the earlier thing I said, that our science base continues to create wealth; it is just that in some sectors—notable exceptions, of course, being pharmaceuticals and chemicals—a lot of that wealth is captured overseas. The Foresight programme is partly oriented to remedying that, and other measures will encourage this working towards a more venturesome culture right across the board.

(Mr Taylor) Chairman, Dr Bray, I think, misunderstood the point; when I talked about the Scientific Research Allowance, it covers capital spending, it is a special allowance covering capital spending on scientific research and it receives a 100 per cent allowance. Now, I do not know how widely this is known and that is the point I am making. Of course, there are other allowances against current expenditure, which we are all aware of, but I think it would be well worthwhile just clarifying that point for the benefit of the Committee.

Sir Trevor Skeet

94. Mr President, can you confirm that funding for Foresight Challenge and the DTI budget to support Foresight comes entirely from new money?

(Mr Lang) I cannot confirm what next year's Public Spending Round will reveal, but I can confirm what has already been announced as having been correct in the announcement that took place.

95. But, surely, on the years ahead, it would be rather surprising if we did not take this as new money, would it not, in a state where you have a figure pushing 50 per cent of your total revenue gain to health and also to social security, more money should be provided in a new form for science?

(Mr Lang) The Technology Foresight Challenge does involve an announcement made by my predecessor of £40 million; that was a new money

announcement and that will lever in another £40 million, over three years, creating a figure of some £80 million overall.

96. That is entirely new money and does not come as a transfer from some other project?

(Mr Lang) He announced that as new money, in May this year.

97. And what about this £70 million?

(Mr Taylor) Chairman, the definition of new money is money that had not previously been assigned to that heading, and therefore that is new money, it is money over the previous baseline; by any definition that is new.

Chairman

98. That is not additional then?

(Mr Taylor) It is additional because it would not have been spent if it had not been announced.

Dr Bray

99. Additional in the application of the amount; the total is not necessarily new but the allocation of a bit of it is new?

(Mr Taylor) The semantics of budgets are delightful. If the then Cabinet Minister, David Hunt, had not made the announcement that he was allocating £40 million of new money then, that money would not have been spent on Technology Foresight, and in that sense it is new money.

Chairman: Okay. Can we turn now to ROPAs: Dr Jones.

Dr Jones

100. Does the same apply for the ROPA awards, because we have certainly got the impression that it is about reallocation of a predetermined budget: can we just clear up the situation on the ROPA awards?

(Sir John Cadogan) The ROPA scheme came not at the last budget allocation but the one before. Government was looking for a way of encouraging academics to be connected to industry and the user and, at the same time, without constraining academics to be short term. The ROPA scheme was devised with that end in mind. It is a unique scheme because, on the one hand, those people who have attracted strategic money from industry have an entrance to the competition, and if they are successful in the subsequent competition then they can take that money and do whatever they please, providing it is scientifically sound and has not been done before; so it is completely responsive mode and therefore people are encouraged to get connected to industry. The first round there was a pilot, which we discussed with the Research Councils Three Research Councils participated, in areas they chose. A fourth Council was disappointed it did not come in, extra money was provided in that budget allocation in the first year. I was questioned in this Committee about savings that we had asked the Councils to make and whether they were real savings and what we were going to do with them, and that is where that cash for ROPA came

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[Continued.]

[Dr Jones Cont]

from. The pilot was a success, an extraordinary success. It was successful scientifically, indeed, EPSRC was so impressed with the quality of the applications that it transferred money from its own grant in aid to provide more money for the ROPAs, and the then Chancellor of the Duchy found another matching sum of money, so more money was put in. When it came to the second round, all Councils were invited to participate. Did they want to participate? They all did. Even PPARC wanted to participate. I wrote to Ken Pounds and said, "Do you really want to be in this, Ken? Are you sure; are you connected to industry?" Yes, they wanted to be part of it. They were asked how much money they thought they would need. They were allocated that amount of money, and you will recall, Chairman, that at the last Budget there was, in fact, £41 million additional to spend in the forthcoming year; and the then Chancellor wished to bring about a reorientation of the £1.2 billion and said, "I want you to give priority to £67 million worth of initiatives", one of which was ROPA, "and here is £41 million." In other words, the Councils, quite frankly, were asked to realign some £25 million out of their total £1.2 billion, and they could do that in any way they liked, provided priority was given to ROPAs; providing priority was given to studentships; providing priority was given to new equipment; providing it was given to responsive mode grants in chemistry, physics, mathematics and medicine, and Fellowships for the Royal Society, and so forth.

101. Can we talk about those projects then. On Friday, in the debate, which unfortunately I was not able to be at, the President said that the ROPAs were an important and successful element in Government science strategy. Now is not that rather too soon to come to such a conclusion; indeed, in the report on the ROPA, which was published last week, the conclusion is that the ROPA scheme is in its infancy and it will take a little while for outcomes from an adequate number and range of types of ROPA projects to become available? But there is widespread concern within the scientific community about the quality of some of these schemes. I have got here a news release by your predecessor and there were two projects there, for example: one is to study children aged 2 to 5 years old to investigate how learning to name types of foods, for example, fruits or vegetables, associated with positive or negative experiences can affect their later choice and eating of these foods. Now that is the sort of project that, I would imagine, if it came from a Labour council would probably be ridiculed by the Government. Another is about the spawning period of salmon. I am sure that these are useful projects, but really they are hardly at the cutting edge of science and that the—

(Mr Lang) With respect, Chairman, the Committee has been urging us to save the budget of basic science research, blue skies research, curiosity-driven research. It is precisely the kind of attitude that picks out individual projects and says, "What's the point of this, it can't possibly make sense?" which gets that sort of basic research a bad name. If Sir Alexander Fleming had been living in the present circumstances, the HSE would probably have called and said that he ran a

dangerous and unhealthy laboratory and he ought to clean it up.

102. It is the quality of these projects. A large proportion of alpha graded projects are being turned down by the Research Councils and yet a high proportion of ROPA schemes are being accepted, and there is concern that better quality projects, perhaps of the type that Sir Alexander Fleming might have put forward, are being turned down for these type of projects?

(Sir John Cadogan) There is no evidence whatsoever for that.

(Mr Lang) There really is no evidence. This is a young scheme and what is encouraging is that the scheme is doing so well at so early a stage in its development. An analysis shows that, across all Research Councils, of those ROPAs which went to university departments within the scope of the 1992 Research Assessment exercise, over two-thirds went to departments rated four or five, the top two ratings, compared to 65 per cent for Research Councils' other grants. That is a very encouraging start to a scheme which has been very warmly welcomed both in the academic world and in the industrial world.

Dr Jones: Perhaps you should compare that with schemes that have been turned down from those departments.

Mrs Campbell

103. If I may say, that seems a very curious way of assessing the efficacy and success of ROPA awards. Cambridge University, as the Minister has pointed out, was one of the main beneficiaries of the ROPA awards and yet there is a feeling among some University staff that ROPA awards and the funding of ROPA awards actually prevented some other long-term and high rated projects from being successful. If you are funding 50 per cent of applications for ROPAs and only 20 per cent of alpha rated proposals coming from the Research Councils, which is the case in some, I believe, how can you be sure that the ROPA applications are of as high a quality as those coming from Research Councils with an alpha rating?

(Mr Lang) By its very nature, this is a scheme that is concerned with curiosity-driven research, blue skies research, and it is going to be many years before the outcome of some of this research is seen in measurable quantities that enables evaluation of that kind to be made. But what is encouraging so far is that all the evidence that has been able to be adduced does point to research of a high quality being undertaken by researchers of proven ability.

(Sir John Cadogan) I think I will have to go on numbers, I am afraid. No grant scheme has had such an open analysis at such an early stage, in any Research Council at any time; most of the people have not even started work. What we have an analysis of is where the grants have gone, who has got them; there is a full list. I do not know about the two particular applications there—I could not possibly comment—but I certainly will look into it and I would be interested to see where they are. But the great names of British science have received these grants. It is a

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[Mrs Campbell Cont]

perfectly valid—perfectly valid—comparison to look at all research grants awarded and look at which departments they go to: whether they go to grade five departments, or four departments, or three departments, it is perfectly valid to look at where ROPAs go. The facts are, the numbers are—you cannot get away from the numbers—that there is very little in it and, if anything, ROPAs have gone to higher graded departments; that is a fact. You can say, "Well, it doesn't matter" if you wish. The other thing is the numbers show that, over the piece, 47 per cent of the ROPA applications were successful. But, remember, all ROPA applications have been through what in my experience is the toughest sieve of all; they have had to persuade industry to put money into it, and if there is any suggestion that industry puts money into dud people then, frankly, we are not living on the same planet. It is tough out there; so they have been through the sieve. Mrs Campbell has referred to 20 per cent; that is selective quoting. The research grant success across all Councils varies enormously from panel to panel, the range is from 20 per cent to 60 per cent, and what is more there is no pre-sieve—there is no pre-sieve. So those are the numbers. Now, you can draw what conclusions you like, but those are the numbers.

(Mr Taylor) Chairman, before we lose sight of one important thing, ROPAs are designed to try to get industry interested in research-driven, curiosity research-driven projects, and that is a very valuable tool. The second thing is that, despite perhaps accusations that you might then make that they are likely to be lower quality, the evidence is that they are not lower and that they are going to the best category departments. Therefore, I think we should encourage it, bearing in mind it accounts at the moment for about 1.7 per cent of total Research Council funding. It is a very healthy development, and the report is an interesting one.

Dr Jones

104. Would not a more accurate description of the ROPAs be that they are some kind of initiative, designed to give the impression that the Government is doing something useful, in terms of long-term research and development, when really the fundamental budgets are being undermined and—

(Mr Taylor) That is an extraordinary allegation, bearing in mind that the whole purpose is the science base has to get closer to industry, and it is not for the benefit of short-term, industry-driven solution-finding, because the whole purpose of ROPAs is it is driven by the curiosity researcher. That seems to me to be an extremely good relationship.

Chairman: We will leave that there, if we may.

Mr Batiste

105. I must say, when we went to the Max Planck Institutes and saw the curiosity-driven research there we were, I think, much impressed by the benefits that Germany had received from this, and I think many

of us feel that ROPAs combining that together with industrial funding is actually a very important step forward for us. But we now have a number of initiatives and priority areas for spending. In relation to the Research Council budgets themselves, do you deliberately keep back an element for responsive awards to things that have not been foreseen, that come up suddenly but are very worthwhile and should be funded; what sort of proportions would this be?

(Sir John Cadogan) No money is kept back; it all goes to the Research Councils. The Research Councils have a view themselves as to how much responsive mode they should put money in, whether it be absolutely classic responsive mode with no restrictions whatsoever or responsive mode within a directed area. For example, you might feel that a certain proportion of funds ought to go into new materials, and the Research Councils may say 20 per cent of that should go into warm superconductors but 80 per cent could be open to your best ideas. Now, at the last allocation, for the first time, the Chancellor specifically said to Councils, "We are very concerned to protect curiosity-driven research" and he said it in the debate, and indeed extra money was provided in the allocation specifically for responsive mode in chemistry, physics, mathematics and medicine, specifically, and those were sums of money which had to go in to this area.

106. Right; but will the initiatives, like the Foresight Challenge and the ROPAs and the others, all of which go towards this curiosity-driven research, pre-allocate, as it were, remove a fair amount of discretion from individual Research Councils as to the sort of things that in the future they will be able to fund, or is there some very discretionary level of funding that is unrelated to initiatives and programmes that have been established?

(Sir John Cadogan) Each Council has at its disposal its funds and it makes a judgement as to how much should go for responsive and how much should not; they make that judgement.

107. They make the judgement themselves?

(Sir John Cadogan) According to their community, yes, but they would get guidance—

108. But, of course, in the Foresight programme you will have a role in this now because Foresight will change that?

(Sir John Cadogan) In the particular case of Foresight cash, which is a small proportion of the total budget, there will be bids from the community; having regard to the Foresight initiatives. But the bids will come from the community, the community has got to provide the ideas.

109. Do you think the implementation of the Foresight programme is going to make a very significant difference to the way in which the Research Councils allocate their funds?

(Sir John Cadogan) As I said earlier, the Foresight process will be a significant factor in Councils deciding their own particular priorities; it will be one of the factors. A most important factor will be the strength of the science base and the engineering base

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[Continued]

[Mr Batiste Cont]

related to it. But it will vary, of course, if I may say so, from Council to Council.

Mrs Campbell: I would like to ask about the formation of the new Technology Foresight Steering Group and what principles actually guided that formation; was it, for example, spread of expertise, private, public sector experience, and did gender play any role in deciding the membership?

Chairman

110. Who would like to comment on that: Mr Taylor?

(Mr Taylor) I am happy to, but I think Bob May is the one responsible for chairing the committee.

(Professor May) Yes. My understanding of this Group, which I have not yet had the pleasure of chairing a meeting of, is that it was a group of people that were chosen in the first instance to reflect in the earlier stages a broad balance of the areas in which the 15 panels were set up. We have learned by doing and the panels themselves have been somewhat reoriented, as you probably know. We have put Information Technology and Communications together, and conversely we felt that Agriculture and Natural Environment were just trying to cover too large a waterfront and have made two separate panels; and we have created a sixteenth to deal with Marine things. Likewise, we have reconstituted the Steering Group, keeping it in being as a sort of oversight, advisory group—keeping some of the original members, but putting on some new members to reflect the change in emphasis from the earlier sort of thinking/planning to a phase of implementation and dissemination. So the new members include a Mr Pen Kent, who is the Executive Director of the Bank of England—that reflects the direction that we earlier discussed of finance being important; Ms Barbara Beckett, who is the General Manager of Business Development at W H Smith, a particularly innovative retailing operation; Mr Richard Jones, who is the Director of Engineering in Sony, in South Wales, which is an inward investor, and that touches again on something we discussed earlier; Mr Brian Blunden, who is the President elect of AIRTO, which is the Association of Independent Research and Technology Organisations (such things are going to be so important in disseminating Foresight into organisations that do not have the size easily to afford a dedicated individual); the Chief Executive of the Higher Education Funding Council for Scotland, John Sizer; and the Chief Executive of the Economic and Social Research Council, Ronald Amann—a Council which, I have to tell you, I think is of exceptional importance as it increasingly moves to deal with those issues at the heart of our future, of understanding how biological and physical constraints interact with institutions and people. And if I may parenthetically say, the research project which was mentioned earlier, with a slight air of derision, sounded absolutely spot on to me; that is the sort of thing we should ask about, and one of the central things in that area, still in parentheses, is George Miller's classic

paper on the number seven, plus or minus two, for the rate at which young children can remember and learn things. But I digress. Back to the main theme: and John Sizer, the Chief Executive of the Higher Education Funding Council in Scotland, recognising that we need to reach out beyond London—Britain is not the 25 miles of corridors in Whitehall, it is entirely surrounded by reality.

Mrs Campbell

111. Is there any member directly from the university sector?

(Professor May) Continuing members would be Mike Brady, Head of Engineering at Oxford, and, of the ones I just said, John Sizer is university sector also, and of the people still on are John Cadogan, Suzanne Warner, somebody who has past connections in the Research Councils and universities but at the moment Head of Government Relations at Cable & Wireless; the Technical Director of Thorn EMI, the Executive Director of ICI and somebody from DTI itself; and I would say Mike Brady and John Sizer and many of these other people have interconnections with universities. There is also my own chairing of it; that is the only thing I really know anything about, universities.

Chairman

112. Well, I think that answers the question pretty well. Just one final point: sector panels. How about the composition of them, are they going to be concerned with implementing the reports already produced; I assume they are: would that be right? And how much time will they devote to keeping their recommendations under review and refining them perhaps?

(Professor May) They will be keeping their recommendations under review; they will be making reports; they will be, as you have just seen, subject to a second look and a reconfiguration; and they will be subject to all the input we have about areas that we may have missed—things that slip through the cracks; things where a panel may have run away in one particular direction. They will be under continual review and reporting.

Dr Bray

113. The structure that you have outlined is remarkably reminiscent of Selwyn Lloyd's little Neddies and sector working parties. Does this echo recall any memories?

(Mr Lang) Dr Bray has the advantage over me there, Chairman. Old though I am, I do not recall.

Chairman: The final answer, I think, Secretary of State. Secretary of State, thank you very much for your time and thank you for bringing Ian Taylor and Chief Scientific Adviser and, indeed, the Director General of Research Councils, all of which, as a team, have contributed substantially to this afternoon's performance, and I am very grateful indeed for what you do.

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[Continued]

[Dr Bray Cont]

Sir Gerard Vaughan: Chairman, can I ask a very simple question?**Chairman:** The President of the Board of Trade has another meeting.

(Mr Lang) Foresight is a forward rolling programme.

Chairman

116. You are looking forward to its continuity and development?

(Mr Lang) You put it beautifully, Chairman; and can I thank you for the courtesy of your questions. I and my colleagues remain at the Committee's disposal in future.

Chairman: Thank you very much.**Sir Gerard Vaughan**

114. Do you intend to repeat Foresight?

(Mr Lang) Repeat Foresight?

115. Yes?

(Mr Taylor) Foresight never ends.

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WEDNESDAY 25 OCTOBER 1995

Members present:

Sir Giles Shaw, in the Chair

Mr Spencer Batiste

Sir Trevor Skeet

Dr Jeremy Bray

Sir Gerard Vaughan

Mr Andrew Miller

**Letter to the Clerk of the Committee from the Centre for Exploitation of Science and Technology
(TFC 42) (25 September 1995)**

It is quite soon to be assessing the Technology Foresight exercise but you are quite right in focusing on the implementation issue. This is an aspect which CEST has repeatedly raised with OST since the first ideas for a UK Technology Foresight exercise were made. How the results are to be used by the participants and others is possibly the most important issue to be decided before a Technology Foresight exercise is even started. In replying to your questions I am representing the views of the industrial Members of CEST and a number of companies and individuals with whom we work in exploiting science and technology.

Following your order of questions:

1. COULD WE (UK?) HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

The UK needed to undertake a large-scale national exercise in order to help in national priority setting by developing some sort of shared vision of the possibilities, both commercial and technological, open to the UK. Such an exercise was needed to carry forward the SET White Paper and the Competitiveness White Paper.

It is a mistake to believe that this is the first use of Foresight in the UK. A number of organisations including CEST have been undertaking more focused Foresight exercises with some real success in encouraging innovation, creating new programmes and changing attitudes.

2. WAS THE PROCESS HELPFUL . . . ?

The project has been helpful in that it provides a basis for a discussion with companies and public sector organisations about innovation. In addition, a great deal of potentially useful information and opinion has become more readily available. CEST hopes that much of the background information collected by the Panels and held by OST will ultimately be made available to help companies use the results profitably. In the light of the demand for more detailed analysis of foresight data we receive, companies who are aware see the process as useful. The main benefit is seen to be the formation of active networks between the participants.

In addition Foresight has again emphasised the need for interdisciplinarity, and much less restriction of research into the traditional discipline boundaries. This seems to be less a question of radically new HEI course combinations but more to do with the ability of specialists to inter-relate better.

3. WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN OTHERS?

Our most serious criticism of the project is the almost total lack of consideration as to how the results were intended to be used. One might say the "exploitation of Foresight lacks foresight". This is a point that CEST raised publicly before the project started¹ and has raised with OST during last year. We have known for some time that the participative nature of Foresight raises expectation amongst the participants that some change or innovation is possible. Indeed, with good workshop and Panel selection a group of innovators naturally forms to take things further. However, if they gain the idea that the originator of the process has no provision for the follow through process then motivation drains away and the whole exercise becomes an expensive waste of time. The people who carry ideas from Foresight onward are often different to the more visionary who participated directly in Foresight. There is an innovation gap to be bridged.

¹ See R C Whelan, *Approaches and Lessons*, CEST, (1994).

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[Continued

In follow-on studies of the Technology Foresight process CEST has found that there is great danger that the fragile new groupings are at risk of being lost.

Technology Foresight did not really involve the next generation of business people, engineers and scientists. This younger cohort is difficult to identify, but in CEST workshops we have found that they have quite different values, expectations and confidence to the more senior people who normally populate Foresight Panels, workshops and similar advisory groups.

The Delphi exercise was largely a waste of time, the results were available too late to help the Panels, the preparation of the questionnaire consumed too much valuable time, the questionnaires were far too long, the explanation to the respondents was inadequate and thus the findings revealed little or nothing new.

The Foresight project was UK-centric. Much more account should be taken in future of the trends and needs of the key UK export markets, both current and potential, in any future exercise. Whilst account of this was implicit in some panels, this "outward" perspective needs to become explicit.

4. SHOULD THE EXERCISE BE REPEATED?

Certainly, the exercise should become a regular (routine?) part of the UK. This might take the form of Government maintaining an overview of the process, but instead of attempting to manage the project directly, transfer the management to competent private sector groups. Organisations who undertake foresight work as part of their current activities would then perform Foresight for UK in their field of competence. In this way the process would be progressed by the interested parties with some expectations of continuity. The responsible Government Department would then be strengthening the competent organisations in place.

The full-scale consultation could be performed at about two to three year intervals. If it is thought desirable that a Delphi exercise be included then this should be performed either one year before or after the main exercise, i.e., *out of synchronism, or interlaced.*

5. HOW SHOULD TECHNOLOGY FORESIGHT BE IMPLEMENTED?

The exploitation of Technology Foresight will be in very specific projects, in companies, HEIs and Government Departments. These can be classified into Research Priorities, Infrastructure Priorities and New Programmes and Initiatives.

The first stage in this process is one of dissemination. This is a major programme in its own right. There will need to be some detailed studies of the likely audiences and the best ways of communicating with them. Certainly way beyond the Foresight Challenge, which stands a chance of being decided before some of the potential challengers have the opportunity to bid.

CEST now knows that even in companies who directly participated in the Foresight Panels awareness is very low. It is not uncommon to find less than 10 per cent of workshop participants to be aware of the Technology Foresight project. This amongst otherwise technically aware staff.

6. WHAT ACTIONS . . . ARE YOU TAKING . . . ?

CEST is undertaking with its Members a major programme to disseminate and exploit Foresight. The focus of this programme has been how to interpret and make best available the results of Technology Foresight to industry. CEST assumed that the Research Councils had, or could establish, the mechanisms to interpret the results for themselves. The use of Foresight outputs by companies is a great deal more problematical and needed attention.

CEST's view is that the results have to be assessed in the framework of the business strategy of the company. We therefore prepared a document intended to be given to busy executives to show how foresight could help them.¹ Over 1,000 copies of this report have been distributed by CEST (free of charge) to companies and organisations who we believe could use foresight profitably.

In addition we are currently giving workshops to take companies through a debate, stimulated by foresight, but also including their own business vision, so that they can come to a view as to what potential for innovation they have in their company.

¹ *Acting on Foresight*, CEST (1995).

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[Continued]

The results of this might be new R&D projects, new partnerships, new methods of production.

We will make this experience available to DTI, OST or any other organisation who wishes to run a more general dissemination programme.

7. WHAT EFFECT . . . , OST TO DTI TO HAVE . . . ?

We hope that once the integration of OST into DTI is complete this will lead to greater coherence and an effective communication to industry of the potential benefits of Foresight.

In summary, the Technology Foresight exercise was a step in the right direction. It has created new networks and understanding. As an exercise it is at risk if the results are not built upon and exploited in a planned and methodical way.

Examination of witnesses

DR ROBERT WHELAN, Chief Executive, Centre for the Exploitation of Science and Technology (CEST), and DR MICHAEL ELVES, Chairman of CEST's Committee on Technology Foresight, were examined.

Chairman

117. Dr Elves, Dr Whelan, good afternoon. It is good to see you. So sorry we kept you waiting a little time. As you can see, we are few in number but the penetrating views of the four of us are probably worth the totality! We are most grateful to you for giving us the time to let us hear your views. I wonder if I could start with a question to each of you for both of you to answer. What actually do you do and what is the origin of the organisations in which you are involved? Dr Whelan, you are Chief Executive of the Centre for the Exploitation of Science and Technology in CEST. We ought to know a little more about its main purposes and how it came about. Dr Elves is Chairman of CEST's Committee on Technology Foresight. It might be a good idea for you to tell us what you do in these various functions.

(Dr Whelan) CEST, the Centre for Exploitation of Science and Technology, was created in late 1987. It was the result of an initiative taken by ACARD, as it was then, and ACOST and a group of 18 companies to create a centre whose mission would be to look at where future business opportunities might exist for the United Kingdom and the companies within it, to look at the science and technology underpinning those, to look at opportunities afforded by new science and technology for industry and also to look at some of the barriers that might stop companies exploiting those opportunities.

118. This was pre-foresight Foresight?

(Dr Whelan) It was pre-foresight Foresight, yes.

Mr Batiste

119. It is a totally corporate endeavour, there is no government input?

(Dr Whelan) There is some government input but we have tried to keep the government input at around

about 20 or 30 per cent of our funds. In other words, we are very much dominated by industrial funds.

Sir Trevor Skeet

120. ACARD was in it as well. That was demoted and CEST came into being?

(Dr Whelan) Yes, ACARD ran a study which they called Exploitable Areas of Science. It was published by HMSO. It looked at a couple of areas, if my memory serves me correctly, bio-technology and information technology, and it identified some of the possibilities that might exist and it also made a recommendation that a group like CEST should be established.

Dr Bray

121. CEST also looks at implementation. It is not just identifying opportunities.

(Dr Whelan) That is quite correct.

122. In a sense the burden of your criticism of Foresight appears to reflect the different backgrounds of CEST.

(Dr Whelan) It reflects, I think, the observation that if you wish to get results, initiatives, whatever form it is—and we will talk about that in a while—from these types of exercise then it is very important that you think about that implementation process either before or as you are doing the Foresight exercise, largely because the Foresight exercise affords an excellent opportunity to form networks and collaborative groups, particularly people who have really quite different backgrounds and it is very important to use those in the exploitation of Foresight itself. That is the basis of my comment.

Mr Batiste

123. The point about CEST itself is that you produce reports where you think there are bottlenecks and problems of special concern.

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[Continued]

[Mr Batiste Cont]*(Dr Whelan)* Yes.

124. Would you actually provide stimulation in relation to a specific project. Say, for example, there was a gap in pharmaceuticals of some kind which you have identified. Would CEST itself initiate amongst its members an exploitation programme? Is it funded for that?

(Dr Whelan) Yes it would. It has done that and there is quite a bit of evidence of that. We have done quite a lot of work in the field of material science in 1989/90 which resulted in the creation of a National Centre for Surface Engineering, which was created last year. It resulted in the Link programme for surface engineering, which also came in last year. We were the instigators for the Centre of Adhesive Technology, again another collaboration between groups of companies, located in the Welding Institute. On our environmental work we formed groups of companies which looked at new water technologies, new process efficiencies and we were able to show with that group of companies that environmental concerns could, in fact, lead to better operating processes.

125. Money and numbers. What sort of budget and numbers do you have?

(Dr Whelan) We have at the present time 30 odd members. Our total turnover is around about £1.8 million, something of that order. Our full-time staff is around 20. We have quite large leverage on staff because I normally have to supply project management and I draw in groups of individuals from companies and from universities to actually man the project. I can find myself at any one time looking after literally groups of hundreds of individuals.

Dr Bray

126. I find it very difficult to remember who the present Secretary of State is but who was the Secretary of State in 1987.

(Dr Whelan) Pass.

Dr Bray: Who was the Secretary of State setting up the CEST initiative?

Chairman

127. Paul Channon in 1987. I was the Minister for industry at the time. Thank you for that. That has been a useful explanation. Dr Elves, we know a lot more about you and your organisation but you are Chairman currently of the CEST Committee on Technology Foresight. Was that a Committee brought out and put together for the Foresight exercise?

(Dr Elves) I have been associated with CEST as a Glaxo representative on the CEST council since 1988. The old Glaxo was one of the founder company members. At the beginning of this year CEST was re-organised and we reduced the council which was getting too unwieldy in number and turned it into an elected board from amongst the membership. I am now one of the members of the CEST board of directors and I am responsible to that board as Chairman of the CEST Research Committee. This was established at the beginning of this year as well. One of the first programmes that we undertook as the new CEST

Research Committee was indeed a look at Foresight and its implementation because we believed at that time, and still do believe, that this was a major initiative into which there was a lot of effort being put by many people throughout the United Kingdom science base, in industry, in academia and in Government. We felt that we needed to crystallise some of the findings that were coming out because we could see that there were defects in the process, and that there was a serious risk that a lot of the good things about Technology Foresight would slip down the cracks as it were. In other words, little in the way of cross-panel discussion seemed to be taking place. Also, and I think this has turned out to be the case, particularly companies when they look at the panel reports tend to go naturally to the panel that is 99 per cent relevant to their activities. What they will find there generally speaking is nothing very new, particularly if they are a major science based company. Where we feel that major benefits are likely to come is by taking a sideways look at panels that are not intimately associated with their own activities. The document that we put together in the first six months of our existence as a Committee, the "Acting on Foresight" document which I hope you have got copies and if you have not we can certainly supply them, is designed to take an all-embracing look at the panel reports and to draw out common themes and also to indicate where there are themes that are coming through in perhaps a rather small number of panels or just one panel that we believe have got wider implications.

Chairman: Thank you for that. I think any questions that are now going to come will be the ground on which we are looking to discuss these issues. Jeremy, would you like to start?

Dr Bray

128. Do you have different views about what the role of Government should be in science and technology? Dr Whelan, could you tell us what you think the role of Government should be?

(Dr Whelan) Would you like to start?*(Dr Elves)* Could I start with that one, Dr Bray?

129. By all means.

(Dr Elves) Quite clearly Government has a responsibility in science and technology, and we include engineers within that definition by the way. The roles Government has, which are crucial ones, are first of all putting in place the necessary structures to ensure that we have got the people base on which our science and engineering technology can be built. This means a high standard of education and development of science and technology skills in our young people. If we do not have this then in years to come we will have a failing science base and ultimately possibly a very, very weak one. The second area is the support of the infrastructure of the public sector science base. We see this as something that is declining and does need to be given some urgent attention. Our universities are falling behind in not having state of

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[Continued]

[Dr Bray Cont]

the art equipment and facilities in which young people can be trained in science and engineering technology.

Chairman

130. Forgive my interruption but the use of the word "infrastructure" suggests to me buildings and all that, do you mean that or the base?

(Dr Elves) I mean the total infrastructure, the buildings in which they have to work, the laboratory set-ups, the equipment, everything.

Dr Bray

131. The staffing?

(Dr Elves) The staffing too.

132. Just at the universities?

(Dr Elves) No, I think increasingly in further education colleges, for instance, and also the schools have to be seen to be important here too.

133. What about the vast network of institutions, particularly in the medical sector?

(Dr Elves) We would regard them as part of the public sector science base. I would couple them with the university science base.

134. So all the research council base, the NERCs?

(Dr Elves) Our public sector science base has got to be properly supported and properly equipped working in state of the art facilities if we are going to be a competitive science and technology nation with the rest of the world.

135. In what respect does the science base differ from what Glaxo are involved in?

(Dr Elves) Well, we are rather more free in what we can spend our money on. If we need a powerful NMR machine, for instance, we will go out and buy one because the business will justify it. We have that. We have equipment on our Stevenage site now, for instance, where our biggest NMR machine is only one of a few in the United Kingdom.

Mr Batiste

136. "We" as Glaxo in this context?

(Dr Elves) We as Glaxo, yes. Industry has their destiny in their own hands.

Dr Bray

137. Is the pattern that you have described as the role of the Government in science as one which is very well adapted to the pharmaceutical industry, the large companies in the pharmaceutical industry, particularly relevant to engineering sub-contractors?

(Dr Elves) It obviously has been in the past which is why the United Kingdom has a very successful pharmaceutical industry but we have to live in the future.

138. Are you saying that the structure which is justifiable in medical related institutes and research facilities should be extended, there should be similar

coverage across the wider fields of physics, chemistry, engineering?

(Dr Elves) I believe that is the case but that is not the same thing as saying that every academic centre should have everything they want.

139. No, of course not.

(Dr Elves) It needs to be justified.

140. The parallel of that is taking into account the existence of bodies like the laboratory of molecular biology at Cambridge against the GMC sequencing operation and the rest of it and to do comparable things in engineering we would have to re-invent all the DTI laboratories, the National Engineering Laboratory, Warren Springs, road research.

(Dr Elves) Yes. I think the maintenance of infrastructure is a major problem.

141. You are saying that all those are needed in the public sector?

(Dr Elves) We need to decide what we as a nation want out of science and technology and we have to then put our investment where we want it, but bearing in mind of course that the pot of money is not bottomless. We have to make choices.

142. This is quite distinct from the private sector industry application of science and technology, the infrastructure support that is there needed in appropriate areas of science and technology and that is complementary to whatever the public sector does.

(Dr Elves) It is often a little ahead of what the public sector does but of course we often welcome our academic colleagues into our laboratories and they have access to a lot of our machines. There is a third element I think that Government has to take responsibility for if we are going to be successful in science and technology and that is the regulatory area. I think we must be very careful that regulations are based on good science and technology and that they are not created in a way that actually impedes progress.

Chairman

143. The regulatory area also must be looking to verify products in the pharmaceutical industry?

(Dr Elves) Yes, but what we are thinking of in particular as a very good example of this regulatory problem is in biotechnology where I think the House of Lords Select Committee very rightly pointed out that that had gone a step too far and had actually impeded our ability as a nation to really exploit biotechnology fully.

144. Dr Whelan, do you have anything to add to that very substantial expression of view?

(Dr Whelan) Only to say that given that there is this complex relationship which is part viewing Government if you like as customer and part as the supplier then Technology Foresight clearly is an exercise that may help that process. There was, and there is, a dialogue process running and it does seem that these sorts of Foresight exercises ought to be able to contribute to both sides understanding their particular requirements. After all, if you just take the environment area, the quality of life issues that are

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[Continued]

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associated with that, and the wealth creation potential that exists if you like within almost the same set of regulations, there is a very fine balance. Clearly the regulatory authorities require to have scientific and engineering understanding that underpins both those perspectives.

Dr Bray

145. Could we make one possible conclusion from what Dr Elves is saying to get an idea of timescales against pay-off. If you look at the provision of infrastructure and research in the public sector and the reaping of the benefits of that by the private sector, would you say that it is broadly true that the medical pharmaceutical type of infrastructure in universities was broadly built up after 1950?

(Dr Elves) It is before my time but I would think there is probably a lot of truth in that.

146. That was the date of origin for the development of molecular biology?

(Dr Elves) That is true because molecular biology and cell biology, for instance, which preceded it, really had its origins in the 1960s. That is when it burgeoned. Molecular biology come on as a second wave beyond that.

147. There was a 30-year time lag between the provision of molecular infrastructure and the reaping of benefits?

(Dr Elves) Yes but let us be careful about drawing too many conclusions from historical patterns because events are gathering pace. Molecular biology has led on to molecular genetics and the whole pace of biological science has really been escalating. We really cannot see what is going to happen next but what we must be able to do is make sure we know what is happening now and ways in which it can be exploited.

Sir Trevor Skeet

148. Dr Elves, you derive from the largest in the world pharmaceutical company and you have got your own Technology Foresight programme.

(Dr Elves) For most major science-based companies it is engrained in the culture.

149. It pervades the culture of most of these companies. BT and Nuclear Electric have one as well. What benefit do you derive from it?

(Dr Elves) From being aware what the technology drive is out in the world at large we derive enormous benefits because that is where our research programmes have their origin and fortunately a number of them come to successes in new drugs.

(Dr Whelan) I think another point is that accepting these larger companies have these sort of exercises, the fact that the UK runs a national exercise, provides a convenient way of gaining not only a different perspective, because after all the internal Foresight exercises are essentially internal, secondly, I think it provides them with an opportunity of almost benchmarking their thinking against external factors. You accept that the Technology Foresight exercise has some consensus component within it. That is fine but

the fact it has taken a very wide view is useful to companies because they can use it to say, relatively speaking, had we thought of this? Are we less or more advanced in our thinking than these companies?

150. I have been attending a conference of the BBSRC and they tell me the panels are not talking to one another. In fact, some of the panels have virtually lapsed. That does not sound as if the money employed in this great project has been successful in Foresight. What would you say the value added is for the government's great efforts in this direction?

(Dr Whelan) This is an area where I would share some of your concerns because I believe that the exercise raises quite high levels of expectation. It constructs groups of people who have become quite enthusiastic. There is no question about that. The question is how do you put in place an implementation process that builds on that enthusiasm. To be sure some of these opportunities will gain momentum and build up on their own but I think from CEST experience we would say that these relationships are often between people who have not worked with each other and therefore they are somewhat fragile in the early days and it is necessary to manage that process. I think that the feeling at CEST amongst the CEST members is that we could have understood the audiences, if you like, for Foresight in more detail earlier. I did not really have any doubts in my mind that the Foresight exercise would be successful to some extent and that there would be things that we could construct initiatives upon, and I am sure that is the case and I think that has been the view of the Research Committee in CEST too. There would be no point in undertaking this piece of work to winnow out some of the areas of promise otherwise but I do think that there are activities that should have been placed in hand earlier in order to bring the possibilities of success, even if it is just within groups of private companies, to a higher degree of possibility.

151. Can I just ask you a final question. I have had a look at all the papers you have produced. Some of them are very impressive. You create initiatives primarily on the environment, waste minimisation and transport and communications. Only a limited number of papers here are on innovation for a very expensive price of £50 and down.

(Dr Whelan) That is a bargain.

152. Do you take this as being able to make a comeback to any effect or change?

(Dr Whelan) There was a lot of debate in the early days of the CEST council about how you would measure whether these activities were having any effect because, as you rightly point out, producing lists of reports really does not tell you that.

153. Exactly.

(Dr Whelan) So we decided that we would not measure ourselves on reports. We regarded reports as one the techniques we would probably have to use in order to start initiatives because after all people need something to talk about. What we now measure ourselves on are initiatives started, working groups started, companies undertaking something new, a

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[Continued]

[Sir Trevor Skeet *Cont*]

collaborative programme established, things of that type. And I think we can claim in practically all of the areas we have operated that we have been able to create something of that type. The interesting thing, of course, is there is a time delay. In other words there is a period between, for example, completing the Foresight like activity which generates the report, if you will, and actually seeing an initiative started. However, you should not interpret it that nothing is happening during that period. It is that gap period, as we have had said in our literature, that is really so important. There is no doubt that you have to manage the collaborative groups, be they workshops, be they people thinking they might start a new programme in that particular area, you have to manage that gap period. If you do not manage that gap period, people lose interest and when you lose interest it is very difficult to resuscitate it.

154. Can I ask a final question on that. You have got a paper "Bridging the Innovation Gap". It is a cheaper paper. In fact, how many of those did you print and distribute in order to have that influence?

(Dr Whelan) To give you an idea of the types of circulation we achieve on some of these documents. We have sold over 2,000 of the environmental document which talks about industry opportunity. We have given away a thousand of the documents I have just distributed to you "Acting on Foresight". The Innovation Gap ones I am not sure of the exact figure but normally you are talking about between 500 and 1,000 of those. I have to say although we put a price on them most of them are actually made available free.

Chairman

155. Could I just ask if Dr Elves wants to add anything. I think that is a comprehensive answer from the CEST point of view. Possibly in relation to your own experience, do you think the results of Foresight were in line with your own expectations?

(Dr Elves) Within a large company Foresight has not told us anything we did not know already within our mainstreams and one of the objectives of the CEST action on Foresight was to actually get the Foresight messages into parts of industry that have no tradition in science and technology, or indeed of Foresight itself, because they are the ones at the end of the day who have got the greatest potential gain from the programme, and yet ironically they are probably the most difficult organisations to get anything, particularly a panel report, past the chief executives. We are talking here about small and medium-sized enterprises that are our industrial future.

Mr Batiste

156. Would it be fair to say that those who have participated in the Foresight exercise have not learned anything they did not know already and those who should learn from it did not participate in the exercise?

(Dr Elves) That is not what I said. I think the breadth of people, experience, background and everything else brought together in these networks was one of the greatest things about the whole programme.

I saw in some of the workshops I attended, for instance, people I would never ever meet normally. That brought a lot of people together and it started to raise expectations. I must say again that a lot of purely commercial people took part in these workshops. For those of us on the science and technology side it was educational to learn about their side of the fence and it was probably quite important for them the other way around.

Chairman

157. So if we had to make an assessment and if we drew a line under the existing scheme you would be saying that it certainly started a whole lot of people thinking or getting involved in areas which they would not normally have gone for. Whether it had a national impact here is too early to say but it has got to be worked through, is that right?

(Dr Elves) It is definitely too early to say at this stage. It must be worked through, that is important, we cannot just let it lose momentum.

Mr Batiste

158. Can I just follow that for a moment and get into this question of the innovation gap. Our impression from our genetics inquiry in relation to your industry in the United States was in fact that most of the far seeing research, the sharp end stuff, is taking place in small companies rather than in the big pharmaceutical companies and the big companies are buying these companies up when they have proven the technologies and the ideas that they have got. This tends to suggest that it is actually the small business sector and the venture capitalists who are the drivers of real foresight in your industry.

(Dr Elves) In the United States where biotechnology is exceptionally well developed it has certainly grown up from the small and medium sized enterprises, to use our United Kingdom language base. The bulk of that however came out of American universities and was set up to exploit the discoveries made in those university departments. They were fortunate, they did not have the innovation gap that we identified in CEST some years back because the American venture capital business saw fit to fund that gap and they could take the thing further towards the exploitability or utilisation phase. At the moment we have not got such a facility.

159. So when CEST talks, as it does very strikingly, of the innovation gap in its memorandum to us, it seems to me there are several different gaps that you are talking about. There is a finance gap, a venture capital gap, which makes it much easier to bring ideas out of universities because in America the venture capitalists are very proactive in approaching the academics whereas here it would have to be guys like yourselves who would be trying to stimulate and trying to get the capital. That is one of the gaps. The other gap that you referred to is where you were saying that the originator of the process has no provision for a follow-through process and the motivation drives away and the whole exercise becomes an expensive waste

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[Continued]

[Mr Batiste Cont]

of time and the people who carry forward ideas from Foresight are different from the more visionary ones who participate in Foresight. That seems to suggest a corporate innovation here within the companies themselves in that there are not good lines of follow-through from research into development. Is that a fair analysis?

(Dr Whelan) I think that is actually quite a fair assessment. We came across this issue when we ran workshops which were concerned with future thinking. You get one particular type of people whose mind set has adapted to that and then you realise that in order to take those initiatives further, to create a project, in a sense you actually find yourself talking with quite a different group of people who have, I was going to say, a more business-like perception of the method by which the opportunities that are identified would be exploited. In a sense part of that is finance, part of that is the way in which the companies are actually organised and part of it is in the way in which responsibilities are driven etc., etc. We were basically trying to just make the point that you should not assume that just because a company has participated in creating a particular idea for an opportunity—these are at the idea stage—that that company would automatically, if you like, pass that through itself and say: "Okay, here is something that we should exploit".

160. So that in effect the absence of an aggressive and proactive venture capital market in Britain, and even more so in the rest of Europe, on the sort of scale and with the sorts of objectives in the United States forces more large scale organisations to reach backwards but by their structures they are less effective in driving the new technology quickly?

(Dr Whelan) Can I explain it like this with two points. The first point is you might argue that what I am actually talking about is an internal pool inside the company that pulls things that are more visionary into practical operational reality. The other way of perhaps looking at it is if you have gone through a period, such as the United Kingdom industry has gone through over the last ten or 15 years, where there has been much more clarity, a reduction in quite a lot of activities, particularly in some corporate activities where things have become very divisional product focused, then perhaps a visionary group or person comes up with an idea for a new area of business, where is its home, which division does it fit into? You find that people say that in days past we would have had a corporate group that would construct what the business case is, find out how we put it together and put it into the appropriate division but those sorts of activities seem to have been almost slimmed down and removed. Companies have become "anorexic" if only we can lose a bit more weight we will feel better, "Corporate bulimia!"

161. So in effect there is a big difference in what you are saying between different industrial sectors, say pharmaceuticals and chemicals which have been equally successful at having this strong pull, but there is a sense of aimlessness within, for example, the engineering sector to get similar ideas pulled through the larger companies?

(Dr Whelan) It may not be aimlessness, that may be being a little unkind, but if you like they may be so product focused in particular divisions that they do not actually have any facility for, shall we say, taking a much broader view. The interesting thing about Foresight in that context is that we have actually used it in companies in that sort of situation in order to promote a discussion with a broader remit.

162. So to avoid Foresight becoming what you say it could be, which is an expensive waste of time, what implementation would you like to see now?

(Dr Whelan) My view is that the issue with Foresight is much more clarity about the audiences, if you like the companies, the way those companies are particularly going to operate which potentially ought to be able to exploit this. It is quite one thing I think to broadcast the results of Forecast, which is the traditional way of looking at, but I think for Foresight to be effective we have got to understand, if you like, the target companies in much more detail. The evidence that we have got is that if you do individual advocacy, which we do, it is actually perceived as being really quite useful material. Therefore, the process has to be one that is very much inside companies rather one that is——

163. You in CEST, bearing in mind the description you gave, would you see as part of your role trawling through the Foresight exercise identifying companies that should be picking up the ideas within it and helping drive those companies?

(Dr Whelan) Our booklet *Acting on Foresight* is written in a very unusual way. It is aimed at answering the questions of a relatively non-scientifically sophisticated chief executive to get in through the door. I will ask Bob in a minute to tell us what we do next because what we do next is absolutely crucial.

Chairman

164. This is the next question that I want to pose to you. Should the findings of the exercise be subject to review, do we leave it up to the working panels and so on to implement it as far as they can in each of their own sectors? How do we cast into the future with this scheme? Do we renew it every five years or what?

(Dr Elves) At the moment I think it has got to be an ongoing process because I do not think we have really finished this one yet. We have got to do a lot more cross-panel speaking. One of the things that CEST is doing is arranging a series of dinner meetings where we are gathering together several panel chairmen under one roof and trying to get them to talk together.

165. There is a proselytising job to do.

(Dr Elves) Yes.

166. Based on those with a large experience of the working panels?

(Dr Elves) Yes.

167. And you foresee that lasting quite sometime?

(Dr Elves) That is right. We have then got to also take the Foresight messages into companies. Academia is not generally a problem because they see Foresight

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[Continued]

[Chairman Cont]

as an opportunity. The biggest challenge that lies ahead of Foresight is getting into companies where companies can then start to make use of the science and technology opportunities that are already there and can be created in the future. This is what our workshop system is all about.

168. Could I ask what role do you think government should play in the next phase, in the dissemination of the information?

(Dr Whelan) A number of mechanisms exist which operate at the level of the individual company, business links, if you like, the research associations, various industry associations and groups of that general type. It seems to me that government could do much to make sure that these groups have the resource and the responsibility that goes with that resource to deliver it and to work rather closely with their individual member companies.

169. The member companies being those who have participated?

(Dr Whelan) No those who participate in those particular industry associations and groups. Some of these groups are industry specific but quite a lot of them are regionally specific like the various clubs that exist in various areas of the country. It seems to me that there should be a responsibility placed upon them to work with the companies who are leading within their particular organisations. It is a bit like when you try to sell a consumer product, one the techniques used is to identify who are likely to be the first purchasers and to very much target your efforts on those. In a sense what one has got to do is to follow the same approach which is to regard it as something that has got to be solved and therefore you have got to identify the companies which people believe are the leaders, the people to look up to and make sure they are adopting and using Technology Foresight with their suppliers and customers but essentially acting as a bit of a beacon.

170. Dr Whelan, would you not be in some danger of inviting market leaders to help their potential competitors along?

(Dr Whelan) I think in terms of Foresight material there has already been plenty of evidence that groups of companies we would naturally think are very fearsome competitors have cooperated in Foresight. I would give you an example of retail companies that have cooperated on discussions about fraud and counterfeiting. There is a ubiquitous problem which they have all got to do something about. They can only do it as a group but there is no doubt as an issue it will bring forth the exploitation of a number of areas of technology. It is a question of identifying those cross-company issues that people feel they can collaborate on that would pull them into new technology.

Sir Trevor Skeet

171. Surely this is happening in the Ministry of Defence now? Would you say it is happening in the Board of Trade and the OST.

(Dr Whelan) In the sense they are—

172. You are talking about the role of government where the government should do more. In the Ministry of Defence they do. They pick up sensitive areas and develop them but is this happening in the Board of Trade and with OST?

(Dr Whelan) I think that this is a responsibility not only for the DTI and OST but actually for all government departments which are, after all, major purchasers. It seems to me that DTI, though, has an extremely important role in working with the various associations that represent various parts of the industry to get these Technology Foresight messages into those companies so it is very much a DTI effort and other government department responsibility.

173. What sort of private sector groups do you think should take over the future running of Technology Foresight exercises? Have you got any estimate of the cost involved?

(Dr Whelan) I could not make an estimate of cost but my view is that Technology Foresight is about continuity and there is no doubt that there is a natural requirement to maintain that continuity and I think the government has some role in that but, on the other hand, it seems to me that if government could encourage all sorts of groups like ourselves, if you like, to take responsibility for various areas of Foresight then we would have almost a natural driver to make sure that was carried through in the longer term which would be quite independent, shall we say, of changes of view that might come through the government system.

(Dr Elves) A good example, for instance, of the private sector doing something out of Foresight is the work that the Chemical Industries Association is doing in connection with the development of a Catalysis Institute in the United Kingdom. The Association of the British Pharmaceutical Industry is also looking at reports to determine where it could serve as a mediator in bringing about change in the industry as well along Foresight lines, possibly working with Research Councils.

174. Do you think the Steering Councils could be helpful on this? Do you think the Panel Chairmen might bring that about?

(Dr Elves) Both of those bodies ought to be taking an active role in getting the Foresight message and Foresight action brought into reality.

175. Are they taking the sector role you have in mind?

(Dr Elves) At the moment we cannot see a lot of it but, as I said earlier on, it is early days.

Chairman

176. Is this year's Forward Look an improvement in your view on last year's.

(Dr Elves) I think it is an incremental improvement, yes. It is very much more meatier than last year's and has got some deliverable stuff to be identified.

177. There is a chance more action may flow?

(Dr Elves) Hopefully.

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DR ROBERT WHELAN and DR MICHAEL ELVES

[Continued]

[Chairman Cont]

178. What evidence do you see that the results of Technology Foresight have been used in the Forward Look proposal?

(Dr Whelan) I think it is too early to be realistic.

(Dr Elves) As the Forward Look indeed states.

179. They have admitted that. In the future one would expect to see a greater correlation.

(Dr Elves) I think we have now got the shop store counter laid out. We can now measure progress against what happens on it.

Dr Bray

180. The sorts of output measures which are discussed generally on science policy areas are things like patents and incomes from IPR and so on. Is there some scope for lateral thinking on this comparable to that found in the United States where they talk about "wagon movements" or in Hong Kong "traffic jams" as a measure of current economic activity?

(Dr Whelan) I suppose if one had some initiatives in transport you ought to be able to say something about traffic jams and air quality and things of that type.

181. The longer the traffic jams, the faster the growth.

(Dr Whelan) Something like that.

182. For example, on the research priorities, the one which rates support from the largest number of different sector working parties is modelling simulation and the obvious thought is are sales of software packages a good measure?

(Dr Whelan) They could be but you probably want to look at some more specific examples than that.

183. I was intrigued going round Zenica's lab enquiring what are the routes by which they get their dynamic molecular modelling software. It was leading edge stuff and it was university departments' enhancement of standard packages, yet you hardly ever see this put forward in research proposals or research reports as a major channel of output.

(Dr Whelan) You mean in terms of how many of these packages are actually used?

184. Outputs of research that are measurable in a clear way.

(Dr Whelan) Yes but I mean the issue with measuring the outputs of research is that the outputs of research, certainly more strategic research, of the type your Foresight talks about, are likely to emerge in all sorts of different areas and the difficulty is in identifying a suitably generic measure for the up take of modelling. I can cite specific cases where the adoption of modelling techniques in making casting moulds has revolutionised some of the foundry companies but I am not sure that you could use that as a measure.

Chairman

185. Dr Elves, have you got any views on output measures?

(Dr Elves) Not any more than Bob has already mentioned. I think the software modelling in the

chemistry area is a very difficult measure because a lot of these measures are soft. For companies like Glaxo and Zeneca the outcome measure at the end of the day, to measure the success of that software, is whether a drug comes out of it. Meanwhile I think there is a lot of immeasurable benefits that flow from it. For instance, a lot of the work that is done on software modelling developing in the chemistry area is very much collaborative work between the industrial scientist and his academic colleague. We have major collaborations with universities in this area and sometimes too small companies spin out to actually market outputs from that research. That could be another measure too. It is rather difficult to put a finger on.

Dr Bray

186. Would it be a case of saying that what is really important in output measures is not to look for some blanket measure that can be applied across the whole of research and development but rather to encourage researchers, or sponsoring organisations or something, in specifically their particular field as to what the appropriate measures are and to ask for them?

(Dr Elves) I think that is the only way to do it. I think we do tend to put things like industry and other activities into one big black box and it does not work like that.

Mr Batiste

187. The oracle of Delphi was noted for the impenetrability of its announcements and I rather gathered from your comments in the memorandum that the Delphi questionnaire maintained these good historic traditions! Was this exercise flawed inherently in the way in which it was implemented or was it actually a waste of time as part of the Foresight exercise? In other words, when the next Foresight exercise comes up can Delphi be a useful part of it if structured in a different way or should we proceed without it?

(Dr Whelan) I think the first point is that Delphi as a technique has certainly been used quite effectively. There are some rules for using Delphi, some rules of thumb I think you might say. It does sample anonymously. The number of questions, for example, should not really be more than about 50 if you are going to expect to get a reasonable response. You probably have to do a number of them spaced over years in order to get some sort of pattern track in them. My comments are not directed towards Delphi as a technique, I think it is fine used in its place. The main comment here is the way in which it overlapped the workshop process and the way in which some chairmen said that it dominated the time that they spent in the workshop processes. The workshop processes on the other hand were very highly valued indeed by most panels, no question of that, which I think supports the idea that one of the outputs is in fact in new interactions. CEST's view is that one approach would be to use the workshop and the Delphi in a sort of interleaved fashion so perhaps in two years time you do a Delphi and a couple of years after that you

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[Continued]

[Mr Batiste Cont]

would actually do another workshop process. You would not attempt to overlap them and do them at the same time. They are sampling different things. They are trying to deliver a different type of output. The thing to do is to separate them out in time and then you would not run into this problem of the one crowding out the other. It is an operational issue more than anything.

(Dr Elves) I suspect, from the position of one who filled the Delphi questionnaires in and knows a number of people who did so as well, it is going to take some time before the folk memory of this particular process

has been eradicated. It will not be treated very sympathetically, I do not think, because a lot of the questions, certainly in the ones I answered, were irrelevant to the issues that were important to us. They went to commercial colleagues as well and their comment was: "I did not even begin to understand some of the questions".

Chairman: I think we had better leave Delphi in its little black box. Thank you very much for your time in answering our questions and for the way in which you have thrown light on your impressions about Technology Foresight, we are most grateful.

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[Continued

**Memorandum from Professor Peter Day, Director, The Royal Institution of Great Britain
(TFC 10) (15 August 1995)**

1. This memorandum is in response to your invitation of 19 July to submit views about the process and implementation of Technology Foresight to assist the Science and Technology Committee in their inquiry.

2. If we could predict the future we would all be rich because, knowledge being power, we would have a unique competitive advantage. But the one thing we can be quite sure about is that the future will be different from anything we have thought of. That sad fact, which is well authenticated by past experience, might lead to the conclusion that any forward planning is by its nature nugatory, and that the best one could do is to identify important novelty as soon as it bursts upon us, and react to it decisively. Such a counsel of despair is clearly not a valid approach to needs and opportunities in other areas of government planning, so what is special about scientific research?

3. The unpredictability of research outcomes has been the bane of research management since time immemorial. That this should be so is an inevitable consequence of the research process. If one knew the answers (or even the kind of answers) to the questions being asked of nature, the activity of defining answers would not be research. Yet it is an inescapable fact that the new knowledge created by scientific enquiry, when translated into technology, has been the greatest single influence on human progress over the last 500 years. As Patrick Blackett, a President of the Royal Society, and one of the wisest protagonists of science policy working in Britain since World War II wrote in his Nehru Lecture of 1971:

"Though everyone accepts that the vast wealth of the developed countries today is somehow due to science, it is by no means fully agreed as to how in detail it happened".

4. If it be true that even wide consultation among knowledgeable practitioners is no guard against the unexpected, then what should be the function of an activity like Technology Foresight? In my opinion it can only be useful on the shortest of time-scales and towards the most limited objectives. That is certainly not the same as saying it is of no use, but it does offer the strongest caution against making it a determining influence across a wide swath of science funding decisions. It also cautions against acting on specific conclusions from the exercise in such a way as to inhibit flexible thinking in the future: the twin pitfalls of attempting to pick winners, and then put too many eggs in one basket, loom dangerously. Finally, whatever the conclusions that have been reached, they cannot be left in place for too long without being reconsidered and updated.

5. The above considerations are quite general. Now follow some specific comments on the conduct of the Foresight exercise which affect the validity of its conclusions. Commendable efforts were made to seek input from a large cross-section of industry and academe by what has become known as the Delphi method. Yet such consultation is only as revealing as the questions permit, and as recipient of two questionnaires originating from different Foresight Panels I have to say that the questions were poorly framed and targeted. As a practitioner in basic science I am more than willing to consider technological implications and outcomes of the work I do. Nevertheless the vast majority of the questions posed would have been addressed more sensibly to a marketing professional. Failure to comprehend the range and limitations of the expertise residing in the group being addressed must surely curtail very severely any validity in the answers received. Perhaps that is one reason for the disappointingly low rate of return of the questionnaires, given how important the enquiry was. Hearsay suggests that several Panels were well aware of the deficiencies in the questionnaires, and based the substance of their reports on their experience and deliberations of their own members. While, in a certain sense, that may lead greater authority to the views emerging, it means they are based on a much narrower range of opinion that might appear at first sight. This factor should be borne in mind when deciding how firmly to implement on the Panels' recommendations. In particular, recommendations to establish large directed programmes, especially if they are embodied in fixed facilities, should be treated with caution. Science and technologies which, by their nature, are heterogeneous and diverse, are unlikely to be advanced most effectively by setting up highly organised centralised establishments or programmes. Finally, because experience shows that most seminal developments in science take place between the boundaries of established disciplines, it is unfortunate that little emphasis appears to have been given to interdisciplinary considerations when drawing up the Panels' membership.

6. My conclusions about the conduct and implications of the Technology Foresight Initiative are as follows:

Its recommendations are only warranted as short-term extrapolations from what is known; they cannot take account of the unexpected, though it is the latter which will be most influential in moulding the future.

Its recommendations must be treated with caution, especially when advocating substantial and specific directed programmes.

If basic science and technology are to be brought into closer contact with the wealth creation process, it cannot be on a prescriptive basis, or on the basis that fields of science should be supported in proportion to their contribution to current market needs, however those may be perceived. The most effective way of improving

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the appreciation of technological drives on the part of basic scientists, and of the opportunities arising from current science on the part of the technologists, is to concentrate on contacts between practitioners. Encouraging regular contact between individuals would be cost-effective and beneficial to both communities.

Examination of witness

PROFESSOR PETER DAY, Director of the Royal Institution of Great Britain, was examined.

Chairman

188. Professor Peter Day, thank you for coming. You have already got the feel of the meeting by witnessing the last session.

(Professor Peter Day) Indeed.

189. We are most grateful to you. You are Director and Fullerian Professor of Chemistry at the Royal Institution. I think we had better start by asking you just what is a Fullerian Professor of Chemistry and what is it that the Institution currently does? We know what it was founded to do but perhaps you could tell us a little more about it.

(Professor Peter Day) Perhaps I should go back a little bit and say by trade, if you like, I am a solid state inorganic chemist who worked for many years in the University of Oxford where I held a personal chair in that rather arcane subject and then I spent a few years directing a European research laboratory in Grenoble in France and then I came back to the Royal Institution up the road in Albemarle Street. I will not attempt to describe the Royal Institution to you in two or three sentences, that will be out of place, but briefly, it combines a research laboratory with activities involving communication of science to the public at large and in particular to young people. It is a combination of functions which, as far as I know, does not exist anywhere else in the world.

190. I seem to remember those marvellous lectures by distinguished professors. I attended one myself on, I think, the year of the quiet sun. It is still going and still has a substantial output of academic work. It still involves children, does it?

(Professor Peter Day) The output of academic work, which I think is closer to the topic we are talking about this afternoon, is very substantial indeed. One could probably say that in terms of its size the laboratory housed in our building, which goes under the name of the Davy Faraday Research Laboratory, is probably the most productive academic research lab in Britain in the subject that we deal with, which is in fact solid state chemistry. I say this not only for myself, of course, but for all my other colleagues who work there. As far as the research activities are concerned we work rather like a very small university department. I think my approach to Foresight is primarily that of an academic, who is interested in technology transfer and who works in subjects which undoubtedly have that capability, but who comes at it from the basic science perspective.

191. Right. Could I start by asking a very general question as to your opinion as to which areas of

science and technology should the Government really be involved in and which areas should be left to the private sector, and indeed how important is the interface between the two?

(Professor Peter Day) That, of course, is a very large and difficult question and many people have agonized about it for many years. I had the advantage of hearing what the previous witnesses before the Committee said, and they used the important word infrastructure. I would add to that an adjective, and say that, first of all, it is the responsibility of Government keep in place (and enhance as time goes by) what I would call the intellectual infrastructure of the nation in science and technology because that is the basis from which everything else follows. Custodians of such intellectual infrastructure may be organisations, but also individuals, such as academics, research scientists and even graduate students or students who are entering, on their study.

Dr Bray

192. Can you give us examples of what you mean by intellectual infrastructure?

(Professor Peter Day) I mean those people who are custodians of knowledge at the absolute cutting edge of the discipline in which they work.

193. Those are people, what is the actual intellectual discipline?

(Professor Peter Day) The intellectual disciplines are those of chemistry, physics, biology, mathematics, engineering, etc., the traditional subjects.

194. You are not making the point that particular ideas in science, say like the Darwinian ideas of evolution, can be adapted as a model, an intellectual model, and applied to all sorts of ideas?

(Professor Peter Day) No, that was not the point I was really making. I was saying that any nation must have a pool of people who are equipped with knowledge and appreciation of a particular discipline, as it were chemistry or whatever, or within that say solid state chemistry, which is at least at (and if possible slightly in advance of) the prevailing world level. The nation inevitably benefits from hosting people who carry that knowledge with them. Now the word "infrastructure" carries all kinds of other implications (for buildings, equipment and so on) but

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[Continued]

[Dr Bray Cont]

in my view all of that leads towards this other rather less tangible good.

Chairman

195. You are talking there about a public resource?

(Professor Peter Day) Yes.

196. And a commitment to public funding and to maintaining such a resource?

(Professor Peter Day) Yes.

Dr Bray

197. Your memorandum is highly sceptical about the feasibility of Foresight at all. Is it quite as vacuous as that because although a new idea may burst upon the world of science like, say, high temperature superconductors the time-scale through to application is very much longer than the increase in the number of chemists and physicists attending conferences in that particular area.

(Professor Peter Day) I am interested you should use that example. It is one that is often quoted. That particular discovery was made in 1986. The first commercially available products using the fruits of what was a purely scientific discovery at the time, are now in the market place and have been for perhaps the last 18 months. That is, something like seven or eight years from a discovery which was utterly novel when it appeared, and a total surprise.

Dr Bray: That is only the very beginning to products which—

Chairman: Your point is that it is a pretty quick time-scale for developing an entirely new engineering system.

Dr Bray

198. That is only the very beginning of the application of superconductors. The application is going to run much wider than that and the time-scale of development to maturity of the derived technologies is much more likely to be 20 years.

(Professor Peter Day) To maturity, definitely, but I used the word "products", not just demonstrators. GEC Marconi make a microwave filter which you cannot buy in your corner shop but it is available. It is an object some six inches long which replaces a similar one previously made from copper.

199. While this may be an unpredictable almost random process as seen by the research scientist because the development application time-scale is so much longer for the industrialist or the enterprise, the economy generally, there is a problem in Foresight in which of the many things that come up at times which are going to be fruitful in particular areas. So are you being perhaps wholly correct from the point of view of the research scientist in being too sceptical about Foresight in the eyes of the industrialists?

(Professor Peter Day) I was really pointing out a difficulty which is inherent in the nature of scientific research. I agree with you that I am adopting the point of view of the research scientist, but that is where the

creative process first begins. If one looked back, for example, and asked oneself supposing a Foresight exercise had been done even ten years ago, still less 20 years ago, what kind of topics might have been identified? When one looks around at us now actually in the commercial sector, not simply on a research basis, one can see a number of most important developments that almost certainly would not have been in a Foresight Panel's deliberation. You were speaking with a bio-technologist a few minutes ago. Genetic engineering, with its bio-medical implications, is one point where even ten years ago one would not have imagined events would have gone at the astonishing pace which we have seen. The companies concerned reacted to these new developments very effectively and in something close to what computer people call "real time". I give you another example with information technology. I do not think that ten years ago anything like the WorldWide Web and its implications would have figured in a Foresight. That (I should say by way of parenthesis) was actually invented by the particle physics community based at CERN in order to communicate better with one another across the world. Those are two examples. I suspect if we look back in ten years at the result of this exercise we will find similar discrepancies.

Sir Trevor Skeet

200. Do you think that basic science will be damaged by the Technology Foresight programme?

(Professor Peter Day) I think it could be and this is one of my worries. It could be if the funding mechanisms which we have in place to support the basic research programmes in this country (mostly in universities) are skewed in some way towards the outcomes of this exercise. That worry arises from a view about the unpredictability of the outcomes of studying basic science. If one looks across the country, certainly in the sciences with which I am familiar, the small sciences, of chemistry and materials, one sees a kind of bubbling cauldron of activity. There are many many different things going on. The problem we have is in connecting all of that most effectively to the industrial base. That seems to me a very real problem and something that we must address strongly, but the Foresight approach rather smacks to me of picking winners and I am very sceptical about picking winners for some of the reasons I just gave you.

201. Government will never pick winners. It is industry which will pick winners, if at all. You are concerned about the funding of it. Would you make some recommendations about what should be done? Should there be a fiscal inducement or do we follow the Board of Trade suggestions about Link programmes?

(Professor Peter Day) Perhaps I am being overly negative. I do believe there is one very very positive outcome of this Foresight exercise which must be carried forward and, as previous witnesses said, there will be enormous disappointment if it is not. That is the result of the actual process of conducting the Foresight exercise, the way in which it has brought together very large numbers of people who previously

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[Continued]

[Sir Trevor Skeet Cont]

were very little in contact with one another and which has enabled them to appreciate one another's point of view and one another's problems. I believe that is what should be the core of carrying forward the results of this Foresight business—not exactly setting up programmes in particular areas but encouraging inter-action and contact and networking (as indeed the previous witnesses said and I agree with them enormously) below the Chief Executive level. Not Research Directors talking to university professors and heads of departments, as it were, but somewhere much closer to where the new science is actually being created.

202. You are saying that the value of this enormous exercise which has been kept up to this year and is going on in perpetuity is going to be in dialogue and dialogue only with those people who matter?

(Professor Peter Day) Yes. I think there could well be other outcomes. I am sorry you should say dialogue only.

203. That is what you said.

(Professor Peter Day) It is the "only" that suggests somehow that is an outcome that one can put on one side as being of less value than perhaps the concrete establishment of a research endeavour. I do believe that that dialogue is the absolutely fundamental component for any more effective transfer of our academic research base into the industrial world.

Dr Bray

204. You said it is impossible to pick winners but are there not stages where it is the only way of doing things? The individual research student choosing which scientist to go and work for his doctorate or the post-doc choosing what team to join? In fact, what people mean when they say you cannot pick winners is that other people cannot pick winners but only they can and it is the graduate student or it is the professor, it is not the industrialist, and the industrialist means it is him and not Government.

(Professor Peter Day) Personally I have embarked on many unsuccessful research projects.

205. You have also chosen some winners or you would not be where you are today.

(Professor Peter Day) Some succeeded but you do not hear about the ones that did not.

206. No, but you do hear about the ones that do so it is possible to pick winners.

(Professor Peter Day) One can pick winners some of the time, it is a sort of statistical process. The traditional difficulty with science funding is always the difficulty of connecting output with input I am afraid.

Chairman: We are debating on the National Lottery today so we must not spend too long on that!

Mr Batiste

207. One of the key recommendations of the Chemicals Panel was the creation of the independent new National Institute for Applied Catalysis and you do not agree with that. Can you explain a little why?

(Professor Peter Day) It depends what one means by "Institute" because the word can mean many things. I think that my disapproval was encompassed in what I said in rather more general terms a few minutes ago about the establishment of large managed programmes. The reason for my scepticism is the sheer diversity of science as it is carried on from day to day. If one takes the particular example you mentioned we have a word—catalysis—which encompasses many topics, from the mechanism of action of enzymes in biotechnology to the reaction of nitrogen on clean metal surfaces, in short many different kinds of chemical reactions catalysed in many different ways. There is a huge diversity within that one word. That, it seems to me, would be very difficult to manage. I am far from saying that catalysis is not an important topic, I think it is an exceedingly important topic.

208. I understood that.

(Professor Peter Day) I am sure that if you ask any chemist he will say: "Yes, catalysis is an exceedingly important topic". I would suggest, however, that because of the diversity behind that single word it may be less effective to set up a large managed programme, especially if it is enshrined in some way in bricks or mortar or in large scale equipment. Such an approach might address certain parts of this diverse scene but are unlikely to address the whole of it.

209. So you would see the better mechanism for addressing the whole as what?

(Professor Peter Day) As a much more effective networking of the kind that I have described.

210. So the work itself is actually carried out in individual companies or universities and it does not cost the Government any money?

(Professor Peter Day) Money always is expended, you cannot do experimental work without spending money. It would be partly industrial and partly from Government sources. It is the mechanism I am trying to get to, that by creating networks of the people who are most concerned in particular parts of this very large field of catalysis, for example, one could get a more effective outcome. Perhaps I am disguising the problem by saying "an" outcome because there would be many outcomes in different fields: biotechnology is very different from the chemistry of the Haber process or whatever.

211. Do you think this is a reflection of the proposition you put forward to us in your evidence that you are seeking to network at relatively lower levels in companies whereas suggestions like this tend to come from the good and the great?

(Professor Peter Day) There is always an element of that when one has such a large scale inquiry. That is why I said that the practitioners are the effective creators of novelty, not the Research Directors. The practising scientists are the people who should be more effectively connected with one another, if one can create the mechanisms. We are speaking of organisational mechanisms, though they may also be

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[Continued]

[Mr Batiste Cont]

technological mechanisms too, such as databases and IT mechanisms.

Dr Bray

212. You have models in molecular biotechnology in particular now where both the network and the institute have a major contribution to make and are making one. For example, we visited the Institute of Molecular Medicine at Oxford and another similar institute at the Wellcome Development Environment Institute at Cambridge where the whole institute is created like that with half a dozen different research groups built around established researchers in the area and there the institute is felt very genuinely to add to the resources of each individual team and the principal useful element in that is not the common piece of apparatus but the coffee room.

(Professor Peter Day) You are absolutely right to point to the crucial importance to the progress of science of drinking coffee! I was director of an international research laboratory in Grenoble whose purpose was to make available in fact—

Chairman

213. Coffee!

(Professor Peter Day) Beams of neutrons is what got people to the coffee machine! I frequently said that one of the most potent catalysts of international collaboration within Europe in condensed matter sciences was the coffee room at the Institute Laue-Langevin in Grenoble. You are quite right in that diagnosis. The coffee encourages people to a place where they can then talk to one another. I am also saying that with current technologies you can go beyond that, you do not actually all have to come together, in the same place. It may be that there is large fixed equipment which actually requires people to come together as in Grenoble but beyond that, one can network and interact. Let me give you one very concrete example: I am co-ordinating a Network funded by the European Community in my own field, that of molecular super conductors, which is quite inter-disciplinary. We have seven laboratories in five countries, three chemistry laboratories, three physics laboratories and one crystallography laboratory. We interact with one another face to face from time to time but almost daily through E Mail and all the other mechanisms that now exist. This is a very powerful way to pursue an enterprise of that kind.

Dr Bray

214. Two questions specifically about that. What is the largest group within that network in one place?

(Professor Peter Day) In the number of research workers gathered together?

215. Yes.

(Professor Peter Day) Not very large, maybe ten people.

216. How often does the group meet physically?

(Professor Peter Day) Twice a year although we meet in small sub-sets more frequently. Another very

important aspect is in transferring graduate students from one lab to another in order to do particular experiments. I send people to Bordeaux for two weeks to do crystallographic experiments because they happen to have exactly the right kind of apparatus there.

Chairman

217. That also enhances the feeling of being a team I take it because they really do get to know one another?

(Professor Peter Day) Yes.

Mr Miller

218. I am fascinated by the exchange on networking and also your comments that regular contact between scientists and technology has been cost effective and beneficial to both communities. You have just expanded how this happens in laboratories for which you are responsible. I have to say when I was running a crystallography laboratory a million years ago or so the practice was that only the technologists acted as the bridge between different scientific disciplines, the technologists whose task it was to solve practical problems given to them by the scientists and who then had to go out and seeing solutions. Are you saying something different is happening as a matter of routine in British institutions these days?

(Professor Peter Day) In basic science we are all becoming much more multi-disciplinary in our approach and that brings us closer to the perspective of the technologist, which is very much task-oriented. You have a particular goal which you have to move towards and you assemble the group of expertises which you require to attack that particular matter. This is a very familiar way to proceed in an industrial lab, and has been for a long time. It is much less familiar in basic science but I think it is rapidly gaining ground. It is a very productive way to work.

219. You agree that one of the aims of the Foresight programme is to foster this discussion between workers of all disciplines so it cannot be all bad. How else other than through a large-scale product like this can we encourage the exchange that you are talking about to grow? I strongly take the view that one of our weaknesses has been that we have worked in little niches. Perhaps in examples you have given on a small scale these networks are beginning to grow. Is it not helpful that the Foresight programme is promoting that kind of growth?

(Professor Peter Day) Yes indeed. I do not want my remarks to be construed as entirely negative. I did say that I think a very strong positive outcome from this exercise has been the way it has brought together a lot of people who otherwise would not have been in touch with one another. What we have to do in my view is create mechanisms, to continue and enhance that interaction.

220. It is what we do with it rather than the process?

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PROFESSOR PETER DAY

[Continued]

[Mr Miller Cont]

(Professor Peter Day) I think the process was very useful in creating all those contacts now in place. First of all, one should enhance those contacts because the Foresight process was started by panels with relatively limited membership, then seminars with larger numbers of people, but to gain the greatest benefit it really has to be carried through to a much greater fraction of the active research community.

Sir Trevor Skeet: Professor, can the Delphi questionnaires be made to work.

Chairman

221. You heard the views of your colleagues. Are you also an undertaker?

(Professor Peter Day) My own view was formed as a purely personal one having received a couple of these questionnaires and set out to answer them in perfectly good faith. Turning over their pages I found with great frustration there was rather little I could usefully say. I have subsequently discovered, talking to a number of colleagues, that they came to similar conclusions. Consulting people is always useful if one approaches them with sensible questions.

Sir Trevor Skeet

222. Some of the 15 panels were completed but it could be analysis which could be useful if properly carried out. Can you think of any way in which they could be improved?

(Professor Peter Day) In one sense by making the exercise a bit more complicated. I think this was a laudable effort to simplify matters. Each panel dealing with a specific sector sent out one questionnaire and they sent it, of course, to an enormous range of people from applied science sectors, engineers and technologists and also to people in academe and basic science. In my view one really should be asking somewhat different questions to each of those disciplines. That will require rather more thought in devising the questions. In its self the Delphi procedure is a good one.

Dr Bray

223. The point is made in a number of the Foresight panels that the crucial points in science are interdisciplinary and that is true not only between different areas of basic science but between different bits of basic science and applied science. What are the institutional implications of this? How do you facilitate the fertility of interfaces?

(Professor Peter Day) I think it has become much easier because of the various technological means of communication that we now have all around us. It is also much easier in industrial labs than it is in universities because in many universities the faculty structure is still wedded to the old distinctions between disciplines that go back to the 19th Century. I spent a

long time in Oxford trying to overcome this since I happen to be interested in a subject that is relevant to more than one discipline and hence building. I do think things nowadays have become much easier because one can communicate so readily. E-Mail is a wonderful way to communicate not only with people on the other side of the world but people on the other side of the street!

224. There are institutional forms which have been tried, one currently is the Isaac Newton Institute at Cambridge where they have six month workshops in mathematics and collect the world's experts together with whatever interface people think it would be interesting to hear from, not necessarily for the whole of the workshop. Another model is the NATO workshop where you are asking what are the factors going to be in the stability and efficiency of aircraft, you get the chaps together for three or four months during the summer and they come up with an answer at the end of the summer.

(Professor Peter Day) I am very familiar with NATO workshops, I have participated in a number of them and I have even organised one or two. Certainly to collect a group of people and put them in some quiet place, pose then some questions and have them discuss and produce answers is very effective. It is a procedure which has quite a long half-life because it is not only what happens in that short period of time which is important but the memory that group of people have of it afterwards and the contacts which they have cemented.

225. Are there these or other institutional forms which would supplement or fill out the Foresight exercise? The Foresight exercise is rather narrowly concentrated on trying to see the future whereas what really matters to the scientists is what the future actually is, what the science is and where it is developing.

(Professor Peter Day) I believe that scientists are very creative in forming their own structures, at least in basic science. I alluded to the invention of the WorldWide Web. That came out of a high energy particle physics laboratory. It was an answer to a need the particle physicists had because in the nature of their discipline they are scattered all over the world. They wanted to communicate with one another about the experiments which were being done in one place. This mechanism set up by people from the computing division of CERN has proved immensely effective for many purposes they did not envisage.

Chairman: Thank you for giving us your time and answering our questions. Again, this has been a very useful session for us on the interpretation of how we might do better with Foresight in the future. I think we get the general view from you that you quite like the process and are certainly not against seeing it continue but it is a matter of reaching a lot of individuals and getting them to co-exist together more happily. Thank you very much.

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[Continued

WEDNESDAY 1 NOVEMBER 1995

Members present:

Sir Giles Shaw, in the Chair

Mr Spencer Batiste

Sir Trevor Skeet

Mrs Anne Campbell

Sir Gerard Vaughan

Dr Lynne Jones

Examination of witnesses

PROFESSOR SIR GEOFFREY ALLEN, FRs, MR STEWART MILLER, Director, Engineering and Technology, Rolls Royce, and Mr JOHN BENNETT, Secretary General, AIRTO, were examined.

Chairman

226. Thank you for coming to the Committee and allowing us to have some discussion with you about Foresight. I suspect you have all been to the Committee before, have you not? At least I think Sir Geoffrey has.

(Sir Geoffrey Allen) A long time ago, yes.

Chairman: We are taking a note of the proceedings and you will have a chance to see the draft of that, but our main interest is to pose questions to you. Some might be directed specifically to an individual, but if any of you wishes to add to any question, we will be pleased to have your contribution. There is an interest to be declared.

Mrs Campbell: I want to declare a relevant interest in that I am a Non-Executive Director of the Welding Institute which is a member of the Association of Independent Research and Technology Organisations.

Chairman

227. And I suspect, as Mr Bennett is a member of AIRTO anyhow, it must be a comfort to him. Perhaps I can start by asking a general question as to what input have you personally in your several and different capacities made to Foresight? What have your organisations in effect done to contribute, because I have no doubt they have, and if you can say why you decided to devote this sort of time and commitment to it, we will obviously be pleased to hear that, or if you decide it would be much against your grain to do so or it would be with an ill grace, please give us your view, but we want to get some feel as to how you set about your contributions.

(Mr Miller) I can give you an answer in two capacities, Chairman, and in my industrial capacity, first, as Director of Engineering and Technology for Rolls Royce, and then in the current phase of the Foresight activity, the implementation phase, I am a member of the Engineering and Physical Sciences Research Council which is of course looking very actively at the recommendations of all the panels. First of all, as an industrial representative, like many, many others, I made my contribution to the Delphi exercise

which seemed to get rather lost then in the bureaucracy. I did not personally sit on any of the panels, but our Director of Engineering for the Aerospace group of the company, Mr Ruffles, was the Deputy Chairman of the Defence and Aerospace Panel and he and I worked very closely together and I like to think that I gave him some advice because, as a company, we were anxious to support the whole exercise and we do identify with the conclusions which that particular panel produced. The Engineering and Physical Sciences Council, as I gather all the councils, are looking actively at their programmes and how the objectives of particular research work can be identified with panel recommendations. That, as an industrial member of the Research Council, very much accords with my own approach and the approach of the industry which I represent. The Foresight Challenge of course, with the announced government funding of £40 million, plus a hope for £40 million of industry contribution, represents the first opportunity to take panel recommendations forward and although the research councils themselves are not making bids for that particular sum of money, they are, however, acting as facilitators to groups of companies and university departments who will be making these bids through the next few weeks and that approach has been strongly endorsed by the Council only just last week.

228. Thank you for that. That is most helpful. Sir Geoffrey?

(Sir Geoffrey Allen) Chairman, you may be surprised to learn that I have made no direct contribution to the Foresight activity.

229. Now is your chance.

(Sir Geoffrey Allen) However, I was President of the Institute of Materials and at the time that OST began to talk about Foresight I was a member of the Council of the Royal Society. The Institute of Materials had just brought together rubber and plastics, metals and ceramics and before OST began to talk about their Foresight activity, we were looking for an activity to persuade people to forget about all the pains of merging and think together about a single activity and we chose a materials strategy which is a form of Foresight as a way of taking our minds off the merger and so we are absolutely committed to it. I happen to

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[Continued]

[Chairman Cont]

know Robert Foster who was at that time in charge of setting Foresight on the road and he and I were great friends and we had long talks and we decided that having worked out the outline for what the Institute of Materials would do, we would then wait for OST to start to get its act better defined so that we could make sure we were not duplicating. In the end, the activities in terms of profiles were rather similar. We chose twelve sectors of industry, just as the Foresight Panel chose 15, and we, being a small institute, decided we could only tackle three at once, so we took aerospace, the biomaterials and materials for power generation as our three and we set off three studies which were led by industrial groups of eight or nine people with just a sprinkling of academics in because in the Institute of Materials at the time there was a feeling that if you just do materials research without an object in mind, then you produce a lot of solutions and spend the next ten years looking for the problems. In fact what we have done is in each area we hired a consultant who could put up a cock-shy of what he thought ought to be done in the next 20 years and then the working parties tore these papers to shreds and rewrote them and reassembled them. In the last year we have issued these three reports. We were very careful in that the first time the reports were publicised, we issued them with the label "draft" on and for each report we got about 20 or 30 companies around the table and one or two academics to help us edit the reports, so the final version came out as a result of the interactive process. We are a bit further down the track in the sense that we did think about the follow-up to the report being issued. Of course it is easier for us as we have only got three reports and each one is highly focused, but we are in a good position now and two of our teams will want to compete in the Challenge competition, but I set them off on the track that the companies involved had to believe in this sufficiently to pump-prime them themselves and that the role of the Institute would be to provide help with managing the process and the secretarial effort and also to help with addressing the EPSRC, for example, and the LINK scheme in order to get money for academics when the Panel wanted help from the academics.

230. Could I be clear, that this is something that the Institute did in its own right?

(Sir Geoffrey Allen) Yes.

231. And of its own volition?

(Sir Geoffrey Allen) Yes.

232. Are the results of this, as it were, published or just circulated to the members who participated?

(Sir Geoffrey Allen) Well, they are circulated to the members of the Institute, but I have to say the thing I have not told you yet is that we kept very close contact with Mrs Williams and the members of the Foresight activity in OST. John Campbell, who is Chairman of their materials activity, we made a member of our steering committee and we have benefited enormously from the interest generated by the OST activity.

233. So it was related to the OST initiative, but done in-house at your own initiative?

(Sir Geoffrey Allen) Yes, and that is our degree of commitment to this kind of activity.

234. Thank you for that. That is unusual, but very helpful. Mr Bennett?

(Mr Bennett) If I remember what the original question was—

235. What contribution have you or your organisation made personally to Foresight?

(Mr Bennett) Could I answer, Chairman, on behalf of my organisation? Firstly, we very much welcomed the Foresight initiative from day one and we are pleased to have representatives on eight of the sector panels, including the chairmanship of the Transport Panel. Our members were involved in the Delphi process and I think between them they managed to complete 100 Delphi exercises and they also took part in, or chaired, 49 workshops around the country. Continuing from there, we are very pleased now that we have an AIRTO representative appointed to the main steering committee which we think is very important for the implementation phase and, also, the recently appointed Chairman of the new Marine/Maritime Sector Panel who is also the Chief Executive of BMT and an AIRTO member. We have an involvement and a commitment to the Foresight process. Additionally, while the process was going on AIRTO did provide a forum for the various representatives to get together. So that they could compare the methods used in the different panels, how far they are going, and what the exchange of information could be, because the impression I gained was that during the Foresight exercise there was not too much interchange between the various panels, but we tried to overcome that as far as the AIRTO interest was concerned.

Mrs Campbell

236. I wonder if you could tell me what you think are the mechanisms by which the UK could become more competitive as a result of this Foresight exercise and, also, what should be aimed at industry and what should be aimed at Government and how they should inter-relate?

(Sir Geoffrey Allen) If you look at the manufacturing sector of industry then the only way they can be competitive is by attention to two things: product development and the development of effective manufacturing technology processes. If you look at, for example, the Materials Foresight, it addresses materials developed for particular products or particular end uses and the other thing they give high priority to is the ability to produce the materials and to form them. These are absolutely essential. I used to be Research and Engineering Director of Unilever and being able to read the market well ahead is also pretty important and we are not always as good as we should be at that.

237. Are you telling me that it is really industry we should be aiming for?

(Sir Geoffrey Allen) Yes. The government can be facilitators. For example, in our materials for power generation we hope that the DTI will provide a project

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[Continued]

[Mrs Campbell Cont]

manager for us and that is excellent. I hope, of course, they will provide pump-priming money, particularly for the university side. I am a great believer that industry should pay for the things it believes in and at the end of the day they should make the running in terms of implementation. The Government can help enormously in making sure that there is real capital between the academics and the research institutes and the companies.

(Mr Miller) I think I can make some general comments on behalf of the aerospace sector where, leading from the panel report, it benefited greatly even from an integrated academic community with the industry already formed. I think the Technology Foresight exercise stimulated that discussion network and I am very confident that the greater dialogue and common purpose that follows from that is going to develop our national competitiveness. That is a response from both sides of the community. I think the process of going from research perhaps in the university institution to eventual exploitation in the marketplace by industry is one aspect that was highlighted by the Foresight Panel and particularly two aspects: one, the demonstration of technology prior to commitment on a large-scale in an industrial programme and the link between bench research and industrial investment of large sums of money. That is key in the high-technology industries that I am describing to you. Another key conclusion they drew, which is vitally important to us in the hugely competitive world industry in which we are operating, is dual-use technology, the exploitation of military-funded work into the commercial sector as well as in the defence sector. That approach is more highly developed in the United States than it so far is in this country. It is very strongly supported by many Government departments in the United States and it is something that we need to do more of in this country. Both of these, I think, as additions to the process of exploitation of science, would give ourselves a greater competitiveness.

(Mr Bennett) You cannot under-estimate the importance of the networking that is associated with Foresight. I think what we do need to become more competitive as a country is to work much more in teams, not competing against each other but competing against people overseas. I think Foresight has really brought that spirit about. Two important networks have been formed: one is up and down the supply chain—and you must not under-estimate the importance of the supply chain in bringing about changes in industry. Firstly there is the big and the good motivating the small and the not so good on the one hand and secondly, there is the very extensive meaningful links that were formed between academia, the RTOs and industry at all levels. I think that is extremely important. We now have a sense of team spirit to succeed which we did not have before. The other thing about Foresight is, everyone has said it is not about picking winners, but I believe ultimately it must be and somebody must bite this bullet. I think you cannot really have 10,000 people involved in an exercise that ultimately does not make some choices. Government often says it is not very good at making choices and, therefore, it should make them. I believe

that the government must make choices and it must get better at it. This is really what I would like to see and I can enlarge upon that later on. I have some ideas I would like to put forward.

Mr Batiste

238. Can I come back to this networking, which is something that has been a recurrent theme in the evidence we have heard and it obviously is extremely important. When in a previous inquiry the Select Committee went to Japan, we were told of the huge amounts of grey information which floated around in the system transmitted by word of mouth through a network of personal contacts that were built up out of the particular structure of Japanese society and they attributed a lot of their success to plugging into this grey information system. When we are talking of networking in the UK, are we talking about information that is not readily available or, rather more, of a sharing of experiences of people from different companies, with different products and experiences that can be mutually beneficial?

(Mr Bennett) One of the main advantages of networking is that people can discuss ideas in the half-developed stage, if you understand what I mean. Before things get crystallised or in the public domain where they are accessible to all, people have access to discuss these ideas with other people and I think that is terribly important, that one gets an early warning of what other people are doing, how they are thinking and which direction they are moving in. I think it is enormously important for people to work together before they have entrenched positions of their own and I think this is really important networking as I see it, that people have the freedom and the ability to interact with each other, not only on finished ideas but while they are being developed.

239. In relation to companies like the aerospace industry, to what extent would you be happy that people in your company are at the stage of half-formed ideas talking to potential competitors in other companies about those ideas?

(Mr Miller) There are two or three aspects to that question. Where we are talking about the Foresight exercise in this country, of course Rolls Royce as an aero engine company has no competitors. The networking that is very important to us, however, is the contact with the academic community where we want to stimulate half-formed ideas. The company already has a large number of links into the academic community and in various engineering and other departments. The academics welcome the opportunity to have the needs of the industrial marketplace put to them so that they can point their research in particular directions and we find that that dialogue is vitally important. That is something that the company has been doing for a long time, but it is now being done on a much wider scale in the Government's Foresight

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[Continued]

[Mr Batiste Cont]

exercise. We have no great concern even in a European context about doing pre-competitive research.

Chairman

240. How do you define that?

(Mr Miller) Working, for instance, with European Community funding with our competitors in France or in Germany on long-term programmes of research. I say that we have no concern, provided we are confident that we can take the results of that research and bring them to the marketplace more quickly. That is up to us then, our own industrial processes.

Dr Jones

241. Do you put money into that as well?

(Mr Miller) Yes.

Chairman

242. You share the results across the industry and it is based research?

(Mr Miller) We share the results and we are prepared to take the risk of that research being discussed with competitors and refined and developed and shared, provided we are confident that our own development can then get ahead and get to the marketplace more quickly.

Sir Gerard Vaughan

243. On the networking, is your experience that it is bringing financial advice in to many people, research people, at an earlier stage? The difference between, as I have seen, this country and Japan, for example, is that in Japan financial people come in very early where work is going on, whereas in this country they tend to come in much more for finished products.

(Sir Geoffrey Allen) I think the networks about which we are speaking now rarely involve financial people. I think the networks are orchestrated in a business sense by people who know what the end product is that they would like to build and what would be successful in the market rather than actual finance, and that is true in Japan too. I happen to work for a Japanese company and I have to say that their networks are very robust in the sense that they can withstand severe distortion and so on, but always in those networks at the nodes there are people who know exactly what they want to take out of it and this is what we have to learn. I think networking is no good unless, as Stewart said, he knows what he is going to take to the market out of that information faster than his competitors.

244. That is really what I was trying to ask you. Do you think the networking here is working in that sort of direction?

(Sir Geoffrey Allen) Yes, in some areas. For instance, in food and drinks I think Nestlé and Unilever have excellent networks which are interactive in the food area. Looking at microbiology and how this impacts on the safety of food processing, for

example, is something which is shared across the world.

(Mr Miller) I would like to add, Chairman, another illustration of networking in another direction which follows from my association with the research councils where, in pursuing some programmes in what we call innovative manufacturing, we have developed a network across two sectors of industry. One of the sectors that we are supporting with research programmes is the construction sector which is not the most high-technology sector of activity in this country and we have created some networks where manufacturing industry experience is being read across into the construction industry and is being welcomed by many companies, both large and small, in the construction industry. Now, that is in another dimension and I think that is greatly to be encouraged.

Sir Trevor Skeet

245. Sir Geoffrey, I think it is a dictum of yours that Foresight influences the future rather than predicts it, but then how are you going to involve in the Foresight Programme all companies, particularly the non-technological ones, particularly when it comes to implementation?

(Sir Geoffrey Allen) I think one has to take a pragmatic view and say that the big companies really are big enough to look after themselves and I have very little worry about them getting involved. When they see something that is useful to them, they will come and take it, or they will make sure it is being generated. The small companies of course are a very special case and I am sure that Mr Bennett will want to speak about that. There are two kinds of small companies, broadly speaking. There are the high-tech ones and again, you know, they are right at the cutting edge of technology and they will either sink or swim on their own merits and they will know better than anyone in the Foresight activities what they ought to be doing, but the real problem is the small to medium companies that are not research oriented or research based and they have to keep changing the level of technology or they are the ones that get caught out by the sea changes in technology. When I was on the Industrial Research and Development Advisory Council of the European Union, I was fortunate enough to be given the job of organising a little activity to try and raise the level of technology in these companies. We had four pilot schemes and in each one at the centre of the pilot scheme we put a research association, and Mr Bennett knows this very well because it was his association that did particularly well, and we brought eight or nine European small companies around the research associations, each of whom had a similar problem of raising their technology and the research associations did not do research with them, but they already knew what was required and it was just a system of technology transfer. I think the suggestion that these small companies should get involved in R&D is unwise. I think what they should get used to is the fact that their technology is always going to be changing and that they should be going to groups like the RTOs, the research associations, to get the technology.

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[Continued]

[Sir Trevor Skeet Cont]

246. What you are saying then is that as far as the big companies are concerned, they have got Foresight and, therefore, they do not require this, but the contribution which they can make to all the programmes is collaboration across the board and also to interest the small companies which may not have a standing here.

(Sir Geoffrey Allen) I must say that big companies do get something out of Foresight because no big company can have all the first-class people it would like to have within its own company, so they can have access to others.

247. Let me put this point to Mr Miller. BAe is the biggest exporter in the United Kingdom. Rolls Royce coupled in with that provide about £7 billion worth of exports a year. Should we not encourage these two companies particularly in this field?

(Mr Miller) Particularly in the field of working with smaller companies? Is that your question?

248. Yes.

(Mr Miller) I am sure British Aerospace do exactly the same as Rolls Royce and that is work very closely with their supply chain. There is a series of tiers in an industrial structure where we first have major subsystem suppliers. They, in turn, have their own suppliers eventually down to the nuts and bolts that attach all the different parts of an aeroplane or an engine together. Going back to Mrs Campbell's question about competitiveness, it is necessary for a competitive end product from either British Aerospace or Rolls Royce to have absolutely competitive subsystems and that can only be done by collaboration from the very start of research through to the design, through to the development, through to the manufacturing phases through associations with preferred suppliers and the opportunity that the findings of Technology Foresight should give not just to these supply chains in aerospace but in all the other industrial sectors that were addressed ought to spread that benefit across all of manufacturing industry, but it is a vitally important relationship.

Chairman

249. Mr Bennett, would you wish to comment on the point in respect of Foresight reaching all companies, particularly small ones?

(Mr Bennett) Yes, very briefly because obviously a lot has already been said. I think there are really two important players here. I think one is the large companies through the supply chain and that has already been mentioned and I think the supply chain is a very good trigger for innovation. It says, "We will only buy components from you, providing you take on board this sort of technology or these sort of methods" and, therefore, it is really a trigger and a pressure which only the customer can put on a company. The small company gets its technology very often from the AIRTO member, from the research association, which was set up 70 odd years ago for that very purpose. The research association look at the output from academia, on the one hand, and look at the needs of the industry, on the other, and somehow to couple these together. The vast majority of AIRTO members, not

all, are associated with basic manufacturing industries and I think they play a very important part in supplying the technology. Do not under-estimate the power of the supply train which is the trigger for the companies to take on board new technology.

Dr Jones

250. CEST have advocated that Foresight findings need to be re-interpreted according to the individual needs of the companies, which is what we have been talking about now about networking and I know that AIRTO have said that they want to be given responsibility for diffusing information to companies in their sectors. Should this be left to research associations like AIRTO or big companies to get on with it as they see fit or should there be some kind of organisation of this process?

(Mr Bennett) I do not think organisation is necessary. I think they have got the will and the ability to do it.

251. Are you confident it is going to happen?

(Mr Bennett) I am pretty sure it is going to happen. It must eventually require rather more funding than the research associations and other bodies are prepared to put into it.

252. Let us talk about the funding for basic research in the public sector. Are you satisfied as to its adequacy and are you confident that the process of Foresight which will redirect money into priority areas and into schemes such as ROPAs is not going to leave the research councils, for example, with difficulty in funding their basic missions? You mentioned a little while ago about the need for funding for this dissemination process. Where should that come from and how does that fit in with the whole science base?

(Mr Bennett) The AIRTO view is that the prime role of universities is to do good basic, perhaps undirected research on the one hand and to produce good graduates and postgraduates on the other. Therefore, that is somewhat of a hands-off experience. So we do believe that universities should have the freedom to follow their own whims and fantasies as far as basic research is concerned. There are other players in the innovation chain as well as universities and, of course, they must be adequately funded as well. The IMI scheme we have talked about, we have talked about ROPA, we have talked about the LINK scheme. These are all schemes to link academia with industry either directly or through intermediate organisations. I think it is enormously important that universities are not directed through funding or any other means to solve day-to-day problems of industry. It has got a role far bigger than that.

253. Could I invite you to be specific about your comments about the need for funding for the dissemination of Foresight findings to companies?

(Mr Bennett) I have been drawn here but—

Chairman

254. It quite often happens.

(Mr Bennett) — I will take the bait. Can I go back and put the thing into perspective? Prior to the OST

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[Continued]

[Chairman Cont]

White Paper, the DTI had funds for co-operative research which the associations had access to which enabled them to do co-operative research. The result of the OST White Paper was that the OST had the responsibility of basic research through the revamped research councils and for funding universities, etc., and the DTI did put in place a number of schemes for technology transfer. It had hoped, and it is beginning to happen now, that research associations and other players will have access to some research council funding. At the moment we have access to the LINK scheme; we do not have access to ROPA; we may be getting access to IMI, though it is not immediate. We would like to be able to compete on equal terms with other organisations as we believe we have a role to play here.

Dr Jones

255. How is this going to affect the research base for basic research if these little schemes start taking off little pots of money?

(Mr Bennett) I am not really saying that the IMI or the ROPA budget should be increased. It just needs greater accessibility and greater competition for its funds.

(Mr Miller) Going back to the Panel reports, the Defence and Aerospace Panel was one of the few reports that was quite specific about the funding that it recommended, large sums of money in the context of which we are speaking, on dual-use technology, which I have mentioned, £24 million per annum, and the demonstrator programmes, also, which I have mentioned, where there was a recommendation of £30 million per annum. The contrast with reality presently in DTI funding is very striking in that on civil aerospace, for instance, the CARAD programme for civil aerospace research and development is under great threat that it might be wound up. In the aero-engine part of that the DTI contribution to research and development is actually negative because industry contributes money by way of repayments on Launch Aid far greater than the current research support which DTI supplies. So what little we are getting, which is far less than we are paying back, is under threat and is contrasted by one or two orders of magnitude with the sums of money available to both our American and our French competitors. So the response of the Government to the very specific recommendations of the Defence and the Aerospace Panel is eagerly awaited. There has been no reply so far.

(Sir Geoffrey Allen) Can I come back to the broader point that is raised. I think that in the excitement of rushing to exploit our science base we must be very careful not to wreck the base and drain the capital there. At the moment all the debate in OST and in the research councils is about exploitation. Of course I support this, that we have to develop both industry and the quality of life in society. This is where our potential is going to be realised, not in the universities and the research labs, but we must not forget that the science base does need attention and it is not clear at the moment that the research councils are giving sufficient attention to that. They are rightly

very keen to demonstrate that they can deliver on the exploitation side. The science base has actually been broken into more parts than it used to be. When I was Chairman of the Science Research Council always the new things happened at interfaces between physics and chemistry, between chemistry and biology, and if I wanted to know where something important was going I would call in the chairman of the biology committee and the chairman of the chemistry committee and they each would sit there and tell me about the marvellous things that were happening and then suddenly they would start falling out over one project, each claiming that project as theirs and I knew then that is where something was happening.

Sir Gerard Vaughan

256. Listening to what all three of you have said on this, are there aspects of DTI research capabilities which are now being lost and which are not being replaced by, for example, privatised laboratories? That is only the DTI. Are there other government departments where research capability is slipping away as a result of this exercise? I thought you were saying just now that it was.

(Mr Miller) My comment, Chairman, was about DTI funding of work in industry and in universities. Of course the Ministry of Defence has very large research capabilities in its various laboratories. The scale of work there is reducing and that leads me just to mention again the great importance of dual-use technology to make the very widest application of any particular programme, be it in defence or commercial. There is spin-out and there is spin-in provided enough thought and intelligence is given to it.

257. I actually asked about the DTI capability. Are we actually losing areas of capability which the privatised laboratories are not stepping into or are unable to step into?

(Sir Geoffrey Allen) I think what is happening of course is that there is a shortening of timescales. In a government-sponsored laboratory, you can really afford to think long-term. I think the medium term is as far as one dare go in a privatised laboratory because you need commissions and they have to be recognised as such.

258. Is this something we should be worried about?

(Sir Geoffrey Allen) Concerned. There is a problem on both sides. The government laboratories, if they are not carefully managed, and it is rarely that they are, do tend to set solid and become rather dreary and they lose the spirit of enterprise. On the other hand, the privatised labs have to live for the here and now. They have got lots of enterprise, but the problem is to try and put those two things together.

Mr Batiste

259. Following that up, if I may, for one second, do you think that one of the problems that the Government may be faced with, if there is a further significant switch from the public laboratories to the private sector laboratories, I suppose especially in the

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defence sector, is that the Government's capacity to act as an intelligent customer might inhibit it?

(Sir Geoffrey Allen) I think it is very difficult, in my experience, for the Government to act as an intelligent customer!

Chairman

260. Despite having a long-term role in it?

(Sir Geoffrey Allen) Well, I have seen lots and lots of proxy customers and I have never seen any that worked.

Mr Batiste

261. The Materials Panel identified areas of lower priority where funding should be restricted, which I am sure is extremely helpful. It is a question we have put to previous witnesses, that if you are identifying high-priority areas, you should also be identifying the low-priority areas. Firstly, do you agree with the background to that assessment and do you think all the panels should have done this?

(Sir Geoffrey Allen) I think it is a very important thing for a panel to do. It is one thing to paint a picture, but you then have to give it some perspective and I admire the Materials Panel for doing that. I have to say that the kind of things they have put emphasis on have actually been emphasised in our three independent reports and they come together quite nicely. I think that if you look at the things they say we should not do, they are rather small beer compared with the big things that they say we should do and I would have liked to have seen more perspective there, a bit more discipline.

262. They were too hesitant in picking losers?

(Sir Geoffrey Allen) Yes, absolutely. That is the only thing, but at least they have set the pattern that this is something that each panel ought to do.

(Mr Miller) I have a brief addition to make. I think the point is well made because deciding to stop something in a scientific environment is far more difficult than to start, but we have talked a lot about the networking and the communication, and I think the challenge to prioritise down as well as prioritise up is far better met if there is a much wider consultation about the needs of the marketplace as well as the technical potential.

Mrs Campbell

263. I wonder how we are going to encourage the interdisciplinarity between the panels and also between industry sectors because that seems to be something in which there has not been much co-operation between the sectors at the moment.

(Mr Bennett) I will talk certainly briefly about industry sectors. The DTI launched two years ago a Carrier Technology Initiative Programme which I think is an extraordinarily good idea. The idea of this programme is to transfer and adapt technology which is used successfully in one sector of industry to another sector of industry, so I think that is good. I would just comment very briefly on the DTI. I think the DTI,

certainly as far as the headquarters and the policy are concerned, has really been much more focused in recent years in identifying areas which do need special attention rather than having a blanket view, so I think this is one very good example where they did pick up this need to transfer technology across sectors.

264. Is that to do with interdisciplinarity? That is to do with between different industries, but not necessarily different sectors.

(Mr Bennett) Of course some of the sector panels were disciplinary based and some of them of course were industry based. There was a mixture of panels. I think the ones that are industry based did naturally bring together the various disciplines. The one like Materials, which is disciplinary based, did not have that opportunity, but I think they have been interacting and interfacing with other panels. I do not see that as a great problem. I think the networking has really helped us here.

(Mr Miller) I think I can illustrate what some parts of the research councils are trying to do to answer your question. The EPSRC of course has restructured itself with a Technical Opportunities Panel and a Users Panel which is meant at the next level of decision-making to involve a breadth of opinion and that has seemed to be working in pointing individual research council programmes at each other. I have seen that begin to happen in the process of discussion. I would also like to add that you would expect from this end of the industrial research spectrum that I would probably differ a little from my colleagues and say that university research should not all be blue skies and there has got to be a balance between basic programmes and at the other end the applied programmes. The ROPA scheme, which has come in for considerable comment, in principle, I think is an excellent scheme because it looks at the activity which has come from the applied end and generates new work at the basic end. It seems to me to have been criticised for quality rather unfairly because we have seen recently some statistics about how the original ROPA awards went to high-quality university departments, so I think the scheme ought to be encouraged. It is a means of getting this balance. That is not an interdisciplinary question, but it is going back to something you asked earlier.

Sir Trevor Skeet

265. Foresight has become a sort of never-ending process and I am just wondering what the role of the panels should be. I am advised that the panels do not speak to one another, that some panel chairmen have disappeared and been replaced. What should their role be? Should they not be concerned to concentrate on implementing the findings which these panels have discovered?

(Sir Geoffrey Allen) Of course I am not involved in the OST part, but I can assure you that in the Institute of Materials that is exactly what we have done; we have concentrated on the implementation of the findings, for example, in power generation and we have recognised the gasification of coal as a major technology for the next century. We have now got a

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group of eight or nine companies with a couple of academics who are now setting out a programme and they are going to apply for money from the Foresight Challenge. The companies around the table are actually putting money in and we hope to help them get money from the Engineering and Physical Sciences Research Council. We expect that they will appoint a project manager and every year they will report back to us on progress and we would expect to disband the group in three years. We do not want it to go on for ever.

266. But, if I may say so, you are concerned with a small group.

(Sir Geoffrey Allen) Yes.

267. But AIRTO is concerned with eight groups. Are they achieving the results in exactly the same way as Sir Geoffrey has suggested?

(Mr Bennett) To answer your original question, I think the whole emphasis of Foresight now must be on the implementation.

268. Exactly.

(Mr Bennett) We have had the discussion, we have had the conclusions and now the implementation. I said earlier that I think people have really started to think that 27 recommendations is perhaps too many handle. It is perhaps too many balls in the air at any one point in time. AIRTO is producing a paper which I will try the idea of out on you now, if I may, is a challenge-led approach to wealth-creation and quality of life. We believe that decisions really ought to be made based on a number of criteria, improving the quality of life, to stimulate innovation in industry, based on national scientific technological strengths and, last but not least, they must be easily understandable and involve and benefit people. Such challenges, for example, could be to improve the quality of air in the industrial cities by a measured amount or to eradicate a particular disease, Alzheimer's disease for example. There is a whole range of things that one can do. I think this has a number of advantages. One is that it would bring home Foresight to the man in the street and I think particularly the man in the SME. It is something pretty sexy, something you can relate to, whereas the Steering Committee Report, with all due respects, is really not. I think it would bring people working together. Also, you have got something which is measurable, you can measure the success of it. I think that decisions should be made. They should be fairly large projects, perhaps £200 million each per annum. They should take, we suggest, ten per cent of the UK R&D spend. This is not new money, this is just re-allocation of existing money towards these priority areas. We think that by doing that you can make some real impact. I think you will help to implement one of the recommendations of the OST White Paper, that is to improve the perception of the man in the street of the importance of science.

Chairman: You have now got it on the record, Mr Bennett.

Dr Jones

269. The science budget is level-pegging, it is set to go down slightly but in real terms, the DTI budget is falling and the defence budget is falling. If we are having all these suggestions for directed money, are you not concerned about the effect this might have on the science base?

(Mr Bennett) I do not think so, no. These sort of programmes are not implementation programmes. They involve a lot of very basic research on the one hand, the development of instrumentation, right away across from the basic science to the end. I think it can be done with careful thought and careful planning with the re-allocation of existing funds. I think it will stimulate the universities in many areas in the same way that it will stimulate industry and the man in the street, and I do not think it would be a significant dilution of the basic research which industry must do.

270. Could I ask the other members of the panel to comment?

(Sir Geoffrey Allen) I would be concerned about going entirely in that direction. I think there is a layer in the science base that does need to be free to create seedcorn, but thereafter then I think there are stratagems that one can apply to direct. I certainly agree we ought to have a few big programmes to get the thing off the ground. That is really what my Institute is doing.

(Mr Miller) Can I make two brief comments returning to Sir Trevor's question? You queried that some panel Chairmen had disappeared. I think it is healthy that they are replaced. This sort of exercise is very demanding of time and you cannot expect people from industry, for example, to continue to do this work forever. So I think the change is natural and can be beneficial. I would hope, secondly, that the work of implementation is devolved more to the research councils which do have an infrastructure to direct and manage programmes and encourage the academic work. I think too many additional panels and groups and steering groups will not add greatly when, in fact, the main need is for the government to respond to the recommendations, and we come back to the funding question again.

Mr Batiste

271. Leaving the implementation part of it aside for the moment and thinking of the Foresight exercise itself, if this is to be repeated in the future what aspects of it do you think could better be contracted out to private sector organisations rather than run by Government?

(Mr Bennett) I did not serve on any of the sector panels myself so I cannot really say very much about that. The reports I got back were that these people did an excellent job. I think the private sector has been used effectively. I have not really seen any criticisms that the panels themselves were bureaucratic or dominated in any way by the public sector.

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272. Do you think any part of the role that is performed by government should have gone further out and been more extensively used by the private sector?

(Mr Bennett) I think the Government had a role to get the show on the road, which it obviously did, and I think having done that it may wish to consider delegating more to the private sector, but I have no major criticisms about the way the process was carried out.

273. As far as the administrative support that is required for the future of the programme is concerned, your comment is that you prefer to see it used in the existing structures of the research councils?

(Mr Bennett) I have heard nothing to the contrary. I think the independent facilitators did a very good job. That is a private sector involvement.

Chairman

274. Broad agreement on that?

(Sir Geoffrey Allen) Yes.

(Mr Miller) I would agree.

275. Thank you, gentlemen. We are very grateful for your time and we are grateful for the contribution that you have made to the evidence we needed. Thank you very much.

(Sir Geoffrey Allen) Thank you very much.

(Mr Miller) Thank you very much.

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[Continued]

Examination of witnesses

MRS HELEN WILLIAMS, Head of the Transdepartmental Science and Technology Group, and MR IAN FREEMAN, Head of the Technology Foresight Branch, Office of Science and Technology, and DR RICHARD KING, Head of Technology and Innovation Policy Branch 1, Department of Trade and Industry, were examined.

Chairman

276. You are most welcome. You have the double advantage of being able to sit in and see what a gentle lot we are really when it comes to questioning and listening to the trend. You are most welcome, Dr Richard King and Mr Freeman with you, and we are grateful the OST has come to talk about something which after all was initiated by OST. Volume 2 of the 1995 Forward Look gives total planned expenditure by each Department until 1997/98. Why is it not possible to give a breakdown for the programme lines beyond the next year? Are you restricted in how far you can actually forecast your spend?

(Mrs Williams) Chairman, in the case of government departments, their science and technology budgets are to be deployed in support of their various policy objectives which, of course, vary from department to department. In most departments of state the decisions about S&T expenditure therefore follow policy. Decisions are made by people in policy divisions and in many cases what the outcome of those decisions will be in terms of the breakdown of S&T is not known more than about a year ahead.

277. I understand that and obviously I understand the rubric of the Treasury and so on, but insofar as you are trying to deal with institutions who are planning science developments for a considerable period of time, are you satisfied that it is reasonable to confine them really to one year ahead or possibly two at the most?

(Mrs Williams) The actual text of department statements in Volume 2 does outline different departments' thinking about the broad policy challenges they see, looking not just one year ahead but five and even up to ten years ahead, and departments offer some broad commentary on how the balance of their programmes will need to evolve in order to respond to those challenges.

278. There would be an assumption, would there, that a five-year scheme would carry more than 70 per cent of its votes?

(Mrs Williams) I think they probably vary very much.

279. But there is some forward projections component involved?

(Mrs Williams) In different departments there will be projects for different lifetimes. In one case they may be one-year schemes or two-year schemes or three-year schemes.

Sir Gerald Vaughan

280. Would it be fair to say to you that the statistics produced by the different departments are pretty inconsistent in some areas—I can give you

examples if you want—and that something ought to be done about this, and I hope you are trying to, or is it not fair to say that in your view?

(Mrs Williams) Departments like MAFF or Environment or Transport are all using S&T for different policy purposes and it may be in the nature of the work they are supporting and the policy context that the amount of breakdown which is helpful or meaningful varies from one department to another. As I have explained, we do agree with departments a broad standard format for the presentation of the prose in their Forward Look statements so that they begin with something like, "Forward-looking policy challenges" and then move on to talk about how to balance their programmes to make change and then to say something about how they are progressing White Paper objectives. In terms of the years up to 1995/96 in the case of the Forward Look, I think departments do give a certain amount of detail about how their S&T budgets have been deployed.

281. We are interested in the LINK programmes, for example, and the Department of Transport shows the funding for the LINK programmes, but the Department of Trade and Industry does not.

(Mrs Williams) I accept there is an inconsistency there and indeed I think it is perhaps a gap in the Forward Look that we do not present a consistent statement across departments about what their involvement in the LINK programmes is and this is something I think we would want to look at in next year's Forward Look.

Chairman: Perhaps you can pop next door and crawl about in the DTI.

Mrs Campbell

282. I am concerned about the consistency between this year and last year. Certainly last year there were a lot more statistical summaries of the actual figures that you show in the table and pie charts and bar charts and so on and more explanations, but this year you do not have a separate entry for the higher education funding councils and they are all lumped together and I wonder if you could explain was this just lack of time or a deliberate attempt to cut down the work or what?

(Mrs Williams) The background to it is that there is still quite a lot of material in the Forward Look about the funding councils, but that we no longer have a discrete section in the statistical supplement and nor do we give information that was in last year's statistical supplement about the subject breakdown.

283. Why?

(Mrs Williams) The background to that is essentially that it was not possible to give the subject breakdown information for the new universities as for

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[Continued]

[Mrs Campbell Cont]

the old and for various reasons it was decided that we would, therefore, not attempt to give a partial presentation of that information, just having the old universities, but this is something that for next year's Forward Look we are hoping to give a more complete analysis covering the full spread of universities.

Chairman

284. It was the absence of data for the new universities which suggested that HEFCs would be omitted from this year's.

(Mrs Williams) It was not omitted altogether. Table 1 in the overview did produce the aggregate of funding council figures for spending on research and the relevant Education Department statements in volume 2 also covered spending by the funding councils in England, Scotland and Wales.

Dr Jones

285. Could I ask about EU funding? In the Government's reply to our 1994 Forward Look Report, we were promised that the figures for total Framework R&D received by UK institutions would be actually given. That promise does not appear to have been kept, so why is that? Also would it be possible to break down information on attribution between the various public sector research funders rather than giving a lump sum?

(Mrs Williams) Let me take the first part of the question first because I am not sure I understand the second part of the question, so I will come back to that. On the first part of the question, we do in the Forward Look this year give the estimated aggregate UK contribution to European Union R&D and that figure is presented in table 1 in volume 1 and also appears in the statistical supplement. That is something like £370 million in 1995/96 rising to £415 million in 1997/98, so we give the aggregate UK share or contribution in any case to the overall cost of the European Union R&D. We have not as yet been able to give any more detailed information about how that expenditure actually comes back to the UK in terms of the stream of income from the European Union into the UK from the Framework Programme because we do not have complete data about that.

286. I would have thought that that would have taken into account in the reply that we got to our report.

(Mrs Williams) What we do have very complete data on is the actual breakdown of the Framework Programme itself in terms of the sub-programmes and that information is set out in great detail in the *OST Guide to the Framework Programme* which is a document we produced in order to encourage people to apply for Framework Programme money.

Dr Jones: What about attribution of new funds by the research sector?

Chairman

287. You actually put in a lump sum on the attribution between public sector funders rather than distributing it.

(Mrs Williams) The total UK contribution to European Union R&D is set out. I am not quite sure I understand what you mean by attributing it to sectors.

Dr Jones

288. The amount that is reduced from the various budgets.

(Mrs Williams) Well, I do not think that there are any attribution figures for particular departments. Departments' base lines for science and technology which appear in table 1 in the overview have come out of the Public Expenditure Survey. In the Public Expenditure Survey one of the factors that is taken into account is the extent to which a department's area of interest may benefit from European Union R&D, but I do not think it is possible retrospectively to identify any share of the total that can be attributed to particular departments or to particular sectors.

Mr Batiste

289. The Steering Group on Technology Foresight said that the OST's co-ordination of the Foresight process should be exercised through the annual Forward Look and the Government must ensure that Foresight messages are received loud and clear by appropriate programme managers. In the 1995 Forward Look you said that a period of interpretation and evaluation will be required by all the stakeholders in the process. The process of evaluation is now well under way and we can anticipate the next Forward Look. How are you going to use that to implement the results of the Foresight Programme?

(Mrs Williams) We will be expecting departments in next year's Forward Look to give an account of how they are responding to the various recommendations of the Foresight reports that apply to government departments. In this year's Forward Look, the 1995 Forward Look, clearly that came too hard on the heels of the Foresight reports for them to say anything than the fact that they were attending to it.

290. So you would expect a detailed response in the 1996 Forward Look by each individual department to all the individual recommendations that would affect that department or that programme?

(Mrs Williams) It will certainly be essential that the Forward Look gives an account of how Foresight is being reflected in departments' programmes because the whole point of the Forward Look is that it presents an up-to-date statement for the community of how departments are deploying their resources and one very important influence on the deployment of their resources is the outcome of the Technology Foresight Programme so that must be reflected in the Forward Look. We may want to publish separately from the Forward Look a rather more detailed account of how not just government departments, but also the science base and other players are responding to Technology Foresight. I think that we could over-burden Forward Look if we attempted to include all of that in the Forward Look document itself.

291. If I have got this right, the OST, in exercising its strategic role, anticipates summaries within the

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[Continued]

[Mr Batiste Cont]

Forward Look for 1996 and simultaneous publication of detailed analyses of how the Foresight Programme has been implemented not just by government departments, but by research councils and the other participants?

(Mrs Williams) Well, that is an option. Perhaps I should just go back a bit and remind the Committee that in this year's Forward Look the Government said that it would publish a first interim progress report on implementation of Foresight by the end of this calendar year. We are working towards that at the moment. We will then have a further progress report in next year's *Forward Look* which is to be published in May. We may alongside that *Forward Look* want to publish a separate account of how Foresight is being taken forward or we may decide to defer that. We have not yet taken a firm decision on the timing of the second Foresight progress report.

Chairman

292. This is very important. Obviously there must be a method by which government would seek to make an assessment as to the implementation and, therefore, as to the extent of success which the Foresight process will produce. Are you seeking to do that on an annual basis or are you merely saying that after 18 months or two years perhaps it is possible to do that? Obviously the implementation of the Foresight Programme is an on-going concept, but the actual measurement of what happened from, let us say, 1985 through to 1998 is something that is much more complicated. In other words, are you drawing a line and saying, "This is what actually happened", or is it merely a matter of the dipstick each year to provide some kind of comfort?

(Mrs Williams) There will be a dipstick every year because we publish a *Forward Look* every year. We are also, though, considering longer-term assessment of the effectiveness of the Foresight Programme. This is something we are working up at the moment so we have not got a template. There are a number of measures we are looking at. For example, measures of the awareness of Foresight in industry and in SMEs, measures of the quality or quantity of linkages between academia and business, the number of companies who are actively engaged in Foresight activities, the number and value of Foresight projects that are under way between the public and private sectors.

Chairman: Obviously the Committee's inquiry, we might hope, will throw up suggestions in this area which we hope the Department would consider.

Mr Batiste

293. In large part the value of the Foresight Programme, according to the evidence that we have had so far, is in the detail and in the relationships that are being established which you have just said you are trying to find templates for measuring. Equally, the impression that we have had is that many of the private sector organisations and many of the individuals who have participated in the programme are keen to see that the government is responding in detail to the items that have been raised and it is clear—and this is something that is really very important to us—that the

government will respond in detail on these points, will establish a clear yardstick and will provide recurrent measurements of how those yardsticks are succeeding.

(Mrs Williams) Yes, indeed. There is a clear commitment on the part of the government that the government collectively and individual departments will make serious and considered responses to Foresight. The process of consideration cannot be expected to be an instant one. Some of the infrastructural issues which the Foresight report raise are almost intractable issues which will take some time for government departments to get their minds round.

294. Talking about the other government departments is really where it leads into the next part of this. You have the overall government strategy role; have you yet had much interplay with other government departments about their spending plans and priorities and seeking to set their departmental judgment against a wider strategic judgment?

(Mrs Williams) In relation to Foresight, there has been quite a high degree of departmental involvement from the outset because all the panels have had in membership a representative of the relevant sponsor department and, indeed, departments continue to be represented on the panels which we have retained and now have a new remit. As part of the process of following up the Foresight reports each department has established a Foresight action manager at a fairly senior level and those Foresight action managers constitute a Whitehall Foresight Group which OST chairs, which I chair, the remit of which is to progress-chase and co-ordinate government departments' responses to all the various Foresight recommendations which relate to them.

295. In this context, if you were to feel that a particular department had not in its spending plans or in its other judgments reflected the message of the Foresight programme, you would be raising it in this co-ordinating committee and if it was not resolved in that co-ordinating committee the issue would pass up through the Whitehall structures?

(Mrs Williams) Indeed, up to the relevant ministerial committee.

Dr Jones

296. On these measures, could you give us some idea how you intend to check the kind of information that you said would be needed to make the assessment?

(Mrs Williams) Collecting the data is one of the difficulties because clearly we do not want to have to set up hugely costly and elaborate data collecting exercises and we also need to beware of getting false readings because the data is not actually as pure as it needs to be. In terms of the number of, for example, Foresight dissemination events, we get intelligence on that through the panels and the secretariats which we staff. I mentioned the number of Foresight projects, collaborative projects; we would have information on that through our intelligence.

297. You said one of them was the degree of awareness in SMEs, for example.

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[Continued]

[Dr Jones Cont]

(Mrs Williams) We might. I am not saying we will. We would have to commission some sort of attitude survey in order to get that information.

Sir Gerard Vaughan

298. Foresight was meant to use scenario planning and if you look at the reports from some of the panels it is quite clear that they either did not want to do this or did not understand it or were not able to and this must have made things very difficult, surely. Some of the panels have simply given forecasts of various kinds. Did the steering groups try to apply scenario planning to the recommendations that were put to them from the panels or not? I can give you examples if you want.

(Mrs Williams) I think I am going to pass this question to Ian Freeman, who is my expert on Foresight.

(Mr Freeman) That is a difficult introduction, Chairman. I think it is fair to say that the steering group did not develop systemic scenarios right across all the various Foresight sectors of consideration, but what it did bend its mind to very considerably and very carefully were some strategic visions of the future about the kind of way in which the economy was moving, the kind of global environment in which British companies were going to find themselves, the kind of global competitiveness which not only the UK but also Western European and American economies were going to be facing from the Pacific Rim and so on and develop this scenario about how it was going to be important for us to remain competitive if we were going to really develop knowledge-based industries and stay in the forefront in that kind of a way. It developed its analysis from that kind of vision, just to mention one relatively simple starting point for you.

299. Did this matter very much in your view that not all the panels were able to look at it in this way? Looking at the future, do you think they ought to?

(Mr Freeman) I do not think it has mattered too much in this first stage because we have always said all the way along that Foresight is going to be a continuous process. Nobody is claiming, least of all individual panels, that they have necessarily got all aspects of their analysis right first time round. Some of these findings are going to have to be updated, some of them are going to be consolidated and one of the remits that the existing panels still have is to look at that. In the sense that there is not consistent scenario-making right across the board between the panels, I do not think it has necessarily been that critical. Where panels begin to feel that there is a weakness in some of their analysis, that is an aspect that we would wish them to address and to catch up on, if you like.

Sir Trevor Skeet

300. CEST have been doing their best to see that companies make use of the results and understand the processes of Foresight. What is your Department doing particularly on this front beyond what is being done by CEST?

(Mrs Williams) Well, Chairman, the now 16 sector panels have a remit to go out and disseminate their reports throughout business, throughout the scientific community and promote action in response to their reports. We, therefore, I think, see the panels as being the focus of our efforts to reach out to industry and to companies, large and small.

Sir Trevor Skeet: Yes, but surely you are putting it down to the private sector, are you not, to distribute all this information and to implement it?

Dr Jones: You heard Mr Bennett mention the need for funding for that. Have you any thoughts on that?

Sir Trevor Skeet

301. I wonder whether we can get an answer to the first question first.

(Mrs Williams) Ultimately it has to be up to the private sector to respond to the Technology Foresight reports, but we see a role for OST and the Government and for the panels in stimulating that response, particularly in those sectors which traditionally have not had close links to the science base or in the smaller companies which equally need to be led towards a more innovative way of thinking.

302. Well, I see that recently three new chairmen of panels have been appointed. Is this to stimulate the interests of the chairmen in the work of their committees?

(Mrs Williams) A number of the original 15 panel chairmen decided after their panels had produced their reports that they could not continue. It was not because of any lack of enthusiasm for the task, but you will understand that having been chairmen of the Foresight panels, it was an extremely demanding and time-intensive task, so I think it came about that three or four, or four or five, of our panel chairmen asked to be relieved and that is the context in which we had to appoint new chairmen to a handful of the panels.

Chairman

303. Do you yourself as the sponsoring department, as it were, discuss these things with CEST? Do you have meetings with them?

(Mrs Williams) We maintain close working links with CEST. Indeed we were quite heavily involved by CEST in helping them write their booklet, and I forget what it is called now, but the one which is trying to explain Foresight to industry, *Turning Foresight into Action*, or something like that.

Mrs Campbell

304. I just wanted to change the subject slightly to the Foresight Challenge Awards. The awards are to be assessed, I understand, by a very small group of people consisting of the Chief Scientific Adviser, the Director General and three others. I wonder if there is a danger that that group will become a research council in its own right. It is extremely limited in membership and is it really going to have the expertise and time to evaluate all the bids?

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[Continued]

[Mrs Campbell Cont]

(Mrs Williams) If I can respond, it is not the intention that the Challenge Awards Group that you refer to should do all the assessment themselves, although they are responsible for making the final recommendations to Ministers. We expect that they will want to draw on advice from relevant research councils, from the relevant sector panels and it is also planned that the Challenge Awards Group should discuss their shortlisting of projects with the Technology Foresight Steering Group, so I think we have actually built quite a number of checks and balances into the process so it is not the Challenge Awards Group unaided that will be making the assessment.

305. Can you tell me how many enquiries or applications you have had up to date and are you going to do a peer review on them?

(Mr Freeman) We have had a lot of enquiries to date. I cannot give you the exact number, but I can let the Committee know that subsequently as far as the precise number to date is concerned. Perhaps it is sufficient just to report this evening that there have been a lot of enquiries, but we have it in mind to deal with the applications, and especially it is relevant if we get a lot and we hope we get a lot, in a two-tier approach. The first approach is to seek outline bids in which applicants will only have to give us, say, two or three sides of information, about 1,000 words we have invited them to give us, to state essentially what the project is, who the partners are going to be and what aspect of Foresight their particular project will address. The Challenge Awards Group in association with the other sources of assessment that Mrs Williams has just mentioned, and we have enlisted the help of the research councils in this, will give an appreciation of those outline bids. Now, clearly that will not be possible in a very detailed kind of way, but having assessed the bids and undertaken a kind of shortlisting of the outline bids, of which there may be quite a considerable number, those that look really promising will then be invited to make a full bid to the Challenge Awards Group and that full bid will then come in and we will then, with the help of the research councils, for example, be deploying some of the referees, the peer group referees, within the research council system to help the Challenge Awards Group assess the full bids, of which there will be a lot more information about the research methodology and databases and so on, so there are two tiers.

306. There obviously is some concern that the Steering Group does not include any representatives from the live sciences or food and drink sectors and I wonder if you think the checks and balances are sufficient to overcome that disadvantage.

(Mr Freeman) I think they probably are. We should remember that Professor May himself is pretty expert in that kind of area. We will also, as I say, be expecting to draw on referees provided to us, for example, by the BBSRC and the MRC, so we will not be without expertise in that area.

Chairman

307. Could I ask you how many you anticipate awarding? Obviously I know you have differences in scale and differences obviously in the value of the projects, but the object of the exercise, I trust, will be to make a pretty wide distribution to stimulate further application in subsequent years.

(Mr Freeman) Yes.

308. Have you got a fixed idea in mind purely on the quality?

(Mrs Williams) I think the answer, Chairman, is that we do not want to spread the money too thin. I think the terms and conditions document suggested that the typical successful project might involve expenditure of between £1-2 million. On the other hand, we are also conscious of the need to allow the funding of smaller projects and that is projects involving SMEs which would not have the funds to put into large projects. Ultimately, it is going to depend on the nature and the quality of the bids we receive, but I think we are thinking in terms of tens or scores of projects rather than hundreds of projects.

309. And it looks as though the competition may be quite strong.

(Mr Freeman) It looks as though it is going to be quite intense, yes.

Mr Batiste

310. Could I turn to the Foresight secretariat now and my understanding is that the secretaries of the panels came from a variety of departments and that many of them have now returned to the departments from whence they came. Was there a collective debriefing before they went back to see whether any of the administrative aspects of their work could be improved in the future? In other words, the team has been broken up now and people have the first-hand experience, so if the exercise is to be repeated, have you had a debriefing process to learn the lessons that need to be learned?

(Mrs Williams) We have indeed had a lot of debriefing. I should explain that the team has not wholly been broken up and there is quite a measure of continuity. When the Foresight Programme got under way towards the end of 1993, we had to recruit at quite short notice about, I think, seven full-timers to be secretaries for the 15 panels. Because at that stage we did not know how long the Technology Foresight exercise would continue for and whether it would be a success, we appointed these people on one-year contracts, which is why, come the beginning of this year once the reports had been produced, we had to release the secretaries as they had come to the end of their contracts. There is also a core Foresight team within OST and there has been substantial continuity there. We have now recruited replacements for all of those panel secretaries who left and I think in the written evidence that we sent you we did actually give you quite a detailed breakdown of the staffing of the Foresight team this year as compared with the last financial year, and overall we have increased the staffing by four full-time equivalents, something like

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[Continued]

[Mr Batiste Cont]

15 to 20 per cent. In particular, we have strengthened the clerical support available to the panels.

311. That apart, you are happy with the administrative structure that was provided for the panels?

(Mrs Williams) We would always like to be able to offer the panels even more of a Rolls Royce service than we actually provided them with. It was certainly tight, but we managed and we think we have now got adequate resources in place for this next phase of the programme.

(Mr Freeman) I also think we can now look forward, being part of the DTI, to being able to latch on very substantially to a programme of work and assistance that we can look forward to getting, to complement panel activities, from the DTI sector divisions and also the government regional offices. I think that has been referred to in the memorandum that we let you have and, equally, if you wanted to ask any further questions about that, Richard King is here. I do think it is an important feature of this second phase of the programme that we can now interlock our efforts in OST and complement them very substantially with the resources that are available in the rest of the department.

Chairman

312. The LINK programmes and things like that?

(Mr Freeman) LINK programmes.

Dr Jones

313. Could I take up a point that I raised earlier and that was the resources for the dissemination of information. You heard Mr Bennett say that more were needed. Are you satisfied that there are adequate resources for this?

(Mrs Williams) The government have provided quite a lot of money and additional money for LINK. They provided £6 million more for LINK in 1995/96. There is also the Foresight Challenge.

314. Actually disseminating the information to SMEs?

(Mrs Williams) The panels themselves have had a working budget to fund workshops and conferences and produce literature, and then the DTI has a budget of £2 million over this year and next year to fund a whole range of dissemination and networking activities.

Chairman

315. Will they be working with the DTI panel?

(Mrs Williams) Yes. We are working to ensure that there is co-ordination between those DTI sponsored activities and what the panels are doing so that we get synergy.

316. Would you like to break your Delphic silence?

(Dr King) Thank you, Chairman. The resources that we have provided are split equally between the government offices and the sector sponsorship

divisions. The work of the government offices will be to promote dissemination of the findings and to promote further networking activity, particularly in the regions, using where they exist pre-existing business networks, of which there are some quite strong examples around the country. The work of the sector divisions will include a certain amount of interpretation of Foresight findings or tuning them to particular sectors of which our divisions have a very large coverage. That will also involve working with the trade associations and other bodies, including the research and technology organisations, to put out those interpretations and findings to a wider group of companies, particularly the smaller companies which were referred to in your earlier session.

Sir Trevor Skeet

317. Mrs Williams, I referred to the Delphi. It has received very unfavourable comment from Glaxo/Wellcome. They say it is the weakest part of TFP, it is too technical and difficult to answer as well as being irrelevant to their business interests. They go on to say that the Delphi process has served very little use in the overall process. Have you looked at AIRTO? AIRTO make their complaints, but they are suggesting that if it is repeated it should be simplified and made less time-consuming. What is the future of Delphi?

(Mrs Williams) Chairman, we recognise that we do need to learn from the experience of the first Foresight exercise. I think it would have been surprising if we had got everything right the first time. As a first step towards evaluating the various components of the 1993/95 Foresight exercise we have asked all the panel members (that is about 300-odd people in total) for their views on how successful or unsuccessful each element of the process was. They have had a questionnaire to fill in on this and we will over the next few months be analysing their views and reflecting on what will emerge from that. We certainly will want to look very carefully at the design of the next Foresight.

318. You have not made up your mind at the present time what you are going to do with it?

(Mrs Williams) No, we are still reflecting on what can be learnt from our experience.

319. In view of the fact that so many companies have reported unfavourably about it, would it not be a good idea to reach your valuation now and abandon it?

(Mrs Williams) I think we want to see what the 300 panel members themselves think of the process and then we will reach a view in the light of all the various views that have been expressed.

Chairman

320. I think there was one particular additional aspect. The timetable for Foresight was reckoned to be so short that panels had to prepare their draft reports without really getting much benefit from the huge time-consuming Delphi operation and I suspect that is a major problem for you to address.

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[Continued]

[Chairman Cont]

(Mr Freeman) I think that situation did vary quite a bit from panel to panel, Chairman. There were some panels already operating in an area where they were used to talking about science and technology policy and where they had already got pretty close working relationships with the science base, where they were therefore able to take on board the various facets of the Delphi exercise really quite quickly despite the restricted timetable. There were other panels where the whole notion of working with the science base and being deeply involved with science and technology policy was much more novel and where clearly handling all the different components of the process posed that much more of a challenge for them. I think I would like to say that it is the case that we are looking carefully at the lessons that we have learned from that first Delphi exercise. I think it is very important that we do not, if you like, throw out the baby with the bath water in the light of the first round reactions because, despite the criticisms, we got a very good level of response to that Delphi survey. Of about 8,000 questionnaires going out, we got 3,000 back. Some people might be saying that they were not particularly satisfied with their own answers, as it were, but, nonetheless, a lot of the material was useable. We have secured a much higher rate of return than has been the case with national Delphi exercises, for example, in Germany and Japan. So from that point of view there may well be worthwhile components that we should retain.

Chairman

321. Why was the timetable so short?

(Mrs Williams) I think, Chairman, there was a sense of urgency on the part of OST and successive Ministers—first, Mr Waldegrave and then David Hunt—to tackle Foresight in the sense that it was really important to get the science base and industry talking together about how we could better use our science and technology to help industry. The panels have been working towards producing their reports in time to inform the 1995 *Forward Look* and the second Competitiveness White Paper and they did it. In the process of working to that admittedly rather challenging timetable, they generated an enormous momentum which I think we are still feeling and getting the benefit of.

Sir Trevor Skeet

322. Mr Freeman, you are aware that with these several thousand papers that you have got, the firms spent a lot of money filling them in, so are you taking that into account?

(Mr Freeman) Yes. I think one has to look at the Delphi exercise as being an important contribution to a terrific outreach that we secured with the programme and a very, very major degree of consultation was possible. It enabled the first national Foresight exercise in this country to be far, far more I think than a typical Whitehall committee exercise. We had a terrific

outreach with it. That was partly contributed to in no small measure by the fact that we had the Delphi survey. Had we had to try and achieve the same level of outreach using what you might call more traditional consultation methods, regional meetings, seminars and so on, the cost would probably have been just as much as, if not actually greater than, carrying out the Delphi survey.

Dr Jones

323. On that point, you are saying that the level of outreach was wide as a result of the Delphi exercise, but if, for whatever reason, as you were saying earlier, many of the panels were unable merely to take those into account in reaching their recommendations, would it not be true to say that in some cases the recommendations are based on a much narrower range of opinion than might appear at first sight and is this a problem?

(Mr Freeman) Yes, I would accept that the amount of time the panels had to take on board and digest the Delphi findings was limited and hence in that respect the degree to which the findings were used and reflected in the full analyses varied from panel to panel and certainly one of the lessons that we have taken away from the first exercise is that next time around, assuming we do do another Delphi, we need to phase it in and give the panels (or the equivalent to panels, whatever they will be then) rather more time to digest the results of that type of survey than perhaps we had the first time.

324. Does it not undermine the whole exercise in fact if you say there is consultation, but that consultation is not effective?

(Mr Freeman) I do not actually believe it does.

325. Then are you satisfied that what is coming out of the panels is truly reflecting what people think?

(Mr Freeman) I think some of the panels' reports did reasonably successfully take on board aspects of the Delphi survey, even if it was only to the extent of helping them to confirm analyses that they had already made and data that they had secured from other sources. As I say, I think the Delphi exercise also had a value, an important value, in emphasising that Foresight is a consultative process. It is a process which involves a much wider community than a traditional committee-type investigation which we have got so used to.

326. Will we have any analysis for future use of the use to which the various panels made of the consultation exercise so that we can in future, when we see what the outcomes are, see if that is relevant?

(Mr Freeman) As Mrs Williams has indicated, we are canvassing opinion now amongst the 300-odd panel members about what they thought of the Delphi process, how valuable it was, as well as other aspects of the Technology Foresight Programme.

(Mrs Williams) I agree with everything of course that my colleague has said, but I just want to come back, as it were, on a small factual point. All the panels had the first round Delphi results in the first half of

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November 1994 and then they had the final results, because there were two bites of the cherry, in mid-December. So all the panels did have access to the outcome of the Delphi survey before they completed their reports, and they were completing their reports in February.

327. It was suggested to us by Professor Day that they actually ignored the results because of their inadequacy.

(Mrs Williams) With respect, I do not think that is correct. Some panels highlighted the Delphi results in their reports and others chose not to highlight the results, but I do not think that means that the panels ignored them.

Chairman

328. Mrs Williams, that is the end of our questioning and I must say, on behalf of the Committee, I am most grateful for the extremely competent way in which you have handled these issues. I think we realise that OST has put in a huge effort in a relatively short timescale to get a new direction for the evaluation of science and to prioritise issues and prioritise objectives in various areas, and I think we are delighted that this has got off the ground in the way it has. We shall look forward to seeing you again if you are willing to come and give some more Delphi utterances to us. Thank you very much indeed.

(Mrs Williams) Thank you very much.

**Letter to the Clerk of the Committee from the Office of Science and Technology
following oral evidence given on 1 November (TFD 79) (27 November 1995)**

Thank you for your letter of 2 November, asking for further information about Technology Foresight and the Forward Look. I attach an annex addressing the topics you raise. I am sorry that it has not been possible to let you have it sooner.

We are in process of considering the content and format of the 1996 Forward Look, and I thought it might be helpful to let the Committee have an early indication of the sort of document we envisage.

The 1995 Forward Look was a comprehensive document, which provided a valuable work of reference. It made great strides towards the White Paper goal of giving the industrial and research communities, and others, a clear and up-to-date statement of Government strategy for science, engineering and technology (SET).

In planning for 1996, OST aims to build on previous work and to make the Forward Look more effective in its presentation and influence. In particular, we aim to produce a document which provides a clearer statement of the Government's strategy and key objectives for SET and the current and proposed measures for achieving them. It should focus on forward plans for expenditure, the policy developments which underpin them and the extent to which they are meeting White Paper objectives. It should be fully informed and shaped by Technology Foresight findings and should report the work done on output measures and performance indicators. It will reflect the transfer of responsibility for science, engineering and technology policy to the DTI and the opportunities that this presents to exploit DTI's contacts with industry.

We are still developing our thoughts on how these aims might best be achieved and discussing them with other departments; but the result is likely to be a shorter document, if possible a single volume of reasonable length. This may mean publishing a separate volume of statistical information; we are discussing the options with the Central Statistical Office. We are aware of the need to provide continuity in the data sets published and in the coverage of the document as a whole.

We believe that the result will be a Forward Look which proves even more useful to the Committee and to other readers.

TECHNOLOGY FORESIGHT AND THE FORWARD LOOK

The Committee would like more information on the DTI's income from and expenditure on research in the past and projections for the future. They would like to receive, for the years from 1992-93 to 1997-98, the expenditure or planned expenditure for projects included under Table 20.2 of the Department's entry for the Forward Look broken down, for example, to show allocations to the LINK programme or EUREKA (rather than total programme costs, as given in the Departmental Report). Some of these figures are already available in the Departmental Annual Report, but may have been adjusted in the light of the extra funding for Foresight. I would also be grateful for an

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explanation of how the figures in Table 20.2 relate to those given in the table for "Industrial Research and Space" on page 61 of the current Departmental Report and the projects covered in the Chapter on Innovation and Technology in that Report.

Table 20.2 in DTI's Statement in the 1995 Forward Look gives an overview of DTI's total expenditure on S&T, broken down by main budget headings. The statistics are supplemented by a detailed description of the programmes and projects supported under these headings. Further information on DTI's S&T expenditure is given annually in the Trade and Industry Expenditure Plans Report.

A breakdown of Industrial Innovation spend is given in the table on "Industrial research and space" on page 61 of the Government's Expenditure Plans 1995-96 to 1997-98 for Trade and Industry. As requested, a further breakdown, showing expenditure on programmes such as LINK and EUREKA, is given in the attached table. Allocations of funding are subject to the PES 1995 settlement. The Department will set out detailed S&T expenditure plans resulting from the current year's PES round in the 1996 Trade and Industry Expenditure Plans report, due to be published in March 1996.

The Committee would also like to know how the extra £70 million allocated to Foresight by the DTI will be spent. In the light of Mr Taylor's comment that "the definition of new money is money that had not previously been assigned to that heading" (Q. 97) the Committee would like to know whether money was transferred from other headings to provide the extra sums for the DTI and the OST foresight initiatives referred to. The Committee would be grateful for copies of recent speeches made by Mr Taylor to the Royal Institution and to the CBI.

The Department provided to the Trade and Industry Select Committee, in July 1995, a note (attached) on the distribution of the £70 million announced in the second Competitiveness White Paper. The Department's spending proposals under these and other headings are subject to this year's PES round.

The £40 million allocated by OST for Foresight initiatives was announced by the then Chancellor of the Duchy of Lancaster on 22 May 1995 as being "extra public money" and was added to the OPSS provisional plans in the 1995 Forward Look (Volumes 1, Table 1).

Copies of Mr Taylor's speeches at the Royal Institution and a CBI/AIRTO conference are enclosed.¹

Why has it proved so difficult to provide the information on Framework Programme funding promised in paragraph 55 of the Government's Response to the Science and Technology Committee's Second Report, Session 1993-94 or even a total figure for receipts from EU programmes?

It was not possible to announce a figure in the 1995 Forward Look because estimates of the amount received by the business and university sectors (the largest components) were not available in time.

The estimated total for 1993-94 (the latest year available) is £218 million. Of this, £104 million was received by business enterprise, £97 million by the "old" universities and the remainder by Government departments and Research Councils. Figures for the "new" universities and for other recipients such as charities and research associations are not available. The data is gathered by asking the organisations who do the research about their sources of funding for their work, so even for the sectors included above the figures are likely to be an underestimate.

We expect to be able to publish a breakdown of the figures for 1993-94 in (or in association with) the 1996 Forward Look. We may also be able to include figures for 1994-95.

Why is it not possible to break down the attribution of EU research funds between individual departments in accordance with the recommendation in paragraph 9.41 of the Report on "The Impact of European Community Policies for Research and Technological Development upon Science and Technology in the United Kingdom" (July 1993)? (See also Questions 33 and 34 of the session with the President of Board of Trade). Have EU receipts been attributed to the OST in the past?

Attribution of the cost to the UK of EC R&D programmes is calculated each year on the basis of policy responsibility and is one of the inputs to the annual Public Expenditure Survey. This arrangement allows for EC expenditure on R&D to be taken into account in the expenditure discussions; but, because attribution is an input, not an adjustment made at the end of the Survey, there is no way of determining precisely its effect on the final provision for domestic S&T.

The percentage attribution of the total R&D programme expenditure for DTI (excluding OST), the Science Budget and other departments for this year and last year is attached. EC expenditure has been attributed to the Science Budget since the mid-1980s.

¹ Not printed.

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[Continued]

DTI industrial innovation expenditure, March 1995 (£ million)

	1992-93 Outturn	1993-94 Outturn	1994-95 Estimate	1995-96 Plan	1996-97 Plan	1997-98 Plan
Industrial Innovation, of which:	135.4	126.2	114.3	108.8	104.9	111.2
R&D by Small Firms, of which:	18.0	21.5	19.6	16.5	16.3	16.2
—SMART	12.1	12.8	12.3	10.9	11.0	11.0
—SPUR	5.9	8.7	7.3	5.6	5.3	5.2
Collaborative Research Projects, of which:	94.9	83.0	65.9	46.8	34.1	36.6
—LINK	15.6	14.9	14.1	15.3	17.4	18.8
—EUREKA	22.7	19.9	19.8	14.4	12.5	13.4
—Other Collaborative R&D	56.6	48.2	32.0	17.1	4.2	4.4
Sub-total	112.9	104.5	85.5	63.3	50.4	52.8
Technology Transfer, best practice and other innovation	22.5	21.7	28.8	45.5	54.5	58.4

Notes:

1. A breakdown of "Industrial research and space" table, page 61, Trade and Industry Expenditure Plans report 1995.
2. The "sub-total" line (i.e., the R&D element of Industrial Innovation) equates to the Industrial Innovation line in Table 20.2, page 117, of DTI's entry to the Forward Look 1995, although in this instance the 1995 Forward Look includes additional funding in the years 1995-96 to 1997-98 as announced in the second Competitiveness White Paper.
3. "Other Collaborative R&D" covers closed programmes such as Advanced Technology Programmes and General Industrial Collaborative Projects.

FOLLOW-UP TO SIR PETER GREGSON'S APPEARANCE BEFORE THE TRADE AND INDUSTRY SELECT COMMITTEE ON 28 JUNE 1995

What are the reasons for the planned changes in the composition of expenditure on industrial innovation between 1993-94 and 1997-98?

Over the period 1993-94 to 1997-98, the balance of DTI's expenditure on industrial innovation will shift away from generating new technology to concentrate more on encouraging companies to exploit existing technology better and on influencing the broad environment which allows innovative firms to flourish. This shift in emphasis is a result of DTI's review of its innovation policy announced in parallel with the Government's White Paper on Science, Engineering and Technology, in May 1993.

The Department has allocated a further £70 million to new science and technology activities over the next four years, as announced in the Competitiveness White Paper "Forging Ahead", published on 22 May 1995. Of this, £42.6 million is new money from Treasury, with the remainder being found from existing budgets. The money is planned to be spent on five broad areas, as shown in the table below. Much of this money will directly contribute to DTI's implementation of the Technology Foresight Programme.

Distribution of additional £70 million for DTI Science and Technology activities

Programme	Allocation over four years 1995-96 to 1998-99 £m
LINK	New LINK programmes (additional to DTI's annual commitment to LINK) 11
Smaller Firms	Additional support of the SPUR scheme and new support to help smaller firms gain access to finance 18
Information Society Initiative	A new information Society Initiative to support the development of multi-media applications 18
Technology Transfer	Increased support for technology transfer, particularly accessing overseas technology 21
Foresight Networking	New support to disseminate Technology Foresight on a sectoral and regional basis and encourage networking 2
Total	70

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[Continued]

Percentage attribution of EU R&D expenditure

	1994	1995
DTI (excluding OST)	60.6	57.7
OST (i.e., science budget)	13.5	13.5
Other departments/unallocated	25.9	28.8
	100	100

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[Continued

WEDNESDAY 22 NOVEMBER 1995

Members present:

Sir Giles Shaw, in the Chair

Mr Spencer Batiste
Dr Jeremy Bray
Mr Ian Bruce
Dr Lynne Jones
Mr Andrew Miller

Sir Trevor Skeet
Mr Patrick Thompson
Sir Gerard Vaughan
Dr Alan Williams

Examination of witnesses

DR ALAN RUDGE, Chairman of the Engineering and Physical Sciences Research Council and Deputy Group Managing Director, BT, and DR DAVID CLARK, Director of Planning and Communications, Engineering and Physical Sciences Research Council, were examined.

Chairman

329. Dr Rudge and Dr Clark, you are most welcome and thank you very much for giving your time to come to the Committee. There are several reasons why we welcome you—not only because of your eminence in your field and your activities with the EPSRC, but also because it so happens this is the final evidence session I think in the Committee's inquiry into the Technology Foresight system as presently applied, and we do recognise of course that it is very early days but we nevertheless felt it right to make a relatively short inquiry as a dipstick at this stage to see how things are going, how they are settling and how the Councils feel about the Foresight initiative. Can I start with a general question which either of you may wish to answer: the Government has said that innovation is substantially the responsibility of companies. Do you agree with that?

(Dr Rudge) That sounds like a good one to start with! It depends on how you define "innovation". If they are defining it as the complete process, that is, the innovatory process as being one which includes, if you like, the start of the concept right through to delivering a product and servicing the marketplace, then definitely predominantly it belongs to industry. I think you have to then say "What is university research and why are we doing it?" Indeed, you could ask the question "Why does Government fund research at all?" I think I asked myself that question because after all, the research councils spend £1.2 billion per year and before I took up my job I had to ask myself why we spend the money at all. If you were trying to justify it on the basis of inventions, or even Nobel prizes, then I think you would have a pretty tough case to make. I think you could buy them cheaper than that! So why are we doing it? I think the reason is to build the core technological competence of the nation for the next generation of challenge. You are actually building pools of expertise in different areas, and those areas of expertise will furnish you by a number of routes with

the expertise the nation needs to tackle the next generation of technological challenge. And those levels of challenge are considerable. That is why we spend it. When you go through it on that basis, it is fully justifiable and we do not have any problem with it. The innovatory process defined in this way really belongs to industry, in that what the university research sector is primarily building is the core competence, the expertise, which can be tapped and which will feed the innovation in industry. I am speaking very broadly here and there will always be an exception, of course.

330. So as a research council you would feel your role is to be an engine, at least, on which Government money reaches the level where it still stimulate the core or create the core within which industry can then fundamentally develop? Do you see any other role for Government in that?

(Dr Rudge) I think there is a role, and you have to consider what the role of the research councils are vis-a-vis Government. Let me try to explain that, in our view, the Government really sets the broad policy and decides how much money it can afford to spend in this area of competence generation. The research council takes the Government's policy guidelines and the funding and it does two things: first of all it sets up a broad map of areas of activities which it believes are relevant to meeting Government policy—and remember a strong element in the new Government policy was that research should not only be excellent but also relevant. We interpret that relevance as meaning that our broad areas of activity should be relevant, and we spend some considerable time in the research council trying to map the broad areas—not deciding on one project against another. We then have an executive whose task it is to populate the map with projects. To do that we go out to the academic community and ask for 50 per cent. of our projects to be proposed by them in responsive mode within these very broad maps.

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[Continued]

Dr Bray

331. On the core competence, there are two aspects of it commonly referred to: one is the training and research and the other is the generation of know-how—that the current generation of scientists ought to know about quantum case, for example, and that they can handle it competently if they have only been taught undergraduate level work. How far should the know-how aspect of it be carried through by the research councils into education?

(Dr Rudge) We regard ourselves as an agency of government, and our task is to build that competence. As part of our remit, we consider it our duty to try to determine that there is a sensible flow or interaction between the knowledge bases we build and Industry, and we take a strong line both in terms of looking for that to happen and trying to encourage it. So our remit, I think, extends as far as trying to ensure there is a good interface between the people we are funding and Industry.

332. It is a highly dynamic situation, because your invention or discovery today has no application at all. It may well be very important in its application in ten years' time so, within that pipeline, the research councils presumably have to look down through that future pipeline all the way to as far as they can see towards that application?

(Dr Rudge) Our task I think is to ensure two things: that the work is done in a relevant area, and that the research is good quality research. To obtain research money, a researcher submits a proposal which indicates "this is the area I am going to work in: this is what I am hoping to achieve and here are some milestones of my programme of work". Our task is to ensure that that plan is followed, or if it is diverged from that we understand why it is diverged from. In other words, that it is a good quality decision and we are not giving money out to somebody and having them spend it idly. I cannot tell whether the outcome of some piece of research among the many hundreds of projects we support is going to be called a breakthrough in ten or twenty years' time, but we can tell if it is good quality work being done by good quality people, and that whatever they say they are going to do, they do.

333. Supposing you have a situation where a new discovery has been developed further, and it is thought likely that there are applications but there are no commercial companies prepared to carry it through to the point of application, yet they clearly want the steps taken in research and development needed which take it on further. Should the research councils have an obligation to take those further steps if it seems likely food for further investigation?

(Dr Rudge) I think that has to be a matter of judgment because we are talking in a very generic way now and we have to look at the specifics. I do not think they have an obligation to do it in the sense that we have limited funding and, therefore, our task first of all is to ensure that we maintain a broad range of research activities. As you well know, one can take a good concept which has been demonstrated fundamentally in a laboratory, but the cost of taking

that through to some product or service is ten or 100 times the research expenditure. The cost spirals enormously very rapidly and it would soon be beyond our capabilities to fund, particularly as we would get no return from it.

Sir Gerard Vaughan

334. Are you happy with the way things are working? You have told us what your aims are, but are you happy with the way it is working out at the moment?

(Dr Rudge) At the moment, yes. We in the EPSRC have introduced a number of very fundamental changes in the way we work to try to make ourselves a more effective agency and I think after the first twelve months we are feeling that we have made significant steps and that the process is working. That is not to say we are totally satisfied with everything we are doing because of course we are not. But if you go back to the question Dr Bray put, should we follow the development through and should we be funding demonstrators, I do not think we should, I really do not think we should.

Sir Trevor Skeet

335. Dr Rudge, I am very impressed by your idea of area descriptions and area maps. What is the distinction between the kind of research conducted by BT and that conducted by the EPSRC? Surely what BT does is very much broader than would be done by the Research Council which is limited in funds?

(Dr Rudge) No, I would not say that. I would say it is the other way round and what BT does is very much narrower than the Research Council. BT has a similar process to Foresight. In fact the OST visited BT before coming up with the Foresight process and I suspect that it was influenced by our process. We do exactly the same thing within BT. What we do is we look at the future of BT in terms of its strategy, its ambitions and goals and we try to deduce what are the technologies which will be key and we draw our map. We then invest our research money to grow expertise in the areas which we think are going to be key, but that is a much narrower range of activities than would be performed by the Research Council which looks at a very broad range of potential business opportunities.

336. But, Dr Rudge, you can see the conflict with an earlier statement that you made, that so far as public monies are concerned, if they are prepared to do a broader area, why not let the public do it and why do it by the company? Surely you are interested in this particular sector and would you not pursue it with enthusiasm?

(Dr Rudge) Of course. If you take a sector that BT is interested in, which is quite a broad-ranging sector, but it is not involved in chemical engineering, for example, or many of the other things that the EPSRC does. Then we mine those areas as thoroughly as we can, but there is an enormous range of possibilities. We also take a part of our research money and place it with the universities and we do that because we want to tap into the expertise and knowledge which is being built into the universities.

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[Sir Trevor Skeet Cont]

337. Yes, but would it not be right to say that you pick up the relevant parts, leaving it to the others if they want to expatiate on it more broadly, and you leave it to them?

(Dr Rudge) We hope we get the relevant parts and of course one has to have a portfolio of research activity, you cannot base it on a single project. But you have a portfolio, some of which pans out and some of which does not. For example, in BT we do not put our money into chemistry, but the chemical industry does. But with regard to the work that the EPSRC would stimulate in information, radio and communications-type technologies, where those areas are strong we would certainly be putting our money into the same departments to try to build competence in those departments. And similarly in the other areas which we foresee in the future are going to be key to us.

Dr Williams

338. Can I ask about your links with the universities? I understand that you hold university information days. What exactly are those and should other companies follow suit?

(Dr Rudge) Sorry, are you asking a BT question?

339. Yes, on your links with universities. I understand that for information purposes, in order to tell them what you are doing, to interest them in your work and to find out what they are doing you hold seminars and courses with the universities. Could you describe broadly what you do in those information days and whether other companies should be doing something similar?

(Dr Rudge) Other large companies may well be doing something similar, but we do a number of things. One is that we have short-term fellowships where we have academics coming to spend time in our laboratories and we have longer-term fellowships where they spend longer times in our laboratories. This enables them to build relationships and to understand the kind of thing we are doing, and we hope the relationships will benefit us in the future. Also in terms of the seminar approach, we choose a broad area of activity that we think is going to be key to us or we think is going to be a problem in the future. We invite a number of university departments or groups to come to our laboratories and we give them a day's presentation telling them why it is important to us, and what our problems are. We then ask them to go away and for those who are interested to submit us a proposal with a framework of £1 million for a five-year programme. We want to know what they can bring to bear if we were going to fund them within this envelope. What can they bring to bear, what resources have they got and how well will they manage it because we are also interested in management of research and we look at research management as an important challenge.

340. Of your R&D budget of £240 million a year, it is only about £4 million invested in universities. Why is that so low and how does that compare, say, with your competitors overseas in Germany, the

telecom industry in Japan and the United States? Have they got much closer links with education institutions?

(Dr Rudge) Well, I doubt that they have stronger links than we have with our universities in the UK. They will have their own programmes and I have no idea what the money is because they do not usually declare it. First of all, the £4 million is identified as strategic university research and it does not include the fellowships and it does not include academics that are often paid to take part in projects directly as project support. In other words, if you are working on a project in a particular area and you know in Essex University that there happens to be an expert, you may well pay that expert to come and contribute to your project, and that is not included. The £4 million is definitely set aside as university research money. About 6 per cent of our research fund. Corporate Research is money that we are spending not directly associated with a product or service, and we are spending it to build expertise. From my point of view, on occasions I will be willing to spend more if there was the expertise there to tap. The number of people we have in the UK, for example, in some of these areas is fairly limited and there are other companies obviously taking up their time, so there just are not the people available.

341. Is there a closer co-operation though in our competitor countries?

(Dr Rudge) I do not know of any of our competitors that do more than we do in terms of relationships with academics because we actually manage it. We have people whose job it is. We have a small unit whose job it is to actually manage our interface with universities, and for every university in the country we have a member of our research staff identified with that university just as a general contact with the university. In addition to this our Programme Office has people whose job it is to go out and find out what is going on in the universities and identify where we can build relationships.

Mr Batiste

342. Following really from that last point, we had several examples when we were visiting the United States where companies had not dissimilar relationships with the universities to the ones you have just described, not just for participation in projects or just for research, but for actual products that might be exploited where an academic may well come up with an idea which is a very exploitable proposition and look for a company or sponsor to develop it in America, but mostly that would happen in small businesses or start-ups very often with the intervention of large companies behind it where it might pick it up later to develop it beyond a certain point. Is this part of your experience in the UK as well?

(Dr Rudge) Yes and no. What you have to understand also is that BT is not in the manufacturing business. We do not make telephones and we do not make switches and all those things which 20 years ago perhaps we did. We do not do that today, but we go out to industry and buy that stuff and we specify what we want. Basically what our research activities are

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concerned with is the development and the management of huge systems that have to manage and control the networks of the future. Occasionally we can go to a university for a product, I can think of one project in particular where the academic was a mathematician and what he offered us were some algorithms which allowed us to route traffic through a network more efficiently than the systems we were using on the day. Now, we actually entered into a contract with that academic and took his product, and we eventually applied it in our network. There are therefore cases of it, but there are not so many cases of a specific type where you go and see somebody who has got a new widget for a telephone, say. I often get people writing to us with these ideas and I have to tell them that it is not our business and we do not actually make telephones.

Mr Miller

343. Dr Rudge, the Steering Group Report made a number of recommendations on infrastructural issues. For example, paragraph 40 starts off by saying something that appears at first sight to apply BT's argument on the asymmetry rules in that it recommends action being taken to address various regulatory issues identified by panels as influencing the competitive scope of sectors should be taken forward by the DTI deregulation units and relevant Government departments. Many of these recommendations are not specifically related to research topics but are intended to ensure that the regulatory system is favourable for innovation. How important are those particular recommendations to you?

(Dr Rudge) That depends on whether anybody listens to them or not. The fact that they are identified not by BT but by people active in the industry and in technical areas for support within the Industry is interesting. Certainly the regulatory environment is very critical for the United Kingdom. We have got a regulatory environment which is very focused on competition in the United Kingdom, trying to get a balance of competition within the United Kingdom. It does not give much attention to the competitiveness of the United Kingdom, and how the companies here can compete with other companies around the world. Because the technology change is very rapid today and the markets are changing and merging at a very high rate. It is very difficult to identify which market is which and who is competing with whom today in the IT world. Everybody is coming from different directions and competing in the same market place. If you look at the problem of regulation which is intended to follow the lines of either the technology or market sector, then the lines can become nonsense in a very short time because of changes in the market place. When the market does change, those regulatory lines can often become barriers to progress. They slow companies down, and it is that slowing down which knocks-on right back to the research end of the business where people see we are not making the progress we should be making. That is why you get the kind of comments we have had in the Foresight

panels made by people who can perceive that certain matters were not moving and were being blocked.

344. But in your particular industry this could presumably mean a change of regulatory regime—let us say the merger between OFTEL and ITC, for example. Do you think all these sorts of structural changes identified will take place? What are the obstacles in the way stopping them from happening?

(Dr Rudge) As you gentlemen may well know, there was a Select Committee that looked at the regulation in the area of broadband networks—the so-called Super Highway area—and the Committee studied the issue and became quite expert in the problems and made recommendations. It happened that those were not taken up which was disappointing to me in particular and to some of my colleagues and other people in the industry. Whether anybody would listen to the Technology Foresight analysts and act on their advice when they would not act on the Select Committee's recommendations I do not know.

345. If they are not going to listen to the arguments coming from one of Britain's successful companies, what hope is there that they will listen to a body like the Steering Group?

(Dr Rudge) I hope that you gentlemen perhaps would ask yourselves that question.

Chairman: That is a very fair response, if I may say so. We will apply our minds to just that!

Dr Jones

346. Following on from that, we have been told briefly by other witnesses that if Foresight is going to be of any value, the findings have got to be disseminated right down to the SMEs and also the OST told us they were planning to have some kind of output measures for the process. Could I ask whether you agree that it is appropriate that we should go down that route, and what you feel about the mechanisms that have been set up for doing that and the resources that have been devoted to it, and whether they are adequate?

(Dr Rudge) I should make it clear right at the beginning that I believe the Foresight basic concept is a good one. The idea of pulling together this knowledge and trying to map out what are the key underpinning technologies in the future I think has to be a good thing. Certainly we do so in BT and I see on a national scale that it is still an equally important exercise. I think it is important to recognise that Technology Foresight is part of the process and not the complete process. We in the EPSRC see it as a very key input to what we do. We designed our system to accept the Foresight recommendations as part of the input to help us formulate our map of relevant areas of activity. We look upon it as a key input—not the only one, but a key one. We are, therefore, in this case the other part of the process. We are the people who take that guidance, implement the practical research projects and carry them through. In industry it would be the task of the companies. Now, you said that the recommendation has itself got to be got down to the small and medium sized companies. I think that is true, and I think the communication exercise ought to

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[Dr Jones Cont]

receive due attention and that we ought to ensure to the best of our ability that we do communicate. When you get down to the very small companies, there are many of them for whom it will have little meaning. There is too big a gap between the level of the Foresight recommendations and somebody who is struggling for the existence. It depends very much on the nature of the company, and the kind of broad advice, or even detailed advice, given is not likely to lead to some small company shouting "Eureka" and making a fortune. But it may well mean that advice is given to a large number of small companies as to what changes could be imminent, and therefore they would be alerted to the fact that their businesses have got to change.

347. Can I direct your mind to the actual process? Obviously the two organisations you are representing here are very attuned to what is going on, but how do we disseminate the findings to people who are not at the moment involved in those networks? Mr Bennett of AIRTO said his organisation would be interested in taking part in that process, but that they have not got the funding to do that. Should there be additional funding made available for this process and who should be doing it and where should the money come from?

(Dr Rudge) I am a strong believer in making use of the AIRTO type structure. In other words, the fact that there are 100 independent research and technology organisations out there who have strong links with small and medium sized companies seems to me a mechanism that we ought to make use of in terms of communicating and interpreting the benefits of these exercises. You asked me whether there should be more money. Well, it is very easy for me to say "Yes", but nobody ever says where it is going to come from, and I think it is something that should receive attention. This research council is putting forward a concept called the Faraday programme, which is to help close the gap between the academic world and the AIRTO and similar organisations and, with the DTI, to help the onward dissemination of information and support.

Dr Bray

348. You have yourself had experience of AIRTO, is that right?

(Dr Rudge) I was their first President about fifteen years ago.

349. And you are a director of one of them?

(Dr Rudge) Yes, about eight years ago, but I therefore know their strengths and weaknesses.

Mr Thompson

350. On the question of funding, it is not quite clear to me (and I am a latecomer both to this Committee and this Report) where you feel the funding should come from. I was at a meeting only yesterday lunchtime with a senior industrial engineer. I do not necessarily share the view he put forward, but he said he did not think this was all a very good idea, and he would much rather see any funding provided by industry go more directly into industry itself, so he was

critical of Foresight. Could you say a little bit more about that and would you be able to convince this industrial engineer that money ought to be coming from industry as well as from Government?

(Dr Rudge) In terms of the dissemination of information?

351. In whichever way you like to take the question.

(Dr Rudge) I think the dissemination of the Foresight information should be Government funded (if it is going to be funded) but I think industry has to pay its dues by actually devoting the time and the attention to receiving it, because we are talking about people's time here.

Chairman

352. And using it?

(Dr Rudge) Yes, and if they were going to divert key people's time to attending seminars and so forth and picking up information, then any company would want to see some benefit from it otherwise why spend the resource in that way? So I think there is a contribution from industry. I think the communication process, since the Government owns Foresight, is probably something the Government should fund.

Mr Batiste

353. When this Committee was taking evidence about the Japanese system, we were very struck by the amount of time and effort which companies put into what they call the "grey information system", a very informal network of people passing information between companies and different organisations interacting with government. Then when we took evidence in this inquiry into the Foresight process, we found very many people emphasising the importance of the informal networking that it seemed this programme created and it seemed that this had identified rather a great lack in the British system up until this point that people had found Foresight had spun off. Would you agree with their assessment, that this was important?

(Dr Rudge) Yes, I think I would and as David and I were discussing this outside, perhaps he would like to say a little bit about networking.

(Dr Clark) From my perception, one of the great benefits of Foresight has been the added benefit of the networking. I think the Foresight reports by themselves were quite valuable. But in the process the fact that the providers of knowledge in the universities, and the users of knowledge in industry and commerce and elsewhere, actually got down together to discuss the national research agenda, I think has been of enormous benefit. I think as well as the dissemination of the results of Foresight, maintaining those informal networks should be an important part of, and on-going form of, Foresight.

354. You lead me directly into my next question. How do we go about reinforcing and maintaining these networks and who should be doing what?

(Dr Clark) Well, I think the fact that the individual Foresight panels, or, in one case, a reconstituted panel,

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are now on-going, I actually think personally that one of their most important roles is to keep this catalysed networking. I think that is probably a more important role for those individual Foresight panels than sitting back and saying, "How are we going to implement what we have already done?", because clearly what has already been done, as Alan said, has been fed into the research council process and other organisations. I think it is their responsibility to take account of Foresight recommendations, rather than the Foresight panels to sit back and say, "Let's keep an oversight and make sure people do what we tell them to do". But the panels were responsible for building up these networks and I think that that is a very important continuing role that they could actually play.

Chairman

355. Has your Council made a recommendation to that effect?

(Dr Clark) No, it has not.

(Dr Rudge) We have not made a recommendation.

Mr Batiste

356. If the panels then are to be at the centre of this development of networking, which I think most people would regard as sensible and desirable, is there a role which the Government can play additionally?

(Dr Rudge) We just said, I think, that the communication is a government role. But first of all we have to consider whether Foresight is a one-off thing and I do not believe it is.

357. I meant in relation to the networks specifically.

(Dr Rudge) I understand, but I was just saying that you must assume that the Foresight process has to be an on-going process or it does not have value. Because the world does not stop just because we have stopped doing Foresight—it is changing all the time. Therefore, you need to have a meeting of knowledgeable people, that is an on-going process of Foresight, perhaps with a few less people involved, but, nevertheless, an on-going process. If you assume that, then I guess the Government's responsibility will be to ensure that there is communication coming out of those panels and that the panels themselves are properly organised and that there is dissemination of the results.

358. Essentially that there is secretarial support for the panels to ensure the structure is there?

(Dr Rudge) And perhaps some funding of the communication process, whatever is decided.

Chairman

359. Could I ask in relation to your last remark, I take it your Council would be of the opinion that the Foresight process should continue?

(Dr Rudge) I have a lively Council, so I would not like to speak, as Chairman, on their behalf without having discussed this subject with them. But my guess would be that they would agree with the view that

both David and I would offer and that is that it should be on-going.

Dr Bray

360. Can I ask Dr Clark whether the Foresight process has influenced the allocation of funds in either the responsive mode or the directive mode?

(Dr Clark) In both. Can I just say that the interactions between EPSRC officials and the OST during the Foresight process have actually been very good and very business-like, and at various stages in the preparation of individual panel reports, they let us see them in draft and so forth. So when the EPSRC came out for the first time and said, "Here is the programme we would like", and in February of this year we came out with the broad map that Alan described and we put it out for consultation with the universities and said, "Please put it in a responsive mode or target programmes in these areas", that process was already picking up the emerging findings of Foresight. We have just gone through that process again of establishing the Council's priorities, and we will be going out again into the community in February with a new, slightly refined map, and Foresight will have figured in that because the two expert panels which inform the Council were asked to take particular account of the final recommendations of the Foresight in coming forward with their recommendations. So the Council is just going through the process, and we will have to await the Budget next week, of thinking where money should be going next year, and already there is an indication that things like further research into sensors, which is one of the generic technologies featured by the Foresight, is likely to happen. So I think in establishing our priorities, Foresight has been taken account of, but, as Alan has said, it is one form of guidance amongst many.

361. In what respects is the procedure now different from what it was before?

(Dr Rudge) In the EPSRC?

362. No, in response to the community in evolving and developing the map.

(Dr Rudge) Because when we change the shape of the map, it changes the funding that flows down to the individual programme areas and, therefore, would change the number of projects one can fund in those areas.

363. The EPSRC has always been in dialogue with the community.

(Dr Rudge) That is right.

364. And refining its plans in the light of the actions. What I am asking is how far has the Foresight exercise changed the way the Research Council reacts to the science community in its concerns?

(Dr Rudge) You say that the Research Council has always been in touch and it was in a funny way, but very much a bottom-up sort of thing where there were a lot of politics in whose projects got to the top. And a very hierarchical system of committees. Committee on committee. So in my view a project rose until it reached a committee where nobody understood it and

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then it was either funded or handled otherwise. We have changed that because we have inverted the process. What Foresight does for us is it performs a big exercise of drawing in the information and formulating it in a concise way. An exercise which otherwise we would have to organise for ourselves and individually as research councils. Or at least cooperatively if the other councils follow our process. So it is a big exercise and an important input to us. We still listen to the supplier base, if you like, but we take this nice, concise set of recommendations and inputs and we lay them against our map and overlay them and make adjustments where we think it is appropriate.

365. What you are describing is where the Foresight process is more or less now an integral part of the EPSRC process.

(Dr Rudge) We built the new EPSRC process in anticipation of Foresight. We knew at that time that Foresight was going to come. It came twelve months after we had started operations, so we built our process anticipating that it would come.

Dr Jones

366. If you move to this top-down, as opposed to bottom-up, process, are you confident that if there is somebody at the bottom who has got a brilliant new idea your new structure will be able to pick that up?

(Dr Rudge) Very much so because we do not tell the individual researcher what project he should recommend to us. But we map out very broad areas of relevance, and they are pretty broad areas, and the individual researcher can put his proposal forward and it is peer-reviewed. In other words, we use the experts out there, his peers, to actually decide which projects to go for.

367. I understand the process of peer review.

(Dr Rudge) What I mean is that the peer review process is to do what they (the researchers) are very good at doing. They can judge the priority order of projects. We the Council cannot judge that and the executive does not try to judge that, so we let the peers do that, so it still goes through the peer review process. But we have decided on the broad map of where we are going to put our pots of money.

368. But they are expensive.

(Dr Rudge) They are always expensive.

Mr Bruce

369. Chairman, before starting my questioning I have to tell you that I am a paid adviser to the Telecommunications Management Association and I tell you that because BT interacts with them a great deal. The question I was going to ask you I think you have almost answered, but I think it is important to put it on the record. The Royal Society has expressed concern about the distortion of funding because of the Technology Foresight programme and I am going to read what they have said because frankly I cannot understand where they are coming from and I think it is important that we understand what they have said.

"The Society's greatest concern is that the pressures for implementation of TF [Technology Foresight] will be unevenly felt across funding agencies, government departments and industry. We believe that disproportionate pressure on OST-funded agencies, or inadequate responses from other government departments, will seriously reduce the benefits of TF, distort research council programmes and lead to a divergence between OST-funded science and that supported from other sources." Do you agree with that, or do you think the opposite: that this process is going to get rid of some of the distortions currently in research councils?

(Dr Rudge) I think what is referred to here is what I would call a danger of a misuse of Foresight. We have a Foresight process, and I think I have described to you how we think it is important to us in terms of mapping things out. There is also a danger that, in attempting to hurry the process somehow and ignoring the fact that Foresight is only a part of the process, for the OST or Government to try to take projects out of context and fund them independently. Picking projects out and running with them before they have gone through the process I have just described to you, there will be a distortion in research council funding. Foresight should not attempt to do the job of the Research Councils. It plays an important role in advance of them, but it should not attempt to do their job. I would agree with the Royal Society that if you start picking out bits of Foresight and funding them separately and taking them away from the Research Councils then you will start to distort the pattern because we have spent a long time trying to get the balance right. If you keep pulling the money out randomly you do not achieve the optimum balance.

Mr Bruce: I think you have explained very well what the Royal Society was trying to explain. That is very helpful.

Sir Trevor Skeet

370. The new Steering Group and sector panels have now been established. Are you satisfied that they are fit for the job?

(Dr Rudge) I could not really answer that since I have not actually been asked to audit them and I do not honestly know. I have not looked at it closely to see. I think the people that I saw being pulled into the research panels previously, the sector panels, were impressive names. They were good people in the industry and people whose abilities I would recognise and I would just assume that we would go on and ensure that we do get good people in those panels. That is important.

371. Dr Rudge, the Steering Group made appointments in the past. I understand the practice has changed and now these appointments are made by the Chairmen in the panels. Is this a good idea, or is that not self-perpetuating?

(Dr Rudge) I was not aware of that, and I think it is not a good idea if it totally becomes within committee. I think you are absolutely right, and it would be better if there was a joint responsibility perhaps with the Steering Group to ensure the panels

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are well balanced and do not become biased through the interest of a particular chairman.

372. I am most concerned about your fifteen panels. There must be trouble at the periphery of these panels. How are you going to accommodate those problems?

(Dr Rudge) Well, I think the whole process should not be too fixed in the following sense. I think already there has been a merger between the communications and the IT panels. When I saw the first list of the panels I was astonished they were separate, but at least this year they have been merged. I think the Steering Group's job would be to look at that plethora of panels and close them, or open them up, or change them, to keep a reasonable coverage of what is happening in the world, rather than letting them perpetuate in the specific areas you start with.

373. Finally, with your general expertise in this, would you make a recommendation there should be more sector panels than there are at the present moment to cover some of these marginal parts?

(Dr Rudge) I think I would not like to give an opinion on that until I had looked at it and thought about it. It is important for the Steering Group to look at this to make sure there is a reasonable balance.

Mr Thompson

374. Government initiatives, you probably agree, come and go depending on the enthusiasms and fashions at the time. Do you feel there should be more coherence in the Government's initiatives to encourage research and innovation in this country?

(Dr Rudge) Yes.

375. And I think in 1994/95 we are talking about some £26 million being spent on realising our potential awards. Would you like to see greater quality control as far as the allocation of money for these awards is concerned?

(Dr Rudge) Within the EPSRC we are satisfied with the quality control we have over our awards. The pity of the ROPA Award in many ways is that it was not well transferred into the research councils, and we had to pick it up as an initiative that started somewhere else and manage it and that caused us some problems because it disturbed the balance of priorities we had set. But we did go through a quality control process, if you like, and we have done a review of the ROPA grants to see where they have gone and to look at the quality of the groups they went to. I think when you look at it you will appreciate why we are not worried about the quality of the work.

376. Just on that point, can this be done without peer review?

(Dr Clark) I think it is a pity that it is thought that peer review is not used in ROPA. Certainly conventional peer review is not used, but there are elements of conventional peer review which are used. In our case, every ROPA application that came in was sent to a referee. We did not say to the referee "Is this outstanding?" we simply said "Is this technologically feasible: is it highly innovative and breaking new territory?" and so forth, and if they said "No, it is

boring" or "No, it is not going to work" we did not fund it. But it was not on a scale of one to ten. There is an element of peer review in the fact that these are people who have been identified by industry as being of high calibre, and we therefore had a check on whether industry was satisfied with the calibre. For every ROPA application we were able to say we were satisfied with the interactions among people, so again, this was a test on the quality of the individuals. Finally, we did have small panels: not conventional peer review committee panels but typically three or four industrialists and one academic who said "Yes, we believe this is in the spirit of ROPA". I think probably the reason EPSRC found ROPA less painful than in other research councils is that we used it in the way I think it was intended—namely to fund very original new things. Most of our ROPA grants are short—12 to 24 months "proof of concept" grants—and we say "If it works come back through traditional peer review and seek a normal grant". There has been much speculation in the press about the quality of ROPA grants, but all I can say is that when the press came to us and asked for an on the record statement of what we thought of ROPA, our statement was that EPSRC was broadly content with ROPA, but that statement was never published.

Sir Gerard Vaughan

377. You take part in LINK. Are you satisfied with the way the LINK activities are going? I get very mixed comments on this at the moment.

(Dr Clark) I think LINK for many years was overly bureaucratic and perhaps people both in academia and industry did not understand it. I think we went through the pain barrier on LINK a few years ago, and if you talk to people who had experience in the early days, they said it took for ever to get a project approved because there was too much bureaucracy. I think the system has improved. Industry recognises it is a brand name they can work with. Many academics are now more comfortable than they were in the past. I do not think LINK is the answer to everything, but the beauty of it from the point of view of a funding organisation like the EPSRC is that it is a docking mechanism where you can pull together many sponsors of research. Many of the LINK programmes involve DTI, several research councils, MAFF or whatever. I think the beauty of LINK, dare I say it, is that it is a convenient docking mechanism, and now it is a recognised brand name that much of industry and academia are happy to work with. But it is not the answer to everything. I do not think you should try to forcefeed all academic collaborations to the LINK framework, but it has its place.

378. If I can turn to a slightly longer question, I understand you are contemplating developing interdisciplinary research centres. Would you like to say a bit about this, and how do you choose which disciplines to put together?

(Dr Clark) We are not contemplating establishing them. EPSRC inherited from SERC eight IRCs that were set up between I think 1988 and 1992—the last one being I think on biomedical materials. There were

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[Continued]

[Sir Gerard Vaughan Cont]

twelve set up by SERC and eight of those were bequeathed to the EPSRC, and I think that many of those interdisciplinary research centres have been very successful and have fulfilled the roles that were expected of them. But in fact the EPSRC Council at its meeting on 1 December will be receiving a paper discussing for the first time the future of those eight IRCs, so as of now there are no plans for new IRCs; rather we are content with the broad portfolio we have got, but they will have to be reviewed in due course.

(Dr Rudge) They will be reviewed, but I do not want to pre-empt the Council's debate on it at the next meeting. They came into existence with a ten-year guaranteed funding, which is going to expire in the next couple of years. The difficulty is deciding what you do about that because the original concept was that after ten years of funding, they would have enough industry funding to be virtually self-sufficient and this clearly is not going to be the case with a number of them.

Dr Bray

379. Dr Rudge did mention the Fraunhofer institutes and the Faraday concept. That is distinct from the IRCs.

(Dr Rudge) Yes. Well, when I say "distinct from", they might well be able to apply for a Faraday programme.

380. But the Government did in fact designate a number of trial institutes for Fraunhofer-type experiments, did it not?

(Dr Clark) The postgraduate training partnerships.

(Dr Rudge) Yes.

381. Do they get any support from the EPSRC?

(Dr Clark) The postgraduate training partnerships were an initiative from the Government ahead of the last election which was in response to the Prince of Wales Working Group on Innovation, the John Fairclough Review. One element of the Prince of Wales Working Group of course was the Faraday concept and one element of the Faraday concept was using the AIRTO-type organisations for training. But it was only one element of the Faraday process, and five pilot postgraduate training partnerships were set up in the EPSRC area in 1992 and they are going very well so far, but they are not the whole of the Faraday principle.

(Dr Rudge) Sorry, I did not recognise the reference for a minute, but I was actually on the Prince of Wales Committee and was partly responsible for the Faraday concept in the first place, but the situation was, as David has said, that only a small subset of the whole Faraday scheme was picked up and run with at that time and we would like to see the rest of it implemented.

382. The other work, apart from training and research, was that there was also support for a core competence in the institute and also a substantially contract research activity, so there were those three elements, contract research, training and the maintenance of the core competence with a

government-subsidised research programme. Is that the full front of the concept as you see it?

(Dr Rudge) The basic idea of the concept was that if you take the university and the academic world and take the small and medium-sized company, that is not an easy boundary. While there are many small companies that manage to work with universities, a university group would soon become saturated if it tried to work with large numbers of them because it could not handle the interface. At the same time you have got an industry out there of which AIRTO is a part, but there are other organisations too outside of that body who already have many, many connections into small and medium-sized companies on a business-like basis. They have got all those connections in place and there is a network there. The idea was to try to improve the relationship between the intermediate body and the universities so that you get good interaction and a good flow of knowledge, expertise and so on. And then improve the interaction between the intermediate body and the many channels it has with industry. The PPTP scheme, as such, involved only one element of this with Farrady our part of it, the EPSRC part of it, would be putting some money with the intermediate organisation which they would spend in the university. The University then becomes the customer of the intermediate organisation and you get a good interaction there. The university will respond to the money incentive the expertise would then flow between the two.

383. So there are three basic types of activity. One is postgraduate training and research, one is the interest of the core competence in their particular area of activity and the third is the practical experience which comes from contract research.

(Dr Rudge) Yes.

384. And those are necessary both in the relationship of the institute to the customers and its relationship to the universities.

(Dr Rudge) That is right.

385. Would you like to see that concept further developed?

(Dr Rudge) We currently are considering and discussing with the DTI what we have termed the "Faraday Programme" and we have used the word "programme" rather than "centre" because we are not talking about bricks and mortar, we are not talking about building anything, but we are talking about putting a programme of activity in place which would have those attributes you have just described and improve the flow between the small and medium-sized companies, through the intermediate to the academics.

386. Would it entail, for example, the recognition of a particular AIRTO as having a Faraday competence?

(Dr Rudge) Yes, if it were an AIRTO or any other body, they would tender for whatever proposal we put out with whatever terms we put it on and we would initiate this with one or two pilots, probably one to three pilots.

387. Would you see this done by DTI or by the Research Council?

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[Continued]

[Dr Bray Cont]

(Dr Rudge) It would have to be a joint activity because one half of that cycle is very much in DTI's camp. That is between the industry and the intermediate. Between the intermediate and the university would be our territory.

Mr Batiste

388. Going back to the decision of the review you are about to undertake of the interdisciplinary research centres which seems to be based on the fact that they have not generated adequate levels of finance from industry, what levels of finance have they generated?

(Dr Clark) About 50 per cent, and that is across all of them now. The one which gets the most by a long way is one in processing systems, at Imperial College, and in fact I suspect that they are in a position

where they could very much move into dominant funding from elsewhere and not be dependent on us. But others which are working in areas of research which are much more upstream, as Alan has said, it is unlikely that they will be able to form the very strong links with users, so I think that the Research Council have to decide that it will have to be horses for courses. Some will fulfil the original expectations, and they will move out of protected funding from the EPSRC, and others I think we have got to look at and say, "Well, this is an important area of research of high quality, highly interdisciplinary and how do we keep competence in that area?"

Chairman: Thank you, Dr Rudge and Dr Clark. We have come to the end of our session, I am most grateful for the way in which you have answered our questions. Thank you very much indeed.

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Memorandum from the CBI (TFC 53) (September 1995)**INTRODUCTION**

1. The CBI welcomes the opportunity to submit evidence to the House of Commons Select Committee on Science and Technology on Technology Foresight. As the programme is moving into a new phase—one of dissemination and implementation rather than consultation—a review of progress, we feel, could be particularly helpful in ensuring that the full benefits of the programme are realised.

2. The CBI through the work of its Technology Group, directed by members on the Technology and Innovation Committee, has played an active part in the development of the programme, and indeed provided substantial input to the Office of Science and Technology during the development of the 1993 White Paper *"Realising our Potential"*.¹

3. During the consultation phase leading up to the start of the Technology Foresight programme, the CBI urged that any programme must have a strong market focus, rather than being solely driven by technology. This balance between technology push and market pull is critical if the UK as a whole is to benefit from the strength of its science, engineering and technology (SET) base. In reality it is innovation which is the key to commercial success. In its broadest sense this has been defined as the "successful exploitation of new ideas" by the Department of Trade and Industry and the CBI, emphasising the need to ensure that development of both new and improved products is strongly focused on the market place.

4. Although making the points above, the CBI recognises the strength of the research base in the UK and that new technologies, products and processes can emerge from "basic research". It is important that as we harness the expertise and skills of the SET base for the benefit of the UK, we do not "throw the baby out with the bath-water". Whilst moving to align the research base with the needs of the country we must build upon rather than undermine its strengths. However the UK has only a finite amount of money to spend in this area, and realistically can not attain excellence across all types of research in a global market, as technologies become increasingly more complex and diverse. Expenditure in this area must be balanced against social and economic needs.

5. The CBI has therefore supported the objectives of the Technology Foresight programme to improve wealth creation and the quality of life in the UK by harnessing more effectively the SET base. The exercise is, to a certain extent, a logical progression bringing together leading industrialists and academics to identify emerging market needs and technologies, from which opportunities for the UK can be matched with perceived strengths.

RESPONSE TO THE KEY QUESTIONS

Could we have continued without some exercise such as Foresight?

6. Undoubtedly the UK could have continued without the Technology Foresight programme, however the question does, perhaps, need amending slightly. If the question asked whether the UK could afford not to develop an exercise with the objective of enhancing the technological competitiveness of the UK, the answer would be no.

7. Competitive pressures from around the world will continue to mount and it is the ability to develop new and enhanced products and processes, with ever-decreasing time to market, which will differentiate truly successful world-class companies from the "also-rans". In the annual CBI/NatWest Innovation Trends Survey,² companies are continuing to report a year-on-year decrease in the life and time to market of both products and processes (p. 18, exhibit 1). In order to respond to this pressure companies need to address both organisational and technological issues. Many companies do not need what could be considered leading edge technologies; their business could be transformed by being in the position of acquiring existing technologies, which especially applies to small and medium size enterprises (SMEs).

8. However, future competitiveness depends upon the UK having a strong and technologically advanced manufacturing capability. Such technologies can provide high added value in manufactured products have significant positive effects on the local supply chain. In order to sustain this capability many companies have already initiated internally some form of strategic forecasting.

9. The Foresight exercise has always been promoted, not only on the actual output, but also on the process itself. The UK has often been perceived as losing out when it comes to exploiting the excellence of its research

¹ *Realising our Potential: A Strategy for Science, Engineering and Technology*, May 1993, HMSO, Cm 2250.

² CBI/NatWest Innovation Trends Survey, Issue 6, 1995 (Addendum I) (Not printed).

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base; whatever the argument for or against this observation, any mechanism which reduces perceived barriers to industry-university co-operation must be welcomed. To a certain extent the publication of "Realising our Potential" in 1993 represented a watershed in shifting mutual perception by both sides.

10. Companies are now looking more and more to both other companies and universities to increase collaboration on research. In the 1995 CBI/NatWest Innovation Trends Survey (p. 16, exhibit 5) 85 per cent of manufacturing companies reported collaborative activities with academics, other companies and consultants. On balance, 28 per cent of manufacturing companies increased their collaboration with academics and this rose to 45 per cent when asked about intentions during the coming year (the questionnaire was circulated during February 1995).

11. In conclusion whilst undoubtedly the UK could have continued without such an exercise the potential benefits—in both identifying emerging market and technological opportunities as well as creating links between industry and universities—are great. Failure to take advantage of its SET base, could have serious implications for the future competitiveness of the UK.

How should the recommendations from the Technology Foresight process best be implemented?

12. The recommendations can best be split into two main types of recommendation—those associated with technology issues and, of no less importance, infrastructure. Dealing with the technological issue first perhaps the key output is the information collected on the major emerging market and technological opportunities and, indeed, background information collected as part of the "scene-setting" carried out by the Foresight panels.

13. The first step associated with implementation must be dissemination of the output and promotion of wider awareness. Although under way, the CBI feels further thought needs to be given to the process. Whilst numerous activities have been initiated the overall process has, to date appeared disjointed. We have urged the OST in our position paper "Turning Foresight into Action" (attached as appendix 1), to draw up a clear *communication plan*. We concur with OST that the Foresight programme must continue to be flexible and driven by the industrialists and academics on the panels themselves, the process must continue to evolve—one of its key strengths to date.

14. However, this does not preclude the identification of a clear, over-arching, communication plan which should identify in the first instance, the broad types of audience who would benefit from the information. These include those at the senior executive or board level, requiring a strategic overview of emerging technology compared to those, for example, in more technical disciplines who need access to detailed information. In addition the information gathered in the Delphi questionnaires could prove beneficial to the marketing side of a business. Once the audience and type of information are identified, the mechanisms and timescales of the dissemination process would follow.

15. It is also possible that the OST has missed an opportunity to utilise existing technology as a means of communication—that is via CD-ROM. A disc could be produced which would hold all the data associated with the reports and Delphi questionnaires and provide easy access to search and source relevant information. Information on a CD-ROM must be appropriately designed—it is not sufficient just to place the 15 reports onto a disc. The benefits of such an approach could be large, with easy circulation of information to libraries, universities and schools, not to mention companies. However design costs could be substantial.

16. Considering the direct practical measures required to implement the Foresight initiative, the CBI has recommended to the Office of Science & Technology that *Issue Managers* be identified to lead each of the projects forward.¹ This will reduce potential misunderstandings which can arise during multi-partner projects. The Foresight Challenge Fund, launched by the OST on 25 September, has taken this up, requiring that proposals identify Project Managers and costs associated with these are recoverable. Such managers, who would be tasked with developing a business plan and carrying through a particular recommendation, are essential. The Fund is designed to attract at least equal funding from industry and we would urge the OST to include the cost to business of seconding an employee to a particular project, as part of any company's contribution. In addition the CBI recommended that a business plan should be a requirement of qualifying funding in most instances and again this has been recognised in the Foresight Challenge Fund guidelines by the need for proposals to identify milestones and targets. Attached is the CBI's response to the OST on the consultation for the Foresight Challenge Fund.²

17. There is a need for *exemplar projects* to be identified during the implementation of the Foresight recommendations. Such projects could include those associated with awards from the Foresight Challenge Fund, but should not exclude other independent initiatives. High profile projects which are seen to be a success could

¹ Turning Foresight into Action: a CBI position paper, submitted to the Office of Science and Technology, July 1995 (Addendum II) (Not printed).

² Letter to Sir John Cadogan, dated 3 August 1995 (Addendum III) (Not printed).

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play a crucial role in the overall perception of the relative merits of the Foresight exercise and future development of the programme itself.

18. Perhaps the greatest impact Technology Foresight should have is on Government spending to support the science, engineering and technology infrastructure. Certainly by December 1996, the Government should be able to show that the £6 billion or so spent in support of R&D across the departments was being adjusted to take account of the Foresight findings. This should include that a quantitative shift in funding can be demonstrated by the Research and Funding Councils. The OST has intimated that this would be required for the 1996 Forward Look and we would urge them to follow this through.

19. The impact of Foresight on Government spending must also cover education and training as well as university research. It is imperative that the UK has well and appropriately trained personnel in the future, requiring that the foundation of learning is put in place today. Students need to be encouraged to take science and mathematics if the UK is to develop the scientists, engineers and technologists required to be competitive 15 years hence.

20. This need is emphasised even more clearly against a backdrop of a decreasing number of children taking science and mathematics at school. Whilst a broad basic grounding in science for all school-leavers is essential and the compulsory science component of the national curriculum at GCSE must be a step forward, there must also be a steady stream of the most able students into both industrial and academic careers—science, engineering and technology can provide very attractive and interesting careers, and this needs to be promoted to school pupils. The CBI is trying to contribute to this process through Manufacturing by Design, an initiative of the National Manufacturing Council to promote manufacturing as a career in schools. The initiative is based upon the CAD software "Design View" provided by Computervision with curriculum materials developed by the National Council for Educational Technology and is sponsored by the Department of Education and Employment (originally as the Department of Employment), GEC, Shorts and Unilever. Manufacturing by Design also assists with establishing links between schools and local industry.

21. Many of the Technology Foresight reports also talk about more general infrastructure issues—for example in the Transport Panel report. All businesses require an effective transport and communication system as well as a stable economic climate which will assist growth rather than hinder it. Such a framework, along with a well trained workforce, is also necessary to attract inward investment to the UK.

What effect do you expect the transfer of the OST to DTI to have on the implementation of the Technology Foresight initiative?

22. Overall the CBI believes the move of the OST to the DTI should prove beneficial; at a time when Technology Foresight is entering a phase of dissemination and implementation there is a strong argument for such a move since one of the prime objectives of Foresight is wealth creation and the respective roles of the two departments are complementary. This has been more than adequately demonstrated by the working relationship between the President of the Board of Trade and the Chancellor of the Duchy of Lancaster who, for example, attended a joint press conference at the re-launch of the LINK programme at Centre Point earlier this year.

23. Although we believe this move can be beneficial, safeguards must be put in place so that funding to support the long-term research infrastructure in universities is not reduced, or driven short-term. Companies look to universities for a long-term research capability balancing "blue-skies" or basic research with that which is strategic or applied. Consequently the "ring-fencing" of the OST's budget, especially that associated with the Research and Funding Councils, must remain water-tight. This should be clearly demonstrated in any future budget allocations by Government and in 1996 Forward Look.

24. Another key concern over the OST move has been with respect to its co-ordinating role across Government. The strength of the OST in the Cabinet Office was its ability to work independently of the Government department infrastructure. Although arguments could be made as to the effectiveness of the OST in this role, such co-ordination is essential when it is considered that the varying Departments all have their own research budget. The annual Forward Look publication gives an overall snapshot of this often isolated activity and there should be no reason why this important co-ordinating role cannot continue in the future.

25. The science and engineering base in the UK is generally held in high regard by other countries. However, at least at the anecdotal level, it can prove difficult to access the skills and technology in the science base for the benefit of UK industry. The possible reasons for this are numerous including lack of mutual understanding (on both sides) and problems over allocation of ownership and rights to exploitation of intellectual property. The former has improved dramatically over the last few years, although the latter continues to give cause for serious concern. The move to the DTI, however, could assist with both of these, facilitating discussion and ensuring that any intellectual property arising from collaborative research is exploited for the benefit of both partners and that there are benefits for the UK.

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26. It is, as yet, too early to judge whether the move will be deleterious or advantageous in the longer term. Industry does not want a science base which is directed on the short-term, but one that continues to provide the highly trained personnel for the future, develop long-term research objectives in science and engineering, and provide the foundation for emerging technologies.

Was the process of the Technology Foresight initiative helpful to you? If so, in what ways?

27. Although unable to answer this question directly, members of the CBI have been fully involved during the first phases of the programme. This suggests that businesses do recognise the value in the process, however, its overall success will only be judged favourably in light of some positive benefit to companies and the UK. If the information and activity arising from Foresight does not assist companies, it is unlikely that they will continue to contribute to a process which can be time consuming for those involved. The Government must continue to maintain a strong commitment to Foresight—anything less will be greeted critically.

Was any part of the process unhelpful or weaker than the others?

28. Before addressing the weaker aspects, it is perhaps appropriate to set out the positive side of the programme. During the first phase many academics and business people were brought together to consider and identify the emerging market and technological opportunities. Such interaction must be beneficial to the UK. In addition there is now a wealth of information available, not least through the panel reports themselves. The results from the Delphi questionnaire also constitute a significant mine of information.

29. However the weakest part of the programme has, we believe, occurred during the "dissemination" phase. The danger signs occurred following the publication of the reports, when there was a distinct lull in the activity of the programme with a risk of losing the momentum generated in the initial phase of the process. Whilst, to a certain extent, this lull in activity was not surprising as the Foresight team in the OST organised the publication of the various reports, greater consideration should have been given to maintaining momentum and keeping all those involved fully aware of planned activity. The OST may claim such plans were in place, but the perception in industry was different.

30. We have already mentioned the need for a communication plan. It must be recognised that effective dissemination will not automatically occur following the publication of the reports. Whilst these are an excellent account of the activity and results of the panels they are only one output for disseminating the findings. If wider dissemination to those not previously involved in the programme is to be successful, then the type of audience and information useful to them must be considered. Although the situation is improving, there are still companies, at the leading edge with respect to technology who are either unaware, uninvolved or, more worryingly, unsure of what the programme can provide for their company. This is especially true for smaller firms.

31. The mechanisms for disseminating information to SMEs should be carefully considered. Many do not have the luxury of looking more than a few weeks, months or a year ahead. Many would benefit greatly by being aware of technologies available today. Furthermore it may be inappropriate to disseminate the findings to SMEs in an overt sense. Events aimed at SMEs should consider, in the first instance, the impact of existing technologies on their business leading them to the longer-term opportunities. In addition the supply chain will be a major mechanism for SMEs to become entrained in the process through knock-on effects from the larger companies to which they supply products or services.

32. The OST has claimed that dissemination is a "process" driven by the panels, however a plan is clearly needed to clarify the objectives and targets. Implementing such a plan requires adequate resourcing—both in terms of personnel and funding. Unless adequate resources are allocated to the process then business will view this as a strong indication of Government's commitment, or lack of it.

Should the exercise be repeated? If so, when?

33. Since the inception of the Foresight exercise, the CBI has argued that it should be on-going. This does not mean it should be slavishly repeated in the same way, but that it should evolve according to the lessons learned during the first iteration and the objectives established at the time. To date the panels themselves have operated in parallel, although in future they could be staggered. This would ease the burden of all panels having to report at the same time. In addition it may be necessary to repeat exercises for the different panels at varying intervals—the speed of technological advance will vary greatly between, for example, the electronics and the construction sectors. However, considering this variation, a periodicity of between three and five years would be appropriate for the major consultation phase, although Foresight activity between these should be sustained.

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34. As part of any iteration the initial task of the panels should be to review progress against the key recommendations and identified market and technological opportunities. This, to a certain extent, will determine the form the evolving process should take. However it is important that the sectoral panels control this process and adequate resources are provided to support their work.

What actions, if any, are you taking to assist your members in considering the Technology Foresight proposals?

35. The CBI has largely seen its role as one of raising awareness of the Technology Foresight programme. Consequently our activities have been directed through two main conduits—circulation of material to members through mechanisms such as articles in CBI News, which recently included a piece by the new Chief Scientific Adviser Prof Robert May, and through a series of conferences based on themes arising out of the 1993 SET White Paper. The third such conference aimed directly at Technology Foresight, will be on 23 October 1995. Additional activities of the CBI's Technology Group have included assisting the OST with a series of regional workshops for the IT and Electronics Panel during the Autumn of 1994.

36. Although not directly linked to Technology Foresight, the CBI, under its Cross-Sectoral Technology Initiative,¹ has attempted to facilitate sharing of research in generic technologies across sectors. The forum provides an opportunity for those at a senior level in companies to come together and discuss specific technologies in an informal arena. All technologies discussed are at the pre-competitive stage. Following the 23 October conference on Technology Foresight, the forum will be meeting to discuss a strategy to take the initiative forward.

Concluding remarks

37. The overall view of the CBI is that the first phase of Technology Foresight has been a success—co-ordinating 15 sector panels, consulting widely on the programme and publishing the reports to schedule was a significant feat for which the OST should be warmly congratulated. However the most critical phase of the programme, that of dissemination and implementation, is now under way. It is essential that Government maintains its commitment to the programme by providing the necessary resources, both financial and administrative. Without such commitment it is unlikely the UK will take full benefit from all the hard work put into the exercise.

Examination of witnesses

DR BRIAN EYRE, Chief Executive, AEA Technology, MR STEWART JUDD, CBI, and DR PHILIP WRIGHT, Secretary, CBI Technology and Innovation Committee, CBI, were examined.

Chairman

389. Dr Eyre, you have been listening to the Committee in action and, who knows, you may get asked some of the same questions. You are very welcome and thank you for sparing the time to come along.

(Dr Eyre) Could I just present John McClelland's apologies. He is the Chairman of the CBI Technology and Innovation Committee and I am a member of the Committee. He would very much have liked to have been here himself, but he was called overseas at short notice.

390. The CBI is well represented by yourselves. As I say, you have heard the questions and I will start off with the same one as I asked our previous witnesses and you see what you can make of it. Obviously we have discussed innovation and the Government has said that it should be the responsibility or substantially the responsibility of the councils and I think obviously the question I must ask

you is do you agree and perhaps you would care to comment on what the Government's role should be in relation to this matter of innovation as that would be helpful too?

(Dr Eyre) Thank you, Chairman. I do not know that I have a lot to add to what Alan Rudge said. Clearly the Government has a key role to play in the education and training process, the provision of people that are going to make innovation happen both through the schools and the universities and that is the role the Government must have a key part in, and Alan stressed that, and also in developing the universities through the investment in R&D in universities as well as from the EPSRC and so on.

(Dr Eyre) I think there are other areas where Government does have a role to play and again they were touched on earlier this afternoon. Regulation is clearly one area and making sure that it is not counter-productive and does not inhibit innovation and competitiveness. Government has an important role in protecting the interests of British companies in the

¹ See Addendum IV: Dual-Use Technology and Cross-Sectoral Co-operation. Report following a series of Dual-Use Technology seminars facilitated by the CBI, initiated by British Aerospace and sponsored by the DTI (Not printed).

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DR BRIAN EYRE, MR STEWART JUDD
and DR PHILIP WRIGHT

[Continued]

[Chairman Cont]

international community, in Europe and more widely, in making sure that we can operate on a level playing field and that we are not facing unfair subsidy of innovation in other countries, for example. I think again, in connection with the international arena, Government has a role obviously in attracting inward investment to the United Kingdom, and that does feed into the innovation process in the long run, and of course we have seen a lot of that in recent years. There are therefore a number of ways in which Government directly, through its policies and the exercise of those policies, does facilitate and help innovation. More directly, of course, the DTI does have a role in helping to set benchmarks and to provide the information for companies to compare their innovative performance with others, and the CBI does work quite closely with the DTI in assisting the promulgation of that type of information.

Sir Trevor Skeet

391. But surely, Dr Eyre, it is the companies who are at the sharp end. They are the ones who understand the principles of innovation. Surely you look to them (except for the matters which you have enumerated) and you must expect the answers to come from them. Is it not the practice abroad in Japan and the United States for answers to come from the companies rather than the institutions?

(Dr Eyre) I agree with you that at the end of the day it is industry that has got to actually carry out the process of innovation—

392. Exactly.

(Dr Eyre) — but you have just mentioned Japan which is an area I am familiar with where there is actually a very effective partnership between industry and MITI and STA and the universities, all playing their part in keeping the innovative process in Japan going, but at the end of the day it is industry which has actually got to make it happen.

393. What you are saying then, in effect, is that if the Government can largely be kept off your backs so industry can proceed further, we will get the new initiatives that we require?

(Dr Eyre) I do not think I actually said that!

Chairman

394. You are exonerated!

(Dr Wright) Perhaps I may come in on some of the activities the CBI has been involved with for instance with the DTI, particularly in the innovation unit. We do recognise the need to promote innovation within companies themselves. Back in 1993 we published "Innovation—the Best Practice". This was followed up with the Winning Report in 1994 trying to spread the best practice of innovation and making sure it was taken on board with companies. Now we have got another initiative called "Probe" where companies can benchmark themselves, and that includes components of innovation.

Sir Gerard Vaughan

395. How important are the various general infrastructure issues which have been identified by the Steering Group and some of the panels? Do you think these are really going to be implemented?

(Dr Eyre) Do you mean in terms of the recommendations from other panels on things like transport and utilities and so on?

396. Yes, and information about business risks associated with innovation and so on. There are a lot of comments here, and I wonder whether you think these recommendations will be carried out, and if not, what will stop them being carried out? Do you have any views on this?

(Dr Eyre) It is not an aspect of the Foresight process that I am particularly familiar with. These are the panels that dealt with the infrastructure issues. I certainly took close interest in some of the technology based Foresight panels, like the ones on materials and energy and defence and aerospace.

(Dr Wright) I think we are mainly concerned with education and training areas. We should find that the recommendations that have come out of the steering group reports about quality and the type of individuals that are needed should be addressed by certainly the schools and indeed higher education funding councils. I think that must be taken into account.

397. If I can quote from one of their statements. "We recommend that further research be undertaken to understand the managerial and financial approaches to the containment of business risks associated with innovation." Am I going along a line you want to comment on, or do you feel this is irrelevant?

(Dr Wright) No, I think it is relevant. We have a relationship, for instance, with an innovation research programme being managed under the ESRC and indeed the former technology head of the CBI is now managing that programme and we still facilitate interactions between that programme and our companies to see what sort of areas it would be appropriate for those academics participating in that programme to address.

Dr Bray

398. You heard what Dr Rudge said about the way Foresight has influenced the procedure for the allocation of funds in the responsive mode and the directive mode funding. Does that meet the requirement you set in your memorandum that the Government should be able to show that money it spends in support of R&D is being adjusted to take account of Foresight fundings?

(Dr Eyre) Yes, I think it is a fair reflection of the point we made in our submission. Clearly Foresight was a major exercise. It involved a lot of people in a lot of effort. I think it was a worthwhile exercise which achieved a lot, but if, at the end of the exercise, it simply results in fifteen reports that appear and stay on bookshelves gathering dust, then clearly in the long run it will have failed. It has got to feed through and have some impact on the way we make judgments about areas that we should support and so on, and the

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[Continued]

[Dr Bray Cont]

research councils, as major distributors of government funding in R&D, obviously have an important role to play in that. I therefore support the view that EPSRC should take into account the recommendations from the Foresight panels in determining its future strategy, and indeed in the way it then feeds the funding through to its recipients.

399. So you see this situation from two points of view with two different hats: one from the point of view of AEA technology, and the other as a member of the CBI committee. Taking specifically the AEA technology role, where you have a very broad competence in research generally and applied research in particular, have you felt there any impact from Foresight?

(Dr Eyre) Yes. We adopt a Foresight type approach in trying to define our strategy for our own investment in R&D, including money we put into universities.

400. You have done that all along, but what I am asking is whether the market has changed in any way as a result of the Foresight exercise.

(Dr Eyre) I think it is far too early to say. The report has only been out for six or seven months. Certainly we have taken into account (and I have read those reports which are relevant to our areas of interest) the work that the Foresight panels have done in trying to shape our own R&D investment, but I think in terms of the effect on the market, it is far too early to say.

Chairman

401. Is the CBI of the opinion that the Foresight process should be continued?

(Dr Eyre) Yes, quite simply. We have discussed it and we think it should be continued. How it should be taken forward needs to be thought about carefully, but dissemination is obviously one important issue that needs to be addressed, and we need to disseminate the findings of the Foresight reports more effectively. They are not, of course, tablets of stone. The outside factors taken into account in carrying out Foresight recommendations are changing all the time and all of those areas need revisiting on a timescale that is appropriate for the area you are considering. Some are moving much faster than others.

Mr Miller

402. You heard the exchange, I am sure, between Dr Rudge and the Committee on the question of networks. It seems to me axiomatic that the Foresight programme should have the benefit of creating a number of informal networks. Do you agree with that assessment? What role do you see the CBI in particular having in such networks and, furthermore, do you believe that other organisations in society, for example, trade unions, should have a role to play in such networks?

(Dr Eyre) Firstly, I think that one of the successes of the Foresight exercise was the networks that it created, networks that were not there before and it not only involved 300 or 400 people directly on the panels,

but the people involved in all of the consultation exercise ran into many hundreds, if not thousands, so that was a positive outcome and brought people together who had not been brought together before. The CBI does have an important role and we worked closely—and when I say “we”, I mean my colleagues in CBI—with OST during the formulation of the Foresight exercise and in the carrying out of it and again Stewart and Philip are much better qualified than I to say how they are now continuing to work to assist this networking process and so perhaps they can add to that.

(Dr Wright) I think there are a number of activities that we see that we can actually do. The prime one is raising awareness amongst the wider business community. We have been involved in that since Foresight started, writing articles in *CBI News* and recently we had Professor Robert May contributing only this autumn and that is really part of promoting a wider awareness. Also David Hunt, the former Chancellor of the Duchy of Lancaster, came and spoke to a group of our members in May and that was followed up the Shadow Minister speaking to the same group, so we see that there is a broader awareness issue that we can try and contribute to. With respect to helping sustain some of the networks, I think really we have to look at the regional issues. I think that if it is going to be taken on board, it will happen through the regions and the regional offices are aware of what is happening. Indeed I presented something to our regional chairmen and regional directors earlier this year and with this recent initiative there is funding by the DTI through the government offices to drive through the dissemination process and there will be action by myself by the end of this week to write to our regional directors just to keep them up to date with what is happening. I know there are some activities already going on, for instance, a recently arranged meeting between the representatives of Segal Quince Wicksteed, who have been given the contract to disseminate what is going on, with our London regional office and we are looking at ways in which we can assist in that process.

(Mr Judd) I have appointments to speak to some of our county groups. I think Sir Trevor knows of the Bedford county group, but I am speaking in December at a number of county group meetings on the work of the ITEC panel on which I sit, so yes, there is quite an on-going activity.

(Dr Eyre) You raised the question of other bodies. I think one group that do have potentially quite an important role to play, particularly getting messages down to the smaller companies, is the trade associations and I think also trade union groups, and particularly where there are cases where groups of trade unions are coming together to take an interest in their industry and promote the interests of their industry and hold public meetings to do that, then clearly they potentially have a role as well.

403. I was thinking particularly of helping the development of understanding of the next generation

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[Mr Miller Cont]

of a piece of technology and its implication on their work plus their communities.

(Dr Eyre) Yes.

Sir Gerard Vaughan

404. How do you see the LINK programmes progressing? Do you think they are sufficiently well understood? There is a lot of money going in and some people are a little doubtful about the rewards coming out.

(Dr Eyre) I think the LINK process in principle is very good and I have had personal involvement in one or two, bringing together a small company with a large company and a university in a joint programme and where it works, it works extremely well. I think, as Alan Rudge said, there was an initial period where the LINK process was not understood and there were very few awards and people got disillusioned with them, but certainly from what I have seen directly myself, I believe we have got through that process and that the LINK process is beginning to achieve what it set out to achieve which was building bridges between the universities, small companies and large companies.

405. I am very glad to hear you say that.

(Dr Eyre) And when it works, it works very well.

406. Are you actively trying to progress the programmes through your membership?

(Dr Eyre) On an individual basis because of my own personal position, I suppose, partly in AEA Technology but as an engineering scientist, I have been approached and I have actually helped facilitate getting the links together between the relevant parties and have seen one or two take off in that way and I have been very encouraged. I think if it is applied properly, then it can achieve a lot.

(Mr Judd) We have published guideline documents on access to mechanisms for technology transfer. I think we have distributed those widely throughout the membership and have gone through a whole range of workshops, publications and things like that, so the CBI is fairly active, but in the end I think, as Dr Eyre says, it is really up to the individuals to make the thing work.

(Dr Eyre) You have got to get the players together really.

Dr Jones

407. We have already been discussing the point of disseminating information and you will have heard the earlier discussion with Dr Rudge who said that he thought the Government should have overall responsibility for ensuring that this takes place. Obviously the CBI said it is doing its bit with newsletters and meetings and so on, but does it not need to be more structured and set out and are you satisfied that that is being done and that the necessary resources are being devoted to it? If I could pick up on the discussion about the LINK programme, that is starting to be successful and well thought of, but the DTI funding for such schemes is set to decline. Do you think there should be an expansion of that

programme or are you satisfied with the level of resources devoted to it?

(Dr Eyre) Taking the last point first on the LINK, I cannot answer that question because I do not know, for example, whether the demand is greatly exceeding the funds available. I believe that the DTI must still maintain their support for the LINK programme. They have withdrawn, as you know, from direct funding of R&D and technology-based programmes, but I thought LINK was what they were going to continue to support.

408. I was wondering whether you think it should be expanded.

(Dr Eyre) Well, I think the LINK process is good and if the demand for LINK-type programmes does expand, then I think there will be a case for increasing the funding to go into it because I think it is a very good way of building the bridges, particularly between small companies and the research base in universities and large companies. Going to the question of dissemination, I do believe that the Government has co-ordinated the whole of the Foresight exercise and they must retain the responsibility at the end of the day for co-ordinating the dissemination. That is not to say that all sorts of bodies cannot play an important role. The CBI can play a particularly important role because of our very large industrial membership. We in fact have been concerned about the dissemination process. I think there was a hiatus after the initial Foresight process was finished. I think there was a lack of appreciation more widely in industry of what it is about and we are still not completely satisfied that that vacuum is being filled adequately, but things are beginning to move and there are newsletters coming out and so on, but I think we remain concerned.

409. What would you like to see done?

(Dr Eyre) I think we would like certainly to see more effective communication with the industrial community and I think this is an area where the CBI can actually help OST more.

Dr Williams

410. Can I come back to something that Dr Jones raised in an earlier discussion about the Office of Science and Technology intending to develop output measures for the Technology Foresight process linked in with the dissemination of information and how successful that is going to be. What kind of output measures would they be and, if I could throw back to you for comment one of your pronouncements on Technology Foresight, you said that you would like to see a quantitative shift in the £6 billion that the OST provides now for science research.

(Dr Eyre) Which the Government provides.

411. Yes.

(Dr Eyre) The total R&D budget is £6 billion.

412. Would that be one of the output measures?

(Dr Eyre) Yes, I think provided we do not look at it too mechanistically and sort of say, "Well, next year there should be 5 per cent of the recommendations picked up and being funded through government funding". I think we should be looking for a shift of

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[Dr Williams Cont]

emphasis. I think we are already seeing it from the research councils, that they are taking it on board and mapping out their future strategies, taking Foresight into account. I would expect MoD and the other government departments who are funding the science and engineering base in this country also to be doing that and we should be seeing a shift, a visible feed-through of the recommendations from Foresight into the way the money is actually spent. I think, however, it would be very dangerous to say "This has got to be done on this timescale and so many projects have got to be taken up". That would be wrong.

(Dr Wright) If you compare activities now with those prior to when Foresight actually existed, I think you would already see a shift, but that is an interim measure. The real success would only be judged by improving the competitiveness of United Kingdom industry, and that is ten to twenty years down the road.

(Mr Judd) We had a meeting in the CBI technology and innovation committee at the end of phase one, and one of the concerns expressed was that the OST did not appear to have a well structured plan for carrying on the output of the Foresight programme into phase two, and that concern was expressed forcefully to the OST who were present at the meeting, and we understand they have taken on board that message. Moves are afoot to try and introduce some sort of structured approach to the way in which the dissemination programme and the follow-on programme are tackled. We have yet to see this actually being put in place, but we wait with some degree of interest to see how it is going to be done. They certainly did not adopt a very businesslike approach initially, and were caught somewhat unawares, we found.

Mr Bruce

413. The Government has put 1.9 million for this last financial year into administration and supporting the Foresight programme. Do you think, in the roll-out of trying to get the benefits, that money is adequate? Is it too much? Can we cut it down? Or should it be even more? If you think more money should be provided, should it be the CBI and your members who provide it directly?

(Mr Judd) There are a number of issues covered there. My understanding is that there will be a combination of roll-out on a sector basis and going back to what was mentioned earlier—namely, how you divide up this sort of activity—and whether it is on a sector basis or some interdisciplinary basis is a moot point. If you take, say, fifteen sector panels and divide them into 1.9 million and in fact then add all the other different regional activities, then it certainly strikes me that on a regional basis the cover is going to be rather thin, looking at that budget. Having said that, it is always easy to say that more needs to be spent, but one of the unfortunate things we have discovered is that the knowledge out on the ground of the existence of the Foresight programme is still very sparse. My colleague was in Newcastle last week, and only one out of the twenty-five organisations at the innovation meeting acknowledged that they knew the existence of Technology Foresight.

414. Should we be looking for Government funding so that it is nice and fair, or should we be looking for sponsorship to companies who are willing to get up and say what a great process this is, and that they want to be associated with it?

(Dr Wright) If you look at the commitment that industries are putting into the Foresight process, it is a considerable one, and I do not think that should be forgotten. There are areas where companies can assist particularly perhaps the most interesting mechanisms maybe through their supply chain. Whether that is covert or under a Foresight banner is up to them. They can decide on what is best for their needs, but that is one way certainly for spreading it into smaller firms.

Chairman

415. Could I suggest to you that whereas obviously Government has routed the Foresight system and it will hopefully take off and develop, the ultimate beneficiaries are going to be your members (or many of them) and your network, and would it not be sensible for the CBI to vigorously prosecute Foresight amongst its membership?

(Dr Eyre) We certainly believe we have a role in promoting it and raising awareness. I am not sure how far we can go in forcing our members to participate, if they themselves do not see a benefit in the process.

416. But if they do not know about it—?

(Dr Eyre) That is part of the problem and that is something we have been trying to address as well. One of the key problems at the moment is actually selling the benefits of Foresight. The reports themselves are good in their own right, but they are not a good way of selling it—certainly into the smaller firms.

Dr Jones

417. There has to be more done than publications. There has to be a personal contact element. When we had the regional training and technology organisations, they said that was a job they could do but they needed resource which could come from industry or government or both. Is there a structure for doing that?

(Dr Eyre) I do not think so. CBI itself has been proactive in trying to promote Foresight and certainly I have been to one of their meetings in London which was very successful to which 200 people came and we had a long discussion and we had university people there and people from industry, but I do not think there is a framework in place of the type you are alluding to.

418. I am talking of a framework where people can get on the telephone and say "I am interested in this article, can you tell me more?", for instance.

(Dr Eyre) Yes.

Mr Miller: But this surely is the relevance of networks—informal ones in particular. I was chairing a conference last week organised by the local tech. on IT, and I was asked whether I could tell them about a particular acronym, and I thought it was bound to be one of the more complicated ones but the company representative asking the question wanted to know what an SME was. We are not getting the message across collectively, are we? I think this reinforces the

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[Dr Jones Cont]

argument for making networks work properly amongst businesses, and helping them to understand the view that the sharing of information does not necessarily undermine their particular competitive position.

Chairman

419. I think good members will understand that.

(Dr Wright) One of the critical things is getting them interested in coming along. It still boils down to a piece of paper landing on their desk, and if they have got a lot of paper coming in from different sources it is easy for it to be filed in that round filing cabinet on the floor!

Sir Trevor Skeet

420. Pursuing this a bit further, is not the crucial part of the Foresight programme the Steering Group and also the panels, which are largely manned by the company sector? Would you not agree with the Chairman and say that they should contribute the larger proportion, while the balance comes from the public sector?

(Dr Eyre) We have touched on really what I think has turned out to be one of the crucial issues of the immediate follow-up of Foresight and that is the effective communication dissemination and what it achieved across a wider audience. I think the second-phase panels that have been set up largely involving the people originally involved have a very important part to play in promoting the dissemination in their particular sectors with the Steering Committee having an overview on that, so to that extent I agree with you that the panels do have an important part to play.

421. So we could say that recommendation and also dissemination and implementation is crucial?

(Dr Eyre) Yes, by setting up workshops and meetings and so on.

422. Exactly, but may I ask this question about OST staff in the public sector: should you not have an increased allocation for them in order for them to do their job properly?

(Dr Eyre) As has been said earlier, the evidence we have is that they have been under-resourced. It has taken them time to get up to any sort of speed in getting the dissemination process going. When you look at the resources they have got and you see the area they are covering, it does look on the face of it very thin.

423. Would you like to give some sort of indication how much additional resource would be required for this particular purpose?

(Dr Eyre) I think this needs looking at. It is very easy for me to sit here and say "Double the money" or "Treble the money".

Chairman: We will take it that the principle is accepted.

Sir Trevor Skeet: But increase the funds.

Mr Batiste

424. You heard Dr Rudge answering questions about research institutes and he gave some detailed answers. I do not want us to go over all the same

ground again, but do you feel as the CBI that in the UK there is a need for some sort of institute rather like the Fraunhofer institutes in Germany? Do you feel that is a gap in our system and, if you do, why do you think that gap has arisen? Why have not government research institutes been able to develop into that kind of institute?

(Dr Eyre) I think that it depends what you mean by setting up institutes. I think we do have the basic ingredients or the basic elements in place in terms of independent research organisations, an organisation like my own, around the country. What is missing is the mechanism for getting the interconnections in place from the universities and the independent research organisations and companies and we certainly need to do more in this area to get the transfer, the flow of information, the flow of technology from the science and engineering base particularly into the smaller companies which are not able to do their own research. The idea of the Faraday concept, the pilot Faraday concept, was a step in the right direction of trying to establish that framework, but I certainly do not think we want to set up a plethora of new institutes because they tend to become self-justifying and fixed entities, but I think we need the framework in place to make much more effective use of what we have already got and I think that is what Alan Rudge was telling you as well, and I agree with that very strongly.

(Dr Wright) One of the things I wanted to say was that there is, for instance, at least in the pilot phase a Faraday north-west network—and I do not know whether any of you are aware of that—and that effectively is not bricks and mortar, as such, but it has been organised by organisations and people interested in the region who have similar objectives and I believe that they are addressing some of the Foresight initiatives indeed.

425. So your perception is that the cement, the links between the different institutions that we have got are likely to come from the networking process that the Foresight Programme has established?

(Dr Eyre) I would hope so. I think if that were to happen, it would be a very positive achievement of the Foresight process. If that alone were to happen, it would be a very significant achievement.

Mr Miller

426. Are you confident that your version of the Faraday concept, which I understand, and, being a north-west man, I understand Dr Rudge's comments as well, are you confident that that will continue to have the full support of your large company members because clearly it will be of greater benefit to the small and medium-sized enterprises, companies which we all, I am sure, would argue need a mechanism to help them grow and not simply fall foul of the takeover mechanisms in the country, but we need to address that issue, and are your large members going to be resistant in the long term to this concept?

(Dr Eyre) I do not think so because I think, firstly, the large companies use the small companies as a key part of their supply chain and it is in their own interests that these companies are using modern technology and

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[Mr Miller Cont]

so on and certainly in my experience, I was involved in setting up NIMTECH in the north-west with Pilkington, Unilever and ICI and we brought a lot of small companies into that.

427. And it is still successful.

(Dr Eyre) And it is still succeeding and I was on the board of it for a number of years and the large companies supported that very enthusiastically, I think, partly because it is in their own interests that they should do so, quite apart from anything else.

(Mr Judd) We have an active programme called "Partnership Sourcing" and with the DTI help, an independent company was set up to try and strengthen the sort of partnership chain, but that is now moving into a much more sort of active role in the sense of adopting links on the technological basis as opposed to just the commercial basis, so there are a number of different activities which one can then adapt. It comes back to what Dr Rudge said. The mechanisms can be adapted to fulfil a changing situation and we think that that is a very interesting possibility.

Mr Thompson

428. Is the CBI happy with the new steering group and the sector panels which have been set up? We heard earlier this afternoon during the earlier evidence that the sector panel chairmen now have responsibility for appointing new panel members themselves, but this all seems rather cosy to me. I wonder how it seems to you.

(Dr Eyre) It is not something that we have discussed in the Technology and Innovation Committee, but I do believe that it is important that you get the right people on the panels and clearly the chairmen are in a very good position to know the right people to support that panel activity. To that extent, I think this is the right way to go. Okay, you may need the steering panel to oversee this and to make sure that it does not get too cosy, in your words, but, nevertheless, I think it is a very sensible way to go forward.

429. Following up on the same line, your position paper calls for the sector panels' finance to be "validated" during the dissemination process. What do you mean or what does the CBI mean by validation in that context?

(Dr Wright) I think that this actually arose from Dr John Taylor, Chairman of the ITEC Panel.

(Mr Judd) I think during the Foresight first phase, and I am a member of the IT and Electronics Panel, as it then was, and now the ITEC Panel, and we had something in the region of 30 people taken from a wide spectrum of the industry, but, nevertheless, they were only 30 people and they were putting forward their views. Now, it was felt that at the end of the day one really ought to go out and re-contact the regional meetings which we had held in the first phase and say, "This is what we have come up with. These are the

sorts of recommendations that we are making. Do you agree or, if you do not agree, please tell us so that we can go through another iteration and come up with a better answer", so validation in that sense is to go out to the wider industrial community to say, "Do you think we have just about got it right or please let us know?"

Dr Williams

430. The final question is to Dr Eyre. I understand that you were the Chairman of the Institute of Materials Panel which conducted a Foresight exercise for the energy industry. The Technology Foresight has also looked at energy. How do you think the Foresight exercise compared with your Institute of Materials Panel research?

(Dr Eyre) The Institute of Materials Panel, which I chaired, looked specifically at power generation and material technology challenges to be found for the power generation industry for the future, so it was considerably more focused than the Foresight Panel's exercise. We did not have any direct sort of formal links with the Foresight Energy Panel, although some of the people I had on my panel were certainly involved in contributing to the Foresight Energy Panel's work. Our report actually came out several months before the Foresight Panel's report and is being taken forward in a very positive way and there are some lessons to be learned from that, but looking at the recommendations which came out of our work in the areas we dealt with, there was a great deal of common ground in some of the general things, for example, clean coal technology, and we were moving very much down the same path on that, but I think that our study was more focused. It was in greater depth within that sector and the recommendations we came forward with reflected that sort of focus in greater depth. One of the things which was very encouraging about it was that we always felt, and I certainly felt as the panel chairman, that having done our job, it was important that we transferred the ownership of that report to the relevant industry people and we have now set up a follow-up panel with a chairman from GEC, a senior man from GEC, and a number of panel members who were not involved in my panel, but there was some cross overlap, but most of them are new people who are now focusing on one of the areas in the clean coal technology area and trying to define a project which they are going to put forward for the Foresight Challenge funding and I think that is a good example of how the Foresight Challenge process has actually led to something that is real and is likely to lead to some new technology.

Chairman: I think that is an excellent point on which we conclude. It is a good little exercise in success, by the sounds of it. Thank you, Dr Eyre, Dr Wright and Mr Judd, for giving your time on behalf of the CBI to be with us and we are most grateful for the way in which you have answered our questions. Thank you very much indeed.

APPENDICES TO THE MINUTES OF EVIDENCE

TAKEN BEFORE THE SCIENCE AND TECHNOLOGY COMMITTEE

Press notice launching the Committee inquiry (19 July 1995)

The Government's Technology Foresight Initiative is an ambitious attempt to take action on science, engineering and technology priorities in the light of a process which should indicate our long term needs, and to form the networks needed to perform Foresight on a continuous basis. The Foresight Initiative was launched in 1993, and the Technology Foresight Steering Group delivered its Report in May 1995.

Now the findings must be implemented, by industry, by commerce, by Government departments and the research community.

The Science and Technology Committee is to conduct a brief inquiry into Technology Foresight to enable it to identify any problems in the conduct of the initiative so far, and any priorities for its future implementation. It intends to complete this inquiry before the Government issues its proposals for implementation in December.

The Committee is consulting industry, Government Departments, Research Councils, the Higher Education Funding Councils and learned societies. The key questions it will ask are as follows:

- (1) Could we have continued without some exercise such as Foresight?
- (2) How should the recommendations from the Technology Foresight Process best be implemented?
- (3) What effect do you expect the transfer of the OST to DTI to have on the implementation of the Technology Foresight Initiative?
- (4) Was the process of the Technology Foresight initiative helpful to you? If so, in what ways?
- (5) Was any part of the process unhelpful or weaker than the others?
- (6) Should the exercise be repeated? If so, when?

Letter to the Clerk of the Committee from J Sainsbury PLC (TFC 1) (31 July 1995)

Thank you for your letter on the Technology Foresight exercise which was addressed to Mr Dow. I am replying on behalf of Sainsbury's as a whole as a number of our personnel were involved in the exercise.

Overall the exercise was very useful and it has helped our Company to focus on food issues both with regard to how we should address them and where any research support should go. Our Board has not discussed the Foresight Project, but it is being dealt with at a technical level.

Although there were few surprises in the Foresight exercise, from the food point of view, obviously the added authority of the exercise is always when it comes to any decision making. The only criticism that I would level at the exercise was that the recommendations in the area tended to be dominated by the sectorial interests that were most heavily represented at the discussion groups, so the final recommendations may have been biased by the initial selection of participants.

Other than this the exercise had a lot of strengths and should now form part of Government research funding policy and should be repeated at such a time when it is felt that the findings have become outdated. I suspect this will be a minimum of five years and perhaps 10 would be more appropriate.

We were grateful for the opportunity to participate in the exercise and welcome the successful outcome.

Letter to the Clerk of the Committee from Shorts Missile Systems Ltd (TFC 2) (31 July 1995)

Thank you for your letter of 27 July 1995 regarding the Technology Foresight (TF) programme. I have attended one session in Bristol which involved aerospace companies such as BAe, Rolls Royce, GEC and Shorts, which I found quite interesting.

With regard to your questions and in particular the attitude of Shorts to TF, the position of Mr Roy McNulty (Shorts President), in the TF programme has ensured that it has received significant attention within the company. Several members of my staff have also attended seminars and answered the questionnaire.

I think it is necessary to have an initiative such as TF to focus the minds of both UK Aerospace companies and government on the need for R&D in key areas of the UK Defence Industry. At the moment the industry is in decline, reaching a critical stage in fact, without a significant number of major programmes to work on and

much less R&D money available to pursue new ideas. If TF helps produce a long-term realistic R&D policy for Defence Companies, concentrating on developing expertise in our core business areas, (such as VSHORADS missiles), and evolving our technology base to meet the future requirements, then, in my opinion, it will have been worthwhile.

The one day seminar I attended was very interesting because it allowed research directors/senior managers in a variety of key aerospace companies to consolidate their views. I feel that two or three sessions might have been more helpful to me personally as my only involvement with TF subsequently was to receive updates on progress by post.

I would certainly welcome a repeat of this sort of initiative to ensure that views remain coherent in the face of rapidly changing/evolving threat scenarios and the continuing decline of the defence industry.

I trust these views will be of help to you in your inquiry.

Letter to the Clerk of the Committee from Rank Xerox (TFC 3) (28 July 1995)

Thank you for your letter regarding Technology Foresight and I am happy to be able to assist with the conclusion of the inquiry. Dealing with your specific questions in the order in which you posed them:

- Rank Xerox will not take any explicit actions as a result of the initiative but will continue to monitor Government policy.
- The Board of Directors has not discussed Foresight and I believe it is unlikely to do so in future.
- It is hard to say whether the transfer of OST to DTI will have any effect on the implementation. We are more concerned about the downgrading of fundamental research in universities which may occur as a result.

Regarding the Foresight events:

- In my opinion an exercise such as Foresight should continue but probably linked to socio-economic and market trends.
- The process of the Technology Foresight initiative was not in itself helpful to Rank Xerox.
- I think the exercise should be repeated in 2005.

As a general comment about the questionnaire, I found it hard to track the implications of all the multi-part questions. Also some key areas, e.g., the impact of global and local market trends upon demand seemed under-emphasised.

I hope these comments are of assistance to you and thank you for the opportunity of taking part in the initiative.

Letter to the clerk of the Committee from the Machine Tool Technologies Association (TFC 4) (14 August 1995)

I refer to your letter of 18 July 1995 requesting our views and opinions on the Technology Foresight Programme.

As Mr Malcolm Taylor, our President and Managing Director of Bridgeport Machines Ltd, was involved in the Technology Foresight Initiative, I have asked him for his views on this matter for incorporation into our response.

- (1) We—being UK Limited—could continue to operate without a Foresight Programme but would operate without strategies and strategic alliances.

If we want to be "the best" in terms of quality of life, this can only be brought about by being able to generate the revenues through business activities in order to fund such aspirations.

A foresighting programme should be the major tool in co-ordinating and developing strategies that will enable us to identify and incorporate strategies into a national "game plan".

- (2) The process of the Technology Foresight Programme was helpful in providing encouragement that Government was initiating such a programme.

The setting up of panels of academia and "practitioners" was helpful in providing balanced opinions in developing "achievable".

- (3) There needs to be an initial "Directive" so that the work of the panels is focused.
- (4) Foresighting requires to be continuous in order to be meaningful and, therefore, the panels should be retained to work together on a regular basis. Shifts in world economies and developments are continuous and impinge on strategic planning.
By the panels working continuously, this could provide updated programmes every two to three years.
- (5) Technology Foresight should be implemented through structured dissemination of information and targets with programmes that identify key areas for each sector.
- (6) Our members are aware of the Foresighting Programme and other major initiatives but we are still to develop and action a dissemination programme for our members. Our Association is keen to work with the DTI as to the best method of advising companies of this initiative and the results thereof.
- (7) In our sector, we would welcome the transfer of the programme from the OST to the DTI and look forward to participating in a co-ordinated approach in the future.

We trust that our response meets with your requirements but if you have any further points that you wish us to consider, please do not hesitate to contact us.

Letter to the Clerk of the Committee from RHM Technology Ltd (TFC 5) (14 August 1995)

The Food Industry very much welcomed the foresight exercise and as well as contributing through the Research Strategy Group of the Food and Drink Federation, I personally contributed to the Delphi exercise for both Food and Drink, and Agriculture, Natural Resources and the Environment.

Whilst we could have continued without some exercise such as Foresight (since after all we have not had one until now) it is very much to be hoped that a widespread and serious input will have had an effect on Government thinking and the balance of science spending policy. In the Food Industry, for instance, we have long criticised the balance of the spend between (too much) on Agriculture and (not enough) on food. We shall hope to see the balance redressed.

The process of the Technology Foresight initiative was certainly helpful in bringing together a group of Research Directors from across the Food Industry to think together about the targets for pre-competitive research. At the same time, the Government slogan of a few years ago of no Government support for "near market" research now needs to be discarded: it is much better to concentrate on seeing that UK plc concentrates on the targets that will allow British industry to succeed in the future.

A great deal of effort was put into the Delphi exercise by those who took part. It seemed at the time that the process was too rushed, and that more time should have been allowed for it.

The Agriculture, Natural Resources and Environment Delphi exercise covered too wide a field, and in any re-jigging of the arrangements for a future exercise, the spread of this panel should be reviewed.

With these provisos, that the exercise should be done over a longer period, and that Agriculture, Natural Resources and Environment panel's scope should be reviewed, perhaps along with that of others, I think that the Foresight exercise should certainly be repeated. If it is at all worthwhile its output should be stable for perhaps three years and therefore perhaps it should be repeated on a timescale of something like three to five years.

Within this company the output of the Technology Foresight exercise has certainly been taken into account in reviewing our own research plans, since they make a very significant background of thinking to the research scene.

The Executive Committee of RHM has taken note of the exercise, whilst requiring of the research function both to take part in it in depth and to pay attention to its output.

I am hopeful that the transfer of the OST to the DTI will have a positive impact on the implementation of the Technology Foresight initiative. The policy initiatives of the Government in recent years to make the science base in the country more cognisant of the needs of industry ought to be confirmed by placing the OST within the DTI. If so this would be another positive step in the management by Government of the science base.

I would, of course, be happy to enlarge on any of these points if you would find it helpful for me to do so.

**Letter to the Clerk of the Committee from the Institution of Mechanical Engineers (TFC 6)
(3 August 1995)**

Thank you for your letter of 18 July concerning the enquiry by the Science and Technology Committee into the Technology Foresight programme.

ITEM 1

An exercise such as Technology Foresight is definitely required as an ongoing exercise. To continue without Foresight will involve those employed in research following their own intuition, rather than the potential needs of the nation.

ITEM 2

The Technology Foresight initiative has been helpful to us and has followed on our own 1994 identification exercise in future industrial Goals and enabling Technologies, the results of which were passed to the Office of Science and Technology.

We have passed the Technology Foresight information on Key Technologies out to our Industrial Divisions and Technology Groups, in order that they can include these in their future programmes.

ITEM 3

You enquired whether any part of the process was unhelpful or weaker than the others. We found that the regional workshops were variable in their effectiveness, many people feeling that insufficient was achieved. The Delphi Survey Documents were extremely long and several of our members commented that they found the operation too time consuming and indeed tedious.

The volume of papers issued after the survey was very large and has made the results somewhat indigestible.

ITEM 4

We believe the exercise should be repeated possibly in 1998, but that the method of bringing the information together should be reviewed.

ITEM 5

The implementation of Technology Foresight is most important. Obviously actions will be passed to the Research Councils and we note that Government will be issuing its proposals for implementation in December. During the interim period, it is essential that the findings are discussed in detail with those most involved. We will be happy to assist in this activity.

ITEM 6

In order to assist our members consider the Technology Foresight proposals, we have published details in our journal *Professional Engineering*, which goes out to all 78,000 members. As mentioned under item 2, we have also passed out key items to our relevant Industrial Divisions and Groups for their action.

ITEM 7

We cannot comment concerning the transfer of the Office of Science and Technology to DTI until we are appropriately briefed. It is essential that the Cabinet ensure that the Technology Foresight initiative is driven ahead and not merely subsumed into other activities of DTI. There are recommendations within Technology Foresight which may cause Government to review policies in different areas.

Letter to the Clerk of the Committee from the Royal Society of Medicine (TFC 7) (31 July 1995)

We were interested to read that the Science and Technology Committee will be examining the initiative so far and priorities for its future implementation. The Royal Society of Medicine, the Research Unit of the Royal College of Physicians and the charity Research into Ageing have been working together to facilitate the establishment of a National Centre of Ageing. This has also been the subject of a Workshop run by Sir Michael Peckham, Head of Research and Development within the Department of Health. Sir Michael's Workshop was established as a result of the Technology Foresight Report in order to examine ways in which the initiative for a Centre could be moved forward.

The Royal Society of Medicine, along with other organisations mentioned, is now trying to take matters forward with a view to seeking funding from the Foresight programme.

The difficulty we are experiencing is how the Technology Foresight process is moved forward. We have been unable to identify, for example, who is responsible for advising us on an application for funding (the DTI have passed us to the DoH, and so on).

The process of the Foresight Initiative has obviously been helpful because it has provided a vehicle on which to develop a plan of action to fulfil a recognised need—a National Centre of Ageing.

Part of the process which has been difficult is how we can exploit Foresight to move the agenda forward and gain access to the funds set aside.

Letter to the Clerk of the Committee from IBM UK Laboratories Ltd (TFC 8) (2 August 1995)

Thank you for your letter regarding the Committee's enquiry into Technology Foresight. In preparing this response, I have consulted with those of my colleagues who were directly involved in the process, including Dr Rodger Hake, who was vice-chairman of the IT and Electronics Committee.

In answer to your questions:¹

- A group is being formed to determine which areas of the Company is interested in the Foresight recommendations. We are also working with CEST, who have undertaken to provide a filtering of the recommendations to those relevant to IBM UK, and possibly to run a workshop to discuss their results.
- Mr Nick Temple has been in correspondence with Mr Ian Taylor, over the future of the Foresight exercise.
- We do not believe that the transfer of OST to DTI will have any harmful effect on the implementation of the Foresight Initiative. It may be beneficial, in that the DTI understands well the importance of involving industry and already has some mechanisms for so doing.
- Of course the UK could have continued without some exercise such as Foresight. However, the Initiative has provided a high focus on Science and Technology, and has potentially improved the communication between the business and the academic communities. Ideally, the success of the Initiative should be measured in 10 years time, to gauge whether there has been lasting benefit.
- The process of the Technology Foresight initiative has been helpful in that it has allowed participants to find out what others in their chosen "community" regard as important and what they view as potential opportunity.
- The process of the Initiative imposed a very aggressive timescale, at least on the IT and Electronics panel—indeed, the first draft of the report had to be prepared before the Delphi results were available.
- The essential point about Technology Foresight is that it should be repeated; it should be a continuous process of interactive analysis and implementation. Not to commit to repeat the process at regular intervals would severely damage the credibility of the whole exercise.

¹ See pp. 120-121 for list of questions.

Letter to the Clerk of the Committee from Sharp Laboratories of Europe Ltd. (TFC 9) (8 August 1995)

Thank you for your letter which invites me to provide comments to the Science and Technology Committee on the Government's Technology Foresight Initiative. I should like to preface my comments against the points you have raised in your letter by first saying that I strongly believe that the Foresight activity is an important aspect of Government policy for science, engineering and technology. I became familiar with similar exercises carried out by branches of the Japanese Government during the 1980s when I was Counsellor for Science and Technology at the British Embassy in Tokyo. The current UK Project has been, to my mind, different from the aims of the Japanese example in several aspects. In Japan the objective was to identify by a Delphi exercise the key technological factors which would be characteristic of social and economic life in a 10 to 20 year horizon. Once these issues had been identified the next stage was to identify the technological challenges which were set by these scenarios often in quantitative terms.

The Japanese exercises involved people in the public and private sectors, as has the UK programme, but I believe the Japanese are more realistic in what they expect of the outcome. To them the process identifies a set of desirable targets for general benefit, such as elimination of cancer, the self-sufficiency (for Japan) of energy, the exploration of space and so on. The technical problems to be solved are seen as important objectives for current and future Government and industrial research. However the targets themselves are not seen as a "blueprint" for an economic future which industry should follow. There have always been the so-called MITI "visions" of the future which have guided Japanese industry but these have been broad in concept, for example the "electronics age" and the "information age" and so on. Japanese industry's attitude to these foresight activities has been to participate and to take note of the results but there would be commitment to targets only if sound commercial reasons prevailed. The main achievement of their foresight activities has been to help Japanese Government funding agencies to direct their research resources into priority areas particularly by the Ministry of International Trade and Industry and the Science and Technology Agency and to some extent the Ministry of Education, Science and Culture.

The UK Foresight activity seems to have the risk of promising a successful future strategy for industry since the output has been more in terms of product and process targets than in research topics, although I accept that the latter have been included in many cases. The danger is that in securing a consensus with some industry representatives of future market trends these will be either disbelieved by broader industry or wrong. As in Japan, UK industry should take full note of the Foresight activities and take them into account where their commercial sense leads them, but they should not feel forced by Government to accept them. The main benefit of Foresight will be that the Government will be able to focus its limited research funds into areas which by consensus with industry should at least increase the probability of commercial success. Therefore, an expectation of industry to make a substantial proportion (for example more than half) of the funding for the fields of research so identified might be unfulfilled because of short term needs and practical outcome. In these cases the Government has to provide either all or the majority of the funding.

Turning now to the specific questions which the Committee has posed, I have the following comments.

- (1) I have no doubt that the results of the Foresight Initiative will be taken into account in our future research strategy. We are operating in the UK but are owned by a Japanese multinational. It will be valuable to us to integrate UK Foresight findings with information available inside our Company and from similar activities in Japan.
- (2) As a small company we have a Board of Directors but do not operate in a conventional way. Nevertheless I, as the Managing Director, have discussed Foresight with my colleagues, particularly our Director of Research. Our research programme is developed internally, although it has to receive approval from Sharp Corporation in Japan. It will be very helpful to use Foresight results in the process of justifying our choice of particular research targets.
- (3) It is my opinion that the transfer of the OST to the DTI will improve the implementation of the Technology Foresight Initiative. Although I can see the disadvantages which have been articulated by many university researchers I think that overall the Science Base will benefit from having a more integrated framework in which to operate and implement the 1993 White Paper policies. It is conceivable that more funding will be available for universities because of this move since DTI is unlikely to increase the provision of subsidies directly to industry.
- (4) I do not believe that it would have been possible for the Government to focus its research targets with limited funds without an exercise such as Foresight. The great advantage is that these targets are the result of a consensus across a spectrum of industrial technical experts and experienced academics in the UK. It will be very difficult for there to be substantial opposition against programmes which are based on the Foresight priorities.
- (5) I and three of my colleagues in Sharp Laboratories of Europe have been involved in the Technology Foresight Initiative. We have found this to have been a useful way in which to interact with like-minded colleagues from other organisations. In some cases we have an ongoing commitment which will help to continue our participation in the UK scientific and technological community.

- (6) I was not convinced that the particular format of the enquiry forms was optimum and, as I have said earlier, I hoped that there would have been more focus on the technologies required to achieve objectives rather than the technological push aspect which is characteristic of several of the reports I have seen.
- (7) As an enthusiast of Foresight activities I should like to see the exercise repeated. If we follow the Japanese this should be done on a five yearly basis. However, in the intervening time (which is always surprisingly short) there should be a minimum level of activity to keep the exercise on the right track, to make sure initiatives are carried out, to review the previous procedures and make improvements for the next exercise.

Letter to the Clerk of the Committee from BTR plc (TFC 12) (16 August 1995)

Thank you for your letter of 26 July regarding the Technology Foresight Initiative.

BTR did not take part in the initiative but we know that the publication of 15 industry reports earlier this year has stimulated ideas in a number of our companies. The BTR Technology Review Panel—which is responsible for producing a quarterly report highlighting important technological developments within BTR—is presently reviewing "Manufacturing, Production and Business Processes". The Panel agrees with the report's recommendations and, while most BTR companies also share the report's priorities, the Panel is keen to find ways of pushing the recommendations to an even wider audience. In addition the Foresight Challenge Fund has stimulated interest in a number of companies.

Regarding the two other specific questions in your letter, the BTR Board has not discussed Technology Foresight. The reports are necessarily at the macro level and it would not be easy, I believe, for any Board of Directors to formulate a Technology policy, with a clear method for company implementation, based on Technology Foresight alone. BTR believes that the Technology Foresight initiative has been useful for formulating priorities within British Industry and academia, and we hope that the transfer of the OST to the DTI will give added impetus to the initiative.

Letter to the Clerk of the Committee from The Association of Clinical Biochemists (TFC 13) (18 August 1995)

I am responding on behalf of the Association of Clinical Biochemists to the invitation to submit comments on the Technology Foresight Initiative. As the Association is part of the Health and Life Sciences sector, I shall restrict my comments to this panel and its report. I shall respond by answering the six key questions listed in the Press Notice dated 19 July 1995.

- (1) The Technology Foresight Initiative was essential to create a structured debate from which priority areas of activity could be identified. It now seems difficult to understand why the initiative was not conducted much earlier.
- (2) The recommendations must not be ignored. To ensure that they remain with a high profile, it will be necessary to establish a body to co-ordinate funding and activity, and to audit progress with the recommendations. It would seem sensible to continue to maintain the 15 sectors used by the Foresight panels, but there must be an overview to ensure that a balance of progress is maintained. The body should produce an annual report which specifies progress made and problems that remain.
- (3) I do not know what effect the transfer of the OST to DTI will have. Like many colleagues, my initial reaction is negative. At best, there will be a period of consolidation which is bound to delay the work of the OST. At worst, there is a fear that the prominence of Science and Technology will be diminished and much of the good work of Technology Foresight may be compromised. I would love to be proved wrong, but it will take a concerted effort from all in Science and Technology to achieve the desired outcome.
- (4) The Technology Foresight Initiative has prioritised where work in the Health and Life Sciences sector is most needed. This will assist Clinical Biochemists to target their research into the most relevant areas and so enhance their chances of securing funding and significant achievement.
- (5) The only problem with the process of Technology Foresight was that it took time from already very busy people. However, this is an inevitable consequence of any worthwhile new initiative. Hopefully, a repeat of the exercise would be much simpler and less time consuming.

- (6) The Technology Foresight Initiative must be repeated. With careful monitoring and regular reports on progress, it perhaps requires a major repeat once every five to 10 years.

I hope these comments are of some value to you.

Memorandum from The Royal Society of Chemistry (TFC 14) (21 August 1995)

1. COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT

No. Over the past five years there has been a shift worldwide in industry, government and public attitudes to S&T. Pace of change is accelerating, more emphasis on innovation and higher expectations of value for money in all sectors of R&D investment. Timely therefore to change national processes for strategic planning and improve connections between science base and industrial users.

Most competitor countries have already done similar exercise—another good reason not to be complacent.

2. WAS THE INITIATIVE HELPFUL

- Actually got things going and provided impetus.
- New networks between industry, academia and government set up very quickly.
- More opportunities and mechanisms to input on S&T issues.
- Regional workshops were particularly effective although hurriedly planned. New networks formed—very positive!
- Raised the profile of S&T on national scale.

3. WAS ANY PART OF THE PROCESS UNHELPFUL

- Whole process was rushed.
- Delphi exercise suffered particularly. Many people found this weakest part. To academia it appeared too market driven. To industry, too technology driven. Reason was lack of context to questions. Next time do Delphi at workshops after the scenarios have been presented and discussed.
- Delphi questionnaire was devalued because of the ineptitude of the consultants dealing with this part of the process. Some forms were not sent, conflicting messages were given out on how the respondent's expertise level would be used to weight their input. Result was of questionable value.
- On the positive side the Panels found the process of setting the Delphi questions a most valuable process in itself.

4. SHOULD THE PROCESS BE REPEATED

It is too early to say. The answer will be yes if positive implementation of the current process is achieved.

5. HOW SHOULD FORESIGHT BE IMPLEMENTED

Implementation depends on the individual recommendations. The question would take too long to answer. More to the point, industry wants to see it implemented and not just filed.

6. WHAT ACTIONS ARE YOU TAKING

Organising workshops in all the UK regions together with IChemE, CIA, OST and DTI with aims of dissemination and implementation, setting up common interest groups in the regions to pursue and refine topics and promoting collaborative research projects.

The Royal Society of Chemistry is reconstituting its Industrial Affairs Division. In so doing, it has taken positive steps to provide a structure that allows issues found by Foresight to be discussed and acted upon. In particular, emphasis will be given to encouraging activities of a multidisciplinary/interdisciplinary nature.

7. WHAT EFFECT DO YOU EXPECT THE TRANSFER OF OST TO DTI TO HAVE

Transfer could seriously undermine academic support for the process and its recommendations if DTI is seen to be hijacking the science base and diverting funds to low quality industrial support. If this view persists then implementation will be difficult in academia. The transfer may be politically correct but it could be counter-productive for implementation.

On the other hand, being closer to industry could make the Research Councils more effective in their wealth creation mode. Industry sees it as a positive move in principle (will the DTI now respond to industry's needs in S&T?).

The move has to preserve the "independence" of the OST and also to improve communication between Government Departments. It should not result in a reduction in OST budget to make up for DTI reductions over the past few years.

Letter to the Clerk of the Committee from The British Plastics Federation (TFC 16) (24 August 1995)

Your letter of 27 July 1995 advised me that the Science and Technology Committee is to conduct a brief inquiry into Technology Foresight. You went on to list seven questions to assist in the inquiry.

My responses are given in the same order as your questions were raised. They are based to a large extent on the experience and involvement of the Polymer Engineering Group (PEG) which operates within the BPF. A leaflet on PEG is attached. The responses so developed are:

- Yes; but direction would have been lacking and cost effectiveness would have been poorer.
- Yes; it reinforced views that PEG had been developing on a more "ad hoc" basis and provided a useful emphasis to some of our priority areas.
- The exercise was very broad and less focused than we would have liked, when viewed purely from a polymer standpoint.
- Yes; probably in about five years time.
- Foresight provides a direction; the detailed plans need to be developed by industry and/or academia.
- PEG already is collaborating with major polymer industry participants to carry out a more detailed, mini Foresight exercise for polymers. This takes the form of a small, well targeted workshop aimed at studying the needs and the potential of specific polymer areas.
- This should bring the academic interests closer to those of industry but risks the adoption of a dangerously short term approach. With Foresight in place, the old arrangement might have been adequate and the current uncertainty and disruption would have been avoided.

Letter to the Clerk of the Committee from BNR Europe Limited (TFC 17) (25 August 1995)

Thank you for your enquiry concerning Foresight, which was passed to me for response since Mr Perry has left the Company.

In answer to your questions:

- (1) It is not clear that Nortel will take any specific action as a result of the Technology Foresight initiative. As a large company, operating on a global basis, there are many inputs to our technology strategy process and Foresight is just one. However, the conclusions of the relevant panels (IT&E and Communications) fall in line with our overall thinking and provide useful confirmation of the general direction of the communities.
- (2) The Nortel main board has not discussed the UK Foresight initiative, although it has been discussed at senior technical levels.
- (3) Since many of the recommendations of the panels involved DTI taking the initiative in pulling together key industry players, the move of OST to DTI appears to be beneficial. It is vital that the move does not inhibit the Research Councils from undertaking their proper role in driving forward the science base in the UK. But our current view is that this is unlikely.
- (4) There is no doubt that we could have continued without some exercise such as Foresight. However, the process has had significant value in providing a point to stop and take a wide review of progress

and opportunities, and appears to have highlighted some issues which may now get action, whereas without the process they would have lain dormant for too long.

- (5) The initial process was helpful to us in that two of our senior technical staff took part and both found the experience very helpful in extending their networks, broadening their knowledge and refining their views on technology directions over the next five to 10 years. This then helps us with internal technology planning. The impact of this is, of necessity, long term so the immediate impact is not large.
- (6) Our representatives both found that the Delphi exercise was less than satisfactory. A large amount of effort produced very little in the way of concrete conclusions. One should very carefully consider before repeating this exercise.
- (7) The overall initiative does not need to be repeated as such since this launch phase will probably result in a long-term period of planning and action phases. Whilst it would not be appropriate to continue the present large committees indefinitely, we would recommend maintaining an infrastructure which would enable the activity to be supported through the planning and action phases.

Letter to the Clerk of the Committee from The Babraham Institute (TFC 18) (29 August 1995)

Thank you for your telephone call earlier this month and the interesting conversation. I am writing to confirm the situation with respect to the *Foresight* Reports and apologise for taking so long to do so.

Whilst a copy of a particular Report was routinely sent to any scientist who had been involved in the *Foresight* process (for instance our Director had been invited to attend a regional workshop and to fill in some Delphi questionnaires) copies were not readily available to the Institute. The OST were happy to send out copies of the leaflet for each sector, and very helpfully sent me a photocopy of the proofs for the Health and Life Sciences Report so that we could comment to the press. However, we were obliged to pay the full price for each of the four Panel Reports relevant to the Institute (at £15 each), and for the Report of the Steering Group (£25). Any University Library needing to purchase the full set would have had to set aside £250. When one begins to add other Government publications relevant to Science (for example the DTI's Competitiveness White Paper at £19.50) the costs begin to mount up—this latter example, however, is somewhat mitigated by the availability of the text on the Internet.

I hope these comments are helpful to your Committee.

Letter to the Clerk of the Committee from the Economic and Social Research Council (TFC 19) (29 August 1995)

Thank you for your letter of 18 July 1995 requesting the ESRC's view of the recently completed Technology Foresight exercise. I shall confine myself to key points but would be happy to provide any further information that you or members of the Committee might require. Could I respond to each question in the order in which it is listed in your letter.

COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

Left to their own devices, without "external" policy constraints, scientific researchers would undoubtedly produce a great deal of academically valuable and useful research; some of it would be path-breaking in its impact, an outcome not always predictable at the stage of project design. However, such a funding regime would not meet the requirements of the 1993 White Paper, since the scientific producers would themselves be both defining the usefulness of research and assessing its impact, not necessarily very systematically in either case. Technology Foresight establishes the external standard against which priorities can be defined and developed, and the results of research can be evaluated. Though much still remains to be done, a process has been initiated which has begun to draw the academic and user communities together in the development of shared scientific agendas. Technology Foresight provides an invaluable *broad direction* to scientific decision-making and is thus an integral part of the government's current strategy. For these same reasons the ESRC has carried out its own extensive national consultation exercise, which supplements Foresight and brings those issue areas within its own domain into sharper focus.

WAS THE PROCESS OF TECHNOLOGY FORESIGHT HELPFUL TO YOU?

The results of Technology Foresight came as a pleasant surprise to social scientists, who were only sparsely represented on the various panels. The identification of people-related issues by the Steering Group as among the most important ones for Britain is a source of encouragement and opportunity to our research community. The emphasis on such issues as the nature of business process, innovation, regulation, the human interface with IT, and learning has had a very important influence in shaping the ESRC's new priorities. As a result of this exercise our research portfolio will have an enhanced legitimacy and we will be pointed in directions which are most promising for linking up with the users of our research. We must ensure, however, that the people-related issues are not a residual category of the research process, but are fully embedded in it. Technology Foresight findings still contain a few bits of old-fashioned linear thinking which we, together with the other Research Councils, need to overcome in our joint work.

WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

The timing of the exercise was obviously awkward since the Research Councils had to draft their annual Business Plans well before the publication of the final Steering Committee Report at the end of May. This timing could not be helped. ESRC coped by holding special meetings with Technology Foresight panel members to gain a preview of probable recommendations. We also had access to drafts of panel reports. In this way difficulties were overcome. No other problems were experienced. Looking to the future, however, ESRC takes the view that the Technology Foresight findings should be used in a flexible and non-mechanistic way. In order to maximise the creative response from the research community it is important that a relatively wide margin of discretion be given to Research Councils, drawing upon their unfolding links with users to develop detailed programmes. We have the structures now in place to do this.

SHOULD THE EXERCISE BE REPEATED?

The answer is "yes" but, given the scale and cost, the frequency of the exercise needs to be considered carefully. In a sense a proper answer to this question rests upon an independent evaluation of Technology Foresight, the result of which would be interesting to both the user and research communities. We would also suggest that such an evaluation should specifically include a review of the current methods used to see if they could be improved. ESRC will be carrying out its own national consultation exercise on a two-year cycle, but for us the scale is less ambitious and the subject matter more changeable.

HOW HELPFUL HAS THE INITIATIVE BEEN IN DETERMINING YOUR PRIORITIES?

It has had a crucial influence on the provisional priorities listed in our most recent Business Plan and has been a vital ingredient in our own consultation with the academic and user communities (this included the use of focus groups of distinguished users, user questionnaires, a comprehensive consultation of learned societies, and an analysis of the pattern of grant applications and evaluations of completed projects). The ESRC's nine new themes which, like Technology Foresight, will guide our funding decisions in future years have been agreed in principle by Council and will be announced at the end of September.

WHAT EFFECT DO YOU EXPECT THE TRANSFER FROM OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

The ESRC already has good links with DTI in the areas of innovation, innovative manufacturing, business process and intellectual property. These links can be expected to strengthen as a result of the transfer. Ministerial statements following the transfer give important reassurances about the continuing importance of quality of life issues, which are important for the social sciences and have a bearing on areas of the ESRC's research portfolio which it shares with MRC and NERC.

Letter to the Clerk of the Committee from Raychem Limited (TFC 20) (25 August 1995)

Nicholas Godden has passed to me your letter of 27 July 1995 regarding Technology Foresight. Raychem participated in two of the Foresight initiatives—we hosted a discussion forum on Chemistry and we attended an Electronic/IT forum.

It is unlikely that we will change any of our R&D targets or directions as a result of the Foresight initiatives. We have not discussed Foresight at a board level, nor would we expect to, however our senior technical staff have discussed Foresight. The Foresight initiative was useful in the parts we attended in marginally broadening

our perspective in the technological areas discussed. However, we feel the process was more dominated by academia than it should have been, although this may have been the case only in the specific segments we participated in. It was not clear to us that the initiative was really addressing new directions rather than reconfirming existing paradigms. The output that we have received from the Foresight program also seemed to show little unexpected recommendations for future direction. We feel that the initiative somehow should have had more impact on creativity and innovation in the UK. It is not clear to us that this was achieved.

Finally, one organisational critique of the process. We were informed rather late of some of the programs and as a result missed material forums where we would have hoped to have had significant input. It was of some concern that the process was more focused towards the larger UK companies and perhaps not enough attendance required from more high technology innovative small companies.

Letter to the Clerk of the Committee from The Geological Society (TFC 21) (31 August 1995)

I am responding on behalf of the Geological Society to your request for views on the Technology Foresight initiative. The Society welcomes the initiative and believes that such activities should be an important component of national decision-making on science funding and policy. I answer your specific questions of the letter of 18 July 1995.

- While Technology Foresight may not be essential to a successful pursuit of new science and technology, the exercise has shown sufficient promise to merit continuation.
- The exercise took place on too short a time-scale and therefore participation of my section of the scientific community was less effective than it might have been. Nevertheless the Geological Society has benefited because Technology Foresight has made the Society aware of the very many areas of the UK activity where our subject is relevant. The panels for Technology Foresight do not correspond to usual academic scientific disciplines and subjects. We believe that this is a very useful and stimulating feature of the exercise as the relevance of an area such as earth science can be seen from quite different perspectives.
- The delphi questionnaires were widely regarded as not a good way to elicit information and led to the scientific community being rather more sceptical than was necessary. The speed of the exercise was too fast and it is not clear that the panels necessarily contained the optimum balance of expertise.
- The exercise should be repeated and be regarded as an almost continuous aspect of the process of providing information for decision and policy-makers on science and technology.
- Technology Foresight should be implemented by getting Institutes, learned Societies, public sector bodies, research councils and industry more fully involved. There should be wide consultations especially on panel membership, which must not ossify. Good turnover of panel members is essential. Panels need not be large, but the members must command the respect of the community. Organisations should be encouraged to carry out their own Foresight exercises to feed into the national initiative.
- The Geological Society plans to form a think-tank to develop its own Foresight plans on behalf of the earth science community and industries. An objective will be to make sure that grass-roots opinions feed into Technology Foresight.
- I can offer no opinion on the transfer of OST to DTI, although I have read the government documents explaining the benefits of the transfer.

In addition I would like to draw attention to points not covered directly by your questions.

- Some attention needs to be given to the subject areas of panels. In particular the ANRE (panel 11) is considered to be too broad and diverse to be effective. Environment in particular deserves its own panel and impacts on virtually all other panels. A representative of each panel on a separate Environmental Panel might be worthwhile.
- I draw attention to the essential need to underpin Technology Foresight by adequate funding of basic science. A modest shift to topics identified by Technology Foresight is sensible, but must not be so marked as to damage the science base of fundamental research which is an essential responsibility of government. Technology Foresight should be approached with a certain degree of humility, recognising that major developments in science and technology so often come from the unexpected and unimaginable.

**Letter to the Clerk of the Committee from the Engineering and Physical Sciences Research Council
(TFC 22) (6 September 1995)**

Thank you for your letter of 18 July inviting EPSRC to respond to a number of questions relating to Technology Foresight. A written response in the form of comments regarding the questions is given below; please let me know if you require any further input from EPSRC.

1. COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

The simple answer to this question is yes, insofar as a number of activities under ACOST, CEST, DTI and the Research Councils embodied many of the features of the Foresight process, and these have been reviewed elsewhere for example within "UK Technology Foresight" (Parliamentary Office of Science and Technology 1994), "Technology Foresight the identification and promotion of emerging generic technologies" (ACOST, 1994) and "Research Foresight in the exploitation of the Science Base" (Ben Martin for OST, 1993). The unique contribution brought by the national Technology Foresight programme has been to introduce a coherence and consistency of approach across the entire range of science, engineering and technology. This high profile given to the programme by the UK Government helped ensure that a considerable number of key individuals in both industry and the university sector devoted a significant amount of time and effort to the programme. It remains to be seen whether the programme can continue to engage such individuals over an extended period in the future.

2. WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

Although it is very early to try and quantify the benefits of the Foresight initiative, it was definitely helpful to the EPSRC in a number of ways. Firstly, the scale of consultation of both users and providers of research that the programme was able to carry out directly through workshops and the Delphi questionnaire and by proxy through various trade associations, learned societies and other interest groups, is much larger than EPSRC acting alone could hope to mount. Secondly, as a result of this consultation, there has been an endorsement of a significant body of the EPSRC's priorities, in many ways confirming the effectiveness of the current decision-making system in setting programme priorities. Thirdly, the networks established and brought to our attention by the Foresight initiative will remain in place for the EPSRC to use as an organisation, both to transmit and receive information regarding its programme.

3. WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

Anecdotal feedback suggests that the Delphi questionnaires were not regarded by many as a useful part of the process. Expectations were raised by the circulation of the questionnaire which were not realised in the contents of the sector panel reports. Whilst these expectations may have been unrealistic, sense of rejection that this may have created in some quarters may make implementation difficult. On the other hand, reports from the regional workshops were generally very positive. EPSRC staff attended a number of these and they provided an important means to build awareness of the developing thinking within the panels.

4. SHOULD THE PROCESS BE REPEATED? IF SO, WHEN?

The STA forecasts in Japan, which provide a benchmark for Foresight activities, are repeated every five years. Apart from the benefit which might accrue from shadowing an international Foresight activity in this respect to inform the design of our own programme, this period would appear to allow sufficient time for a proper evaluation of the effectiveness of the initial activity to begin and be appropriate to the scale of activity involved. Repetition of the exercise should not be in question given the function of Foresight as an adjunct to science policy-making in the majority of developed economies.

5. HOW HELPFUL HAS THE INITIATIVE BEEN IN HELPING YOU DETERMINE YOUR PRIORITIES?

Since its inception the EPSRC has adopted a number of criteria based upon analysis of socio-economic benefits, ability to capture benefits, provider capability, and research potential to establish priorities and adjust the balance of funds between programme areas. These map directly onto the steering group prioritisation criteria used to establish the generic science and technology priorities deriving from the Foresight initiative. As a result priorities identified by the steering group reinforce many existing priorities for EPSRC's programme, and are expected to highlight a number of areas where a new approach is required. It is to be hoped that the more detailed level of analysis and networks associated with the sector panels will provide some of the means to carry these priorities forward in the form of tangible research proposals built upon new and productive collaborations.

In relation to this, each EPSRC programme area will produce an action plan detailing its response to Foresight and the impediments to action. These plans will form a key part of the programme priority setting process for 1995-96 and beyond.

6. WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

I do not anticipate major modifications. The roles of the Research Councils and the bulk of the DTI that is not OST remain unchanged in the implementation process as do the roles of other stakeholders such as industry, academia and the higher education funding councils. EPSRC and DTI officials were engaged in extensive discussion regarding the implementation of Foresight prior to the transfer of OST to the DTI, and the scope for joint activity in response to Foresight, for example through participation in the LINK scheme, remains unchanged.

Letter to the Clerk of the Committee from the Welsh Funding Councils (TFC 23) (12 September 1995)

Thank you for your letter of 18 July inviting evidence to the Science and Technology Committee's Inquiry. The Council was not directly involved in the Foresight Process or in representations to any of the Foresight Panels. However, its funding function is relevant in the implementation phase of foresight and it has begun to address how it might most appropriately proceed in the coming year.

To date the Council has sought to provide particular steers to the higher education sector in Wales through reserving an element of funding—currently approximately 10 per cent of its total funding for research—for distribution competitively on the basis of proposals from institutions. The small size of the sector makes funding on this basis a feasible proposition in Wales. Proposals led funding has been operated in the interests of the selective enhancement of research quality and, more recently in this last academic year, to encourage further research collaborations with user communities in industry, commerce, the professions and the public services. The Council has already indicated its wishes to build on the experience of this last initiative which it sees as a viable means of taking Foresight forward. A new initiative will be launched for the academic year 1996-97. The details have yet to be finalised but the initiative will be explicitly linked to Foresight.

The remaining 90 per cent of the Council's research funding is distributed by a formula in which the quality of research is the major driver. Quality is measured through periodic research assessment exercises conducted UK wide using a process of peer review. The next research assessment exercise in 1996 will have full regard to the principle of equal weight for all types of research, from basic through strategic and applied to near market, and whether single or multi-disciplinary. The quality ratings awarded will therefore reflect the full spectrum of institutions' research activity. Against the outcome of that exercise the Council will wish to review the basis on which it determines the quanta made available to fund individual disciplines. It will wish in particular to explore the scope for recognising in these quanta the wealth creating potential of particular disciplines. At the same time the Council is also likely to review the proportion of funds distributed by formula. It may well wish to reduce this slightly in favour of proposals based funding since this type of funding allows resources to be targeted more precisely to specific ends.

Of course, in allocating funds the Council has to bear in mind a range of considerations, financial and academic. The Council is mindful of the importance to institutions of a reasonable degree of financial stability from year to year and it recognises a responsibility to all academic disciplines. It is also the Council's policy to consult the sector on significant changes to the funding methods it uses so that any major changes in the funding of research would only be made after consultation with the sector.

I hope these observations will be of help and interest to the Committee.

Memorandum from the National Grid Company plc (TFC 25) (18 September 1995)

1. COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

Yes, but without the advantages of a national review of long-term technology priorities aimed at enhancing the future success and competitiveness of UK industry. Foresight has brought together industry, academe and government in a very wide consultative process and has succeeded in (i) reviewing science and technology

developments over the next 10–20 years and (ii) setting out priorities and opportunities for technology research development and innovation in defined areas.

The findings of Technology Foresight in the energy sector are certainly of interest to the National Grid Company.

2. WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

Yes, the process was helpful to us in confirming the higher priority key technologies which would impact on the energy sector in general and the Transmission area in particular. We undertake our own internal reviews of long term technology developments and their impacts but Technology Foresight has added a wider perspective to this work.

The Foresight process will also be helpful to us when the conclusions are taken on board and acted upon by government R&D funding bodies. This does not appear to be the case at this stage.

We are parties in a co-funding agreement with the Engineering and Physical Science Research Council and would expect to see research projects in priority areas gaining government financial support in due course.

3. WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

We were only involved in a limited way in the process through attendance of one Regional workshop and did not receive the Delphic Questionnaire. The Regional workshop attended was not very effective mainly because of the wide range of topics covered and the limited expertise of participants to assess and prioritise them.

We consider that wider representation on the Energy Technology Foresight Panel would also have been desirable with high voltage Transmission interests directly represented.

4. SHOULD THE EXERCISE BE REPEATED? IF SO, WHEN?

Yes, we think the process should be repeated in two to three years' time. As mentioned above, the Energy Panel should be reconstituted and its membership reviewed. A method of enhancing the participation of interested parties would be to establish Working Groups of Experts in various Energy Technology sectors with Energy Panel members as convenors. This approach could replace the need to hold Regional workshops.

5. HOW SHOULD TECHNOLOGY FORESIGHT BE IMPLEMENTED?

The findings of Technology Foresight should be implemented through the Research Councils and through government departments such as Trade and Industry, Environment and Education. Funding policy should be focused on the identified priority technology areas and these should be promoted by government in the EU and in relation to the Fourth Framework Programme.

6. WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

It is hoped that this transfer should speed up the Technology Foresight implementation process and strengthen the development of a clear government technology policy.

Memorandum from the Institution of Professionals, Managers and Specialists (TFC 26)
(20 August 1995)

INTRODUCTION

1. IPMS is a professional trade union representing the views and concerns of scientific and other specialists across a wide range of disciplines and sectors, many of which have been covered in the work of the Technology Foresight Panels. Scientists and research staff in IPMS membership work in the Civil Service, including the

increasingly fragmented Agencies, Research Councils and institutes and related bodies, as well as for leading suppliers of research and scientific services in the private sector.

2. IPMS has maintained a close interest in the development of the Technology Foresight programme since its inception in the 1993 science White Paper. IPMS' response to the 1994 Forward Look welcomed the establishment of Technology Foresight and expressed support for a wide-ranging process of consultation and involvement, but suspended judgment as to whether at that time the Foresight objectives had been fully met for both wealth creation and quality of life aspects of research. A year later, and following publication of the first reports by the Foresight Panels and the Steering committee, the Select Committee's inquiry provides a timely opportunity to review the first stage of the programme.

3. The IPMS response to the questions posed by the Select Committee are set out below.

COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

4. The 1993 White Paper recognised the need to improve "performance by making the science and engineering base even more aware of and responsive to the needs of industry and other research users". Technology Foresight is, or should be, one of a range of measures designed to improve industrial performance. There is plenty of evidence of the need for such measures:

- UK total gross expenditure on R&D fell from 2.7 per cent of GDP in 1985 to 2.19 per cent in 1993. This compares with 2.8 per cent in Japan, 2.79 per cent in the USA, 2.48 per cent in Germany and 2.41 per cent in France.
- In 1994, Britain had fewer engineers and scientists than most other industrialised nations. There were 45 researchers for every thousand people in Britain, compared with 78 in Japan, 69 in the US and 53 in France.
- Research shows that it is important for innovative and technologically successful organisations to have scientists and technologists in senior management positions. None of the 20 Permanent Secretaries in charge of Civil Service Departments in 1994 were scientists, and only two had a specialist or professional background. Of the 50 staff at Grade 3 or above in the Department of Environment, only three were scientists.
- Spending on defence R&D will have been cut by over one-third in the 10 years to 1996–67.
- Before the recent transfer of OST to DTI total R&D spending in the DTI was expected to be £132 million in 1997–98—a fall of 56 per cent from the 1993–94 figure of £399.8 million.
- British industry shed more than 24,000 R&D jobs between 1986 and 1993. In real terms, expenditure in 1993 was £400 million below 1990 levels.
- Total staff engaged on R&D in Government fell by more than 21,000 (40 per cent) from 1984 to 1994.
- R&D is increasingly subject to a short-term contract culture for both funding and staffing. There are dangers that efforts to boost contract income will detract from basic research. Also recent research suggests that sub-contracting of research by business will involve a loss of in-house motivation and control, reducing its capability to function as an intelligent customer or user of research whether generated in the UK or abroad.

5. Indeed, the new Minister for Science and Technology has recognised that there are wide-ranging problems. In a statement on July 20, Mr Taylor said "It is unwise not to recognise that there are problems in the UK. Too few scientific advances are transferred into industry. Too few industries are stimulated by our science base to conduct strategic research. Too many children drop science and engineering at an early age. The public's esteem of scientists, engineers and industrialists is lower than in competitor countries."

6. What is clear both from the above analysis and the Minister's comments is that the challenge is wider than the remit of the Technology Foresight programme both for science and for economic growth and the quality of life. So although Technology Foresight has a part to play, what is also needed is full commitment to a comprehensive industrial strategy of which science forms only one part. It also needs a continuing commitment of substantial resources to maintaining the science base in both universities and PSREs which relate to their own "missions" as defined in the White Paper and the "Forward Look" and which go beyond the imperatives of Technology Foresight. Among the priorities for action are:

- Improved career development and rewards for research staff, for example by curtailing the use of short-term contracts in all branches of public science.
- Measures to ensure that young people (in particular women) are not only encouraged to pursue scientific subjects of study but that, once qualified, they have more opportunities to pursue a career in their chosen scientific discipline.
- A period of stability to facilitate forward planning of science programmes. The Government's apparent intention to subject public sector research establishments to a further round of prior options

review in the wake of the Efficiency Scrutiny will impose unnecessary stresses and again divert resources away from core research functions.

- A determined effort to increase the "Effective demand" for scientists by raising awareness of the importance of science and technology in all areas of national life, especially industry and government.
- Recognise the importance of employing SET staff in senior decision making positions, as is commonplace among our more successful foreign competitors so that there are "intelligent customers" for SET in all areas.

7. All of these concerns were highlighted in IPMS' comments to the 1994 Forward Look. IPMS is pleased to note the subsequent establishment of the Women's Development Unit in OST, though there is a strong case for increased resources for this important work. The more recent discussions between Research Councils, the Royal Society and Committee of Vice Chancellors and Principals on a framework for career management of contract research staff in universities and colleges are also to be welcomed. Improvements in this area are long overdue and analogous arrangements should also be made available to the staff in the Research Councils' own institutes.

8. Our view that Foresight should be used as a part of a wider industrial strategy is one that is shared by industry. As the Engineering Employers' Federation states "It should be used as the basis for a long-term coherent industrial strategy, informing thought about where industry is going, allowing government and industry to understand better what are the main drivers, and how technology and markets are moving".

HOW SHOULD THE RECOMMENDATIONS FROM THE TECHNOLOGY FORESIGHT PROCESS BEST BE IMPLEMENTED?

9. Two key drivers of change are awareness that an opportunity exists and ability to exploit it. Thus, to maximise the potential benefits of Technology Foresight there needs to be a better understanding of opportunities on the part of research providers and potential users. There needs also to be an appropriate framework of financial support to ensure that, at least in the early stages, research projects are not frustrated either by failing to meet commercial payback requirements or by lack of funds in the Science Budget.

10. IPMS remains extremely concerned both about the level and the allocation of Government support for science. IPMS has previously highlighted the danger that the increased emphasis in the 1995 Science Budget on strategic initiatives such as LINK will leave less money for areas of basic science. The Foresight proposal to move to greater selectivity increases this threat. For example, BBSRC's research institutes are already threatened with substantial job losses as a result of cuts in core funding.

11. At the Press Conference on 22 May at which the Technology Foresight Steering Group Report was launched alongside the second competitiveness White Paper it was announced that an additional £40 million would be made available by OST for Foresight Initiatives over the next three years provided it was matched by industry, but this does not appear to be "new" money. Indeed the Forward Look figures for 1995 suggest only a £3 million increase in funds for the "science" vote and money has already been diverted to fund ROPAs. It was also announced that £70 million would be devoted by DTI over four years to SET activities following Foresight outcomes, enhancing support for SMEs, and to a larger budget for DTI LINK programmes. Yet DTI funding for R&D according to the Forward Look is due to decline from £310 million in 1993-94 to £230 million in 1997-98, so where is the new money?

12. The problem of resources is therefore an area where the Technology Foresight process may yet founder. The likelihood is that the process will generate a substantial new demand for funds. It also requires resources to maintain the Foresight process. This is particularly the case if a wide range of interests are encouraged to participate. For example, many SMEs do not have the human or financial resources to participate. State funding may make the difference between participating in the process or not.

13. IPMS believes that it is particularly important to capture the views of SMEs, working scientists and others at the cutting edge, whether research providers or those involved in marketing or defining the "customer" demand. It is also important, particularly in the quality of life aspects of research, to involve a wider range of interests such as consumers and environmental groups, trade unions and the public at large. Women should also play a bigger role. The work of the Technology Foresight panels to date is a valuable start to this process, but it needs now to rapidly move away from the prescriptions of "wise men" to an active, practical and broad based programme for science and industry.

14. Effective implementation will also depend on the availability of the relevant skills. In the UK current statistical information on skills available is poor, especially below graduate level and beyond the first appointment at graduate level. Long lead times are required to ensure that bottlenecks in skills do not occur. The current total reliance on the market with little intelligence as to what is happening overall is unlikely to produce the relevant skills in the right place at the right time. Improvements should be made in the statistics provided in the "Forward Look". The bringing together of the Departments of Education and Employment should hopefully make such statistics easier to achieve.

15. Careful thought also needs to be given to how the results of the Technology Foresight exercise are to be disseminated and what backing is to be given to help industry to develop the technologies identified. The Government has been reluctant to move that close to the market but in many areas especially where R&D and technology is not well understood or established, the "horse" will need to be led to the "trough". We are not confident that "business links" organisations will be sufficient to the task. We are pleased, however, to see that EPSRC in its response to Foresight mentions the importance of mediating mechanisms when it says it will consider research centres for priority areas and these may include "the Faraday concept and a number of mixed mode possibilities". The White Paper of 1993 mentioned the importance of the Faraday Principle in technology transfer but the DTI was unwilling to provide the funds. We hope it will now think again.

16. As far as the process of dissemination is concerned very little is still known about the crucial processes of diffusion. The role of ESRC and others could be vital in analysing the socio-economic and organisational processes involved both in this aspect and in the Foresight process as a whole to ensure that it is as effective as possible.

WHAT EFFECT DO YOU EXPECT THE TRANSFER OF OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

17. According to the Science Minister "OST will gain from closer working with the Innovation Unit in DTI" and it "will focus extra effort in encouraging inward investors to locate R&D activities in the UK". IPMS remains to be convinced. Although it is to be hoped that one effect of moving OST into DTI will be to improve contracts with industry, IPMS shares the concerns expressed by leading scientists and scientific institutions about the effects of this transfer on long term research and the future security of the Science Budget.

18. Assurances that the Science Budget will be ring fenced must be set against the reality of an eroding science and technology base within DTI, continuing budget cuts and the policy of privatising DTI laboratories. As indicated above DTI expenditure figures for R&D show a planned decline of 56 per cent over the four years to 1988. For S&T, expenditure falls from £409.2 million in 1993-94 to £242 million in 1997-98—a 41 per cent cut. This continues a long trend of cuts. Over the period 1986-87 to 1991-92 when the Department of Energy was separate from DTI and covered nuclear expenditure, DTI spending declined from £462.1 million to £330.9 million in cash terms.

19. In any event as the Technology Foresight steering group recognise, the programme needs to be co-ordinated and monitored across Government. IPMS would agree with the steering group recommendations that the Foresight team in OST should be strengthened and that other Departments need to establish specific arrangements to take forward Foresight programmes within their areas of responsibility and to liaise with national Foresight Panels. These include major areas of health and environmental science which are outside the remit of DTI. Relocating the OST does not remove the need for concrete technology transfer mechanisms and adequate resources.

WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

20. As explained above, there are a whole range of problems associated with and arising from inadequate investment in the science and technology infrastructure and from failure to fully exploit new opportunities. The intention must be that industry and the economy as a whole will benefit as a result of specific actions taken by organisations resulting from the Foresight Process. However, the degree to which individual organisations find it helpful will inevitably depend on their own objectives. On the positive side, the CBI's view is that "the whole process of Technology Foresight has been helpful and valuable in creating academic and industry links". It would be interesting to know whether the CBI have documented evidence of new links arising from Foresight.

21. As far as public provision is concerned, the Research Councils have published a collective response outlining how their programmes will in future be linked to Foresight objectives. One interpretation is that the Foresight priorities have been instrumental in shaping future research programmes and, in doing so, more closely aligning them with the needs of end users. Another interpretation is that Foresight has allowed the Research Councils simply to reformulate existing projects in order to maximise available funding. Neither interpretation is particularly helpful for those scientists who are continuing to lose their jobs as a consequence of progressive cuts in overall public funding.

22. It is also interesting to note from PPARC's response the limitations of the Foresight process: "No one expects Foresight to influence whether we do extragalactic astronomy or not" but "whether we try to spin technology off will depend on the signals we get from Foresight". It is as yet too early to judge how helpful Foresight will be in this latter regard. However, most Research Councils have indicated that responsive mode funding is only likely to be marginally affected by Foresight. The DTI annual R&D Scoreboard gives an indication of how much progress still needs to be made in industry. This shows that investment in R&D by the engineering sector declined by 12 per cent over the last year. Although across the economy the ratio between R&D and sales rose, the ratio to profits declined.

23. In terms of the main Government Departments, it has been suggested that the MOD's "systematic examination of the technologies and capabilities we ought to sustain", reported to the Trade and Industry Select Committee in May, involves a different view of the future from the defence and aerospace Foresight Panel. It would be simplistic to assume that all that is required is discussion by a Foresight Panel in order to produce a shared vision of the future. Furthermore, moves to implement Foresight findings have been patchy so far. The Departments of Health and Environment have set up implementation groups, but the Treasury's new policy statement on procurement does not mention the Foresight proposal to use government purchasing to stimulate the development of new technology.

24. Inevitably there will be losers as well as winners from the Foresight process. No doubt those areas identified as being lower priority (clean processing technology, energy technology, product and life cycle analysis, automation and demographics) will not consider the Foresight process to have been helpful to their interests. There are many more, as yet without any direct involvement in the process, for whom this question will be premature.

WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN OTHERS?

25. IPMS is concerned that although Technology Foresight has dual aims linked to wealth creation and quality of life, in fact the Steering Group report views R&D more from a commercial than a "public good" perspective. The view taken is that although publicly funded science and technology "contributes to a public pool of information", this is "unlikely to be a source of national competitive advantage". The report argues that firms need an "open and liberal market under conducive financial and economic conditions" to promote innovation. It concludes that Foresight results should not be used to direct basic research. It accepts that in some markets, such as bio-sciences and medical imaging, "blue skies research and the market place are not very far apart". However, no guidance is given on how the distinction is to be drawn. As the Financial Times commented "the Government . . . turned almost a century of tradition on its head by making business competitiveness the driving force behind the way it funds scientific research".

26. In terms of human resources, the report repeats the acknowledgment in the 1993 White Paper that "women are the country's single most under-utilised resource". However, it offers no further comments or proposals to rectify this position. It also accepts that levels of technical literacy among senior managers in the UK often fall below those of major competitors. As IPMS has long argued, this is equally true for senior managers in the Civil Service. IPMS' submission to the 1994 Forward Look highlighted the need to maintain and increase the flow of high calibre STEs into senior policy making positions in the government service both in scientific and generalist roles. This is necessary both to ensure the technical competence to deal with complex administrative and political decisions and that "customers" in Government Departments are well equipped to make a fair and scientifically informed decision from among "contractor" bids.

SHOULD THE EXERCISE BE REPEATED? IF SO, WHEN?

27. IPMS' firm view is that Technology Foresight should be a continuing, broadly based exercise making a key contribution to overall industrial policy. Implementation of the initial Panel reports will be a key stage and a major test of the Foresight process. The Government's commitment to publish an end of year progress report is therefore to be welcomed. It should be followed up by regular progress reports which must also cover implementation outside the science base. IPMS' assessment is that the first phase of the Foresight exercise, marked by publication of the Steering Group and Panel reports, has generated significant support for the Foresight approach. The test now is to maintain this goodwill both through implementation of priority recommendations and by drawing in to the process a much wider section of the scientific and lay community. If Technology Foresight is to succeed it will involve changing to a culture based on longer planned time perspectives. If Foresight achieves this against the current climate in which the science base is being eroded through lack of funding, short-termism, and fragmentation it will be very much against the odds.

Letter to the Clerk of the Committee from Kellogg's (TFC 27) (12 September 1995)

Thank you for your letter of the 7 July on the Science and Technology Committee's brief inquiry into Technology Foresight. We will answer the seven questions you raised in the order in which they were asked.

1. WHAT, IF ANYTHING, WILL YOUR COMPANY DO AS A RESULT OF THE TECHNOLOGY FORESIGHT INITIATIVE?

Through our membership of various technical committees of the Food and Drink Federation (FDF) we have been involved in developing FDF's input into the Technology Foresight exercise. Our continuing membership of these committees will ensure our on-going input.

We have been visiting the various UK Research Associations and the suitability of these to our needs. Similarly we have been addressing, and will continue to address our needs for knowledge. This we expect to arise by the transfer of technologies from other areas of the food industry and from industries other than food and by us commissioning research either in conjunction with others or by ourselves. Thus we see a need for technology transfer not only for SME's but also for large companies.

2. HAS YOUR BOARD DISCUSSED FORESIGHT, OR WILL IT DO SO IN THE FUTURE?

They will do in the future.

3. WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

Overall we are hopeful that this transfer will have a positive impact. We believe that it will help the science base in the UK recognise the needs of industry. These needs are in general two fold; new science/technologies and support for their application in both SMEs and large companies. We do have one concern and that is that of the potential to lose a focus on the food industry which is an impression of the DTI perhaps because of the existence of MAFF. Certainly having science and industry bases under one department is in general a positive step.

4. COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

Without Foresight any continuation would have been fragmented and unsatisfactory. The major benefit has been a way of identifying priorities for public funding of R&D with a secondary one of bringing Academia and Industry closer together.

5. WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE OF HELP TO YOU? IF SO, IN WHAT WAYS?

The decision to have a Food Panel was a key step in recognising the importance of the food industry to wealth creation. Also it was helpful, hopefully in recognising the need to increase the funding on food research opposed to agriculture. As mentioned earlier it was of paramount importance in identifying research priorities for the food industry. It has as a consequence assisted in developing a better relationship not only with the RAs and RIs which was good already but also with the Food Directorate of BBSRC.

The framework and mechanisms set up will be helpful to us and we seek to improve the efficiency of our operations. Although during the process contacts were by and large between groups they now offer the opportunity for us to meet with the academics to discuss specific issues.

6. WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

This is a difficult question to answer but one point that stands out was there was a lot of involvement of a few people, relatively speaking, and not much opportunity for dissemination of findings/interim results via meetings or workshops. We suspect that this might have been due to the rushed nature of the process.

7. SHOULD THE EXERCISE BE REPEATED?

The simple answer is yes. The exercise must be on-going otherwise we return to the stop/start nature of previous times. If the process has worked then the outcome should be valid for say four to five years. Thus a repeat of the whole exercise in say, five years would be appropriate.

Memorandum from The Institute of Materials (TFC 28) (14 September 1995)

I was pleased you invited The Institute of Materials to respond to your questions and I am responding on behalf of the Institute. We have made a major effort on Materials Foresight, and I thought the Committee would be interested in knowing something of the details.

We have conducted three sectoral studies—on biomaterials, aerospace and power generation—and more are planned. We are disseminating the results and stimulating action on their recommendations. Materials, being a key technological area for competitiveness and innovation, was allocated its own sector panel in the OST exercise. We have maintained close contact with the panel making our results freely and promptly available. A

high proportion of panel members are also members of the Institute and we have accepted its invitation to be the "product champion" for Materials Foresight. A majority of the other OST sector panels have identified aspects of materials as key ones for their sector, illustrating the way in which materials technology underpins most of manufacturing industry. We expect to conduct a joint dissemination and implementation programme of seminars and workshops with OST.

Let me turn now to the specific questions in your letter to Dr Catterall.

- (a) *Could we have continued without some exercise such as Foresight?*

Let us consider first what was wrong. We needed the following:

Greater wealth creation from our science base.

A recognition of the importance of evolutionary and continuous improvement to the technological base.

More widespread research collaboration with a product focus and within networks based on the companies in the supply.

A higher proportion of investment in new and improved industrial processes, the key to successful commercialisation.

The Foresight exercise has brought greater recognition of these problems but it is too soon to say whether any real and lasting change has been made. Much will depend on the implementation stage at company level on which only limited progress has been made.

- (b) *Was the process of the TF initiative helpful to you?*

Yes. We believe the process will heighten awareness of the importance of materials technology, and are investing our own time and money in it.

- (c) *Was any part of the process unhelpful or weaker than the others?*

Yes. The Delphi method has severe limitations; samples are often small in number and inputs often come from those with vested interests. The long questionnaires are off-putting to busy industrialists. Another weakness is the long gestation period required to launch the panels and their programmes.

- (d) *Should the exercise be repeated? If so, when?*

First it is necessary to define the "exercise". It is mainly in three parts:

- (i) A major analysis at intervals of three to five years.
- (ii) Rapid and prompt dissemination and vigorous implementation over a two to four year period.
- (iii) Continuous structured monitoring, and a review of effectiveness every three to four years.

In summary, the exercise should be repeated but not necessarily in the same form.

- (e) *How should TF be implemented?*

Through the public and private sectors moving investment and research funds towards the priorities identified in the exercise.

Also through strengthened links between industry and universities plus City commitment of advice and investment. The potential importance of advice from the City is frequently overlooked, and equally, the lack of interest by investment—fund managers of longer term programmes is inhibiting.

- (f) *What actions, if any, are you taking to assist your members in considering the TF proposals?*

We have:

- (i) Publicised the TF findings in our monthly journal "Materials World", which is distributed to all our members.
- (ii) Proposed joint workshops with OST and with DTI.
- (iii) Planned a series of regional meetings.
- (iv) Published our own studies of industrial sectors.
- (v) Promoted discussion of our studies to lead to the definition of inter-company projects with universities.
- (vi) Encouraged closer collaboration with other engineering institutions.

- (g) *What effect do you expect the transfer of OST to DTI to have on the implementation of the TF initiative?*

We have noted the policy statement of 20 July on Science Engineering and Technology (SET) by Mr Ian Taylor, Minister for Science and Technology. The statement is reassuring provided it is followed up by supporting and consistent actions, which can be expected to come under detailed monitoring and scrutiny. We think it is particularly important for the policy to lead to:

- (i) A working interface between OST and other Departments (including the other parts of DTI).

- (ii) The development of an effective partnership between DTI and the private sector.
- (iii) A reversal of the reduction of the SET capability in DTI and rebuilding it with the restoration of a Chief Scientist post.
- (iv) Adequate representation of SET within the Cabinet and its committees.
- (v) Maintaining an appropriate Parliamentary Committee to oversee SET work including Technology Foresight, and the operation of OST within DTI.

Memorandum from the Construction Industry Council (TFC 29) (13 September 1995)

It is important to bear in mind the purpose of the Foresight exercise. The objectives were:

- To increase wealth creation and the quality of life.
- To forge new working partnerships between science and industry.
- To inform decisions on the balance and direction of publicly funded science and technology.

The exercise was ambitious and was conducted in a relatively short timescale. The 15 Panels were briefed in April 1994 and had to complete their reports by January 1995. This meant that the process was rushed. Despite this the overall result is better than might have been expected.

It would appear that where there has been negative comment, much of it has been made by those who have forgotten what it was for and who fail to appreciate the timescale over which it is operating.

Dealing with the six key questions:

1. COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

Of course we could. There are many ways in which the objectives could be met. Foresight happened to be a tool which had the merit of catching the attention of a large number of key people in industry, government and academe in a productive way. The precise details of the process do not matter. What was significant was that it happened and that a large commitment was made by many key people. The approach has significance internationally.

2. HOW SHOULD THE RECOMMENDATIONS FROM THE TECHNOLOGY FORESIGHT PROCESS BEST BE IMPLEMENTED?

There is no alternative to a sustained "campaign" orchestrated by government. The continuation of the 15 panels is helpful. The key activities are:

- (i) Influencing research spending priorities.
- (ii) Effecting shifts in research activities.
- (iii) Encouraging people to seize opportunities.
- (iv) Developing collaborative networks.

For construction, the Construction Research and Innovation Strategy Panel (CRISP) is well placed to help with implementation, given the synergy between the Foresight recommendations and the Whole Industry Research Strategy for Construction that CRISP is charged with promoting.

The Whole Industry Research Strategy builds on existing industry improvement initiatives, such as the Latham Review ("*Constructing the Team*") and the Technology Foresight programmes, to create both a framework that will guide and link researchers in their work, and a networking of all parties in construction research. In doing so, it aims to develop a consensus on what research would be most relevant to the needs of the industry and its clients.

The strategy is being developed by representatives from the professionals, contractor, specialists, suppliers, clients, government departments and research and information providers. The representatives come together in the CRISP.

3. WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

It all depends on the wisdom of the people charged with the task. It could be a complete disaster; it could be very beneficial. The worry is over the position of basic science which we feel does not receive the attention required in view of its primary role as an engine to the development of competitive advantage.

4. WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

The CIC is the representative body for the professional bodies in the construction industry. Technology Foresight was directly helpful to a number of the CIC's constituents and, in turn, to their members. CIC has been very supportive of the process and is seeking to promote the results to all its members.

Building relevant bridges between industry and academe is always helpful.

5. WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THEN THE OTHERS?

The CIC has reservations about the conduct of the Delphi Survey. It is clear that there was insufficient time to refine the Delphi Statements. Recipients of the questionnaires found them daunting to complete. In the end, the results of the second stage were not available before the sector reports had to be finished. Considering the effort that had to be put in, the value of the Delphi Survey is questionable.

6. SHOULD THE EXERCISE BE REPEATED? IF SO, WHEN?

It is too early to give a definitive view on this. Some form of exercise is likely to be worthwhile at appropriate intervals. The UK cannot expect to do everything, and a systematic process of identifying the best opportunities should be worthwhile.

Letter and Memorandum from The Institute of Physics (TFC 30) (14 September 1995)

I am pleased to submit a Memorandum by The Institute of Physics, concerning the Technology Foresight Inquiry being conducted by the Science and Technology Committee, which contains our response to the six questions listed in the Committee's Press Notice of 19 July 1995.

In addition, you ask what action this Institute is taking to assist our members in considering the Technology Foresight Proposals. As mentioned in the Memorandum the Institute has taken an active rôle in the Technology Foresight Programme from the very earliest days. We have already:

- (1) Nominated our members for services on Foresight Sector Panels, as Experts for consultation and for attendance at Workshops.
- (2) Produced a booklet listing the main contacts within the Foresight Programme, together with details of our members' involvement, and have distributed this widely, free of charge.
- (3) Set up shadow panels to follow the work of the Foresight exercise.
- (4) Produced a booklet containing our members' views of Technology and Application Trends over the next 10-20, to mirror similar work by the Foresight Panels, and have distributed this widely, free of charge.
- (5) Published numerous feature articles and comments in *Physics World*, our monthly magazine for members, and in our thrice-yearly newsletter, *Physics In Business*.
- (6) In May of this year, with support from the OST, mounted a major three day Foresight dissemination conference.
- (7) Distributed complimentary sets of Foresight summary reports directly to our main contacts in industry and business.
- (8) Acted as intermediary in making the full Foresight reports readily available to our members.

Other ways in which we have supported Foresight include:

- (9) Offered support to each of the Foresight Sector Panel Chairmen, including complimentary use of meeting facilities here at Belgrave Square.

- (10) Made formal submission of the Institute's views to 11 of the 15 Foresight Sector Panels.

For the future we intend to keep the Programme under review, and to respond with new actions and initiatives as the need and opportunity becomes apparent. Currently:

- (11) We have submitted a proposal to the DTI for a project to facilitate dissemination of the recommendations of Foresight to the small technology-based business sector, through our SME (Small and Medium size Enterprise) Club.
- (12) We are discussing with the OST the possibility that the Institute might publish and distribute, at cost, supplementary data generated by the Foresight IT and Electronics Panel.
- (13) We are investigating options for dissemination of Foresight finding to the education sector, in particular to secondary schools and providers of sixth form teaching.
- (14) We are exploring the possibility of a major submission to the Foresight Challenge competition, for a project which would address infrastructural priorities identified by the Foresight Steering Group.

If the Committee required any further information on this submission, please contact either me, or Mrs Susan Partridge, the Institute's Industrial Affairs Manager.

The Institute would be pleased to give oral evidence to the Committee on this subject if this is considered appropriate.

Memorandum

INTRODUCTION

1. The Institute of Physics (IOP) is a learned society and the professional body representing qualified physicists in Great Britain and Ireland. With a membership of more than 21,000, around 9,000 are employed in industry and the public sector, and more than 3,000 in universities.

2. The Institute has taken an active rôle in the Technology Foresight Programme from the very earliest days. We have been involved in consultation and dissemination exercises, and have a good working relationship with both the OST and the DTI. Many of our members have been active participants in the different stages of the Foresight process, and the Institute is well informed on their findings and views.

CONTRIBUTION TO THE INQUIRY

Could we have continued without some exercise such as Foresight?

3. Whilst both business and academia could have progressed without the Foresight Programme, market forces might have driven them along separate paths, and, in the national context, the wealth creating potential of scientific and technological research, development and exploitation is unlikely to have been fully realised.

4. As a result of Foresight, industrialists, academics and civil servants have collaborated, as rarely before, and the resultant networks and contacts are a significant benefit to all those who have been involved, in panels, workshops and other forms of consultation process. Without effective development of the networks, and adequate dissemination of the recommendations from Foresight, much of the potential impact of the Programme will be lost. There is evidence that individuals and businesses are, as a result of Foresight, reconsidering their long-term goals.

How should the recommendations from the Technology Foresight Process best be improved?

5. The key requirement is a visible and sustained commitment by Government to the Foresight Programme. Technology Foresight must be a major component of all Government thinking and action.

6. The Institute believes that the recommendations cannot be implemented unless infrastructural support, pump-priming, and incentives for private sector participation are provided by Government.

7. The Government's commitment to Foresight should be clearly shown by their taking the lead in the planning, funding and implementing of new schemes. The Institute believes that such activities should form part of an overall national strategy in science and technology, with priorities and measurable national objectives.

8. The Institute believes that the strength of the UK science base should not be eroded or compromised as a result of Foresight. The Foresight findings should be viewed as a framework for guiding Government expenditure on science and technology, whether via the Research Councils, the OST or the DTI, provided that this is used as only one parameter in deciding on priorities for Government spending in these areas.

What effect do you expect the transfer of the OST to DTI to have on the implementation of the Technology Foresight Initiative?

9. The move will encourage the DTI to take an active part in the longer term aspects of research and development strategy, with ultimate benefit to UK industry.

10. The extensive resources and influence of the DTI can now be directed to advantage in the implementation of Foresight.

11. A potential disadvantage of the transfer is that Foresight will be seen as a Departmental rather than a Government-wide initiative, with consequent loss of momentum for the Programme. The DTI must not divert funds either from mainstream Foresight activities, or from fundamental research, for short term industrial projects.

Was the process of the Technology Foresight initiative helpful to you? If so, in what way?

12. The exercise prompted both individuals and businesses to review their own positions and plans, and provided them with valuable insight into likely developments in other sectors. Those involved in Foresight panels, workshops or conferences, whether organised by the OST or by third parties such as the IOP, have found the making of new contacts very valuable.

Was any part of the process unhelpful or weaker than the others?

13. Most criticism concerns the Delphi consultation process. Experts felt that questions were both too broad in scope, and too specific in detail, with no explanation of the overall framework or reasoning behind question selection. Second-round Delphi questioning was felt to be entirely superfluous as individuals' views were not affected by the opinions of others.

14. The conclusions of the Delphi survey did not obviously form a significant part of the final sector reports, and questionnaire results were not made available to the science and technology community.

15. The very short timescales for Foresight severely limited opportunity for both dissemination and consultation. This, and the lack of financial support, mitigated against full participation by those working in small and medium sized enterprises (SMEs).

16. Dissemination of even basic Foresight awareness across Government departments was seen to be weak.

Should the exercise be repeated? If so, when?

17. A repeat of the survey phase of Foresight would be appropriate in approximately five years, provided that the effects of the initial programme are monitored and measurable benefits are seen to have accrued. Foresight should be a continuous process, shaped by lessons learned.

Memorandum from the Institution of Electrical Engineers (TFC 31) (15 September 1995)

1. COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

The Institution welcomed the establishment of the Office of Science and Technology and the publication of the White Paper "Realising Our Potential". The "Technology Foresight" programme which was initiated by the White Paper was a timely indication of the importance of the Government's expenditure on science and engineering, and of the need to ensure that the programmes are relevant to wealth creation, and can be exploited by industry.

Clearly "technology foresight" is carried out by many industrial companies and by academic institutions on a continuing basis, though each company and university department will probably be considering a narrow sector, and the process may be intuitive rather than formal. The value of the "Technology Foresight" programme is that it brings the results of these individual insights together in a systematic way so that they are clearly identified and can be acted on as appropriate by the Government, industry and academia.

The immediate outcome of the process has been a review of potential scientific and technological developments over the next 10-20 years, with the identification of priorities and opportunities for technology research, development and innovation in defined areas. Apart from the formal output, the consultation between

industry, academia and the Government at an individual level brought about a clearer understanding of their role and activities with prospects for better collaboration in the long term.

Therefore the Institution welcomes the Foresight process in principle, as it offers an opportunity to generate an industry wide perspective on the future, a consensus on priorities and common action plans.

However it must be recognised that the Technology Foresight programme has produced a particular view of the future and indicated broad areas of science and technology which appear to be of importance for the long term. This will obviously be carefully considered by the Research Councils in allocating future funding but it would be dangerous to use this as an absolute criterion, and reject out of hand research activities which are not covered by the present Foresight proposals. As far as industry is concerned, the recommendations are very broad, and companies need to identify specific technological and market opportunities in which they can invest with a good prospect of financial return. Companies will have to carry the "foresight" process a good deal further before the wealth creation postulated can be achieved.

It should also be noted that there are areas of science and engineering not covered by Foresight, and that there are sections of industry not addressed in the Foresight reports. Support for innovation in these areas should not be withheld just because they have not been identified in the Foresight Programme.

2. WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS.

The membership of the Institution comprises industrialists, academics, and those working in Government, so the benefits are perceived differently by each of these sectors.

The programme is seen to be of value to Government in the following areas:

- (i) It assists OST and the Research Councils in setting research funding priorities in universities and related research organisations.
- (ii) It assists DTI in its support of UK industry.
- (iii) It assists the Department for Education and Employment to set training priorities in universities.

For the industrialist the benefits are:

- (i) It encourages companies to review their own business opportunities and technical priorities.
- (ii) It forms a basis for industry to discuss joint programmes with universities and with Government.
- (iii) Where industry works with universities, research projects in Foresight priority areas are more likely to gain Government financial support. In this way Foresight will influence the longer term product plans of industry.

For the academics:

- (i) Because of the high probability that Foresight orientated projects will attract Government research funding, universities will be encouraged to work in the priority areas set out in the Foresight sector reports.
- (ii) The Foresight process encourages stronger links between industry and universities.

Of course for many large companies who are leaders in their field, and who already work closely with universities, the Technology Foresight programme did not add significantly to their position. Small companies, on the other hand, may have found that the broad sweep of Technology Foresight was irrelevant to their own speciality market.

Generally the process improved communication between the parties and led to a better understanding of the linkages between the research community and industry, though much still needs to be done.

3. WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

There was an inevitable problem in defining the scope of the sector panels, and it is virtually impossible to be comprehensive within a sector and at the same time avoid overlap between sectors. Some of the panels were market oriented, e.g., transport, while some were more technically orientated, e.g., IT and electronics. Yet clearly the transport sector is a market driver for IT and electronics technology. Consequently the process has been criticised both for lack of focus within sectors, and for omission of specific markets and technologies. Now that Foresight has carried out a broad overview, it may be appropriate to focus within the existing sectors, and on the areas of overlap.

This is a widespread view that the DELPHI exercise was over elaborate and unduly time-consuming. With 15 panels and 15 DELPHI questionnaires to organise the OST staff had to carry out the whole exercise in too short a time scale with inadequate time and resources. The questions were not well-thought out and were

often superficial, overlapping and ambiguous, and so did not encourage carefully formulated responses. If the questionnaire had asked some qualitative speculative questions these might have teased out some interesting and challenging scenarios. The process must be completely rethought if any similar exercise is attempted.

The regional workshops were found to be interesting in that there was a very broad spread of expertise and opinion among those attending but they were so general in content that it is doubtful whether useful conclusions were reached.

Despite the efforts of OST to create awareness of Foresight, a considerable proportion of senior management still seems to be unaware of the programme, and there is a perception that the distribution of the sector reports has not been sufficiently targeted at senior managers at the level of Chief Executives and Technical Directors.

4. SHOULD THE EXERCISE BE REPEATED? IF SO, WHEN?

The timescale of vision for the Technology Foresight programme is some 20 years. On this basis a repeat exercise should not be undertaken for four or five years. There is therefore a strong feeling that in the medium term the work should be developed rather than repeated. Within each sector certain areas need to be reviewed in greater detail, and this might be achieved by setting up specialist working parties with main panel members as convenors. There needs to be a systematic attempt to measure outcomes, to terminate unsuccessful programmes and to re-balance priorities.

5. HOW SHOULD TECHNOLOGY FORESIGHT BE IMPLEMENTED?

Technology Foresight translates into wealth creation through the total innovation process of pure research, applied research, development and production with an awareness throughout of market opportunity. Pure research is very largely the province of universities, and the Research Councils control the balance of research programmes through their funding. In this area Government is able to influence the implementation of Foresight. Applied research is generally undertaken by industry, or by joint industry/university programmes. In this case Government programmes such as LINK, which encourage industry/university collaboration can be used to encourage programmes into activities suggested by Foresight. Government also has the opportunity to ensure that the European Fourth Framework Programme reflects priority technology areas identified by Foresight. Greater industrial participation in the Research Councils and with universities should be encouraged.

The Defence and Aerospace Panel has formed sub-groups to interact with all Government Departments and Research Councils to push forward their recommendations. This could be a model for other panels to follow.

However the innovation process only leads to wealth creation when companies devote marketing, development and production resources to bring products to the market place in a timely manner. To this end industry must be aware of the possible future markets identified by Foresight, and make its own judgment about their commercial viability. To aid this objective DTI teams should be strengthened to complement the Research Council activities to increase awareness and technology transfer. The Government is averse to funding such "near-market" activity and to "picking winners". However to ensure the exploitation of basic and applied research it is essential that industry undertakes the investment needed for bringing products to the market. Fiscal measures to encourage such investments would be one method by which the Government could support industry.

6. WHAT ACTIONS, IF ANY, ARE YOU TAKING TO ASSIST YOUR MEMBERS IN CONSIDERING THE TECHNOLOGY FORESIGHT PROPOSALS?

In the Technology Foresight programme a number of senior members of the Institution served on the Communications, IT and Electronics, Manufacturing and Defence and Aerospace panels. The Institution also commented to the panels while they were drafting their reports, and supplied OST with names of members to attend the regional seminars.

The conclusions of the Foresight programme are now available through the printed reports and summaries. To aid the dissemination of this information the Institution is hosting an OST regional meeting on the work of Information and Electronics panel, on 6 October and also a Foresight Forum on 16 October.

The Institution has 25 regional "centres" which are local groupings of members and run by members, and each organises a programme of lectures of interest to the profession. Centres are being invited to arrange lectures on Technology Foresight to be addressed by members of the OST staff.

The Institution has a programme of lectures and conferences numbering around 1,000 a year. A working party has been reviewing the Foresight reports, with special emphasis on the IT aspects, in order to see how topics

raised by Foresight can be included in the programme. In so far as the Institution's regular programme deals with subjects at the leading edge of technology, the whole activity relates to future technological innovation and therefore underpins Foresight.

7. WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

In the Institution's original response to William Waldegrave's request for input to the White Paper "Realising Our Potential" we noted that wealth creation depended on the total innovation cycle from pure science through applied science, development and production in response to a market requirement. In this connection we saw OST's role as promoting the research base, and DTI's role as promoting the manufacturing and marketing activities. We also stressed the need for effective technology transfer between universities and industry and noted the discontinuity between the work of OST and DTI. Hence the Institution believes that, overall there is advantage to the engineering profession in the transfer of the responsibilities of OST and DTI.

We understand the concerns of those who fear that pure science will be neglected, and that the profile of science and engineering will be diminished as the Minister responsible will not be of Cabinet rank. These are valid concerns but can be managed if the political will is there to ring-fence the OST funding and to actively promote science, engineering and manufacturing. Much depends on the personal commitment of the responsible Minister. We believe the benefits flowing from a closer university-industry interaction and improved opportunities for technology transfer outweigh the potential disadvantages.

Irrespective of the formal organisation for progressing Foresight, it is essential that this initiative should not fade away. If the Government is serious about national prosperity it is important that a management process, with adequate resources, should be set in place to sustain and build on the work carried out so far. Many senior industrialists made a strong commitment of time and effort into Foresight, but this will only be sustained if the DTI/OST have a credible management process in place to keep the programme going forward, to build on achievements, to monitor outcomes and to deal with problems as they arise.

Letter to the Clerk of the Committee from the Ministry of Defence (TFC 32) (18 September 1995)

Thank you for your letter of 18 July 1995 advising that the Science and Technology Committee is to conduct a brief inquiry into Technology Foresight to enable it to identify any problems with the current initiative and priorities for its future implementation. You also asked some specific questions, the answers to which are set out below in the order you raised them.

The Minister responsible for Technology Foresight implementation within the MOD is Mr James Arbuthnot, MP, the Minister for Defence Procurement.

The official responsible for ensuring the Technology Foresight Programme is implemented is Mr Paul Sutcliffe, Deputy Chief Scientist (Research and Technology). Mr Sutcliffe is a Grade 3 official and is an independent member of the Defence and Aerospace Panel (DASP) of Technology Foresight, along with Major General Burton, Assistant Chief of Defence Staff Operational Requirement (Land). Vice Admiral Dunt, Deputy Chief of Defence Staff (Systems) (DCDS(Systems)) is also being invited to join the DASP.

Mr Sutcliffe's other responsibilities include providing scientific and management support both to DCDS(Systems), the customer for Applied Research, and to Mr Peter Ewins, the Chief Scientist, the customer for Corporate Research. He also supports the Chief Scientific Adviser in his scrutiny of the overall balance of MOD's S&T programme, especially research. In addition, he supports the Chief Scientist in his role as the UK principal on International Research Collaboration and in his liaison with other Government Departments.

A Joint Working Forum on Civil/Defence Collaboration has been formed with members from the MOD, DERA, DTI, the Research Councils and the OST (Terms of Reference attached). The Chairman of this Working Forum is Mr Peter Ewins. Briefly, the Forum will advise ministers on opportunities for greater civil/defence collaboration in carrying forward the priorities of the Technology Foresight Programme.

The outcome of Technology Foresight was published too late to influence directly the Department's 1995-96 research programme. However, there is a considerable and encouraging concurrence of view on priorities between MOD, OGDs and the Panel. There are, therefore, likely to be good opportunities for taking the recommendations forward and these will be investigated in greater detail by the Joint Working Forum.

WORKING FORUM ON CIVIL/DEFENCE LINKS

TERMS OF REFERENCE

1. To advise Ministers on further opportunities for the development of a co-ordinated approach to the planning of civil and defence S&T, informed by the priorities identified by the Technology Foresight Programme.

2. The Forum will:

- Develop, wherever possible, a co-ordinated response to Foresight, combining defence and civil objectives and will have oversight of any necessary lower level groupings.
- Identify new opportunities for civil and defence S&T collaboration, together with the likely cost to each of the key participants. This should be carried out in conjunction with the private sector, building on existing mechanisms and responding to Foresight.

3. The new Forum will make an initial report back to EDS on the progress it has made by the end of September 1995.

OST

June 1995

Memorandum from the Biotechnology and Biological Sciences Research Council (TFC 33)

INTRODUCTION

1. The BBSRC was established in April 1994, through the incorporation of the assets and responsibilities of the former AFRC and the work of the Biotechnology Directorate and the Biological Science Committee of the former SERC. The Council's mission, as established by the White Paper, "Realising our Potential" is:

- To promote and support high-quality basic, strategic and applied research and related postgraduate training relating to the understanding and exploitation of biological systems.
- To advance knowledge and technology, and provide trained scientists and engineers, which meet the needs of users and beneficiaries (including the agriculture, bioprocessing, chemical healthcare, pharmaceutical and other biological related industries), thereby contributing to the economic competitiveness of the United Kingdom and the quality of life.
- To provide advice disseminate knowledge, and promote public understanding in the fields of biotechnology and the biological sciences.

COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

2. Much of the spirit of Foresight, and many of its elements, have been pursued by research funders for a number of years to assist in the development of priorities. For example AFRC operated a strategy board comprising academics and users to consider future trends and the SERC Biotechnology Directorate canvassed extensively the views of users in order to identify and fund programmes underpinning the foreseen needs of industry. AFRC also formed a Think Tank in 1991 that carried out a series of studies concerning future economic/societal trends and new scientific opportunities, generally following a "scenario planning" approach. This approach has been continued within BBSRC whereby for example advisory groups composed of representatives of the user and academic communities have been developing strategies to underpin the future research needs of the Chemicals and Pharmaceuticals, Food, and Agriculture Sectors. However the importance of the national foresight exercise was to take the supra view and through its political dimension elevate the importance of foresight and maximise the prospect that foresight findings would be taken into account by both the private and public sector in their forward research planning. There was considerable merit in instigating at national level the networking process and establishing cross-contact between industrial sectors which hitherto may not have forged links and between scientific disciplines where synergies may not have been obvious.

WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

3. As mentioned above, from its inception on 1 April 1994 the BBSRC established three Directorates in Chemicals and Pharmaceuticals, Food and Agriculture and six discipline based research committees. Over the past year these bodies have been developing their forward strategies and this has been greatly assisted by collaboration with the Technology Foresight process. For example three members of the Food Directorate committee were also appointed to the Food and Drink Sector Panel, one of whom was appointed its chairman.

The development of the Directorate strategies thus benefitted from the national exercise such that the strategies which have now been published and against which research submissions are invited are entirely consistent with foresight recommendations. Particular emphasis has been placed on multidisciplinary research as highlighted by foresight. Similarly the BBSRC research committees have made use of the foresight in determining their priorities, and have taken on board the Steering Group messages on the need to sustain the fundamental science base and the provision of trained manpower.

WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

4. It was unclear from our standpoint whether the Delphi exercise as conducted was of any material benefit. If Delphi is to be repeated clearly greater thought needs to be given to the format of the questionnaires and their subsequent analysis.

5. Concerning the formation of TF panels, it is important that they have clear and manageable remits. In the last exercise the ANRE panel appeared to have a very large remit which necessitated working through three sub-groups which appeared to be somewhat unwieldy. It is therefore reassuring to see that it is planned to constitute separate agriculture and environment panels in the future.

6. It is also of paramount importance that the TF panels are appropriately constituted. It could have been helpful if the HLS panel had been more equally balanced between health and non-health life science representatives.

7. At times during the exercise we had concerns that some areas may have been falling between the panels. For example it was not clear to us whether research in bioprocess engineering was being covered by any or none of the Manufacturing, Chemicals or HLS panels. As it transpired however most of our concerns about areas falling between panels were alleviated and the Steering Group has an important role to play in this regard.

SHOULD THE EXERCISE BE REPEATED? IF SO, WHEN?

8. The establishment of a national exercise has certainly raised the profile of, and need for, foresight processes. However it could be argued that the next stage should be to encourage research funders, both in the public and private sector, to take up foresight-like exercises as part of their own internal planning. Certainly we in BBSRC are pursuing this on a continuing basis and within Government the continuation of this process could be stimulated by a requirement for each department to report annually on its foresight-like activities.

9. There may also be merit in also maintaining the networks which have been established as part of the national exercise. However it may be that to avoid foresight fatigue there should be a gap of a number of years in repeating the full scale national exercise. In the interim TF panels could be kept in existence to review and monitor activities referred to above.

HOW HELPFUL HAS THE INITIATIVE BEEN IN HELPING YOU DETERMINE YOUR PRIORITIES?

10. The initiative has tended to confirm the views we were developing rather than throwing up any particular surprises. However there are some areas which foresight highlighted which we had not rated as high priority and over the coming months we will be considering these further. It is helpful that foresight also recognised the value of maintaining a vital research base and it emphasised the need for an appropriate balance to be struck between orientated basic and strategic research. However it is important to note that foresight was taking a medium to long-term vision and therefore the implementation of foresight may not always be appropriate to joint funding schemes with industry which in the past have tended to emphasise research with a shorter time horizon.

WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

11. Recent ministerial statements suggest that the effect of the transfer will not be large.

Memorandum from The Federation of the Electronics Industry (TFC 34)

1. INTRODUCTION

The UK's Gross Domestic Product in 1994-95 was £640 billion, to which the IT, electronics communications sector contributed some £48 billion while employing some 700,000 people. World-wide, this sector accounts for £930 billion and at its present rate of growth, electronics will be the world's largest industry by the year 2000, accounting for some 10 per cent of world GDP. Electronics, IT and communications have become so pervasive that they not only represent a key industrial sector in their own right but also the essential enabling technology which drives competitiveness and wealth creation throughout the economy. The Federation is the lead Trade Association for this sector and represents both large and small companies active at the leading edge of technology. The relevance, direction and application of research is therefore of fundamental importance to the future viability of our Member companies. Both the Federation, which acts as the voice of the industry in the UK, as well as many of its individual Member companies made contributions to the Technology Foresight initiative.

The Federation supports the Technology Foresight Programme and wishes to see the excellent output of the Delphi process carried forward. We believe that the mechanism employed to implement the Foresight process will have a marked and lasting effect on the quality, relevance and industrial application of UK research. The Federation Members believe that to carry the initiative forward it is vital that industry is consulted in the same diligent way as it was during the first phase of the programme.

2. SUMMARY

Summary of responses to the questions posed:

- Q1. The Technology Foresight initiative was not essential to Industry. However, Industry, Academia and Government have benefited from the review in that it has provided a focus for directing Government funding.
- Q2. Funding in support of the Foresight recommendations should recognise the importance of the electronics, IT and communications industry to the whole of UK industry and the wealth creating potential of the multi-sectoral technologies.
- Q3. The transfer could be beneficial provided basic research is not compromised while industrially focused research is better directed. The loss of the OST's departmental independence is regretted.
- Q4. The exercise has provided a tool which helps target resources on the needs of Industry. The networking created by the initial review process has been beneficial to industry.
- Q5. The review process was effective, particularly in terms of building relationships. There were, however, some weaknesses.
- Q6. The outcome of the implementation process will determine the answer to this question.

3. CONCLUSION

The Federation thanks the Science and Technology Committee for the opportunity to offer evidence to the enquiry into the Technology Foresight initiative. Our Members, which represent 70 per cent of the UK electronics industry are committed to advanced technology and wish to contribute to the implementation of the Foresight recommendations. In order to justify the investment companies need to be confident that the implementation process is structured in a way that is suited to the industry's needs for exploitation of new technology. In this respect we feel that continuing dialogue between interested parties is needed.

Q1. COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

Yes. Industry would have continued without Foresight, it would use the Forward Look and its own strategic business plans to identify the vital technology needs. However, the more that is done to co-ordinate industrial and academic activity and to focus the resources available to meeting those needs the better. One of the aims of the initiative was to help make the Government's investment in R&D more effective, success may be judged by how significantly Foresight is reflected in the next Forward Look document. Foresight has brought together a framework for interchange and discussion which has:

Identified the critical technology needs of the Nation.

Broadened the general scope of understanding of science, engineering and technology opportunities between industrialists, researchers and academics.

Led to greater common understanding of the constraints and motivations of industrialists, researchers and academics.

Provided a commonly supported framework for assessing government research funding priorities for the near future.

Brought together groups of individual industrialists, researchers and academics in technology discussions which will undoubtedly lead to further wealth creating opportunities.

It should be borne in mind that while Foresight has been a good mind focusing exercise the various findings of the Panels would have been known to that part of a community most intimately involved in a particular sector. The major benefit stems from making the findings known across the whole community and in making the synergy between sectors more visible.

Q2. HOW SHOULD THE RECOMMENDATIONS FROM THE TECHNOLOGY FORESIGHT PROCESS BEST BE IMPLEMENTED?

The Foresight reports should be used to influence Research Council's priorities which control a significant part of Government funding for research within academic and research organisations.

The highest possible priority and support needs to be given to those technologies identified as "key" by a number of Panels. These technologies spread across the various sectors clearly offer the greatest wealth creating potential for the UK.

We bring to the Committees attention that IT, electronics and communications are identified as critical in some form or other in all the Foresight Panel Reports. The Federation urges the Government to allocate funding priority which is commensurate with the importance of the electronics industry to the overall viability and wealth of the UK.

The Foresight related LINK funding announced by the Government is welcomed, but is too small in relation to the task. Additional funding is needed and consideration given to the re-allocation of prioritised Foresight research to other Government research and technology funding sources through the Research Councils and other funding departments.

The integration of technology into company plans should be more widely encouraged by the DTI as a boardroom and business activity linked to business success. Share holders should be encouraged to expect such activity and the linking of industrial interest to a proportion of Research Council's grants is welcomed as it will encourage the transfer and exploitation of research output.

In implementing Foresight consideration should be given to the benefits that come from Technology Demonstrator Programmes, they have the advantage of focusing research effort and reducing risk by eliminating problems before a technology migrates to the production phase. It is important to note that risk is not always encountered as the early research stage but can be a significant factor when transferring a new technology to the production environment.

Q3. WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO THE DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

Since many of the recommendations of the Panels involved DTI led initiatives aimed at pulling together key industry plays, the transfer can be seen as having some benefits. However, it is vital that the DTI continues to support that proportion of long term investigative research within UK institutions that industry finds difficult to justify and that the voice of science and technology is not lost within the broader trade and industry issues. There is some concern at the loss of the OST's departmental independence and a senior level voice within Government, representing as it does such an important area of enterprise in the economy.

Q4. WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

Yes. It indicates a much clearer way for Government to create wealth by targeting resources on the needs of industry. The process was helpful in giving an overview of the national scene and revealing relative strengths, weaknesses and sizes of sectors. Participating Members have benefitted from the networking that the process engendered and as a consequence have established potentially useful contacts with academics and technology organisations.

Q5. WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

Weaknesses were limited to the detailed level of information available on industrial strength and weakness in specific technology areas and an analysis of the impact of internationalism on technology acquisition by companies, particularly in such an international business as the electronics, IT and communications industries. It was not always clear what technology actions were needed to achieve progress or a breakthrough.

Q6. SHOULD THE EXERCISE BE REPEATED? IF SO WHEN?

The success or otherwise of the implementation phase will determine the answer to this question. It is important that the Technology Foresight exercise is seen as the start of a continuous programme of actions to strengthen the UK's technology base and not as a series of snapshots of our position. However, we must maintain the value of the information gained on fast moving areas of technology such as those in the electronics, IT and communication sectors. To this end a smaller scale exercise could be considered on a two to three year cycle, but only as part of an overall co-ordinated plan.

Memorandum from the Food and Drink Federation (TFC 35) (15 September 1995)

The following are responses to the specific questions in the 26 July letter from the House of Commons Science and Technology Committee.

A. COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

We could have continued but in a fragmented manner, without the focus provided by Foresight, which hopefully will lead to a more effective use of research money. The initiative was timely.

The nation needs to:

- Identify priorities for public R&D funding.
- Improve the off-take of these into national benefits.
- Develop better dialogue between Academe and Industry.
- Promote public appreciation of the benefits from SET.

There was no sign of these being achieved by any other means, so that the initiatives created by the White Paper and by Foresight in particular, should improve a situation which was unsatisfactory and would probably have deteriorated even further. The UK lacked common targets for Industry and Academia which as a consequence gave us no common meeting ground or interface.

It is very much to be hoped that the widespread and serious input to Foresight will have had an effect on Government thinking and on the balance of science spending policy. The food and drink industry has long sought a more appropriate balance of the spend between agriculture and food and we hope to continue to see this addressed.

B. WHAT WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

Yes. It stimulated the difficult task of thinking about the future. It clarified issues, raised awareness of others and achieved consensus on where research money should be invested for the longer-term benefit of UK consumers and the prosperity of the UK food industry. The Foresight Sector reports should be a valuable starting point for anyone trying to develop future scenarios.

The Technology Foresight has already been beneficial in:

- Catalysing the Food and Drink Industry into setting up a mechanism (the RSG) to co-ordinate its diverse interests into a coherent strategy.
- Establishing the recognition of the Industry as a significant component of the national economy.
- Identifying the many and diverse influences which will impact on this industry.
- Creating a common framework of R&D priorities within which further considerations can be progressed.
- Developing a network of contacts both within the industry and between industry and academe from which new opportunities will emerge.
- Providing a coherent input to the strategy of the Food Directorate of the BBSRC.
- Stimulating the development of an overall R&D strategy for the industry, addressing both R&D needs and also the mechanisms for improving Technology Transfer.
- Providing a common agenda for the industry's interface with MAFF, the DTI, the DoH and also the other Research Councils.

C. WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

There was insufficient co-ordination of approach between the Panels. The format of the Panel reports was inflexible, requiring repetition of the main conclusions and necessitating their rewriting in other forms in order to achieve understandable communication.

A great deal of effort was put into the Delphi exercise by those who took part. It seemed at the time that the process was too rushed, and that more time should have been allowed for it. The mechanism of the Delphi exercise was inefficient and generated a negative attitude among the consultees who were otherwise unaware of the progress being made within the Foresight Panel.

The fundamental question remains of whether seeking a consensus or a majority view is the best way of predicting the future. The history of science probably tells us that it is unreliable, but the Japanese experience may point to the opposite conclusion.

D. SHOULD THE EXERCISE BE REPEATED? IF SO WHEN?

Since the main objective of Foresight was to identify the main Drivers for Change and then to interpret their potential impacts on an evolving sector, these observations and interpretations need to be reviewed on a rolling basis, as circumstances develop, but should at least be revisited and restated formally at regular intervals. Estimates range from two to five years. This presupposes that the first exercise was successful and the assessment of this (e.g., economic, health indicators?) need to be pursued.

Should the whole exercise be repeated, it should be done over a longer period, and the Agriculture, Natural Resources and Environment panel's over-wide scope should be reviewed, perhaps along with that of others. If it is all worthwhile its output should be stable for perhaps three years and therefore perhaps it should be repeated on a timescale of something like three to five years.

E. HOW SHOULD TECHNOLOGY FORESIGHT BE IMPLEMENTED?

Implementation of Foresight requires the broad findings to be understood and built into the revised plans of all R&D funding sources. In addition the potential beneficiaries of scientific advances need to be aware of what may arise, and the likely timescales for their emergence, so that the enabling steps for their beneficial application can be prepared.

The current phase of dissemination/awareness of Foresight findings therefore needs to be reinforced by clear evidence of commitment by funding sources to reflect these priorities, to give industry confidence in them as the basis for future planning. To monitor this the Sector Committees should be kept in being and asked to monitor progress in relation to their reports.

Within the budgets of the BBSRC and the other relevant Councils, the balance of expenditure between agriculture topics and food topics should be shifted to give more weight to food.

Improved dialogue between Academia and Industry and development of professional technology transfer mechanisms should continue to develop.

F. WHAT ACTIONS, IF ANY, ARE YOU TAKING TO ASSIST YOUR MEMBERS IN CONSIDERING THE TECHNOLOGY FORESIGHT PROPOSALS?

Through common memberships, FDF has ensured that Foresight findings have been built into Research Council strategies/plans; we have developed a coherent statement of the industry's overall framework of R&D needs; and have distributed this for active consideration by all sectors of the industry.

The FDF Research Strategy Group is seeking to ensure that Foresight findings are taken as a starting point for all discussions of future direction within the industry.

G. WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF TECHNOLOGY FORESIGHT INITIATIVE?

Since the timescales of change and therefore of forward planning and investment are comparatively short in the Food and Drink industry, the balance between new science and the support needed for its application, through the SMEs as well as major members of the industry, is important and should be enhanced by the dual role of DTI in both these aspects.

Whilst, however, we see benefit in a transfer to DTI, in that it puts the Science Base and the Industrial Base under the same political leadership, we are concerned at an apparent loss of appreciation by OST of the proactive

input of the food and drink industry to the Technology Foresight Process and the leading importance of the industry both to the national economy and the nation's health.

Initial output by the DTI has perpetuated the impression that they ignore the Food Industry, perhaps because of the existence of MAFF. An outcome which must therefore be sought is that the commitment of DTI to promote Technology Transfer from R&D into all industry sectors should actually increase their recognition and support for application work in the Food and Drink sector.

FDF is hopeful that the transfer of the OST to the DTI will have a positive impact on the implementation of the Technology Foresight initiative. The policy initiatives of the Government in recent years to make the science base in the country more cognisant of the needs of the industry ought to be confirmed by placing the OST within the DTI. If so this would be another positive step forward in the management by Government of the science base.

Memorandum from the Institute of Biology (TFC 36) (19 September 1995)

1. COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

Yes; but the pressures of competitiveness, the rising costs of scientific research, the need to translate scientific discoveries into wealth creation and improvements to the quality of life all dictate that priorities must be identified in order to make the best use of our restricted financial resources for research. A relatively small economy such as the UK can no longer compete on all fronts with the much larger economies of the USA and Japan.

2. WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

Yes; because it has identified some important priorities for all the sectors, including the three main biological areas, i.e., Health and Lifestyle; Agriculture, Natural Resources and Environment; and Food and Drink. We also welcome the fact that many of the Sector Panels called for continued investment in basic research, as this is vital in order to stimulate and maintain our intellectual innovation which can then be developed and exploited technologically. The Institute also welcomes the emphasis on strengthening the academic/industrial interface and has already started to examine new ways by which this may be enhanced within the membership and its Corporate Affiliates.

3. WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

Yes. Many of our members found the questionnaires used in the Delphi exercise cumbersome and not well thought out. Greater use could also have been made of the scientific professional bodies and learned societies in order to obtain a consensus view from the grass roots. Another flaw is that industrial members of Panels may have been reluctant, understandably, to share their "hot" ideas with each other, and for this reason, if the exercise is to be repeated, it is important that a degree of trust is developed between all the parties concerned. Finally, methods need to be developed to identify priorities in the gaps between Sector Panels.

4. SHOULD THE EXERCISE BE REPEATED? IF SO, WHEN?

Yes, but not until a cost: benefit analysis has been done for the recent exercise. Every four years would be a suitable time-scale for Foresight exercises.

5. HOW SHOULD TECHNOLOGY FORESIGHT BE IMPLEMENTED?

This is an area where urgent thought and guidance is required. Unless Government is prepared to provide some funds for developing networks and bringing people together to discuss how Technology Foresight is to be implemented, the whole exercise may lose credibility and collapse. The Institute of Biology, in conjunction with its affiliated societies, is well placed to host such meetings as it has good contacts with universities, research institutions, industry and the media. These might be organised around the theme "Building Business from Biology".

6. WHAT ACTIONS, IF ANY, ARE YOU TAKING TO ASSIST YOUR MEMBERS IN CONSIDERING THE TECHNOLOGY FORESIGHT PROPOSALS?

Two main actions have been taken so far. First, we have published an editorial *Technology Foresight: The Institute's View* and an extensive article *The Biologists's Guide to Technology Foresight* in our magazine *Biologist* in order to update our members on the report of the Technology Foresight Steering Group. Copies of these are enclosed.¹

Secondly, we have held a Symposium, *Innovation and Accountability in Biology*, with our Corporate Affiliates (major companies with biological interests) which discussed Technology Foresight from both an industrial and academic point of view.

7. WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

We appreciate that the transfer of the OST from the Cabinet Office to the DTI may help to develop closer links between science and industry. However, the Institute is greatly concerned that the transfer could seriously damage the outstanding reputation of the UK in basic science; a position built up over many generations. This would be extremely difficult to re-establish, as can be seen from the enormous efforts being made in Japan to correct its deficiencies. We would be very concerned if science funding becomes evermore short-term and market-driven, as this will increasingly be less attractive to the best young brains in the country.

Information about the Institute of Biology

The Institute of Biology is the professional body for UK Biologists. It has 14,600 members and has over 70 major biological societies affiliated to it. Its aim is "to advance the science and practice of biology, to advance education therein and to co-ordinate and encourage the study of biology and its applications". To achieve this, the Institute provides leadership and promotes a united approach so that the voice of professional biologists is heard on policy issues involving biology and biological education.

**Letter to the Clerk of the Committee from the Institute of Food Science & Technology (UK) (TFC 37)
(20 September 1995)**

We do not have any specific replies to your questions but offer the following more general comments.

1. We welcome the initiative taken on ways of improving the contribution of scientists and engineers to the public understanding of SET. One of the barriers to the adoption of technology is public suspicion arising from inadequate information and particularly inadequate relevant education. One starting point could be at Teachers' Training Colleges (including retraining courses for older teachers).

(In this area there is the question of refresher courses for those who have left the professions for a period and wish to return and need to be brought up to date in their subject).

2. Problems exist in the food/health field regarding claims that may be made for such foods as might make a contribution towards improved health. There is a conflict between unsubstantiated claims made for so-called Health Foods and claims that are capable of being substantiated for foods that could make a contribution to health. The latter are at the interface of food and medicine and subject to somewhat restrictive legislation.

3. In the area of innovation we welcome the initiative of DTI in partnership with industry in informing the public (and industry) about modern biotechnology. MAFF Consumers' Panel commented some time ago that this subject should not be allowed to go the way of food irradiation which has been virtually abandoned because of ill-informed public and media opinion.

4. During the course of discussion of the Food Safety Act there were suggestions from ourselves and other organisations that legislation should be introduced to ensure that all engaged in food preparation and service should receive some training in food safety but this was not accepted, possibly due to the climate of deregulation. We still hold the view that employers should be made aware of the risks of employing inadequately trained staff and should be encouraged, if not required, to make use of qualified supervision, at least in critical food preparation operations where safety may be at risk.

¹ Not printed.

**Letter to the Clerk of the Committee from the Institution of Civil Engineers (TFC 38)
(20 September 1995)**

Thank you for your letter of 18 July inviting comments on specific questions related to the recent Technology Foresight exercise. Our comments are as follows:

- (1) Foresight has been long overdue in the UK as similar exercises have been the norm in competitor countries for many years. It is particularly significant as it represents a partnership towards a common goal of wealth creation (and improved quality of life) between Government Departments, Research Councils and Industry. Sadly, co-operation of this kind has been rare in the UK, while other countries have forged ahead in identifying technology trends and exploiting them commercially.
- (2) The Foresight process was welcomed strongly by this Institution which has published many reports on both strategic research policy and industry research needs, since 1981. In this context, Foresight was a natural progression of our ongoing activities and we are proceeding with a follow-up programme to drive the Foresight process forward within the construction industry in order to improve the industry's ability to generate increased wealth from enhanced exports. With this aim in mind, we are preparing an application to DoE for a joint Government/industry "exportism" study.
- (3) The principal Sector Panel of prime interest to the Institution was Construction which concluded that "In order for the UK to create wealth and improve the quality of life, it needs a strong construction industry—one that generates profits over the long term. This will mean addressing overseas markets with greater energy and focus". The Institution endorses that conclusion strongly as, not only has the UK construction industry's output been declining since 1990, but we believe that by becoming more export orientated and strengthening the technological base, the industry will become more competitive.

Despite the Panel's conclusion quoted above, the Institution was nevertheless disappointed at the overall thrust of the Panel's interest which was strongly inward looking toward the home market and toward the building rather than the civil engineering sector. This should be set against our view that if there is to be a significant improvement in the quality of life for the majority of the world's citizens, then the provision of environmentally friendly infrastructure is vital, providing a valuable opportunity for the UK's construction and related environmental engineering industry to enhance its export performance and wealth creating ability.

Many of the Panels' conclusions therefore, were limited in their ability to raise our international competitiveness.

- (4) The Foresight process should undoubtedly be repeated at intervals, dependent on the progress made within each sector since the last exercise. A five year interval is suggested.
- (5) Within construction, a new joint Government/industry group known as CRISP (Construction Research and Innovation Strategy Panel) has been established recently. Not only is this joint initiative most welcome, but it will take forward the conclusions of the Construction Foresight Panel. In addition, this Institution and other similar bodies will be undertaking follow-up projects in their own sectors, which will doubtless be disseminated to relevant parts of industry.

However, it is important to remember that Government policies have an overriding influence on the investment in research and technological advance by industry. In particular, the virtually endemic short-term policies pursued by both Government Departments and financial institutions, and the declining share of our national wealth invested in our infrastructure, act as enormously strong deterrents to the investment needed.

- (6) We have formed an active committee which is driving technology foresight within the civil and environmental engineering community and we are at present preparing an application for a two year joint Government/industry study to create a knowledge base for the technology required to support an enhanced export capability, and to examine the barriers to this objective.
- (7) The Minister for Science and Technology announced in July the reasons behind the move of the OST to the DTI and we are content with his explanation.

Letter to the Clerk of the Committee from the Design Council (TFC 39) (21 September 1995)

The Design Council fully supports the work of the Technology Foresight programme and welcomes the recommendations contained in the Technology Foresight reports.

This programme was necessary and appropriate to help focus UK business on the opportunities presented by new technology in both process and product terms. Too few scientific advances are presently transferred into industry.

We believe that it is essential that the work of the 15 Technology Foresight panels is effectively progressed in collaboration with interested parties, particularly industry. The Design Council considers that further value can still be added to the recommendations by broadening the church for discussions on the implementation of the recommendations to take account of industry groupings and expertise not represented on the original panels.

The Design Council is developing a programme of complementary research which it is hoped will enable industry to consider the values which customers or users seek when purchasing new technology, both at the personal and corporate level. We hope to be able to liaise closely with the panels, particularly the ITEC panel, in to ensure that the maximum value is gained from the areas of common interest.

The transfer of the OST, and hence the Foresight programme, to the DTI should have a positive effect on how it is viewed by those in business and industry who know little of its background. By positioning this work in the main stream of trade and industry policy, the Government has sent a clear signal to UK business about the relevance of Technology Foresight to them. We also believe that it is correct that the Chief Scientific Adviser has retained his trans-departmental role.

It is important that the Government maintains its commitment to Foresight, ensuring that the implementation phase is sufficiently resourced and publicised.

UK business must understand that long-term competitiveness does not depend on cutting costs and squeezing margins but on differentiating UK products and services by innovation and the uptake of new technologies. As well as being excellent at research we must be excellent at using the skills, knowledge and know-how created—otherwise maximum benefit is not gained from the investment made in Foresight.

The commitment to ensuring that this message reaches the long tail of underperforming companies must be continuous and long term. Only then will the UK be able to enter the next century with a world class economy.

Memorandum from Smithkline Beecham plc (TFC 40) (21 September 1995)

Q1. COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT

Yes, but problems would continue to accumulate in the status and performance of R&D, with adverse implications for UK plc:

- (i) Erosion of UK science base.
- (ii) Falling off in public support for S&T.
- (iii) Insufficient focus: funding that is spread too widely and thinly is ineffective.

We welcome the increased importance being accorded by government to excellence in the science base, to the value of developing closer relationships between government, industry and academia, and to recognition of the importance of intellectual property issues in supporting competitiveness. The expense, complexity and range of scientific advances increasingly demand choices and prioritisation. Return on investment in R&D is likely to be higher if public and private sector priorities are broadly aligned.

The Technology Foresight Programme has provided a framework for enhancing an open and wide-ranging dialogue among user and practitioner communities in the context of addressing the key social goals in S&T of wealth and health creation.

Q2. HOW SHOULD THE RECOMMENDATIONS FROM THE TECHNOLOGY FORESIGHT PROCESS BEST BE IMPLEMENTED?

Experience of Foresight exercises abroad indicates that failure is most likely to occur in the implementation phase. In general, implementation must cover a variety of methods, to build on relationships developed during the previous phases of the Technology Foresight Programme.

Research funding bodies such as the BBSRC have shown leadership in exhibiting enthusiasm for starting implementation but there is an important issue in how best to measure implementation and impact. We believe that industry experience in R&D assessment can make a valuable contribution to developing agreed metrics for auditing the outputs from Technology Foresight.

Technology-friendly industries are already familiar with LINK programmes, CASE-type studentships and ROPAs and we agree that these are all important vehicles for the dissemination of Foresight outputs. We urge Government to be bold in implementation. Appropriate initiatives and support from OST (in co-ordinating, providing information and analysis to identify and communicate best practices) will be important to avoid

fragmentation of effort. Some issues continue to impede optimisation of academia-industry relationships; for example, the IPR considerations in HEFCE support of generic research.

The OST Outline Proposals for the Technology Foresight Challenge Fund (July 1995) require clarification. We are concerned at the likelihood of multiple assessor groups for LINK bids (for example, Research Councils, Foresight Panels, LINK board, OST) leading to lengthy review times and limited transparency. We are also concerned about the potential implications of imposing the defined "standard criteria" that give preference to "SMEs and companies in sectors which are traditionally low investors in technology". This criterion appears to penalise companies that invest heavily and successfully in R&D. We caution against focusing excessive attention on SMEs, in the belief that they represent the most important vehicle for new employment and wealth. SMEs are not necessarily suitable vehicles for the roll out of foresight in industrial sectors such as healthcare in which formidable economic and intellectual barriers to entry are already evident, and global scale is emerging as a requirement in R&D.

Q3. WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

The immediate response in parts of academia is to fear that the science base will be wholly subjugated to industrial targets and short-term wealth creation.

Our view is that we do not expect the transfer of OST to DTI to create major problems in the implementation of the Technology Foresight Programme. The transfer has the potential merit of integrating organisations with responsibility for the academic science base and industrial competitiveness. The crucial test will be for the DTI to show that it understands the conditions in which world class science is created.

We have appreciated the support given by the DTI to the pharmaceutical sector. We welcome the opportunity provided by a strong voice that can now be directly expressed by OST in Cabinet; linking the academic base and industry at this level should be beneficial.

Credibility in launching any initiative in priority-setting depends on legitimacy, competency and authority. The major challenge remains that the OST as sponsor of Foresight must convince other government departments of the merits of the proposed priorities and achieve the requisite financial support from all departments. It is desirable for other government departments to follow the lead set, for example, by the Department of Health and Department of the Environment in setting up specific plans to progress foresight implementation.

Q4. WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHICH WAYS?

The Technology Foresight Programme helped us to build contacts in the user and practitioner communities, activities to which we already accord great importance. The Programme also helped to inform a wider community on industrial perspectives prompting, we hope, a greater sense of shared responsibility. Individual SmithKline Beecham scientists were made more aware of the foci of interests in other areas and of the potential congruence with their own work.

Several of the Panel Reports address areas of importance to the pharmaceutical sector. In particular, the conclusions of the Health and Life Sciences Panel are clear-sighted and valuable and the integration of previously unconnected fields is to be applauded.

Q5. WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

Some of the Panel Reports disappointed by their lack of surprises although they provide a useful basis for discussion and inform those academic groups who may be less familiar with key strategic needs. The tendency to banality in some of the conclusions was perhaps inevitable given the format of the Delphi questionnaire where consensus will favour the conventional view. If time had permitted analysis of the spread of responses falling outside of the normal distribution, then other, innovatory perspectives might also have been captured.

The role of the Delphi questionnaire raises some other concerns:

- (i) Potential inconsistencies in assessment and interpretation of expertise level.
- (ii) Lack of clarity in framing questions and lack of explanatory background.
- (iii) Formulation of questions tended to elicit expression of opinions not judgments.
- (iv) Repeat cycle was of little value in absence of discussions that might prompt change of view.
- (v) Co-nomination procedure to identify Delphi respondents is an important approach to widening the debate beyond the usual cabal of opinion-leaders but how is the credibility of the nominees to be ensured?

- (vi) Assuming respondents were credible, many of the Panels seemed to make little use of the Delphi inputs; will this demotivate the respondents, lessening the likelihood of success in the implementation phase/next cycle?

Q6. SHOULD THE EXERCISE BE REPEATED? IF SO, WHEN?

This must be a continuing activity—because the process of interactive debate is of paramount importance, because the feasibility and appropriability of key strategic areas in S&T evolve, and because we can learn from this first exercise in order to improve the process in future iterations.

Foresight techniques can be applied at many hierarchical levels, for example at the meso-level by research funding bodies and at the micro-level by individual R&D intensive companies. These will continue, as appropriate. It would seem unlikely that a macro-level, national exercise can be repeated at intervals more frequently than about five years but the decision as to when to embark on the next cycle will be better informed as we see how the implementation phase proceeds. Considered reflection is also necessary before selecting the tools for the next iteration: the role of the Delphi questionnaire must be assessed critically.

At present, it is right for the emphasis to be on the widespread dissemination of the Panel's findings, their interrogation and validation by principal end-users and the development of metrics with which to audit success.

Whatever the interval to be chosen for initiation of the next cycle, it is essential to maintain momentum. The Panels should be retained, at least in concept (although their orientation will evolve) and the OST Foresight Team must be appropriately resourced. Above all, the motivation of academic and industrial science constituencies for partnership development and shared commitment must be encouraged. The OST should consider what new methods could be employed to facilitate partnership.

One other issue needs to be addressed before future iterations of the Technology Foresight Programme. Should the next cycle accord greater importance to international issues? There is a conundrum in countries seeking to appropriate the benefits of international science. The increasing importance of the role of transnational companies in wealth and health creation demands a broader perspective. In particular, how best should the Technology Foresight Programme be integrated with corresponding activities in the European Union?

Memorandum from the Engineering Employers' Federation (TFC 43) (21 September 1995)

THE EEF

The EEF (Engineering Employers' Federation) is the voice of engineering. It embraces some 5,000 companies of all sizes, from every sector of the industry.

The EEF is a federation of 13 regional associations and a national association for engineering construction.

On behalf of its members, the EEF seeks to influence the decisions of the UK government and the European Union institutions to create a favourable environment for engineering.

The EEF aims:

- To promote the image of engineering and manufacturing.
- To attract sound investment and talented people into engineering.
- To encourage best practice in employee relations.
- To encourage higher standards of education and training in the industry.

It provides to its members economic information and support services in employee relations; health, safety and environmental matters; and education and training.

INTRODUCTION

The EEF has consistently supported the concept of the Technology Foresight programme since its inception in 1993.

We believe that it has the potential to improve the long-term prosperity of this country in a number of ways:

- Through the development of a common understanding (in industry, government, finance and education) of the role of industry and technology in the economy.

- By identifying which industries and technologies are of genuine strategic concern to the UK; and
- Through the development of a comprehensive set of practical measures to support the development of these industries and technologies.

Although the government's 1994 White Paper on Competitiveness makes the assertion that innovation "is ultimately the responsibility of companies", the EEF believes that this substantially underestimates the role of government in enabling, stimulating and fostering innovation within companies. An industry/government partnership will therefore be essential if the very real achievements of the Technology Foresight programme to date are to be followed up with an effective series of practical actions.

TECHNOLOGY FORESIGHT AND COMPETITIVENESS

In November 1992, the EEF launched its "Industrial Strategy" document, to provoke debate on how the long-term future of manufacturing industry in the UK could be improved. A key aspect of the strategy was the need for greatly improved government/industry dialogue.

Where the science and technology underpinning manufacturing are concerned, we felt that an improved dialogue could be achieved by a more open, analytical and structured approach to planning.

We were consequently hopeful, when the Technology Foresight programme was announced in the 1993 White Paper on Science and Technology, that it would help to generate some of the basic information on emerging markets and technologies that was required to promote structured planning and better dialogue.

Whilst welcoming the programme, we initially had two concerns. Firstly, that, for reasons of cost, the programme would not adequately represent the contribution of small and medium sized companies to the UK's science and technology base. This was addressed, however, through a well balanced set of panels and a thorough consultation exercise on the initial findings of the panels. The EEF kept its membership informed of the opportunity to participate in the regional seminars that were organised by the panels.

Secondly, we believed that it would be essential for the methodology of the process to incorporate the effects of emerging social and geopolitical trends, as well as projected developments in science and technology. Having studied the reports from all 15 panels, this seems to have been achieved with varying degrees of success. Good examples include the Transport panel and the Manufacturing, Production and Business Processes panel. We believe that the adoption of a common approach between panels in successive Foresight analyses will enable the conclusions to be of equal utility across all sectors.

The government's decision to publish the second White Paper on Competitiveness at the same time as the Technology Foresight Steering Group report helped, we felt, to underline the links between technology and competitiveness. In writing to a number of ministers following the 1995 White Paper, we noted that some of the Steering Group's recommendations reiterated points raised by the EEF in its response to the Government's first White Paper in 1994. ("Competitiveness 1994" —EEF, Autumn 1994).

Now that the panels and the Steering Group have published their reports the focus must pass on to dissemination of the results and actions based on them.

Where the latter is concerned we are pleased that the Government has announced additional resources to allow some of the panel and steering group recommendations to be followed up. The announcement of £40 million of public money (to be matched by £40 million of industry funds) in a "Foresight Challenge" fund should help to make a start on the priorities identified. We understand that the Challenge fund will be accessible from Spring 1996.

A progress report on the dissemination phase is planned towards the end of 1995 which will also include the government's plans for implementing the recommendations of the panels and the Steering Group. We would hope that this progress report will identify any perceived gaps in the dissemination phase and provide support for them to be addressed in 1996. We also look forward to a similar report towards the end of 1997 assessing the effectiveness of the necessarily longer implementation phase of the programme.

The rectification of any gaps in implementation during 1998, followed by a report at that year's end, would perhaps suggest a five year cycle for the Foresight process, culminating in another full analysis starting in 1999. This would have the advantage of allowing the foresight of one analysis to be compared with actual developments five years on.

Subsequent Competitiveness White Papers could also contain interim updates on progress with the Technology Foresight programme.

THE EEF'S ROLE IN THE DISSEMINATION OF FORESIGHT RESULTS

The EEF has kept its member companies informed of progress in the Foresight programme since its announcement in 1993. This has included the dissemination of general information on the overall aims of the programme, as well as details of the regional seminars organised by the individual panels and on the networks that were being formed.

Following the publication of the panel reports and steering group report we have circulated our own summary of the reports covering those sectors which are of greatest interest to our membership. In addition, we are currently organising the first of a planned series of regional seminars in association with the Manufacturing, Production and Business Processes panel. These seminars will aim to:

- Disseminate general information about the Technology Foresight programme and specifically, about the work of the Manufacturing, Production and Business Processes panel; and
- Provoke debate about the conclusions of the panel, particularly in the area of business processes, and generate a consensus on follow up actions.

We will continue to support the work of the Office of Science and Technology (OST) and the Department of Trade and Industry (DTI) in any other relevant dissemination activities which are subsequently announced.

DTI/OST MERGER

With regard to the recent merger of the OST and the DTI, there has been some concern expressed that this move would be to detriment of the science base. The EEF believes, however, that the opposite will be the case.

The value and quality of UK basic science is widely recognised. This is particularly true of the DTI, which has accumulated many years experience of the sponsorship of collaborative research programmes, such as LINK and EUREKA, which bring together the science base with industrial and commercial organisations.

It is widely recognised that progress does not just take place in a linear way, from science, to technology, to commercial application. The science base interacts with commerce in a complex way (e.g., scientists use equipment built by engineering companies) where the keys to success are communication and mutual understanding.

The government is right to want to gain more for the nation from the public money invested in the science base and industry can learn much from the expertise present in the UK's universities. It is, therefore, appropriate that the Steering Group report should be called "Progress through Partnership". The merger of the OST and DTI provides the best mechanism for both "cultures" to benefit and take forward the progress made through the Technology Foresight programme.

Letter to the Clerk of the Committee from Nissan Motor (GB) Ltd (TFC 44) (26 September 1995)

Further to your letter dated 26 July regarding the Science and Technology Committee's enquiry into Technology Foresight, Nissan would be grateful for the opportunity to provide you with the following information.

BACKGROUND

Nissan has been aware of, and/or actively involved in the following UK initiatives over the past few years:

- Transport and Communications: The Cest Projects—first meeting June 1992.
- "Realising our potential"—Government White Paper—mid 1993.
- Competitiveness of automotive supplier base—Arthur Anderson Survey.¹
- "DTI publications winning/wealth creation/creativity/importance of design, etc."
- Technology Foresight¹—June 1994.
- Innovative Manufacturing Initiative¹ (IMI—EPSRC funded)—mid 1994.

This involvement has been additional to normal vehicle manufacturer activities for safety and environment in the UK, Europe and globally. In the UK we take an active role within SMMT and liaise closely with VSE and TRL for CCIS.

SPECIFIC QUESTIONS AND ANSWERS

Q. *What, if anything, will your company do as a result of the Technology Foresight Initiative?*

A. We are actively involved on the Technology Foresight transport panel, and support the view that the Foresight vehicle should be linked in some to IMI Land Transport research. If this comes about we can see a

¹ Actively involved.

means of working with a group of component suppliers in Informatics/Telematics Technology using the Foresight vehicle as an "enabler". It is not yet clear what support would be appropriate if the "urban clear zone" and "informed traveller" come to fruition.

Q. *Has your Board discussed Foresight, or will it do so in the future?*

A. Not yet discussed as the way ahead is not yet clear enough.

Q. *What effect do you expect the transfer of the OST to DTI to have on the implementation of the Technology Foresight Initiative?*

A. We expect more cohesion between TFI and IMI and more research projects being led by industry focused clearly on improving competitiveness.

Q. *Could we have continued without some exercise such as Foresight?*

A. What was and still is necessary is greater co-ordinated cohesion between government, academia and industry. The Foresight Initiative provided the ideal generation initiative but only recently have the confused variety of initiatives started to come together and a possible way towards implementation begun to emerge.

Q. *Was the process of the Technology Foresight Initiative helpful to you? If so, in what ways?*

A. At the outset the purpose was not clearly understood and the "meeting of minds" between the various players took a great deal of effort. It was interesting to be involved with academics and government representatives but took, and will continue to take, persistence from a few industrialists to keep things on pragmatic rails.

Q. *Was any part of the process unhelpful or weaker than others?*

A. The scope and direction was not clear relative to wider issues that were being debated elsewhere and hence it was difficult to keep discussions focused in a practical and positive direction avoiding duplication but resulting in a unique valuable outcome in the wider context (e.g., competitiveness of UK, IMI, Government transport policy and environment issues).

Q. *Should the exercise be repeated? If so, when?*

A. Yes, updated every five years. The interim priority must be how to turn the conclusions of the first exercise into tangible results. This will require seeing through:

- (1) The joining of EPSRC work with the Technology Foresight vehicle, IMI and Telematics.
- (2) The rationalisation of European work (car of the future) and UK work (foresight vehicle).
- (3) UK future transport policy, urban clear zone and the informed traveller.
- (4) Supplier input and direction.

I hope the above responses are useful and informative. Should the committee wish to discuss any of the issues in further detail or not hesitate to contact me.

Letter to the Clerk of the Committee from the Rover Group (TFC 45) (27 September 1995)

WHAT, IF ANYTHING, WILL YOUR COMPANY DO AS A RESULT OF THE TECHNOLOGY FORESIGHT PROGRAMME?

There has already been a level of involvement in the initiative with the Foresight groups, and at the planning level, as Rover's Managing Director is a member of the Council for Science and Technology. Further to this the reports of the sector groups are being reviewed within Rover by the appropriate technical and commercial areas. The results are being collated at a senior level for the development of appropriate actions.

HAS YOUR BOARD DISCUSSED FORESIGHT, OR WILL IT DO SO IN FUTURE?

Dependent on the outcome of the internal review of Foresight programme reports, a summary and appropriate actions will be initiated at Board level.

WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

It is necessary for industry to recognise and support the outcomes of the Foresight exercise for it to make any impression on the competitiveness of UK industry. With the OST within the DTI, we believe that the organisation will have good incentive to incorporate and advance the objectives of the Foresight initiative into the industrial sector. It is important to realise, however, that the Science Budget should not only be applied to implementing and directing currently applicable technologies, but also to support emerging science and technology. Fears have been expressed that the DTI focus will only extend to those aspects of the Science Budget that are currently industrially relevant. One answer to this is to maintain visibility of the Science Budget and the Foresight initiative at a parliamentary level, this allowing debate on the balance and effectiveness of resource being applied to UK science and technology.

COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

The answer is that of course we could have carried on, but with what? Science and Technology within enterprises is clearly far more effective by applying thought and direction to company's competitiveness, gaps, opportunities and resources. A national study was clearly necessary to achieve the same result in UK terms. This could not have been widely accepted without some broadly inclusive process such as Technology Foresight.

WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU?

Rover took part in the process, but was mainly involved in work outside the Technology Foresight Panels directly. Although there were some benefits in taking part in the seminars and questionnaire rounds, the direct benefits of the process were limited. Some of the perceived benefits of Technology Foresight, such as enhanced networking, were not realised to any great extent. This may be an area where further Foresight development could be beneficial.

WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

As general comments, there were two areas where improvements could have been helpful. Firstly, the questionnaires used by a number of the Panels could have been less complex, with better results from participants. Secondly, some of the groups were possibly too academically biased, with results insufficiently robust to base substantial actions on.

SHOULD THE EXERCISE BE REPEATED? IF SO, WHEN?

Taking into account the previous answer, there is a strong need to encourage a critique of the output of the Technology Foresight programme so far. This would then start at least one iterative loop of the process.

Further to this there needs to be a maintenance and dissemination activity to maintain the value of the initiative. A further complete loop will be necessary, perhaps in three to five years time. It will be important not to lose the threads of the current programme, and the suggestions above may be a way of keeping the activity alive and building credibility.

Memorandum from The Royal Society (TFC 46) (29 September 1995)

1. The Royal Society is grateful for the opportunity to comment on Technology Foresight (TF). The TF initiative is an important innovation in both science and industrial policy; if successful, it will contribute positively to national wealth and quality of life. With the first phase complete and the implementation phase getting underway, it is timely for the Select Committee to inquire into the conduct of the initiative. This submission to that Inquiry has been endorsed by the Council of the Royal Society.

2. The Society is issuing a general statement on TF; a copy is enclosed.¹ This covers some of the issues you raise, and highlights some points of concern. We are pleased to note that many panels went out of their way to stress the importance of maintaining excellence across a broad range of basic research, irrespective of

¹ Not printed. Available from The Royal Society.

TF priorities. However, the specific findings of the various panels must not be regarded as constituting a set of priorities that can or should be used directly to determine funding policies. The findings should on the whole be treated as generic policy statements, not specific funding proposals. A second caveat is that it would flout the spirit of the TF panels and seriously distort the nation's short- and long-term R&D capability if the Government-funded Science Base was shaped by short-term TF priorities while other Government bodies and industry largely ignored TF. TF is meant to inform decision-making in all parts of the national R&D system, not just in the part funded by OST or the Education Departments. Third, TF cannot be implemented without significant additional investment. If the publicly funded element of that investment is drawn from the Science Budget, then the net effect is likely to be a long-term weakening of the nation's capability for innovative, wealth-creating research.

3. TF has proved an effective means of stimulating networking within and between universities, Government bodies and industry. Such networking has always taken place, but its reinforcement is an important achievement of the TF Programme. Successful implementation of TF will depend more on people interacting than on legislation and Government directives.

4. The Society supports science by focusing on the needs of individual scientists. We do not support or prioritise particular disciplines or areas of research. However, the output of several of our programmes in support of individual researchers will contribute significantly to TF objectives. In addition, our unique work on promoting flows of information into the UK about major strategic scientific and technological developments abroad, our recently strengthened industrial fellowship scheme and our meetings with leaders of industry and of commerce all work towards the goals identified by the TF programme.

5. It is too early to comment on relations between DTI and OST. We would wish DTI to recognise the need to take a long-term view on TF. We would also hope that the move of OST into DTI will facilitate a balanced approach to implementing TF, rather than a strong concentration on short-term funding.

Letter to the Clerk of the Committee from the Westland Group plc (TFC 47) (27 September 1995)

Attached is a text that addresses the specific questions raised in your letter, with particular reference to the needs of the rotorcraft (helicopter) sector of the aerospace industry. You will appreciate that the involvement of Westland as a "sub-prime" contractor in both military and civil aspects of the fixed wing aircraft industry ensures we are concerned that this sector of the industry is well invested. However, as the only UK Prime Contractor and Design Authority in helicopters we have a particular view and responsibility concerning that business and have focused the main weight of our response in that direction.

As an introduction may I say that we regard Technology Foresight as a very useful initiative that deserves to be followed up. The real measure of effectiveness of the work that relates to defence and aerospace will be measured by the improvement in industrial effectiveness that results in the aerospace industry in the UK.

With regard to the future, industry and government investment and actions must be focused and co-ordinated if we are to maintain and improve our competitiveness in world terms. This will only happen if further action is taken to follow up such initiatives as Technology Foresight. Transfer of responsibility for the work from the OST to the DTI will be an advantage if it results in an even closer working relationship between the DTI and industry, followed by effective action.

Westland supports the concept of a national capability demonstrator as it has been outlined by SBAC under the name "Foresight Action". Such a programme must benefit the core technologies applicable to the aerospace industry generally and their application to both the fixed wing and helicopter sectors of the industry.

The letter raises several questions relating to Technology Foresight. The following points relate to these questions:

- (i) WHL contributed to the Foresight initiative through funding Professor Balmford's input to the Defence and Aerospace (D&A) Panel, attendance at briefing, completion of Delphi Questionnaires and *ad hoc* inputs as required. The report compiled by the Defence and Aerospace Panel has been circulated within the company.
- (ii) WHL have so far taken no action as a direct result of Foresight. The company is, however, supporting a number of Post-Foresight activities, including:

The Foresight Response Forum

The Foresight Action Initiative

The recommendations from the D&A Panel do not invite action by individual companies, except insofar as a general increase in R&D investment is proposed (this is planned by WHL, but is the result of business factors and opportunities, rather than a response to the Foresight recommendations). Most of the recommendations require Government action, in conjunction with

industry, and it seems likely that this wider industry support will be through trade associations and joint initiatives that are only now emerging through such organisations as the SBAC.

- (iii) The WHL Board has not discussed Foresight, although Board members are aware of the activity and the D&A Panel recommendations. The WHL Board meetings are mainly concerned with decision making and the Foresight initiative has so far not resulted in actions that require high level decisions to be made. Board discussions and approval may be needed in the future if Foresight stimulates some major R&D initiatives or implementation of the D&A Panel recommendations require WHL support.
- (iv) The transfer of the OST to the DTI effectively results in a single Government department being responsible for industry and academic research. This should assist in formulating policies, based on Foresight recommendations, that meet industry's real needs and capitalise on the UK's strong academic base. The effect of the transfer should therefore, be helpful in speeding up the implementation of Foresight recommendations and ensuring a real benefit for industry. It should be noted, however, that this will only be the case if:

The rationalisation does not result in a reduction of Government funding for R&D.

The MoD support the process, as they have a key role to play in implementing the D&A Panel recommendations.

- (v) The Aerospace industry could have continued without the Foresight activity. The aerospace content of the D&A Panel work broadly mirrors the work carried out for NSTAP and its defence equivalent (which has unfortunately never been published). Many of the recommendations are very similar to those of NSTAP. It could be argued that the Foresight activity has delayed the implementation of recommendations from initiatives that preceded it, and other countries notably the US and Germany, have moved ahead rapidly in this period with major aerospace programmes. Nevertheless, the D&A Panel report is helpful as a means of reinforcing the message and providing an academic input that was missing from NSTAP.
- (vi) The Foresight process allowed WHL to make an input, predominantly through supporting the presence of a rotorcraft specialist on the D&A Panel. Inputs were also possible through the Delphi Questionnaires and attendance at consultation briefings. These aspects of the process were less obvious and the consultation exercises covered only high level issues, not detailed issues of important to a particular company. A higher quality industrial input could have been gained by meetings between the Panel and company representatives (in the way the select committees seek industry views) or requesting a structured, written, input.
- (vii) Top priority must be given to making decisions regarding the recommendations of the recent Foresight exercise. It has taken approximately two years to set up and carry out the Panel activities and then disseminate the findings. During the two year period there have been no major Government/Industry Aerospace initiatives followed up in the UK, whereas other nations have launched major programmes. There should be urgent consideration of implementation of the D&A Panel recommendations and no question of a repeat exercise until decisions concerning implementation have been made. In the longer term, the recommendations will need to be periodically reviewed to ensure that the priorities are correct. It is perhaps realistic to consider:
 - A review every two years, producing a supplement of each major Panel report outlining any changes in the environment, priorities, etc.
 - A repeat Foresight exercise every four years, with consideration given to improving the process.

Memorandum from The Petroleum Science and Technology Institute (TFC 48) (26 September 1995)

This submission answers a number of questions raised concerning The Petroleum Science and Technology Institute's (PSTI) views on and activities resulting from the UK's Technology Foresight exercise.

1. WHAT WILL PSTI DO AS A RESULT OF THE TECHNOLOGY FORESIGHT INITIATIVE?

PSTI has already undertaken a number of actions following the Foresight initiative. Specific actions have included:

- Acceptance of invitations from the Natural Environment Research Council (NERC) to contribute to its processes of consultation/action planning following publication of the Foresight Steering Group's report.
- An approach to NERC to devise a new, collaborative working relationship in terms of NERC's interface with PSTI's extensive membership among companies in the upstream oil and gas industry.
- Assistance to NERC in obtaining petroleum industry input to the planning and evaluation of a new thematic research programme.

- Assistance to NERC and to the Oil and Gas Projects and Supplies Office (OSO) of the DTI in establishing a LINK Programme to address certain priority research topics raised in Foresight reports.
- Briefing PSTI's Member companies on both the process and outcomes of Foresight.
- Convening our International Petroleum Research and Technology Forum (Edinburgh, 14-15 November, 1995) to which representatives of OST, NERC and The Marine Technology Directorate Limited (EPSRC) have accepted invitations to present their strategies for Foresight implementation to an audience of senior managers in PSTI's Member companies.
- Actions to improve networking between PSTI and a number of industry:research community interface organisations allied to other industry sectors, with the aim of enhancing co-ordination and opportunity/needs identification in generic and strategic research and ensuring more effective communication on these issues with the research councils.
- Approach to EPSRC enquiring of and offering assistance with its Foresight implementation strategy as it interfaces with the upstream oil and gas sector.

In addition, PSTI is compiling, for wide dissemination, information on its own industry Members' R&D requirements and will comment on how these compare with issues highlighted by Foresight panels as well as by the European Union's fourth framework programme.

2. FORESIGHT AND PSTI'S BOARD

Our Board has been briefed on the progress and outcomes of the Foresight initiative to date and has encouraged our activities towards government's research funding agencies in support of Foresight implementation.

3. EFFECT OF OST TRANSFER TO DTI

Our hope is that we will see greater co-ordination and clarity among the multiplicity of measures to fund and otherwise promote research of relevance, on various time frames, to industry. We also hope for an increased effort to develop more effective measures for research:community industry interaction in pursuit of information technology transfer and innovation arising from research activity, again on a variety of appropriate time frames.

Our concern however is that faced with the research community's fears about a risk to funding for curiosity-driven research (an activity we wish to see continued at an affordable level), the influence of the DTI's industry/wealth creation perspective may be diluted and prove to have little additional effect on the workings of the OST in implementing Foresight recommendations. At a time when "value added" needs to be a primary evaluation parameter in research investments and when funding priorities need to be set, we would regret this.

4. COULD THE UK HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

When Foresight was first proposed, we already held the view that there was a need for improved co-ordination and focusing of industry- and government-funded research, together with a need for an improved linkage between this activity and innovation. We also recognised the benefits of increasing the research community's awareness of its role with respect to industry and in wealth creation. Indeed PSTI was formed in 1989 following an initiative of the OSO (then part of the Department of Energy) and industry to address many of these issues on behalf of the upstream oil and gas industry in the UK. Therefore we identified the need for an initiative in this area and we welcomed Technology Foresight.

There may have been alternative, more efficient routes to a similar end but on the whole the process of wide consultation, using a methodology that had been tried and tested and some apparent success in other countries, was an appropriate choice.

5. WAS FORESIGHT HELPFUL: WHERE WERE ITS STRENGTHS AND WEAKNESSES?

The process of consultation, of enhancing government bodies' (especially research council) focus on industry's views, and the networking which resulted have all be valuable.

On the outcomes of specific panel reports, our views are mixed. The various methods of reporting, emphasising in some cases the generic in others a more focused sectoral approach, we found unhelpful given the lack of clear linkage between them. Such difference in approach were especially marked between the Energy and the Agriculture Natural Resources and Environment (ANRE) panels.

We are concerned that the wide and diverse remit of the ANRE Panel may have diluted the impact of its findings in each of the various sectors it considered. We believe that natural resource issues falling into the

"mineral" category were underrepresented. The existence of an Energy Panel helped considerably to adjust the balance for oil and gas but the relationship between the Energy and ANRE panel's activities and views could have been made clearer.

More generally, we would recommend an assessment as to whether the balance of panel activity between design of Delphi statements and subsequent analysis of responses, scenario setting and analysis, and benchmarking was optimal.

From the outside it is of course impossible to know what was received by the panels and what was omitted from their reports, but in the subject area best known to PSTI there appeared little in the way of step-out thinking.

6. SHOULD THE EXERCISE BE REPEATED?

The Foresight exercise has brought some one-off benefits in terms of networking and profile raising. The profile, clarity and nature of the implementation actions are of course the immediate issues now to be addressed. While recognising the complexity of the task, we are concerned that momentum should not be lost.

Until there are further signs of the beneficial influence of this first Foresight initiative, in terms of co-ordination, clarity of purpose and investment decisions, it is premature to offer a judgment on the merits of repeating the exercise.

However, we would recommend that any future exercise be based on tighter "project" specification, more rigorous analysis of resource requirement and allocation, and greater clarity in terms of the deliverables expected to emerge.

The motivations behind Foresight together with the research community: industry linkages it seeks to influence need to be part of an ongoing process and not restricted to set-piece, all encompassing events.

More immediately, we would like to see a deeper review of how various industries successfully link with the science-base at present, in order to spread good practice and to encourage enhanced interaction.

There may be reasons to conduct partial foresight exercises on a shorter time frame (marine technology is one area which has been raised by others) but we do not see a need for a full-scale exercise for another five years at least.

7. OTHER COMMENTS

It is not clear how the implementation of Foresight findings will sit alongside the actions surrounding the European Union's present fourth and future fifth Framework Programmes. Research is now very much an international activity and Foresight implementation should be placed in this context.

8. PSTI'S FUTURE CONTRIBUTION

PSTI was singled out in the report of the Energy Panel as an organisation operating in a way which may act as a useful model for others. We continue to develop our processes of:

- Networking across the research community: industry interface to determine systematically and disseminate information on research requirements and opportunities.
- Assisting industry: public sector co-ordination and leveraging of research investments in the UK and in Europe.
- Providing independent project management to large, collaborative research programmes (including on behalf of the DTI).
- Maintaining a knowledge-base of international research activity, capability and requirement; and
- Promoting innovation through "hand-holding" assistance to small and medium sized companies (SMEs) in the petroleum service and supply sector and through our work with researchers to promote the transfer of their project results to commercial application.

As part of our contributions to Foresight implementation, we will continue to offer our knowledge and experience in these areas to government, the research community and industry, both in our own and other sectors.

Memorandum from MAFF (TFC 49) (29 September 1995)

- (1) *Is there a Minister responsible for ensuring the Technology Foresight programme is implemented within the department.*

The Parliamentary Secretary, Mr Boswell, has responsibility for Research and Development across the Ministry and is therefore the Minister responsible for the implementation of the Technology Foresight Programme.

- (2) *Is there a particular official responsible for ensuring the Technology Foresight Programme is implemented within the Department? If so, at what grade, and what are his or her other responsibilities.*

Policy Groups within the Ministry are the primary customers for research which is contracted to meet policy needs. The Policy Group Grade 3s will therefore ensure that recommendations from the Technology Foresight Programme which relate to their policy responsibilities are implemented. The Chief Scientist's Group (CSG) has a central role in advising on the scope, balance and quality and in contracting and managing MAFF's research. It will therefore co-ordinate the Ministry's approach to the programme and Mr John Suich, Grade 5 Head of Research Policy Co-ordination Division in the Chief Scientist's Group has been named as the liaison point with OST.

- (3) *What mechanisms (e.g., working groups) have been put in place to ensure that Technology Foresight is implemented?*

The recommendations on research from the Technology Foresight Programme will be considered within the context of the current research programmes in each sector by the customer policy groups and the scientists in CSG. They will ensure that as existing research projects are concluded new ones that are initiated take account of the Programme's recommendations.

The policy groups will continue to seek the views of the industrial users of their research on the content of MAFF's research programme.

The Technology Foresight recommendations on co-ordination between government departments and research councils, such as those made by the Food and Drink panel are being followed up by the establishment of the Agriculture and Food Research Funders Group. The members of this Group are the Chief Scientist from MAFF, the Chief Scientific Adviser from SOAFD and the Chief Scientific Officer from DANI, a representative of WOAD and the Chief Executives of BBSRC and NERC. It has a remit to ensure that there is co-ordination of the total research programme, that there are neither duplication nor significant gaps and that, where appropriate research proposals take account of the requirements of industry and consumers. In addition specific arrangements have been made for co-ordination with DoE.

Concordats negotiated between MAFF and three research councils—BBSRC, NERC and MRC—will also provide the basis for improved co-operation and co-ordination of research programmes.

- (4) *What effects has Foresight had on the plans published in the Forward Look?*

Many of the plans published in the Forward Look took into account the emerging findings of the Foresight Exercise. The Foresight recommendations generally align closely with the Ministry's research programmes and the following examples illustrate how the research programmes will develop to encompass the recommendations. Research aimed at improving the competitiveness of the agriculture and horticulture industry will take into account recommendations on the use of animal, microbial and plant biotechnology, for example in research in the genetics of dairy cattle, and in the improvement of transformation efficiency of techniques to insert DNA into crop species. Recommendations on the development of robotics, sensors and modelling will be developed in programmes on integrated crop management and pest control techniques and in systems to monitor livestock health status.

Research in support of the increased competitiveness of the food industry will embrace the recommendations on giving priority to hygienic processing to promote food and drink safety through the development of the LINK programme on "Advanced and Hygienic Food Manufacture". The aim of involving SMEs in technology transfer will be achieved through the Teaching Company Scheme and the continuing development of regional technology transfer centres.

Research in the animal disease and welfare sectors will also take into account the recommendations on animal biotechnology and employ modern genetics and immunology to improve the understanding of animal diseases such as tuberculosis and foot and mouth disease and assist in the development of novel vaccines. The continuing research in bovine spongiform encephalopathies will include epidemiological modelling studies and work with transgenic mice.

In the environmental sector research is already directed towards integrated ecosystem management and this will be enhanced to implement the Foresight recommendations. Modelling will play an increasing part in many

areas, such as solute leaching, hydrology and climate change impacts. The recommendations on site and soil remediation, waste reduction and treatment will be addressed within the substantial programme of research on the management of farm wastes and the protection of soil from contamination and physical damage.

Memorandum from the Save the British Science (SBS) Society (TFC 50) (22 September 1995)

SBS is pleased to submit the following comments on Technology Foresight (TF) to the Science and Technology Committee with the hope that they will be a useful contribution to the Committee's timely inquiry into this important initiative of the Office of Science and Technology (OST). In addressing the issues we have been guided by the Committee's questions.

1. COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

1. SBS welcomed the TF initiative and believes that it will have a beneficial effect on attitudes to innovation: in industry it will help to extend awareness of likely future developments in technology and stimulate a forward-looking appraisal of market opportunities; in the science and engineering research base (SEB) of academia and the research councils (RCs), scientists and engineers will gain a better appreciation of the potential utility of their research.

2. In terms of a "product" the greatest value lies in the creation of an informal network linking large numbers of scientists, engineers and others from industry, academia, the RCs, government laboratories and other components of the science and technology community. As Ministers and others have repeatedly stressed, the principal value of TF lies in the *process*, rather than in the results which are an expression of today's view of the future.

3. To answer the question: in this country we cannot afford *not* to take every opportunity likely to stir the nation towards making a greater investment in creativity and innovation.

4. But the value of the exercise depends very much on the degree of the breadth and depth of the penetration of participation into the body of British industry: at one end of the spectrum the large, high-technology based industries exercise foresight and already have effective links with SEB; the greatest benefits of TF might therefore be expected to come from its influence on less hi-tech and/or smaller firms where the introduction of more advanced methods and a more adventurous product range could transform performance.

5. It would be interesting to know what level of "penetration" has been achieved in this first TF round.

2. HOW SHOULD THE RECOMMENDATIONS FROM THE TECHNOLOGY FORESIGHT PROCESS BEST BE IMPLEMENTED?

6. The TF initiative is a product of the 1993 White Paper "Realising Our Potential" with its main theme of "wealth creation". But wealth creation costs money; money which neither the British Government nor British industry—on the whole—seems prepared to invest, or to risk, in sufficient measure by comparison with our main competitors.

7. In terms of wealth creation, the responsibility for "implementation" of the Foresight findings must rest overwhelmingly with British industry, where wealth is created, the main costs of innovation, product-proving and marketing are borne, and where the profits of success accrue. Without a much greater level of investment by industry, the TF process will be largely futile.

8. Government has a role here: to ensure that the country's financial structures and fiscal policies favour conditions for increased investment in research, development, and innovation in industry, large and small. It is disappointing that the initiative taken by Stephen Dorrell MP in March 1994, when Financial Secretary to the Treasury, at the request of the Chancellor of the Exchequer Kenneth Clarke MP to make "a wide-ranging review of financial structures, and the flow of savings, in the economy" was later abandoned although many organisations, like the CBI, regard these issues as being of high importance.

9. It is a pity because the conditions for Foresight "implementation" are dependent on much broader considerations than those of Directors of Research.

10. For the Government "implementation" is seen as the act of following the recommendations of the Foresight panels in deciding expenditure in support of research by Government Departments, and especially the research funded through the RCs and the Higher Education Funding Councils (HEFCs).

11. A fundamental misunderstanding is implicit in this approach, very well expressed by Dr Peter Williams, Chairman and Chief Executive of Oxford Instruments plc, in his 1995 Innovation Lecture. To bridge what he calls the "development gap" he points out that "the sheer scale of the expenditure involved should rapidly convince (the reader) that . . . it is industry which must shift its centre of gravity, not the science base."

12. We have three remarks to add:

- (a) While it would obviously be foolish not to ensure that there is a strong presence in the SEB in those areas identified by Foresight, it is equally unwise to use the Foresight outcomes as *the* prescription for the research which is to receive support in the SEB. This is recognised in the panel reports and (albeit in parenthesis) in an edict of the Foresight Steering Group: "Maintain support for truly excellent basic research (whether in a Foresight priority area or not) on a selective basis" (page 82). The panel recommendations are, on the whole, sensibly broad in the areas of research identified. But, nevertheless, the overall emphasis is very *dirigiste* in nature; and in implementation by Government and, through Government pressure, by the RCs the result is likely to be more so.

We believe the consequence, especially in a context of inadequate and declining funding (see (c) below) will be a narrowing of the research base; a further shift in the balance of research towards topics perceived to be of direct use to industry and away from those chosen by scientists and engineers seeing an opportunity to advance knowledge or technology.

This will reduce the capacity of the SEB to reveal new openings—ideas, techniques, and processes—to areas of potential for wealth creation which may be seen as having "high priority" in the Foresight activities of five to 10 years hence. What panel, 10 or so years ago, would have given any thought to "warm" super-conducting materials, or a new form of carbon (fullerines), or the implications of the "World Wide Web"? The history of Foresight-like exercises demonstrates conclusively their failure to foresee developments in technology which a decade or two later come to have dominant influence on the way we live and work.

When many leading British companies are *reducing* their activity in the R, for research, component of R&D to focus more narrowly on the short-term needs of the market place it is especially vital that the SEB be not drawn or pushed in the same direction.

- (b) A narrowing of research supported by the RCs as a response to TF would reveal further failures of Government understanding of the necessity to maintain breadth and diversity in the research of the SEB.

— As active participants in the international research network, researchers in the SEB have their "fingers on the pulse" of the 95 per cent of global research performed in other countries. Such knowledge is essential if we are to understand and appreciate the possible value of what others are doing. But to be favoured as receivers of the freely exchanged information—travelling the world at the speed of light—they must also be able to give value in return; if they cannot, they soon find themselves "off-net".

— In assessing the priority for wealth creation, the panels gave weight to the current capacity of British industry to benefit from exploitation of the results of research. We entirely agree with the view of the House of Lords Select Committee on Science and Technology: "If the science base were restricted to working only in areas appropriable within the UK, its scope and standards would drop dramatically" (Report on "International Investment in UK Science" HL Paper 36-I, 1994, p. 38).

- (c) The Foresight process brought together many hundreds of scientists and engineers all enthusiastic about the potential for wealth creation in their respective fields of research. Naturally many expectations have been raised which cannot be met without extra money.

Here was an opportunity for government to "realise the immense potential" of fully exploiting a science and engineering research base of outstanding quality; the work of all the contributors and the panels set all the possibilities clearly before it.

But in spite of Government statements to the contrary (for example: "an additional £40 million will be made available over the next three years" for the Foresight Challenge—22 May 1995) Government funding for the SEB will be £72 million (1993–94) *less* in real terms over the next two years than in 1995–96.

13. Professor Sir Martin Rees FRS, Astronomer Royal and this year's President of the British Association for the Advancement of Science, summed up his remarks on Foresight made during his Presidential Address to the Association's meeting in Newcastle in September by saying: "The Foresight panels bring people together, forge new links that are themselves worthwhile, and will help the country to exploit what's already been discovered. A Foresight strategy could do harm only if undue concentration on highlighted research areas led to a funding blight on others."

3. WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

14. The reputation of the DTI in the management of research is very poor among industrialists as well as others; in its early years the LINK scheme was bedeviled by restrictive bureaucracy. There is little confidence that the OST activities will fare any better.

15. The transfer of the OST to the DTI is likely to emphasise the trend towards a more *dirigiste* narrowing of the research programmes receiving support from the RCs. Indeed if this is not the intention it is not easy to see a reason for the move; a move which entirely neglects the broad relevance of science and technology to many other important aspects of policy: for example health, the environment, transport, defence, education, etc. It will be correspondingly more difficult to co-ordinate policies across these areas.

16. The DTI could take a positive step towards encouraging researchers in universities to patent their ideas by initiating a change in the law to allow patent application to be made within a specified period after publication, as is the practice in the USA.

4. WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

Nothing to add.

5. WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

17. The DELPHI questionnaires were poor. The wide canvassing represented by DELPHI is important, but the process requires a fundamental rethink.

6. SHOULD THE EXERCISE BE REPEATED? IF SO, WHEN?

18. The most important aspect of TF is the process itself, and especially the creation of the network of contacts. The maintenance of this network, and particularly efforts to extend its penetration into the parts of the industrial base not yet reached, must be a continuing process.

19. The full Foresight exercise should be repeated at least once every five years, perhaps every three.

20. Final Remarks:

- The *process* is the key to the success of Technology Foresight.
- Government must increase investment in R&D, not reduce it.
- Government should not push the universities into performing short-term R&D.
- Much greater industrial investment in R&D and innovation is essential.

Memorandum from the Institution of Chemical Engineers (TFC 51) (27 September 1995)

PREAMBLE

The institution of Chemical Engineers (ICChemE) is a professional qualifying body and learned society with over 21,000 members worldwide. The membership is drawn from academia, industry and other areas across the whole spectrum of the process industries. Members of the Institution were involved in several of the Technology Foresight Panels, and ICChemE was supportive of their work and active in the various consultation exercises.

ICChemE is pleased to assist the Committee by making an input to their debate; replies to the questions outlined have been kept brief to assist the Committee in its collation of input, but ICChemE would be happy to provide further information or input if desired.

REPLIES TO QUESTIONS

- Could we have continued without some exercise such as Foresight?

It was critical that the initiative was taken to jump start some activity in looking at the long term requirements of industry.

- Was the process of the Technology Foresight initiative helpful to you? If so, in what ways?

Yes, in that it acted as a focus for discussions and served to highlight priorities of importance to the process industries. Bringing people together for this purpose was in itself a valuable process.

- Was any part of the process unhelpful or weaker than the others?

The timescales were undoubtedly a problem, not only for those involved in the panels but also for those trying to make and collate inputs to them. It was simply not possible for IChemE to consult with all those we felt would have been appropriate. The Delphi questionnaires particularly received criticism: not as a general process, but the way they were handled in this particular exercise. Panel members found it hard to make use of the outcome from it. In future exercises it is important that the responsible Department provides information on demography, changes and scenarios that is consistent across all panels. There was also felt to be a lack of information and publicity on the regional seminars.

It is also suggested that future exercises be organised with much more provision for considering opportunities at the interfaces between science or industry related interest groups, for example biotechnology.

- Should the exercise be repeated? If so, when?

We believe that this should be a process of ongoing dialogue, although the exercise is undoubtedly worth repeating. More immediately, the panels could put more detail into their recommendations, though without abrogating industry's responsibility for prioritisation. It is essential that there should be some form of monitoring role by the panels.

- How should Technology Foresight be implemented?

The Research Councils need to be empowered and funded to implement the recommendations. We understand that this is already happening, but it needs clear direction and consensus on the way forward, which is probably best achieved under the aegis of the OST.

- What actions, if any, are you taking to assist your members in considering the Technology Foresight Proposals?

IChemE's Research Committee has led discussions within the process engineering community to ascertain what needs to be done. Five "themes" were identified in these discussions: the need to fund the infrastructure; the need for multidisciplinary; the need for a conceptual view of chemical engineering; the great importance of the product/process interface; and the need to link research with education.

As a result, the Committee is undertaking a series of initiatives relating to the various proposals. These include: a meeting, which was held with senior academics and leading industrialists to discuss the panels' findings and to make recommendations on IChemE's future strategy; a workshop and a research fellowship are being actively investigated on the transfer of process systems thinking to the business sector; a series of regional seminars are being set up jointly with CIA/RSC/DTI to disseminate the findings of the chemicals panel; and Subject Group (special interest group) meetings are being planned such as one on "The Challenge of Foresight to the Food and Drink Industries".

- What effect do you expect the transfer of the OST to DTI to have on the implementation of the Technology Foresight Initiative?

We would hope that DTI will allow OST to take the lead in co-ordinating the learned societies and others to implement the recommendations in their own fields. Clear expectations from OST need to be set out, preferable with timescales.

**Letter to the Clerk of the Committee from the Chemical Industries Association (TFC 52)
(27 September 1995)**

Thank you for your letter of 18 July concerning the above enquiry. I am grateful that you have sought our comments on this matter since this Association and its member companies have played a positive role in carrying out the Foresight Programme, and will continue to be strongly involved in implementing the initiative.

The following comments are based on input from the CIA Science, Education and Technology Committee, a body of senior industrialists from a wide range of chemical and pharmaceutical companies, some of whom were directly involved in the work of the Foresight Panels.

For convenience, I have set out our response under each of the questions which you have posed.

COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

We strongly believe that the answer is no. The thrust of the 1993 government White Paper which spawned the Foresight Programme, was to establish a coherent policy of support for research and innovation in the UK to realise the potential of its science base in terms of industrial exploitation and wealth creation. Our industrial

competitiveness will depend increasingly upon excellence in research and innovation to produce higher value-added products and processes, and to open up entirely new markets. We are not alone in recognising this, the governments and industries of our competitor nations have also implemented policies which seek to extract the maximum benefit from public and private sector research and development expenditure: Japan, for example, has had a rolling programme, similar to Foresight, for many years.

The chemical industry's success has been based upon effective research and innovation. It has exploited the UK's excellent science base in terms of its people (the industry's recruits) and its leading-edge research. To continue to do this, and to remain competitive, there will need to be a greater degree of partnership between industry, academia and government, as the White Paper rightly stressed. The only way to achieve this is through a national programme such as Foresight, which supports and enhances an innovative culture across all industry sectors. We believe that the outcome has vindicated this first Foresight exercise, and provided a timely focus for future national strategies for wealth creation and improving the quality of life.

WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

The major benefit of the Foresight process was the impetus which it provided in implementing the aims of the White Paper: i.e., raising the profile of science and technology generally, and promoting the notion of partnership between government, industry and academia, and we were encouraged by the speed with which new networks were established. The regional workshops which were held as part of the Foresight process were particularly effective in this regard. What is most important is that the new networks and lines of communication, between research and user communities, are consolidated and built upon in the future.

WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

Apart from the fact that the whole process was rather rushed, we found the Delphi exercise to be particularly weak. This is not to say that we oppose the Delphi system itself, but it is rather a criticism of the way in which it was conducted. The lack of context to the Delphi questions when they emerged, made them appear too technology-driven for many industrial participants, and too market-driven for many academics. It was only at the workshops, where context was provided and scenarios discussed, that the Delphi exercise added real value. By this time, however, much valuable time had been wasted, and many participants had been discouraged. The Delphi process also suffered from poor administration by the consultants: some forms were not issued, and participants received conflicting advice on how various factors (e.g., the level of a respondent's expertise) would be used to weight their input.

Having said this, feedback from Panel members suggests that the process of actually setting the Delphi questions was a valuable exercise in itself. Naturally, this round of Foresight was something of a learning process, so we are pleased that bodies such as the Commons Science and Technology Committee are conducting reviews such as this so that there is a drive for continuous improvement in future exercises.

SHOULD THE EXERCISE BE REPEATED? IF SO, WHEN?

We do not believe that the Foresight Programme will have any real value unless it is an ongoing process. Innovative companies continually assess their research and technological needs, and benchmark their capacity to innovate against their competitors'. This is a normal and necessary part of operating in a competitive, technology-based, global industry, and if the aims of the 1993 government White Paper are to be achieved, it must become routine for the UK, and become a respected national activity.

We would suggest that after a suitable period of time, say three to five years, the process should be repeated and established on a rolling basis. This would provide an opportunity to refine the recommendations emanating from this round of Foresight, to gauge their feasibility, and to review the efficacy of various routes to implementation. This would not require the same level of intensity as this first exercise demanded, although we believe that we should seek to widen the pool of contributors.

HOW SHOULD TECHNOLOGY FORESIGHT BE IMPLEMENTED?

As the answer to the above question suggests, there are a number of possible ways by which the initiative could be implemented depending upon the nature of the recommendation. For example, the top recommendation of the Chemicals Panel is to establish a new institute for applied catalysis. This is a major, tangible recommendation aimed at improving the UK's performance in a very large field of research and technology which is central to a wide range of activities within the process industries. This will clearly demand a different approach for its implementation than, for example, a project in a more specific area of research, affecting only

a few specialised companies, which might be effectively handled under a LINK scheme, or merely through better links with one or two research facilities.

CIA has sought to implement Foresight in partnership with what we term the "chemicals community", which includes the OST, DTI, the Institution of Chemical Engineers and the Royal Society of Chemistry. A group representing all of these organisations is planning a series of regional and subject-based workshops to disseminate the messages of Foresight, and to establish networks and common interest groups to take the implementation process forward. As we have stated, exactly which methods of implementation are used will depend upon the nature of the projects proposed: it is likely that they will be many and varied.

Most important, of course, is that Foresight is implemented and not allowed to stagnate and eventually wither away; this will be the true test of the validity of the exercise. The CIA recognises the challenge to industry which Foresight presents, particularly among small and medium sized companies, but it will be the responsibility of government departments to ensure that the real momentum and public profile are maintained. We are encouraged that it has already been embedded to some extent within departmental processes, and we have also been pleased with the positive response from the research councils. It is in the implementation of Foresight that the government's role is most profound.

WHAT ACTIONS, IF ANY, ARE YOU TAKING TO ASSIST YOUR MEMBERS IN CONSIDERING THE TECHNOLOGY FORESIGHT PROPOSALS?

Throughout 1994 the CIA actively encouraged its members to participate in the Foresight process. The Association contacted every member company, seeking their views on their research and technological needs so that they could be taken into full account in the recommendations of Foresight. Following our consultations, CIA published the document "*Chemical Industry Research Priorities*", which was launched at the House of Commons in April this year, and which has been widely recognised as a major contribution to the Foresight initiative. Our recommendations complement those of the Chemicals Panel, and SETCOM members, along with CIA staff and other contacts within the membership, have disseminated the results widely; within companies, the research councils, government departments, academic groups, etc. This process will continue and will be enhanced through the workshops to which we refer in the answer to the above question.

WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

Foresight aims to improve links between academia and industry, and it would, therefore, seem appropriate to link the government departments with responsibilities for industrial competitiveness and support for the science base. We welcome this move, and we believe that it could have positive results for Foresight implementation. This will depend, however, on a number of conditions. Most importantly, it is imperative that the balance of support for research through the OST should not be shifted towards near market industrial activities. We firmly believe that the emphasis within the universities should be on basic, fundamental research, and we would vigorously oppose any moves to undermine support for this in favour of more applied work. We are aware of some apprehension within the academic community that this shift in emphasis might become a reality, and if this view persists, the move could have a negative impact on the Foresight process. We would welcome a firm assurance from government that these fears are unfounded.

It is inevitable that with any organisational or structural change such as this, some momentum will be lost as the waters settle down. It will, therefore, be important for government not to lose sight of the objectives of Foresight, or to compromise what has already been achieved by concentrating too strongly on internal issues.

Letter to the Clerk of the Committee from Johnson Matthey (TFC 54) (28 September 1995)

I am writing in response to your letter of 27 July 1995 inviting Johnson Matthey to submit comments on our experience of the Technology Foresight Initiative for the Science and Technology Committee's forthcoming enquiry.

Johnson Matthey is a keen supporter of the Government's Technology Foresight Initiative and was encouraged to participate in the initiative through our close contact with the Department of Trade and Industry. We are committed to contributing to the full process.

As a result of the Technology Foresight Initiative we have looked at priority areas of interest to Johnson Matthey with a view to implementation. Johnson Matthey has had its own Foresight Day, which has resulted in some changes to our long term technology strategy. The company's operating divisions have also held Foresight Days. The Board has discussed in some detail the findings of both our own internal initiatives and the Government study.

The transfer of the Office of Science and Technology to the DTI is generally welcomed. We feel that the DTI are in a strong position through industry groups to identify and promote opportunities for the implementation of Foresight findings. Also, because of the DTI's relations with Brussels, it can use the results of Foresight to influence Brussels' policy and the allocation of funds to the benefit of UK industry. There is however a danger that the DTI, due to its industry focus, will not pay sufficient attention to academic curiosity driven research aimed at maintaining the nation's science base. The UK's recognised strength is its science base and it is essential that this is maintained.

We firmly believe that the Foresight Initiative, or some similar exercise, was necessary. The UK Government could have continued the funding of science and technology without Foresight, however we very much doubt that this would have made the best use of public funds in the vital area of promoting wealth creation.

There have been a few areas of weakness within the process so far. While the Foresight panel reports were helpful, the final Steering Group report was disappointing. This report removed the specific recommendations from the panel report and gave no clear direction on how the generic technologies would be applied to wealth creation. For example, the Chemicals Panel were specific in proposing the establishment of a National Institute of Applied Catalysis. This is a field which the Chemicals Industry Association has identified as a primary target in a report on research priorities. Unfortunately, the Steering Group report did not recommend the establishment of a National Institute of Applied Catalysis. It is also disappointing to note that despite the substantial surveys being carried out by academia and industry, catalysis does not receive a mention in the Foresight News (August 1995).

The major weakness however has been the lack of action, so far, in implementing the recommendations of the panels.

It is our feeling that actions resulting from the first Foresight Initiative must be clearly demonstrated and implemented before any repeat of the exercise should be considered. Without such widely publicised progress a repeat of the exercise is unlikely to receive a very enthusiastic response from the many thousands of scientists and businessmen who have contributed to Foresight so far. However, Foresight should be viewed as an ongoing process and we at Johnson Matthey look forward to continued involvement in this exciting initiative.

Memorandum from the Department of Transport (TFC 55) (20 September 1995)

1. This memorandum responds to the letter of 18 July from the Clerk to the Science and Technology Committee.
2. The Department of Transport is currently evaluating the relevant recommendations of the Technology Foresight Programme. The main conclusions will be reported to the Secretary of State prior to implementation. The Department's Chief Scientist (Dr D H Metz, Grade 4) is responsible for this.
3. Representatives of the Foresight Transport Panel have given a presentation to the Secretary of State on the "Informed Traveller" project, and this is being pursued with the relevant officials. The Department's main Directorate Research Committees will be considering foresight recommendations as part of the process of formulating their research plans for 1996-97. This exercise will inform the Department's contribution to the 1996 Forward Look, although at the moment it is too early to say precisely to what extent.

Letter to the Clerk of the Committee from the Medical Research Council (TFC 56) (25 September 1995)

Thank you for your letter of 18 July. I am responding primarily in my capacity as Chief Executive of the Medical Research Council, but a few of the comments are influenced by my experience as a member of the Technology Foresight Steering Group. In reply to your questions:

1. COULD WE HAVE CONTINUED WITHOUT SOME SUCH EXERCISE?

The idea of trying to get all relevant stakeholders to identify and sign up to some key promising topics and work together to achieve them has the potential to enhance co-operation in research, application of science in industry and the public services, and hence wealth creation in the UK. The potential benefits are clearly much greater than the direct costs, but there are also potential risks (see below).

The potential for benefit will vary between sectors. In the biomedical area, MRC has long had a clear health mission relating to a specific service industry, the NHS, which now has espoused evidence-based medicine. Our mission also relates to a major manufacturing industry, pharmaceuticals, which was already highly R&D intensive and increasingly using the advances in biology both to enhance its traditional therapeutic approaches

and to develop new, biotechnological ones. In consequence, there was already a degree of understanding and interaction between the key components which is not matched in many other sectors. The technological potential of the sector was already clear to those in it and many obvious priorities were already on board.

2. WAS THE PROCESS HELPFUL TO MRC? IF SO IN WHAT WAYS? HOW HELPFUL WAS IT IN DETERMINING MRC PRIORITIES?

It remains early days for an assessment of the initiative or the processes involved. The exercise will have proved valuable if it has demonstrated that potential to a wider audience, and if in consequence the sector is successful in attracting additional public or private funding to help address the potential and priorities more effectively in partnership with the manufacturing and service industries.

The exercise will also have been helpful if it contributes to enthusing scientists with the value both of the Council's mission and of TF, and to the wider UK recognition that both depend as much on a powerful SET base as on anything else. This will, however, depend on how the implementation is handled by all concerned. There are certainly risks of further alienating those who feel that actions in recent years have progressively undermined the strength of the SET base.

The exercise, including implementation, is certainly bringing some in academia and industry into greater contact, and this is desirable if kept within reasonable limits, as the downside is that it takes people away from actually generating the vital new knowledge and products.

MRC is considering TF recommendations in its annual autumnal scientific strategy review; it would be premature to try to judge its impact on MRC priorities.

3. WAS ANY PART OF THE PROCESS WEAKER/LESS HELPFUL?

The process of prioritising was done across all sectors and to a tight time table. This of necessity meant that the exercise was rough and ready. In some respects this was adequate for the purposes. However, with hindsight, there were definite weaknesses:

- The conomination process did not provide a reliable starting point for panel development. Major attention was needed to generate a Panel (I am here referring specifically to Health and Life Sciences) with a spread and weight of membership that would command sufficient respect.
- The Panels were composed of scientific experts in academia and industry, rather than those responsible for leading and managing publicly funded science—in the hope of avoiding "establishment views". New thinking was essential for the exercise, and OST was successful in bringing together many brilliant and creative thinkers. With hindsight, however, the inclusion of some establishment figures who might take a broader, more pragmatic view, would have strengthened the exercise, and helped establish consensus.
- The process was operated by OST, a very new entity, which of necessity had to learn how to conduct Foresight effectively as the programme progressed. As the exercise wasn't piloted, this inevitably threw more of the load of trying to operate the process effectively and to produce reports with the potential to be taken seriously onto the Chairman and members of the Panels and Steering Group than is usual.
- The panel's forward visions, and their recommended priorities would have been more valuable had they been properly related to the background of existing trends and priorities in science and the ongoing initiatives addressing them. Recommendations should also have been supported by more comprehensive evidence. In wishing for better supported work, we are not suggesting that the panels should have been developed into large, authoritative commissions—pluralism is essential—but for slightly more time and effort to be committed to strengthening the credibility of the exercise. It is clear, from comments by Panel members and the scientific community, that the credibility of the exercise was far from secure: firmer support for the process would have made it easier to take forward the recommendations.
- The Delphi questionnaire is an interesting technique, but harder work needed to be done on the questions to make them sensible enough to inspire confidence in the recipients.
- The very specific nature of panel recommendations on how priorities should be taken forward is not helpful to MRC. Specific implementation plans were needed, but these should have been developed separately, over a longer time period, and with broader involvement, to ensure the plans were practical, and took account of existing efforts in these areas, and the limitations on the speed of change.
- The process was centred on UK views: we must always be open to the possibility that the UK view is blinkered.

While tackling all sectors simultaneously meant that one could not benefit from the experience of a pilot sector, it had the merit of being seen to be getting on with the job, so that things could happen sooner, and of not seeming to favour one sector over another. On balance, this was beneficial.

4. SHOULD THE EXERCISE BE REPEATED? IF SO, WHEN?

The exercise should undoubtedly be repeated, in some form, given the rate of change in science and in our perceptions of society's needs. We would expect a second-round exercise to avoid the mistakes of the first round, build on their work, and, overall, offer much greater returns for the effort committed.

However, the timing must take account of the need to test the merits of Foresight by taking it through the implementation phase—though evaluation will be extremely difficult—and recognise that on a national scale high quality scientific effort takes time to develop, and cannot be switched on and off at will. This all argues for a cautious approach to the timing and nature of a repeat exercise—a five to seven year time scale would seem appropriate.

5. EFFECT OF THE TRANSFER OF OST TO DTI?

It is unclear as yet what effects the transfer will have on science policies and operations, although various possible advantages and disadvantages have already been spelt out by the commentators.

For TF, it should logically help the process of co-ordinating SET base and industry actions, e.g., in LINK-type schemes. However, action will also be needed by other Government Departments, and the question is whether they will be more likely to align themselves with an OST located in a strong Department with a specific interest than in its previous more neutral, but less powerful one. Also, as is clear from the scientific press, the move has the potential to antagonise researchers in the science base and make them less likely to support Foresight—and the White Paper philosophy in general.

I hope these replies are clear and helpful—if you have any queries I would be happy to expand on, or clarify, these points.

Memorandum from British Aerospace plc (TFC 57) (29 September 1995)

1. British Aerospace has taken a full part in Technology Foresight through having senior staff on the Defence and Aerospace Panel, taking part in Panel discussions and in workshops connected with the process. We are therefore well placed to comment on the process and further action—although these comments are confined to the Defence and Aerospace sector.

2. Technology Foresight has been helpful in the following ways:

- The process has helped all Panel members consider the issues deeply and in a way that would not have happened otherwise.
- It has confirmed a number of views that we had already developed over the priority technologies in our sector.
- It has extended our network of contacts across industry, government and academia.
- It has given us insights into the work and priorities of other companies and organisations.

3. In terms of process we judge it to be fairly successful. The Panel tried very hard to obtain a fair spectrum of views and to take different perspectives into account. The process was, however, very demanding for those closely involved. Inevitably, therefore, the results might be a reflection of the sub-set of those prepared to take time over the process than to be, in a more objective way, a reflection of views across the sector as a whole. Those concerned from BAe had the impression that the academic community found it somewhat easier to allocate time to this work and this may be reflected in the results. The allocation of time to the delphi process meant that the closing stages of the process were under great time pressure and some of the detailed comments may not have been as fully considered as they deserved to be. We felt that the process and the Report were equivocal about the role of the DERA in the sector. In the Report there was reference to greater harmonisation and integration of defence requirements with Europe but it was not clear that the MOD representation supported this stance. The decision to conduct the entire defence section as an unclassified process necessarily limited some of the discussion and some important defence aspects were not able to be addressed at all deeply.

4. In general close attention to the detail of the Report seems to pose more questions than it answers. This may have to do with the concentration on the mechanics of the delphi process rather than to a determination to get at the key issues. Nevertheless we believe that the broad findings are sound. We would be less sure that the finer details will stand up to the test of time.

5. Taking a broader, national, view we think the process has the potential to be a very useful start to a national sense of purpose and direction which will be welcomed if it can be taken forward. In this context we regard the Technology Foresight so far as an important start rather than having substance in itself. It will have been useful analysis and preparation if it progresses into an implementation phase which serves to change our competitive performance. One of the weaknesses of Technology Foresight, in our view, was that it did not address from the outset the mechanism by which UK Ltd would become more competitive as a result of the process. This question remains open and should be the principal issue for the future. Realising value from Technology Foresight will be about implementing changes which will improve competitive performance.

6. British Aerospace believes, however, that there is an opportunity to make good use of the Technology Foresight analysis phase. We think this opportunity should be seized through the creation of a nationally scaled capability demonstration framework which would be open to a wide variety of enterprises working in the Defence and Aerospace sector. We have in mind that taking forward technology into competitive advantage in the international markets in which we work requires:

- The development by key technologies into practical applications in products and services.
- The development of associated engineering processes which permit cost effective and timely product development.
- The integration of many contributions in complex systems in a more effective manner across the industry.

7. The Defence and Aerospace Panel identified Systems Integration as a key capability. This can be interpreted at a firm or product level but was also intended to apply to the process of integrating complex contributions through the effective use of new tools and processes for concurrent engineering, risk analysis, etc.

8. We believe that these aims can be realised through a major demonstrator programme. The SBAC has identified a concept for doing this under its Foresight Action studies which were specifically aimed at determining how Technology Foresight should be taken forward into practical benefit. British Aerospace strongly supports this concept. It is predicated on the belief that industry should continue to invest in itself but should do so in part in a national demonstrator programme in conjunction with investment from Government on behalf of the wide community which benefits from the strength and vitality of the sector. It is also based on the belief that the opportunities for individual firms are increased by increasing the aggregate level of competence of the sector in UK.

9. FORESIGHT ACTION envisages a programme which:

- Is open to all firms in the industry and to academic institutions working on relevant areas.
- Is focused on demonstrating capabilities relevant to the market place—it seeks to take the identification of such areas from Technology Foresight as well as from the earlier National Strategic Technology Acquisition Programme (NSTAP) and take them forward into advanced application capability.
- Is large in scale—comparable to a major aerospace or defence programme—and large enough to make a difference over a number of years in the UK's competitive ability.
- Adds value through firms working together in partnership in a large integrated programme.
- Advances capability in processes as well as in technology.
- Demonstrates enhanced capability in supply—chain management.

10. We recognise that all these capabilities are best taken forward in major new programmes. But these are much less numerous than in former years. In our view firms need to position themselves for winning places in those programmes that will be available and they need to do so in partnership as well as individually. Foresight action envisages creating such opportunities by integrating numerous demonstrator elements into one (or certainly into very few) major integrated demonstration programmes.

11. This approach would enable firms to take part in work areas that they perceive as important to their markets, it would enable the broader priorities of Technology Foresight to be recognised, it would provide practical implementation of Technology Foresight and take it forward to enhanced competitive capabilities in the sector.

12. We think that this needs to have Government support. The industry should, and does, invest very large sums in R&D from its own resources. It also creates very substantial benefits for the wider community—more than 120,000 jobs in aerospace alone and those jobs are among the highest skilled in the country. The community would benefit from measures for the increased performance of the sector as well as the individual firms. The UK stands at risk of not grasping these collective opportunities. Other nations have long since identified their

aerospace and defence sectors as of primary importance and have taken strategic steps to contribute to their growth and strength. In France and Germany European governments have strong programmes to this end and most challenging of all the USA has very large programmes which help its aerospace industry to advance. In a market which is global in character the ability of the UK Government and the UK industrial sector to join together in a single strategic enterprise is of the first rank in economic importance. Technology Foresight could be maintained as the impetus for this partnership and we think that it should be.

13. Such challenges will not be met by small measures in response. We think that such an integrated programme needs to be considered as reaching about £200 million per annum (although this will have to be over a period) to be shared between Government and industry. Only by this scale of partnership across the sector will the losses in market share be reversed. Since 1980 the aerospace industry alone has lost about 100,000 jobs—many of these, to be sure, have been accounted for by increases in efficiency but more than half are estimated to be due to losses in market share. In the defence sector the pressures have also been extreme with the fall of the Soviet Union triggering major reductions in order intake for many companies. Even companies like British Aerospace which have been able to maintain order intakes at high levels have felt the sharply increased competitive pressure in world markets. We believe, therefore, that we not only have the opportunity to take Technology Foresight forward but we have a pressing need to do so.

Letter to the Clerk of the Committee from the BioIndustry Association (TFC 58) (29 September 1995)

On behalf of the BIA Science Advisory Committee I would like to provide answers to the questions in your letter to Dr John Sime on 18 July 1995. The replies included below are as a result of a consultation exercise we have carried out with our members over the last month.

COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

Of course we could. However, Foresight does focus attention on areas where global needs and UK means of delivery are best matched. It also serves as advanced warning to companies as to where a concentration of Government investment and initiatives can be expected over the next few years. Of course, care will have to be taken in the implementation of the recommendations, in that no exercise of this type is totally prescient and there could be a tendency for smaller companies to be unduly deflected in their innovative R/D activities in order to fit in with the "party line".

WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

Yes—because it was done. It produce few surprises but gave valuable reassurance of the appropriateness of the lines of research and topics being followed in public sector and much industrial research. However as mentioned above such guidance can be a double-edged weapon.

WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

We were not convinced that the Delphi survey produced results which were not available by less time-consuming consultation exercises.

SHOULD THE EXERCISE BE REPEATED? IF SO WHEN?

Yes but not for five to ten years. Biannual updates on progress in the implementation of the recommendations would be useful in their own right and also in that, as an auditing function, they might indicate whether a repetition would be useful.

HOW SHOULD TECHNOLOGY FORESIGHT BE IMPLEMENTED?

As it has been done, by charging all those leading, managing and funding research to respond.

WHAT ACTIONS, IF ANY, ARE YOU TAKING TO ASSIST YOUR MEMBERS IN CONSIDERING THE TECHNOLOGY FORESIGHT PROPOSALS?

We believe that many of our members are not sufficiently conversant with the aims or outcome of this exercise to reap any benefits. We intend to invite the Chairmen of relevant Foresight Panels to make presentations to our members.

WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

Like many other groups, we were greatly concerned about the OST transfer. We believe that this move will *again* marginalise the voice and impact science and technology has over the broad remit of Government policy. In the short term it may have benefits for our members in that the move will probably polarise Government investment and initiatives towards wealth creation at the expense of improving quality of life. Both of these objectives figure in the governments strategy for science.

**Letter to the Clerk of the Committee from The Society of British Aerospace Companies Ltd (TFC 59)
(2 October 1995)**

The Society welcomes the opportunity provided by your 19 July press notice to comment on Technology Foresight at this stage of its development. The SBAC has been heavily involved in the Foresight initiative through our past President Roy McNulty's Chairmanship of the Defence and Aerospace Panel, on which we also had a number of member company representatives. Our membership is grateful to the many individuals who have shouldered the additional and unrecompensed work in support of this national examination of technology priorities and how these can best be focused on wealth creation and improved quality of life.

We consider Technology Foresight to have completed its first phase successfully. It has brought together large numbers of opinions from many walks of life and has drawn out clear summaries of key technologies in the various areas studied. Also, new networks have been formed between individuals, companies, institutions and other groups who, consequently, are now more knowledgeable of their specialist technology fields in general and their own position within them in particular. We are of the firm opinion that Technology Foresight was both a timely and effective start to repairing the damage being caused to industry by the lack of a national technology focus.

It does not detract from the excellent work already done to recognise that the first phase of Technology Foresight also had its limitations. Indeed, it was inherent in the process that this would be so, and it was wholly expected that some new challenges would be faced if Technology Foresight was to be useful as well as interesting. Our comments on the first phase of Technology Foresight are contained in the following paragraphs along with other thoughts that may help give better direction for future work. Obviously, our observations apply particularly to the Defence and Aerospace Panel, but we believe that all the panels will face the next phase from a similar starting point.

For industry, the long term importance of Technology Foresight will be measured by the contribution it makes to the industrial base. However, a weakness of the Technology Foresight concept was the lack of a vision of its intended industrial impact and the means by which this might be effected. Consequently, to date there is little evidence that the first phase analysis has produced any changes with industrial relevance; it is therefore essential that the next (implementation) phase of Technology Foresight should provide a mechanism for delivering industrial benefits. The mechanism should give industry a direct influence on research priorities, concentrate on issues that bear on industrial competitiveness, and lead to a review of Government's pattern of investment in industrial, university and trade matters.

Our members recognise that action as a consequence of Technology Foresight is not just a matter for others. Indeed, at our annual dinner, the then Chancellor of the Duchy of Lancaster, the Rt Hon David Hunt MP, invited the aerospace industry to take a lead on systems integration technologies. We are certain that there is much that industry can derive from the Foresight findings, and firms must question their own technology programmes, especially where these may be at odds with the main thrust of the Panel Reports. However, the most significant effects of Technology Foresight are likely to be those that are initiated by Government adjusting the pattern of public investment to gear it better for long term wealth creation. We would see industry's expertise and continuing investment in market exploitable technologies as being essential ingredients in shaping this process.

Not surprisingly, there is strong support for the Defence and Aerospace Panel's conclusion that a key focus of Technology Foresight should be on applied research. It is in this area of endeavour where technologies giving a market edge are often created, where the potential of these new ideas is subjected to rigorous evaluation, and

where the risk associated with new concepts is reduced. Our members also endorse the Defence and Aerospace Panel's recommendations for changes which will improve the market relevance of applied research; we share the Panel's concern that there is far too little investment at present in Technology Demonstration for UK Defence and Aerospace, especially when measured against the efforts of competitor countries.

The UK aerospace sector operates in a global market in which the USA has especially powerful aerospace players along side some strong European contenders. Whilst the UK still sustains a significant industrial presence, we have been losing market share over the last 15 years. Should these trends continue for another ten years, the UK will have lost a quarter of its early 1980s market share. Unlike competitor aerospace nations, Government/Industry partnership is weak in the UK—not only in terms of public investment, but also in the relative priority attached to this high-tech, strategically important aerospace sector which directly employs about 130,000 people and has contributed on average some £1.75 billion to the UK balance of payments each year since 1985.

The aerospace sector is clearly a successful one and continues to make major efforts to retain its competitiveness; since 1980 some 100,000 jobs have been shed of which 60 per cent were due to efficiency gains but a worrying 40 per cent resulted from lost market share. The view that market forces alone will promote winning competitiveness has its limitations when applied to a global industry such as aerospace. The reality is that success is achieved by those nations where strong Government/Industry partnerships exist, based on an agreed and adequately funded investment in national technology objectives. Firms are not ready to share their technology objectives and Technology Foresight provides a common purpose around which Government and industry could build a strong partnership, if the right mechanism existed.

Against this background, we believe that an excellent way for Government to carry forward the Technology Foresight work would be to work with industry to create a national, capability demonstrator programme in the defence and aerospace area. Such a programme has been identified and developed in outline within the SBAC under the title Foresight Action—an intended connection between the findings of Technology Foresight and the industrial interest stimulated as a result of the work to date. We firmly believe that an initiative such as Foresight Action offers the best mechanisms for future Government/industry investment in a UK technology base which would provide long-term wealth creation and improved quality of life. The key elements of Foresight Action are:

A national programme—large enough in scale to make a difference to the competitive performance of the UK aerospace industry. We believe this means a programme rising to about £200 million annually with the cost shared between industry and Government.

A programme for growth—addressing those areas that will enable the industry to regain its early eighties market share and the benefits from the projected growth in the global market. The relevant issues have already been clearly prioritised by Technology Foresight and the National Strategic Technology Acquisition Plan (NSTAP) that preceded it.

A capability demonstration based programme—satisfying industry's needs to advance on a broad front. Technology is not an end in itself, it must be exploited successfully in a real environment, using the best practice tools and processes. Technology Foresight stressed the importance of demonstrating and developing such capabilities.

Foresight Action is not envisaged as a replacement for either existing Government mechanisms such as CARAD, or current industry investment in R&D. Against the scale of the industry and the totality of Government investment in technology, Foresight Action is a modest programme, but we believe it would have an effect out of all proportion to the investment. It would act as a stimulus for collaboration and allow firms, particularly SMEs, to benefit from both the programme elements that directly concern them, and from the sharing in advanced tools and processes pervading the whole programme. We anticipate that the transfer of the OST to the DTI could help facilitate the development of Government/industry joint investment in such a programme as Foresight Action.

We gave a strong overall endorsement at the start of this submission to the process of Technology Foresight, but the main motivation must now be to exploit the results of that work, including the delivery of industrially significant benefits through mechanisms such as Foresight Action. We believe that for future iterations it will be necessary to update the Foresight Technology objective and procedures, and it may be helpful to bear in mind the following points:

Technology Foresight was launched without any clearly defined process or success criteria in terms of what changes success would bring or what relationships might require review.

Panel memberships included too few young people, and there were inadequate resources available to support the work of the Panels.

The Delphi survey and regional workshops took place before the Panels had had time to form clear views.

There was a poor selection/definition of Delphi statements, and this was compounded by the low level of interaction between the panels.

Notwithstanding the above, the SBAC believes that the findings of the Defence and Aerospace Panel in particular are useful and relevant to our industry.

In summary, the SBAC welcomes publication of the Technology Foresight reports which represent a thoroughly worthwhile exercise, reflecting great credit on those who took part. The first phase of Technology Foresight should now be followed by a programme of action designed to apply the analysis to industrial competitiveness and long term wealth creation. We believe that strong Government/Industry relationships are essential in realising these goals and would strongly advocate a mechanism such as Foresight Action as the best way of achieving this.

**Letter to the Clerk of the Committee from the Department of the Environment (TFC 60)
(29 September 1995)**

The Department has been involved in the Foresight Programme through consultation about prospective panel members and experts included in wider consultation, and particularly through the participation of officials on three Sector Panels—Agriculture, Natural Resources and Environment, Construction and Energy. Through membership or as assessors on these panels we have been kept closely informed of developing conclusions and have been able to contribute the Department's own ideas on priorities. Consequently, many findings of the Foresight process reflect our existing policy priorities.

It should be emphasised that, particularly in the area of environmental issues, our research objectives are largely concerned with informing, developing and monitoring Government policy. As a result we do not generally support industrial innovation in these areas, and the impact of developing Foresight themes on our research programmes is likely to be limited.

I attach responses to the four specific points you have raised, which I hope will provide you with sufficient information for the Committee. I am copying this letter to Dr Fisk and Mr Lee here at DOE, to Mrs Williams (OST) and to members of the Whitehall Foresight Group.

- (i) *Is there a Minister responsible for ensuring the Technology Foresight Programme is implemented within the Department?*

Ministers have responsibility for implementing Technology Foresight as appropriate within their areas of interest. The Secretary of State alone covers all the areas of the Department which may need to address the findings of Foresight and is ultimately responsible for ensuring Foresight implementation.

- (ii) *Is there a particular official responsible for ensuring the Technology Foresight Programme is implemented within the Department? If so, at what grade, and what are his or her other responsibilities?*

Dr Apling, Grade 5 head of Chief Scientist Group, has been co-ordinating the Department's response to Foresight since the beginning of the Programme and currently represents the Department on the Whitehall Foresight Group, chaired by OST. The Chief Scientist Group oversees the quality assurance and evaluation of the Department's research programmes and co-ordinates the Department's contribution to the annual Forward Look of Government Funded Science, Engineering and Technology, where progress in implementing Technology Foresight will be recorded.

- (iii) *What mechanisms (e.g., working groups) have been put in place to ensure that Technology Foresight is implemented?*

A group of senior officials from all areas with relevant research programmes has been established to support Dr Apling in his role as Departmental representative on the Whitehall Foresight Group. Construction Sponsorship Directorate, with a remit to carry out research in support of the industry, continues to be directly involved with the appropriate Foresight Panel and the industry in developing a joint response through a research strategy for the industry.

- (iv) *What effects has Foresight had on the plans published in the Forward Look?*

The 1996 Forward Look will be the first occasion to report in detail any changes Technology Foresight has had on the content and direction of the Department's Research Programme. For the Construction programme, where technology development and foresight drive the aims and objectives, the Technology Foresight Construction Panel activities have already contributed to the Whole Industry Research Strategy which will guide research for the next five years.

Other Research objectives, particularly in the area of environmental issues, are concerned with informing, developing and monitoring government policy, and tend to respond to the consequences of technological change rather than the technology itself. In these cases, the timescale for research to reflect Foresight will be longer.

Memorandum from PPARC (TFC 62) (3 October 1995)**Q1 COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?**

Response: PPARC could certainly have continued without an exercise such as Foresight. By the long-term and international nature of our science programme Foresight will not affect programme balance or priorities. Also we were already developing procedures to identify which technologies required for our research programmes were most likely to lead to wider industrial application; and then to target those for technology transfer.

Q2 WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

Response: Notwithstanding the above, it is likely that the process of the Technology Foresight initiative was helpful to PPARC, insofar as it helped focus attention on the whole range of advanced technologies developed for our research programme which have actual or potential wider application in industry.

Q3 WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

Response: Most of those involved in completing Delphi questionnaires felt they were too long and complex, and were unconvinced that the value of their conclusions warranted the effort involved. From accounts received, the value of the various regional Panel forums was variable. Some attendees felt they had achieved little.

Q4 SHOULD THE EXERCISE BE REPEATED? IF SO WHEN?

Response: The exercise as such should not be repeated for some time in that form. There should be a continuation of the networks and dialogues between industry, science and Government, created by the process. The full exercise should not be carried out for at least five years.

Q5 HOW HELPFUL HAS THE INITIATIVE BEEN IN HELPING YOU DETERMINE YOUR PRIORITIES?

Response: We anticipate the Initiative being of value in determining priorities in our technology transfer and industrial support programme. For example the priority accorded by Foresight to the field of sensors has helped to identify the area of detectors and sensors as a priority area for collaborative research with industry. (A bid to the Technology Foresight Challenge Fund is being developed in that area).

Given the PPARC's Charter mission to pursue basic research, it was not expected that the Initiative would contribute to the assessment of PPARC's priorities between different areas of fundamental science. These are driven by the internal dynamics of the research itself and determined largely by the (national and international) scientific community.

Q6 WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

Response: The move of OST to DTI could have a beneficial effect on the implementation of Foresight if it brings about a closer integration of the variety of current initiatives in this area. It remains to be seen whether OST's ability to influence other R&D spending Departments will be enhanced by the move.

**Letter to the Clerk of the Committee from the Department for Education and Employment (TFC 63)
(4 October 1995)**

Thank you for your letter of 18 July about the Science and Technology Select Committee's inquiry into Technology Foresight and for letting us know of your request to the Higher Education Funding Council for England for written evidence. Please accept my apologies for missing your deadline of 29 September.

You asked what action this Department is taking. The Technology Foresight recommendations range widely across the Department's work from the teaching of science in schools and colleges to the support of the science and research base in universities. The Department's policies are already directed towards promoting selectivity in research and enhancing the nation's skills base, in line with many of the Technology Foresight recommendations.

MINISTERIAL RESPONSIBILITY

The Minister of State, Eric Forth MP, has responsibility for higher education and research. To the extent that Technology Foresight is concerned with research, he has lead responsibility for implementing the Technology Foresight Programme in the Department. However, the other Minister of State, Lord Henley, has responsibility for the school curriculum and GNVQs; and the Parliamentary Under Secretaries, Robin Squire, James Paice and Cheryl Gillan all have responsibilities for education and training at various levels and for various ages. They all therefore have an interest in taking forward the Technology Foresight recommendations.

OFFICIAL RESPONSIBILITY

Officials in several branches are involved in the areas mentioned in the Technology Foresight recommendations. Responsibility for co-ordinating the Department's response rests, however, with Mr C A Clark (Grade 3) as Head of Higher Education Branch. Miss K J Fleay (Grade 7) of Higher Education Branch and Mr E Galvin (Grade 5) of Qualifications and Industry Training Organisations Branch represent the Department on the Whitehall Foresight Group chaired by the Office of Science and Technology. The Department is also represented on the Leisure and Learning Panel by Mr B D Short (Grade 4) of Further Education Branch.

MECHANISMS FOR IMPLEMENTATION

Implementation is being co-ordinated through the usual channels of communication within the Department rather than through specially constituted working groups. Meetings of relevant officials will be held as and when the need arises.

EFFECTS OF FORESIGHT ON FORWARD LOOK PLANS

The Department for Education's entry in the 1995 Forward Look (volume 2, chapter 10) makes clear that the Department is already committed to:

Selectivity and accountability in the use of public funds allocated by the Higher Education Funding Councils for research: and

Helping to secure an adequate supply of people qualified in science, mathematics, engineering and technology subjects to meet the country's needs.

The chapter explains the mechanisms that the HEFCE has been developing to take account of Technology Foresight results. Since publication of the Foresight reports, the Funding Council has been considering further how to take forward the recommendations and will no doubt explain these in more detail to you in its written evidence.

The Department does not engage in detailed manpower planning. But Chapter 10 sets out how it is taking action to promote higher achievement in science, engineering and technology at all levels of education—through the National Curriculum; the Technology Colleges initiative; new targets for initial teacher training in science; the development of GNVQs; the occupational standards underlying NVQs; initiatives in higher education; and initiatives by sector organisations. All this is relevant to the Foresight recommendations on addressing the various skills deficits in areas like IT competence, chemistry, mathematics and finance.

One important area in which further action is already under way is education superhighways, the subject of several Foresight recommendations. In April, the Secretary of State launched a consultation exercise and invited bids for sponsored evaluation of broadband pilot projects. Progress has been made in identifying potentially worthwhile projects, but these will need evaluation before any decisions are taken on the wider development of superhighways for schools. The HEFCs are already funding the development of SuperJANET, a superhighway for higher education.

In short, much of the Department's work already coincides with the Foresight objectives. We are considering whether any further action should be taken in response to specific recommendations and will report on progress in the Government's interim Foresight report and in the next Forward Look.

**Letter to the Clerk of the Committee from the Scottish Higher Education Funding Council (TFC 64)
(3 October 1995)**

HOW WILL THE TECHNOLOGY FORESIGHT PROCESS AFFECT THE WAY IN WHICH YOU ALLOCATE FUNDS?

It is too early to say how Foresight will affect the way in which the Council allocates funds. Enclosed is a copy of the Council's consultation paper *Addressing Technology Foresight*, which was widely distributed at the beginning of August to bodies with an interest in the role of Scottish higher education in the context of Technology Foresight. Responses are due by 31 October and these will inform the Council's advice to the Secretary of State for Scotland and the way in which the Council develops its funding and other policies. I think the paper explores the options thoroughly, and I would hope that it might be of use to the Committee.

DID YOU MAKE ANY REPRESENTATIONS TO ANY OF THE TECHNOLOGY FORESIGHT PANELS OR THE STEERING GROUP? IF SO, WHAT WAS THEIR NATURE?

The Council did not make any representations to any of the Foresight panels or the Steering Group.

WHAT EFFECT HAS FORESIGHT HAD ON THE PLANS PUBLISHED IN THE FORWARD LOOK?

The Council is a Non-departmental Government Body and did not contribute directly to the Forward Look. However, the Scottish Officer's contribution says of the Council that funding mechanisms (including Corporate Plans) will from 1996-97 onwards take account of findings from the TFP.

OTHER QUESTIONS

Regarding the remaining questions, since the Council did not play an active part on the early development of the Foresight Programme, I cannot answer these directly. I regard Technology Foresight as an evolutionary process and at the invitation of the Government's Chief Scientific Adviser I have agreed to serve on the Technology Foresight Steering Group. This Group will guide and co-ordinate the work of the Foresight Sector Panels and advise on actions necessary to take matters forward.

Memorandum from CVCP (TFC 65) (4 October 1995)

1. The CVCP welcomes in principle the establishment of a national Technology Foresight exercise. We regard it as a useful tool which can assist the Government's implementation of a number of policies as set out in the 1993 Science, Engineering and Technology White Paper, "Realising Our Potential". A number of benefits can be discerned already, in particular the way in which the recent exercise provided a forum in which Government, industry and academia could come together to discuss matters of mutual interest. It has raised awareness of the opportunities arising out of current, and likely future, developments in science and technology. It has also doubtlessly assisted the OST in justifying the case for a particular volume of resources to be devoted to the public funding of science and technology.

2. However, we have been concerned by the lack of a clearly defined objective for Technology Foresight. This is not merely an abstract point. Other countries have demonstrated that in order for an appropriate methodology to be adopted, it is crucial that the goals and objectives of Foresight be clearly specified. Moreover the successful implementation of a number of Foresight recommendations will depend upon a clear objective being specified at the outset. In particular we have been concerned by the apparent ambivalence present in the Foresight exercise between:

- (i) The Government's desire to determine public spending priorities within the Science Budget and to use Foresight as a tool to assist in this process.
- (ii) The use of Foresight as a forum in which the various stakeholders in the science base—Government, industry and academia—could come together and develop a sense of common purpose.

3. In our view insofar as the former objective predominates, industry is unlikely to remain engaged; insofar as the latter objective predominates then Government—and in particular the Treasury—is likely to remain unimpressed by the results. The suspicion remains that in practice the first objective has predominated and that there is a temptation within Government to use the Foresight exercise as a rather crude form of priority setting and as a pretext to reduce the Science Budget.

4. We should argue strongly that the greatest benefits from Foresight will accrue from the clear adoption of the second of the objectives listed above. This in itself will help achieve a number of the objectives set out in the OST White Paper as well as in the recent DTI White Papers on Competitiveness. This, however, implies a long term commitment by Government to the Foresight process and a recognition that Foresight involves a continuing dialogue and is not a one-off event.

5. The CVCP welcomes the endorsement of the Technology Foresight Steering Group's final report of the need to strengthen the basic science base in the UK. It also welcomes the recognition which the report gives to the world-class excellence of much of the scientific activity being undertaken in British universities. The CVCP also welcomes the emphasis placed upon the need to train future generations of scientists to international standards and the ways in which this alone can contribute directly to the competitiveness of UK industry. The CVCP hopes that these recommendations will be implemented as a matter of urgency.

6. Our response to your direct questions are as follows:

(i) *Could we have continued without some exercise such as Foresight?*

7. There is little doubt that elements of the Foresight process were already in place elsewhere, but they tended to be disparate and fragmented. For example, many major industrial companies, the Research Councils, some Government departments, and a number of professional associations and learned societies have from time to time conducted enquiries which might loosely be labelled as "Foresight". However, a number of these have not been in the public domain (as in the case of those undertaken within private companies) or they have not been established in such a way as to encourage direct dialogue between Government, academia and industry. The Research Councils have engaged in a degree of priority setting through the PES process and the former Advisory Board for the Research Councils from time to time undertook an evaluation of this kind—but on a much lower scale. The Government's own Forward Look contains certain elements of Foresight and it remains to be seen how this will relate to the output of the formal Foresight process.

(ii) *Did the CVCP take part in the Technology Foresight process? Are you aware of the extent to which the universities were consulted, either collectively or individually?*

8. The CVCP had no formal role in the Technology Foresight process. However two Vice-Chancellors, Professor Burke and Professor Newby, were members of the Technology Foresight Steering Group. Universities individually were invited to provide input to the OST and, of course, many members of university staff were involved in the process through membership of the Foresight Panels. In general we are content that the involvement of the universities in the process was adequate.

(iii) *Was any part of the process unhelpful or weaker than the others?*

9. The Foresight exercise was conducted under extreme pressures of time and resources. This meant that no Panel could comprehensively survey the field which they were assigned (and which in some cases was vast in its scope). The result was that many Panels were forced to focus on particular aspects of their brief which they thought were the most urgent. As a result many of the Panel reports are not fully comprehensive and the CVCP remains worried that the knowledge-base gathered by the Panels may not, at this stage, provide a sufficiently robust basis on which to inform public spending priorities. Clearly if the Foresight process continues then the number of these weaknesses can be remedied. However, it would be mistaken to believe that the Foresight exercise has produced a comprehensive appraisal of UK science and technology at this stage. It clearly has not.

10. We also remain concerned about the balance in practice between the "technology push" aspects of the Foresight exercise and the "market-led" aspects of it. We note, for example, that three of the Panels cover approximately 78 per cent of the UK GDP. There seems to be a disproportionate effort placed on certain technological areas for which there are very restricted market opportunities compared with others where the market opportunities are very great, but which appear to have been dealt with much more superficially. We note, for example, the inevitably cursory analysis given by the Leisure and Learning Panel to areas which are of particular concern to the universities. We suspect that this is due to the historic unfamiliarity of the OST with major parts of the British economy—particularly the service economy. We also note, however, that the Foresight exercise has proved to be very successful in rendering certain parts of the service economy aware of technological threats and opportunities; whilst it has also allowed the OST to forge links with parts of the service economy which it had traditionally overlooked. We have in mind here, in particular, the financial services sector.

11. We also note that the pressures of time and resources have not allowed the Foresight exercise to consider fully certain cross-cutting issues—for example, the regional dimension, the relevance to SMEs, etc. On the other hand, we conclude that the Foresight exercise has been successful in drawing into its discussions many members of British industry (especially from the R&D side of industry) who have proved to be enthusiastic participants. The next stage is to convince Chief Executives and other parts of "mainstream" management that Foresight is of benefit to them, too.

12. Finally we should note that the Delphi survey was not a success. It positively alienated many recipients from becoming further engaged in the Foresight process. Many panels appear to have paid the results scant, if any, attention.

(iv) *Should the exercise be repeated? If so, when?*

13. If the primary objective of Foresight is to provide a means of dialogue between Government, industry and academia then Foresight should, in one sense, be a continuous process. We would not suggest that Foresight exercise should be repeated every year in its present form, but there does need to be a continuing process whereby the Panels can work on those areas of their remit which they had neither the time, nor resources to devote themselves to fully during the present exercise. A more "full blown" Technology Foresight exercise could, we believe, be instituted every five years or so.

(v) *How should Technology Foresight be implemented?*

14. The answer to this question relates back to the two objectives outlined above. Clearly, already Technology Foresight is being "implemented" through the PES process and the priorities being attached to the Research Councils in their corporate plans. Outside the Government machine, however, implementation is much more difficult. The key to success will rest upon encouraging hundreds if not thousands of individual relationships between academics and members of industry. Much of this can only be carried out at a local level. So the DTI/OST will need to work hard to implement Foresight via its local delivery mechanisms—business links, the TECs, Government regional offices, "one-stop shops", etc., and by ensuring that such organisations are staffed by high quality people with appropriate skills. There will also be a need to involve Regional Offices of Universities, some of which are well positioned to contribute to the development of successful partnerships of the kind envisaged. We would be concerned if Foresight were "implemented" through a crude and simplistic shift of budgetary resources within the Science vote to the very abbreviated list of priorities present in the Foresight Steering Group's final report. We note that all of the Steering Group's list of "generic" and "infrastructure" activities were "priorities" in the absolute sense. We should still ensure that the public funding of science and technology allows the emergent and unforeseen scientific discoveries to be encouraged and developed.

15. We remain anxious about the effectiveness of implementation. It was surely a mistake in retrospect, to dispense with the services of the panels' secretariat, thereby creating a quite needless disfunction between production and implementation—and severing a link between panel chairmen and their trusted lieutenants.

(vi) *What action, if any, is the CVCP taking in considering the Technology Foresight proposals?*

16. The CVCP has been awaiting proposals from the various funding bodies—the Funding Councils, the Research Councils, etc—before deciding on whether a collective response is necessary. As indicated above the most appropriate response will be made by individual universities with regard to their own existing industrial links and areas of excellence and competence. The CVCP continues to maintain a watching brief.

(viii) *What effect do you expect the transfer of the OST to DTI to have on the implementation of the Technology Foresight Initiative?*

17. The precise implications of the transfer of the OST to the DTI remain to be seen. Nevertheless we note that the DTI has the necessary resources and expertise to assist in the implementation of Foresight within British industry—in particular within the boardrooms of British industry and not just in the R&D departments. The DTI has available to it a number of initiatives which could be employed to implement Foresight. It might also allow a coherent approach to be adopted at local and regional levels. We would be very concerned, however, if the move of the OST to the DTI signalled a determination to shift science and technology in the universities towards a more applied and short term emphasis. The Foresight exercise has itself demonstrated the continuing strength of UK science and technology across a wide number of areas. We believe strongly that there is a need to maintain a competence across all areas of modern science and technology and not just depend upon Foresight to "pick winners" in pursuit of wealth creation.

Letter to the Clerk of the Committee from BT (TFC 66) (2 October 1995)

I am pleased to have the opportunity of providing feedback on Technology Foresight to the Science and Technology Committee.

We in BT have had our own Technology Foresight process for over five years. Indeed we believe that a visit made to our laboratories by Sir William Stewart during the formative stages of the OST, and the understanding of our process which he took away with him, were quite influential in the design of the adopted system. Consequently we have considerable interest in the fortunes of Foresight. Also, since the themes of more intensive use in the UK of communications and advance information technologies ran so strongly through the Recommendations of at least nine of the 15 panels, we are most keen that the directions highlighted by the two respective Foresight processes remain at the forefront of OST's strategy.

BT had three people who were sufficiently eminent in their fields to be flagged by the co-nomination process to serve on respective Panels. These were Graham Davies (Materials), Barbara Beckett (Leisure and Learning) and John Thompson (Communications). Also, dozens of our experts in the BT Laboratories and many key

people in our marketing, strategy and legal divisions were consulted through the Delphi questionnaire, so you can be sure that the OST had extensive benefit of BT's expertise, and particularly of our own £271 million per annum R&D expenditure, in determining the most relevant base of UK science and technology. Our reward we hope will come from the strengthened UK base of skills and enhanced market opportunity in these key areas of Communications and IT, which will take us all forward in a unique global opportunity for industrial development.

Perhaps I can respond in turn to the questions in your letter of August 2.

1. WHAT, IF ANYTHING, WILL YOUR COMPANY DO AS RESULT OF THE TECHNOLOGY FORESIGHT INITIATIVE?

As I said, we in BT already had our own Foresight Process. As part of that process, we have considerable links with academia. We spend on average £4 million per annum with universities, covering all types of contracts—from over £1 million over five years, to the much smaller CASE Award. We have a full time Strategic University Research Manager to make best mutual use of this investment, but we are always looking for ways to improve the interface. Recently we have introduced two innovations.

University information days—academics are invited to BT Labs and told of our major research programmes and are invited to suggest novel solutions. We have done this for software applications in front of 42 academics and as a result we have supported 10 awards.

Virtual University Research Initiatives—using personal computer video conferencing techniques, we have linked a number of universities to BT. This provides for efficient management of contracts as well as enabling BT to access a number of departments with complementary skills.

2. HAS YOUR BOARD DISCUSSED FORESIGHT, OR WILL IT DO SO IN THE FUTURE?

In general terms, yes. Improvement in R&D and accessing the latest technology is always high on the agenda. Also of course, Alan Rudge, who is Deputy Group Managing Director and a member of BT's Board—in effect the chief technical officer of the company—was and is a member of the Council of Science and Technology and is now Chairman of the Engineering and Physical Sciences Research Council.

3. WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

The company welcomes the recognition of the importance of R&D to the wealth generation of the country and the move of the OST to the DTI would indicate some movement in that direction. However, because of the importance of R&D to the national economy, we would like to be convinced that Science and Technology has not been downgraded and pushed into a backwater as has been the interpretation of some members of the press.

4. COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

Of course the country could have continued without Foresight, but we would have continued with a technology base lacking focus—at least in part—on those prospects for wealth creation and quality of life which will really be required to safeguard our future.

5. WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

Foresight has been useful to BT, just as our own process has delivered increasing benefit to BT over the past five years. For example, it helped BT shift the whole balance of its R&D away from hardware and towards software at a time when the need for this had not been realised by the rest of the industry. The National Foresight exercise has also helped us through networking with other parties on the programmes with which we have been involved. In particular, we have met with:

Customers via regional workshops.

Suppliers and regulators via panels and seminars.

Competitors for mutual, pre-competitive interest in a healthy UK Science Base.

Industrialists and academics from across many professions.

BT's voice has also been heard on matters of national importance with which we are concerned. Furthermore and significantly, it was reassuring to BT's member of the Communications Panel who remained relatively passive on the subject of regulation in telecommunications on grounds of propriety, to have the rest of the panel

almost unanimously vote the impact of regulation to prime position in terms of impacting the UK's opportunity to exploit its science base. The Panel called for the UK regulatory regime to evolve to enable the UK industry to benefit from convergence.

In particular it is helpful that the Communications Panel Recommendations:

Endorse our concern with over-regulation of OfTel (recommendation 2, paragraph 4.20).

Highlight potential growth in the communications business (recommendations 3, 6 and 7) and call for increased UK awareness and market pull.

Propose an increase in the UK skill via more and better coupled Government funded R&D (recommendations 1 and 5).

Recognise the UK benefits arising from BT's international standards work (recommendation 4).

In addition, it is helpful to see the importance to the UK economy of communications and IT, which has been flagged by our own Foresight process, being underlined directly by the Recommendations of other Panels:

Financial Services for security, multimedia services, IT skillbase and electronic cash.

Defence and Aerospace for improved Communications, Command and Control; simulation, synthetic environments and procurement processes.

Construction for the supply chain, improved business processes, and simulation (e.g., by virtual reality).

Health and Life Sciences for medical information technology, quality of life for the aged and surveillance.

Leisure and Learning for distance learning, growth of the software industry and heritage.

Manufacturing, Production and Business Processes for improved networking and business process.

Retail and Distribution for remote retailing, benefits of a global superhighway and security and

Transport for road traffic information and more liveable urban centres.

6. WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

The Delphi process was an expensive part of the Foresight exercise and took a great deal of effort to devise. It may have succeeded in making the vast majority of the UK's competent advisers and opinion formers who were not selected to join the 300 or so panellists, nevertheless feel that they had been involved in the process. However, the result of the Delphi survey were largely ignored. With more careful analysis—perhaps in the second stage of Foresight, as has already started in the Materials Panel—this goal could perhaps be achieved?

It also has to be said that the Foresight process seemed insensitive to the amount of time and energy given in most cases by very senior and busy representatives of UK industry which was offered free and in the best professional spirit for general UK benefit, but into an atmosphere of shortage of supporting administrative competence and budget.

7. SHOULD THE EXERCISE BE REPEATED? IF SO, WHEN?

The process must be ongoing if real benefits are to be realised. BT's experience over more than five years is that only by a constant iterative process will all the issues be identified and dealt with. Over a longer period of time, it even becomes possible to quantify direct benefits or disbenefits of previous decisions on priority. Corrective measures can then be taken, and the process can become self reinforcing for even greater focus and impact.

BT is certainly willing to play its part in allowing people to take part in the exercise.

Letter to the Clerk of the Committee from the HEFCE (TFC 67) (3 October 1995)

Thank you for your letter of 18 July asking for evidence on my Council's approach to implementation of the technology foresight programme (TFP).

The Council did not make representations to any of the TFP panels nor to the steering group. However, my officers were kept informed by OST of the progress of the exercise.

The DFE's statement on the implementation of TFP published in the Forward Look, to which my Council contributed, was necessarily speculative since this was prepared before we saw the extent and nature of TFP findings. However, my Council considered its approach to TFP implementation last week and confirmed the main thrust of what was said in the Forward Look. Inevitably, implementation will not be quite as straightforward as we had envisaged then, and we will have to put in additional work to translate the TFP findings into implementation within our own methods. Nevertheless the timing for this extra investigation is good as we are just embarking upon reviews of our research funding method and the Research Assessment Exercise (RAE) and will be able to take forward TFP implementation within these.

Overall, my Council was encouraged by the TF steering group's (TFSG) commendation of the strategy adopted by the HEFCE for the support of basic research, seeking to support excellent research, across all subject areas, through selective allocation of funds. It also welcomed the TFSG's conclusion that "foresight results should not be used to direct basic research".

The main actions to be taken by HEFCE are:

- (a) The Council will include within its forthcoming review of its method for funding research a study of the allocation of funds between subjects and the desirability of moving funds to the TFP priorities. It will also explore within the reviews of research funding and the RAE the issues raised in the Steering Group and panel reports on multidisciplinary and interdisciplinary research and collaborations between and within higher education institutions (HEIs).
- (b) On research infrastructure, the Council will consider further the option of providing capital funds to support TFP findings when it makes decisions on capital funding for 1997-98, and will return to the question of specific equipment funding for TFP priorities after it has received the results of a current, joint HEFCE/CVCP review of equipment funding.
- (c) The Council provides funds in relation to collaborations between HE and users of research through GR (generic research), and will investigate how far such collaborations are moving towards the TFP priority areas.
- (d) To encourage HEIs to be aware of TFP findings and to consider their approaches to implementation, the Council will make reference to TFP in guidance on 1996 strategic plans, as in 1995, and the Council will consider in due course whether any further encouragement for the sector is needed.
- (e) A joint HEFCE, CVCP, SCOP review of postgraduate education is currently underway under the chairmanship of Professor Martin Harris, the Vice-Chancellor of Manchester University, and it will be asked specifically to consider the manpower-related recommendations of the TFP reports.

The Council stressed the importance of making public announcement of its commitment to TFP and to the implementation of findings, and therefore your inquiry is most timely to allow me the opportunity to lay out our intentions. Do contact me if there is any further information which we could supply that could assist the inquiry.

Memorandum from the NERC (TFC 68) (4 October 1995)

1. COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

The basic idea behind Foresight is a good one. For a number of years, NERC has carried out its own periodic assessments of future priorities in consultation with its user community, resulting in the publication of its Science Strategy documents. However, the National Foresight programme has been able to engage the wider science and technological community (both users and providers) in a major review of research priorities across the board. Whilst it would therefore be true to say that we could have continued without the National Programme, it has enabled cross-connections between different areas which might have taken longer to establish in the absence of such an exercise. The Technology Foresight programme has been particularly useful in the way that it has given notice of the Government's belief that a more secure connection between the science base and the private sector is necessary to increase the competitiveness of the UK in world markets.

2. WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

Although providing a focus on some key areas of science, the Foresight process was probably more important than its primary product. It would generally be true to say that, within the NERC area, many of the needs of the large public sector users are known relatively well as a result of two decades of interaction and experience with commissioned research. However, the connections with the private sector were generally less well established, resulting in more limited knowledge of their needs. Whilst it is important that researchers are aware of the needs

of the user community, it is also important that the user community should be aware of the capabilities of the science providers. The Foresight process has encouraged the further development of networks involving researchers and users, and facilitated the matching of ideas to needs. The exercise has also provided a significant amount of further material for analysis by NERC, and has helped in raising the profile of science and technology in general.

3. WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

There were some structural weaknesses: cross-cutting issues, such as the Environment, were not handled at all well; the panel which included the Environment (Agriculture, Natural Resources and the Environment—ANRE) had too broad a remit; natural resources were poorly represented in terms of expertise; and marine S&T was only added at a late stage. NERC welcomes the fact that these points are to be addressed with the division of ANRE into two panels: an Agriculture panel; and a Natural Resources and the Environment panel. It also welcomes the creation of a Marine panel.

It is vital that the membership of each panel is properly balanced so that all relevant major areas of expertise are covered. This will help to eliminate bias.

We recognise that a discrete timescale is needed for an exercise of this type, but the generally held view is that the timescale set was too short, particularly for the Delphi exercise and the wider communication phase. A 15-month exercise might have been more appropriate.

Provision of adequate resources and secretarial support for analysis and synthesis of results is essential if the process is not to run the risk of being "data rich and information poor". The support provided for the recent exercise was inadequate, particularly in view of the timescale of the exercise. An indication of this lack of support can be seen in the number of inconsistencies across the panel reports: for example, in some reports the prioritisation process is highly specific (and hence less valuable), whilst in others, it identifies generic issues and needs (which is far more useful).

The Delphi exercise has been heavily criticised both in terms of its operation and the significance of its results. It was carried out at considerable expense, chiefly in terms of the time and effort of the respondents, and it is questionable whether such exercises can produce genuinely innovative ideas.

More attention should have been paid at the outset to planning the process, including scenario-building for 10 or more years ahead against which the panels could have positioned their work. On the whole, much of the output of the Foresight exercise is disappointingly short-term in nature and is little more than an extrapolation of existing trends and priorities. The exercise produced relatively few surprises or genuine long-term foresight priorities (i.e., on a timescale of 10–20 years). There also tended to be an emphasis on technology rather than science vision; science push should be as important as technology pull.

4. SHOULD THE EXERCISE BE REPEATED? IF SO, WHEN?

NERC has received a range of views on this issue. There is a view that resources could be better spent on other ways of bringing users and scientists together, which is seen by many as the most important output of the exercise. Nevertheless, the NERC view is that, having started down this road, there would be merit in repeating the exercise from time to time. The major cost in time and effort to complete the first exercise suggests a timescale in the three to five year range. However, the possibility of annual updates of a more modest kind might also be considered, particularly for those areas where events, markets and technologies are moving ahead rapidly.

It will be important for any repeat exercise to be preceded by a full assessment of the first exercise, building on its strengths and addressing its weaknesses. It will be vital to plan properly in advance of the start and to support any future exercise with adequate resources.

5. HOW HELPFUL HAS THE INITIATIVE BEEN IN HELPING YOU TO DETERMINE YOUR PRIORITIES?

NERC has found the initiative to be useful, particularly as a backdrop to our own Foresight exercises. NERC had already commissioned a strategic survey of the NERC user community and its long-term research needs from the Science Policy Research Unit (University of Sussex), and is in the process of completing more detailed surveys in key science and technology areas. It has also established a Technology Foresight Implementation Group, comprising members of Council and key members of the user community, which used the outputs of the Technology Foresight Panels and our own surveys to take forward the Foresight findings in the specific context of the NERC mission. This has led to the identification of 15 NERC Foresight topics, many of them cross-sectoral and interdisciplinary, with strong potential for cross-Research Council collaboration. A number of these topics will be submitted for funding from the Government's Foresight Challenge Fund.

6. WHAT EFFECT DO YOU EXPECT THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

We would not expect the transfer of OST to DTI to have much effect on the implementation of the Technology Foresight Initiative; indeed, it may add to the legitimacy of the TFI results, by enabling greater industry "ownership". However, there are some concerns against which it will be important to guard: chief amongst these is that quality of life, and in particular those aspects that are difficult to value quantitatively, may be accorded less importance than wealth creation. NERC welcomes the recent announcement of the EQUAL ("Enhancing the Quality of Life") scheme which should go some way towards addressing this concern. Another danger widely perceived within the science community is that the transfer might lead to a concentration on short-term objectives at the expense of longer term strategic science and monitoring.

On the positive side, the position of OST within the DTI can be seen as a significant advance, particularly in addressing the perceived gap between science and industry. However, the benefits of the transfer may take some time to become obvious.

Memorandum from The Scottish Office (TFC 69) (9 October 1995)

INTRODUCTION

1. On the 18 July the Clerk to the Science and Technology Committee wrote to The Scottish Office (SO) posing four questions:

Is there a Minister responsible for ensuring the Technology Foresight Programme is implemented within the Department?

Is there a particular official responsible for ensuring the Technology Foresight Programme is implemented within the Department? If so, at what Grade, and what are his or her other responsibilities?

What mechanisms (e.g., Working Groups) have been put into place to ensure that Technology Foresight is implemented?

What effects has Foresight had on the plans published in the Forward Look?

The Scottish Office

2. The Scottish Office is one of the UK's three territorial Departments. It serves a wide range of Scotland's needs including health, education, industry, the environment, agriculture and fisheries.¹ It regularly works with other Government Departments within a UK-wide policy framework.

3. The Scottish Office aims to create an environment where public and private sectors work together to improve the economic, social and environmental conditions for people living and working in Scotland. It seeks to secure, in co-operation with local authorities and others, effective delivery of responsive public services and optimum value for money for public expenditure. This mission is supported by basic, strategic and applied research, other scientific work and promotion of technology transfer. As such, excellence in science, engineering and technology (SET) is an integral element of most, if not all, of SO policy development and implementation—as well as an important Government policy in its own right as set out in "Realising Our Potential" and "Progress Through Partnership". (More detail is given in Appendix 1 which consists of an extract from the Scottish section of the 1995 Forward Look).

Ministerial Responsibility

4. The Scottish Office Minister responsible for ensuring that the Technology Foresight Programme is implemented in Scotland is Mr Raymond Robertson MP. That said, all Ministers retain some element of responsibility, in proportion to the relevance of SET and TFP to their portfolio of interests.

Official Responsibility

5. The official designated as Action Manager for the Technology Foresight Programme in Scotland is Mr Tom Kelly. He is the Assistant Secretary who heads the Higher Education Division of The Scottish Office Education and Industry Department. He is aided by Professor David Tedford, the Secretary of State's Chief

¹ The Scottish Office was reorganised on 2 October 1995. The new corporate structure consists of five departments: The Scottish Office Agriculture, Environment and Fisheries Department; The Scottish Office Education and Industry Department; The Scottish Office Home Affairs Department; The Scottish Office Development Department; The Scottish Office Department of Health (which in turn consists of two groups, the National Health Service—Management Executive and the Public Health Policy Group).

Scientific Adviser, and supported by a Science and Technology Unit (which is dedicated to the implementation of "Realising Our Potential" and "Progress Through Partnership" recommendations in Scotland) and a network of officials in other Scottish Office departments who have policy or functional interests in science, engineering and technology.

TFP Mechanisms

6. Mr Kelly is a member of the Whitehall Foresight Group which has been set up with a specific remit to encourage a response to the infrastructure priorities in the Steering Group Report. The full terms of reference of the Group are:

"To review the recommendations relevant to Government arising from the Technology Foresight Reports; to identify the further actions required and to co-ordinate and report those actions with an interim report to Ministers at the end of 1995 and an annual report in May 1996".

The Group met for the first time on 12 September.

7. Within The Scottish Office, officials on the SET network will meet periodically to discuss and monitor progress on implementing Technology Foresight in Scotland (as well as other aspects of Government policy for SET). The first such meeting is scheduled for 11 October.

8. In addition, the Scottish Office is pursuing a proposal that there might be a forum for representative bodies with a leading interest in TFP in Scotland. This might involve bodies such as the CBI (Scotland), Scottish Enterprise, The Highlands and Islands Enterprise, The Scottish Higher Education Funding Council, The Royal Society of Edinburgh and others. Its purpose would be to promote partnership and develop an agenda for action on TFP within Scotland. Again, an initial meeting is scheduled for October.

9. More generally, the Scottish Office will seek to build on and add to UK activity by stimulating wider interest, working with, for example, a range of industry bodies and existing networks of functional contacts. The Scottish Office Education Department (as was) issued an Issues Paper on 8 September to more than 100 representatives of Scotland's industrial and academic communities. A copy is attached at Appendix 2. The Scottish Office Education and Industry Department is drawing up plans for dissemination to industry. In conjunction with CBI Scotland it will host a series of seminars in early 1996, focusing on the cross-sectoral opportunities of TFP. In addition, The Scottish Office Agriculture, Environment and Fisheries Department has been in touch with the research organisations which it funds to consider how TFP might best be taken forward in context of grant-in-aid funding of biological science in Scotland.

10. The Scottish Higher Education Funding Council (SHEFC) issued a consultation paper "Addressing Technology Foresight" on 1 August. This will help the Council respond to the Department's request for a report on how its policies and actions will be developed to take account of Foresight.

TFP Impact on Forward Look Plans

11. The 1995 Forward Look was prepared in advance of the publication of the initial findings of TFP. It is the Government's intention to embody TFP in the 1996 Forward Look. The Scottish Office will, over time, as existing research projects come to an end and new initiatives are commissioned, align its spending plans with TFP priorities, while, of course maintaining its support for truly excellent research, whether or not in the Technology Foresight priority areas.

TECHNOLOGY FORESIGHT PROGRAMME (TFP): DISSEMINATION AND IMPLEMENTATION IN SCOTLAND ISSUES

INTRODUCTION

1. This paper seeks your views as to how Technology Foresight might be more effectively disseminated and implemented in Scotland.

2. The issues identified in the following paragraphs fall into two categories. Questions are identified below by highlighting. There are some straightforward, factual questions on which replies—in paragraphs 10-18—are sought by 30 September. There are also substantive, strategic questions—in paragraph 20—which require careful consideration. I would ask you to reply to these by 30 October.

Background

3. The Technology Foresight Programme was initiated by the Government in its White Paper on Science, Engineering and Technology, "Realising Our Potential" (Cm 2250) of May 1993.

4. TFP was not expected to produce detailed predictions or prescriptions about events in markets or technical developments in science and research. The aim was to try to identify the contribution which science, engineering and technology could make to the competitiveness of UK business over the next 10-20 years. This was done by bringing together business people, engineers and scientists to help identify emerging opportunities in markets and technologies. Fifteen expert panels pursued rigorous schedules of consultation, analysis and network-building. Views from over 10,000 people were canvassed in surveys, seminars, workshops, interviews and written submissions.

5. The Government announced on 22 May the findings of the first phase of its Technology Foresight Programme. It published for wider consideration and comment a report "Progress Through Partnership" of the Steering Group of the Technology Foresight Programme, and reports of the 15 individual Sector Panels. A summary of the findings of the Steering Group, and the context of the initial phase of TFP, is given in the attached leaflet. More of the available literature is listed in Appendix 1¹ (identifying where copies can be obtained).

6. The Government will be preparing a progress report on dissemination and implementation of these TFP findings later in the year.

7. The process and the further work on TFP will be continued, and extended as widely as possible, to help ensure that resources are used to best effect in support of wealth creation and improving the quality of life, and inform decisions on spending by Government and industry (including those small and medium sized enterprises which are not able to sustain "Foresight" activities on their own).

Activity across the UK

8. The Office of Science and Technology (OST) and the Sector Panels will lead and undertake dissemination activity at UK and sectoral levels. This national programme will, of course, include Scotland. (For example, the Information Technology, Electronics and Communications Panel has arranged a seminar in Glasgow on 21 September.

9. OST is planning to restructure the Panels (with new separate Panels for Agriculture, and Natural Resources and the Environment and a merged Information Technology, Electronics and Communications Panel). Many researchers and industrialists have already been involved in the initial phase of TFP either in responding to the "Delphi" survey by the Office for Science and Technology, or as members of Panels or the various events which have taken place as part of TFP. It is hoped that scientists, engineers and business people from Scotland will play a fuller part in the continuing work co-ordinated by OST at the UK level and, in particular, the Sector Panels.

10. It would be helpful to have suggestions as to how Scottish interests might be more fully represented in activity at the UK level and, in particular, to have suggestions for possible membership of the TFP Panels. Prospective members may come from either the business or science communities. They should be recognised, established leaders or "young lions" expected to be leaders in the future. They will be committed to TFP.

Foresight Challenge

11. OST will, as announced on 22 May, launch Foresight Challenge in mid-September. This competitive scheme offers industry and academia new financial support of up to £40 million for the best Foresight related research proposals. Initiatives must be collaborative, having committed matching funding from industry. Would you like details of Foresight Challenge to be sent to you when available? It would be helpful to know if you have formed, or are planning to form, any new Challenge networks? Is there any way in which you might wish The Scottish Office to support your network/plans?

Dissemination in Scotland

12. Formally, the lead in disseminating the findings of TFP in Scotland is being taken by the *Science and Technology Unit (STU) of The Scottish Office Education Department (43 Jeffrey Street, Edinburgh EH1 1DN: Telephone 0131-244-5518: Fax 0131-244-5451)*. In practice this will mean ensuring that dissemination activity by OST, the panels and other Scottish Office departments is complementary and integrated.

¹ Not printed.

13. The Scottish Office will seek to build on and add to UK activity by stimulating wider interest, working with, for example, a range of industry bodies and existing networks of functional contacts. For example, an initial seminar of leading interests was arranged by the Royal Society of Edinburgh (RSE) on 28 June. Also, some recipients will be aware that The Scottish Office Agriculture and Fisheries Department has been in touch with the research organisations which it funds to consider how TFP might best be taken forward in context of grant-in-aid funding of biological science in Scotland. Others will have received the Scottish Higher Education Funding Council's paper "Addressing Technology Foresight". The Scottish Office Industry Department is also drawing up plans for dissemination to industry.

Dissemination events

14. We would like to encourage other organisations to consider, either individually or in groups, organising TFP dissemination events. The STU would be happy to help with planning activity, offer summary material or leaflets, and, where possible, arrange presentations to these events. Please let us know of any dissemination events which you expect to arrange, and any related requirements.

Scottish Networks

15. It is expected that there will be a wide range of discussion and further consideration of TFP at the sectoral, regional and local levels in Scotland. *The Scottish Office will be working closely with the Royal Society of Edinburgh, Scottish Enterprise, CBI Scotland and the Scottish Higher Education Funding Council on further events and opportunities to disseminate and develop TFP in Scotland.* It would be helpful, however, to have any suggestions for further events or networks in Scotland to bring TFP to a wider audience.

16. It is particularly important to involve the widest possible range of potential users of research and Foresight findings. It would be helpful to have suggestions for other organisations, individuals or networks which might contribute to further consideration or implementation of TFP in Scotland. *I would be happy for you to copy this paper to any such groups.* Our aim is to extend the reach of TFP rather than to confine it to existing (or obvious) participants, or matters identified in the initial Panel and Steering Group findings. (Appendix 2 contains a list of recipients of this paper).¹

17. The diversity and range of issues identified by the Steering Group and Panel Reports suggests that there may need to be several different kinds of network to deal with different aspects of TFP. It would be helpful to know if you have any plans for networks for continuing or new liaison on TFP.

18. It was suggested at the RSE Seminar that there should be a Forum for representative bodies with a leading interest in TFP in Scotland. We plan to arrange a meeting, or several—which would, we hope, involve bodies such as CBI, SE, HIE, SHEFC and RSE—to develop an agenda for action on TFP within Scotland. If you have any views about other key organisations which should be involved, please let me know. Also, I would welcome comments on whether such a group might be of long-term value if convened in a more formal, semi-permanent manner.

Implementation of TFP in Scotland

19. An important task is to identify themes and priorities of TFP which may be specific to Scotland. This may be because of particular strengths in the Scottish research or industrial base, gaps which ought to be filled in order to take advantage of developing markets and technologies, or facilities or activity which are unlikely to meet tomorrow's demands.

20. It would be helpful to have views on the following questions:

What are the themes or priorities to emerge from TFP which are most relevant to Scotland?

How might these be converted to targets for overall effort and investment in science, engineering and technology in Scotland?

Should there be a single implementation strategy or several complementary strategies for Scotland, linking to those for sectors and the UK as a whole? How might this be achieved?

21. I would be happy to discuss with a representative of your organisation what action you can take and what help we can give in taking TFP further in Scotland.

22. Appendix 3 contains a list of the questions raised above.

¹ Not printed.

APPENDIX 3

SUMMARY OF QUESTIONS

ACTIVITY ACROSS THE UK

Q1. Do you have suggestions as to how Scottish interests might be more fully represented in activity at the UK level and, in particular, suggestions for possible membership of the TFP Panels?

Q2. (a) Would you like details of Foresight Challenge to be sent to you when available?

(b) Have you formed, or are you planning to form, any new Challenge networks?

(c) Is there any way in which you might wish The Scottish Office to support your plans?

DISSEMINATION IN SCOTLAND

Q3. Please let us know of any dissemination events which you expect to arrange, and any related requirements.

Q4. Do you have any suggestions for further events or networks in Scotland to bring TFP to a wider audience?

Q5. Do you have suggestions for other organisations, individuals or networks which might contribute to further consideration or implementation of TFP in Scotland?

Q6. Do you have any plans for networks for continuing liaison on TFP?

Q7. (a) Do you have any views about key organisations which should be involved in a Forum for representative bodies with a leading interest in TFP in Scotland?

(b) Do you have any comments on whether such a group might be of long-term value if convened in a more formal, semi-permanent manner?

IMPLEMENTATION OF TFP IN SCOTLAND

Q8. (a) What are the themes or priorities to emerge from TFP which are most relevant to Scotland?

(b) How might these be converted to targets for overall effort and investment in science, engineering and technology in Scotland?

(c) Should there be a single implementation strategy or several complementary strategies for Scotland, linking to those for sectors and the UK as a whole? How might this be achieved?

Memorandum from the Royal Society of Edinburgh (TFC 70) (9 October 1995)

COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

The answer to this is clearly "yes" but we are much better off because of the Foresight exercise. A good dialogue has been established between the various interested parties (government, universities, research institutes, business and commerce) and while we cannot lead in all technologies it is important that we delineate those which are most appropriate to UK capabilities and interests, and which can enhance our competitiveness and increase value-add in key industrial and commercial sectors. Foresight aims to achieve this.

WAS THE PROCESS OF TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

The process was helpful. Insights gained through interactions with academia and industrialists on a wide range of cross sectoral issues were especially useful.

WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN OTHERS?

The Delphi surveys were cumbersome and the accompanying process didn't appear to reach concise conclusions.

SHOULD THE EXERCISE BE REPEATED? IF SO, WHEN?

Foresight must be an evolutionary process. The coupling of market and technology, which forms the basis of wealth creation, is not predictable and some of the more dynamic technological areas will require re-evaluation on a frequent basis, while others can be re-assessed less often.

HOW SHOULD TECHNOLOGY FORESIGHT BE IMPLEMENTED?

1. Government, with support from individual panels, professional and learned societies, and business and trade associations, should ensure that the conclusions and recommendations of the Foresight exercise are widely disseminated and understood.
2. The Research and Higher Education Funding Councils should take account of the priorities identified by the panels and by the steering group. However, we must also maintain our excellence in basic research and ensure continuity of important R&D in areas which may not have been identified as priorities by TFP.
3. Industry should receive incentives which encourage it to predicate aspects of its R&D programmes on Foresight conclusions and recommendations.
4. The Financial sector should be encouraged to support actively commercialisation opportunities which arise from Foresight and related endeavours.
5. Regional dimensions and priorities, which may be different from national ones, must be taken into account.
6. Independent organisations should be encouraged to foster networks and to support the developments of cross sectoral R&D projects which achieve the strategic and infrastructural goals of TFP.

WHAT ACTIONS, IF ANY, ARE YOU TAKING TO ASSIST YOUR MEMBERS IN CONSIDERING THE TECHNOLOGY FORESIGHT PROPOSAL?

1. The Royal Society of Edinburgh supported a cross sectoral study which examined the Scottish Dimension of Technology Foresight. OST circulated the conclusions of this study to the TFP panels.
2. Following publication of the Foresight reports, the RSE organised and hosted a meeting of industrialists, academics, and government representatives to discuss dissemination and implementation of TFP findings within the Scottish context.
3. The RSE has formed an internal Technology Foresight Working Party to elaborate on the output of (2).
4. A senior executive from IBM has been seconded to the Society to assist in developing the Scottish Dimension of TFP. This activity will build on the collaborations already established with the Scottish Office, OST, industry, research institutes and universities.
5. Fellows of the Society are briefed on the output of these activities.

WHAT EFFECT DO YOU EXPECT OF THE TRANSFER OF THE OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

Difficult to predict, but the dangers are that other government departments which have R&D expenditure will not be as fully involved in Foresight as they might otherwise be, and that the move will be viewed as a downgrading of Science and Technology on the political agenda.

Letter to the Clerk of the Committee from Hunting Engineering Ltd (TFC 71) (9 October 95)

Thank you for your letter of 27 July and the opportunity to comment on the above Government initiative. I welcome the concept of Foresight which pulled together representatives from Government, Industry and Academia and encouraged a wide-ranging debate to identify key Capabilities and Technologies in my own area of Defence and Aerospace. Although the list of important topics which emerged was fairly predictable and contained few surprises, I nevertheless believe the exercise was important from two points of view. Firstly, in bringing together such a disparate group of national experts and trying to reach a consensus on where were the important areas in which the country ought to be investing (both its financial and intellectual resources). Secondly, because the exercise had the very clear objective of focusing on those areas most relevant to Wealth Creation and improving the Nation's export potential. As far as your questions are concerned.

What, if anything, will HEL do as a result of Technology Foresight?

The most immediate impact of Foresight as far as the company is concerned is that it has tended to confirm our own investment priorities which we believe are necessary to preserve our position as a weapon prime contractor, namely the emphasis we continue to give to such topics as *System Integration, Modelling and Life*

Cycle Costs, as a strong base from which to develop marketable weapon systems for home and abroad. We will be looking for opportunities from the links established during Foresight to strengthen our capabilities in the areas where we have a strong technology base, e.g., warheads, communications, composites.

Has the HEL Board discussed Foresight, or will it do so in the future?

The company holds its strategy review annually in the early summer. In view of the response to the previous question I do not intend to bring the topic specially to the Board, but it will be an input to our next strategy review.

What effect do you expect the transfer of OST to DTI to have on the implementation of Foresight?

Although there is an argument that a "stand-alone" Department representing Science and Technology is best placed to concern itself about the continuing quality of the national S&T base through sponsoring innovative research to refresh capabilities, my own view is to welcome the transfer of OST to DTI as increasing the chances of better directing the nation's S&T towards Wealth Creation.

As you will see from the above, I believe the most important question on Foresight is not "How well did we do?" but rather "What next?", which I address below.

As far as the process was concerned, my company was not represented on any of the Working Groups. However, we supported a DRA/DIC Working Party on technology benchmarking which made an input to the Defence and Aerospace Panel and my staff also attended a number of the regional workshops, which we found useful for gaining visibility of what was going on, debating the issues and making contacts. If I had any criticism of the initiative, I suppose it would be that the Delphi process was not very "Delphic", and that the outputs were both general and predictable. If we are to have another round in the future, I suspect it would be worthwhile looking fairly closely at the process—"Did the panels have long enough to develop their thoughts and arguments?". "Was there enough interaction across the panels?". "Did we involve enough young 'free-thinking' scientists and engineers?".

Finally, could we have managed without Foresight?, and "Should we do it again and, if so, when?" On both these questions, I believe it is too early to make a judgment, although I would not have thought we would want to repeat the full exercise much more frequently than the Japanese, i.e., once a decade. I remain unclear what exactly were the planned "deliverables". If one of the aims was to ensure national capabilities remained globally-competitive, then the level of funding in "Foresight Challenge" is disappointing. If the aim was to improve links between Government, Industry and Academia so as to foster wealth creation then we must regard Foresight as an encouraging start, but no more. The question then becomes how will the Government build on what has happened to date? How will it ensure the £2½ billion it spends on *Research* is most effectively directed towards wealth creation? What will be the measures of success in the next phase?

Letter to the Clerk of the Committee from Nuclear Electric plc (TFC 72) (16 October 1995)

Further to our telephone conversation on 11 October please find a response to the Foresight questionnaire below.

Could we have continued without some exercise such as Foresight?

The achievements of Foresight to date should not be exaggerated nor should its importance be underestimated. A process such as Foresight is essential if there is to be any framework for making decisions on research investment. The exploitation phase for research i.e., taking ideas forward to wealth creation, is at least an order of magnitude more expensive than generation of the original idea. Nationally, there needs to be a balance between investment in the initiation and exploitation phases. If too much is invested in basic invention—the British disease—then too often the commercial exploitation is carried out by others. If invention is neglected the developments will not be at the leading edge.

A strategic approach is necessary but this would be recognised by almost every company in the land. Those that invest in research do not do so in an unbounded manner; they select research projects that are consistent with their broad business direction or "vision" for the future and which they believe they have the necessary capabilities to exploit. Foresight is a first attempt to develop a national "vision".

How should recommendations be implemented?

Two points are important:

- (i) A "vision" can only be a guiding framework, it is never prescriptive; and
- (ii) The quality of vision achieved to date is decidedly hazy. This latter point reinforces the former. The way of using such information is as one parameter in assessment of priorities for research proposals and it is therefore relevant to Research Councils or anyone else spending Government money on research.

What do we expect from the Transfer of OST to DTI?

In theory this should be beneficial since it reduces the number of players and should focus activities. In practice pursuit of Foresight requires a champion and it will be important that a champion emerges in DTI. Without this momentum will be lost.

Was Foresight useful to Nuclear Electric?

The truthful answer is that Foresight did not generate any new ideas in the energy field but why would one expect it to do so? As explained above our Corporate planning process is a foresight process over a narrow field. The contribution that the Foresight programme was to place it in a broader national context.

Was any part of the process unhelpful or weaker than others?

Nothing about the process is unhelpful but there are major weaknesses in the exercise because it is the first time it has been attempted. Many participants did not and still do not appreciate the objective. Worse some feel threatened and actively resist. Persistence and time are the only solutions to these "people problems".

Should the exercise be repeated

Yes, the plan should be repeated as it can only be of benefit to industry. Following a Corporate Plan analogy, Foresight should be reviewed annually with changes in perspective, refinements in the process as well as progress in research which should change views.

Letter to the Clerk of the Committee from Powergen plc (TFC 73) (17 October 1995)

PowerGen has participated in the Energy Technology Foresight programme via the Energy Panel through responses to Delphi questionnaires.

Our overall impression is that the Foresight process, whilst valuable in itself, was initiated on too tight a timescale and with insufficient resources. Foresight has indeed identified key areas for research and technical development over the next 10-20 years, and should give welcome impetus to newer technologies, e.g., photovoltaics, where a relatively small financial input can make a considerable difference to technological development. However, the programme bears the hallmarks of having been run on a shoestring—with limited technical and administrative support available to industry representatives from the Office of Science and Technology. Small companies or consultancies are particularly disadvantaged by lack of funding for Panel participants.

We suggest that if government wishes to attract and retain first-rate representatives from industry to the Panels, adequate resources will need to be allocated to the Foresight Programme.

The Foresight process has enabled PowerGen to review energy technologies and has provided valuable contacts in companies involved in technology development.

The Foresight Programme's recommendations should now be implemented via the normal funding channels, i.e., Research Councils, Link and other DTI funding programmes and the Technology Foresight Challenge, which is a welcome new initiative. Monitoring of implementation by the Research Councils and academic institutions should be carried out by the Energy Panel. In addition, a major review of the current Energy Foresight Report could be carried out every four years.

The transfer of the Office of Science and Technology to the DTI should, in principle, lead to improved co-ordination between industry and academia.

Letter and Memorandum from The Royal Academy of Engineering (TFC 74) (19 October 1995)

I am pleased to submit a collation of views from a number of Fellows of The Royal Academy of Engineering in response to the Committee's request. The opinions presented are the personal views of Fellows and, whilst they cannot reflect the views of The Academy as a whole, may be regarded as representative. In producing this composite response, every effort has been made to convey the most frequently expressed views but this has not been at the expense of excluding alternative views.

The Foresight exercise has been carried out by nominated individuals recognised for their achievements and expertise. Hence, The Academy, along with other corporate bodies, has not contributed to the detailed work of

the sector panels although some 28 Fellows have participated as panel members. Nevertheless, The Academy has maintained an active interest in overall policy matters, and by means of meetings with those of our Fellows on sector panels, with all of the panel chairmen and the Chief Scientific Advisor, has sought to highlight those aspects of the implementation phase which we consider important. This overview of Foresight and encouragement of multi-disciplinary activities will continue whereas the more specific and detailed activities are more likely to fall to the individual engineering institutions.

I trust that the Committee finds The Academy's contribution helpful with this important subject. Should the Committee wish to seek further advice from The Academy, either in written or oral form, please do not hesitate to contact me.

Memorandum

The Royal Academy of Engineering is the United Kingdom's independent self-governing body of professional engineers of all disciplines. The Academy's objectives are the pursuit, encouragement and maintenance of excellence in the whole field of engineering in order to promote the advancement of the science, art and practice of engineering for the benefit of the public. By recognising Britain's most distinguished engineers The Academy aims to take advantage of their wealth of engineering knowledge and experience. The interdisciplinary character of The Academy's membership provides a unique breadth of engineering experience with which to further all forms of engineering.

In order to overcome traditional barriers, The Academy promotes a multidisciplinary approach to demonstrate the interdependence of different areas of expertise in the effective use of modern technology and engineering. Emphasis is also placed on the importance of well-informed communication between engineers, Government, research establishments, industry, public services and academia.

This evidence represents a collation of personal views from Fellows of The Royal Academy of Engineering. It cannot reflect the views of all contributing Fellows nor those of The Academy as a whole. It may, however, be regarded as representative.

EXECUTIVE SUMMARY

The Foresight exercise has been received by Fellows of The Academy with much support and some criticism. Whilst recognising that the UK could have continued without such an exercise it is widely accepted that this would have been at the expense of a more inefficient use of the nation's resources. Whether such a single exercise can affect the course of technological development remains to be seen, a minority view is that an exercise based on central planning is doomed to failure.

A positive outcome of the initiative has been the creation of new networks, especially amongst panel members, stimulating interest and helping to focus on real issues. To some this was the most valuable part of the exercise. It has also contributed towards a better understanding of the linkages between the research community and industry.

The speed with which the exercise was completed and the Delphi questionnaire were major points of criticism.

There is support for a continuation of the Foresight exercise but this should follow after a measured assessment of the first programme and its implementation phase. There is also a view that Foresight should be a continuous exercise and not a stop-start regime where expertise is lost between initiatives.

The results of the Foresight exercise need to be promoted imaginatively and consistently by key figures in Government, industry and research management. Government policy must take into account the findings and adapt its policies accordingly.

The extent to which OST is affected by its transfer to the DTI will be a function of the integrity of the "ring fencing" of its budget. Its activities in relation to Foresight implementation could be enhanced if it is able to build on the expertise of the DTI. However, it remains to be seen how the relationship will develop in practice.

The first Technology Foresight programme called extensively on the efforts of volunteers. Their expertise and contribution is not to be dismissed lightly but the initiative is sufficiently important to justify a proper allocation of resources in future. Otherwise, it may be argued that we could simply take the results of nations such as the USA, Japan or Germany.

INTRODUCTION

This reply to the questions set out by the Select Committee is a collation of responses from a number of Fellows of The Royal Academy of Engineering. Views were sought from a broad cross-section, representing industry, academia, retired and non-retired Fellows. Not surprisingly, the subject provoked a very varied response which is reflected in the text which follows.

The Technology Foresight programme has come in for some strong criticism especially with regard to the manner in which it was conducted. The use of voluntary experts has both strengths and weaknesses but it should be recognised that in our competitor countries, particularly the US and Japan, the equivalent activity is supported by far more staff, including senior technical experts seconded from Government. The UK Foresight exercise was done cheaply and although the results are very helpful, the initiative is sufficiently important to justify a proper allocation of resources in the future.

1. COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS FORESIGHT?

The UK could have continued without an exercise such as Foresight but it is likely that a price would have been paid in terms of less effective use of the nation's resources. The Foresight exercise affords the opportunity to form an essential strategic view and focus for national Research and Development effort combining technology push, society pull and the climate for acceptance as a way of obtaining a balanced view. Our major competitors, USA and Japan, have had extensive programmes of this type for many years.

The exercise has provided a valuable focus on Science, Engineering and Technology and with a potential improvement in communication between business and academia. It was the first real attempt to promote consideration of ways in which resources and effort should be applied and/or directed, taking account of quality of life and wealth creation issues. In so doing it has attempted to rectify the situation where research topic selection was becoming discredited and industry becoming remote from the process. The strength of academic support during the formative phase and the quality of the participants on the various panels is an indicator of high anticipated value for the exercise. A major benefit is thought to have been the establishment of networks rather than the immediate conclusions presented in the individual panel reports.

Notes of caution have been sounded in questioning whether such a single exercise can have sufficient impact to have much influence over technology development. Also, Foresight is viewed by a minority as an exercise in central planning, doomed to failure in the way that centrally planned economies invariably fail. The alternative proposal is for an exercise which more closely couples academic research with industry: a micro rather than a macro approach could be much more effective.

2. WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

Fellows who responded positively identified the creation and stimulation of networks, especially amongst panel members (but also in the wider sector committees), as the most valuable part of the exercise. Panel members were able to meet with their peers to review the whole range of technology and science and find out what others in their "community" considered to be important and of potential opportunity. Individuals were able to compare and validate their own company's Foresight processes against the wider exercise, providing them with a broad perspective on their industry. The exercise is believed to have focused on some real issues, striking a good balance between academic and industrial objectives. By addressing those issues not normally considered, the panel discussions stimulated interest and helped to focus on real issues, potential solutions and their practicality, drawing on the views of a large number of this country's experts.

The initiative has contributed towards a better understanding of the linkages between the research community and industry. Through emphasising a number of trends in the research environment, panel members are now able to plan the structure of future research programmes, to strengthen the linkages between science and engineering research and business processes, to exploit the potential of distance learning and to establish centres of excellence spanning several institutions. There is an increased awareness of the need for strategic thinking by those whose role includes the initiation and organisation of research.

The initiative has created a greater awareness across Government, industry and academia on the importance of the role of technology in wealth creation and quality of life. It has been a most comprehensive study linking priorities for research and technology to market requirements and also, the first time for many years that Government has taken a leading role in determining a UK strategy for Science, Engineering and Technology. The results of the exercise may not in themselves be particularly new within expert communities but it has encouraged debate and a focusing of views which will be helpful in determining future strategy. The main achievement, that of stimulating networking amongst and between industry, academia and government must now be consolidated and built upon.

Among Fellows who responded negatively there was a view that the concept of the initiative was helpful but it had generated nothing which was not already obvious and had diluted it with consensual platitudes with some downright misunderstandings. Some organisations found the initiative unhelpful, having already invested sufficient technical effort to know their own future needs and having established focused relationships with universities. Some traditional industries believe that they were inadequately represented and their continuing contribution unrecognised. The balance of membership on at least one panel was thought to be lacking with insufficient representation from manufacturers.

3. WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

Two main areas of criticism identified by Fellows were the speed with which the exercise was completed and the Delphi process. A process such as that undertaken is valuable if properly planned and given enough time. In this case it was too hurried and poorly executed and alienated many of those whose assistance was being sought. Insufficient time was available to think through some of the phases and to learn from the experience being gained. The initial brief was too vague, there were too many parallel activities to be undertaken and the absence of any indication as to how the output was going to be used by Government did not help to focus thoughts and establish questions with some depth. As a consequence of minimal consultation, poor analysis of overlapping and ambiguous questions the results rendered from the Delphi process were superficial at best and useless at worst. Fortunately, in many cases the situation was retrieved by means of successful regional workshops for specialist sectors.

It is accepted that there may be no alternative to extensive questionnaires but those produced were tedious to complete. In some areas, many of the questions were inappropriate and appeared to reflect the pet hobby horses of the panel members. Questions were so diverse that it was difficult for individual respondees to have an expert view on more than a small percentage of them. It came as no surprise therefore that the validity of responses received was reduced and the final results not particularly useful due to a wide dispersion of views and priorities. The quality of the final reports was thought to be highly variable with some panels taking a somewhat narrow definition of their brief and producing a rather selective view of the sector. It has been suggested that greater care should be exercised in selecting panel members, notwithstanding the extensive co-nomination process employed in the first programme.

A view widely held is that the exercise was notably more successful in developing ideas about the future than in encouraging the formation of networks between business and academia. This claim is based on the failure to include those outside the R&D community in the sector panels. It is the marketing directors rather than research directors, who are likely to be more influential in determining business strategy.

Another weakness in the exercise was the mutual misunderstanding by academics and industrialists as to the purpose of the process. Many academics clearly believed that the purpose of Foresight was to persuade industrialists to take up the technology they choose to research. On the other hand, many industrialists believed that the purpose was to direct academic research into those areas relevant to industry's needs. Little attempt appears to have been made to reconcile these opposing views.

4. SHOULD THE EXERCISE BE REPEATED? IF SO, WHEN?

Much support has been expressed by Fellows for repeating the Foresight exercise. Some type of analysis must form part of our technological planning scene and the results of the current exercise must be used to develop policy and strategy and not ignored. As we enter the implementation stage of the first exercise there is a view that priority must be given to achieving some promising signs of progress before contemplating a repeat exercise. Continuation of this first exercise to a future target date, with a full review of measurable results before embarking on a new exercise has also been proposed. The absence of a commitment by Government to repeat the process at regular intervals, of say three to five years, would severely damage the credibility of the whole exercise. Additionally, any future such exercise must be properly resourced and done at an appropriate speed.

An alternative approach to well defined, individual Foresight exercises is to regard Foresight as a continuous process of interactive analysis and implementation. The output must be used to adjust policy priorities and also in decisions such as the termination of those activities showing sustained failure to "pull-through". Sector level analysis and evaluation may be repeated more frequently than an overview of the whole proceed but each should aim to build on a develop the work that has already been done. Resources could also be devoted to encouraging and helping organisations and groups (e.g., trade associations, companies, educational institutions) conduct their own Foresight activities.

A great deal of experience has been gained about the Foresight process by OST and the individual panels but this is in grave danger of being lost as personnel move to other posts. There is an immediate requirement to collate this experience and to publish it as a handbook for others to use as a guide for their own exercises.

5. HOW SHOULD TECHNOLOGY FORESIGHT BE IMPLEMENTED?

There is no simple answer to this question. The main outcomes must be readily accessible to key figures, i.e., those in positions of influence in industry, in research management and in professional activities. As in most things, the "people factor" will be critical in any implementation process and thus the choice of individuals to devise or become part of any implementation plans will be central to success.

Response from Fellows can be classified broadly under headings requiring action by Government, Research Councils or Industry/Academia.

Government

As a result of the initiative, Government now has a wealth of data from sources which it has failed to tap in the past. It must use the results to guide its policy towards research funding, its general policies in support of industry-led developments and also as input to more general policy decisions in the difference sectors; for example, understanding that if it sets new targets in say, environmental matters, that industry will be able to respond with new technology. Since Foresight is a Government initiative, it must take the lead in implementation through new action, especially in conjunction with industry and not simply through the reshuffling of existing funds.

Research Councils

In the current exercise, this was left too open-ended with the major (only) identified implementation being the use of the Foresight recommendations to prioritise and direct funding to the Research Councils. At the same time, the Research Councils were being totally re-structured and were busy identifying their mission statements, corporate plans, priority themes and methods of selecting projects for funding before the Foresight recommendations were made. The reformed Councils must be given time to stabilise and to strengthen their links within DTI.

It must not be forgotten that Foresight is about long-term developments, over the next 25 years. Instant changes of direction in research are not appropriate. Whilst it is tempting to implement more concrete proposals and to forget about the more abstract, longer-term but equally important ideas, this must be resisted. The panels need to evaluate the actions taken and warn against short-termism.

With the Research Councils organised properly, implementation in the universities will become straightforward since they will be responsive to changes in the direction of funding. The biggest issues are:

- Ensuring technology pull-through into existing industries.
- Generation of new industries to provide the nation's wealth tomorrow.

The details of how to ensure this should be the focus for the next two or three years. It is a complex problem involving the financial community, major technically-based companies and venture capitalists. It also requires university faculties to be educated in and encouraged to form new business start-ups.

Industry/Academia

The mechanisms by which Industry's needs can be better matched to Academic capabilities are well known. Individual projects should be implemented through partnerships between individuals, companies and academic institutions who have a mutual interest in a particular subject.

The Royal Academy of Engineering Personal Chairs and Senior Research Fellowships are good examples as is the LINK programme or the joint Rolls-Royce EPSRC Research Programme. All of these indicate clearly that the way ahead lies through jointly funded programmes in which industry chooses the projects. The initiative should come from one of these partners who should promote the concept. This process would be analogous to establishing a company—a prospectus would be prepared and an application for "ownership" of a particular topic would be made to the OST.

The involvement of Small and Medium sized enterprises (SMEs) in the Foresight process has been and remains an extremely difficult area. Nevertheless, in the achievement of results the OSTs new access to DTI expertise in this field should prove to be an asset.

6. WHAT EFFECT DO YOU EXPECT THE TRANSFER OF OST TO DTI TO HAVE ON THE IMPLEMENTATION OF TECHNOLOGY FORESIGHT?

The extent to which OST is affected by its transfer to the DTI is dependent on whether it retains its independence and the "ring-fencing" of its budget or whether it becomes fully subsumed into the DTI. It has also been pointed out that the DTI is not the parent ministry for all the sectors covered by the Foresight programme. Also, it could be argued, Science, Engineering and Technology are so central to the future prospects of the country that the only logical location for the Foresight work is in the Prime Minister's Office.

On the positive side, Fellows identify the following benefits flowing from the transfer of OST to DTI:

- It affords an opportunity to bring a more commercial approach to R&D. Although not necessarily welcomed by Academia, DTI should use its position to improve communications between the Government, Research Councils, Universities and Industry, using Technology Foresight as the vehicle.

- DTI has much of the funds and the infrastructure across the country to support implementation, although it will have to take a broader view of science than simply as it relates to industry.
- DTI will improve the implementation procedure and will instil the necessary sense of realism when it comes to dealing with Industry.
- It will be beneficial if it encourages the DTI to take an active part in longer-term aspects of R&D strategy beneficial to the UK economy. OST must also encourage and not inhibit the Research Councils in taking the Science Base forward rather than forcing it into short-term expediency.
- It will help to reduce the difficulties which sometimes occur when dealing with the two departments on related issues.
- It may strengthen LINK-type initiatives, which would be a positive step.

The major concerns as to the detrimental effects of the transfer of OST to DTI are:

- The status of OST is diminished. Its extraordinary nature and priority are no longer credible and it is now just another subsidiary element of the DTI. Departments which previously were supportive of science and technology may be less positive now that it is linked to the DTI with significant consequences for Foresight activities which cover a very wide range of departments. From experience, major Government departments resent direction or control by other departments thus the transfer of OST may severely limit its effect on many aspects of public life.
- The implementation of the Foresight initiative might simply duplicate current DTI initiatives and style. It is very important for technology to have different types of support available which reflect the various phases of development from pure science to applications. Opportunities to take the Foresight recommendations forward may be severely restricted as a result of the transfer.
- There is potential for a much more short-term and pragmatic solution to research needs, to the detriment of longer-term research and the future of UK R&D.
- The potential for abandonment of the Foresight recommendations in favour of short-term priorities.
- Previous experience of DTI initiatives does not support the view that the transfer will make the whole exercise more relevant to industry.
- The level of understanding and support for research in the DTI. Industrial research heads should be employed to ensure that this does not become a problem.

Memorandum from Glaxo Wellcome plc (TFC 75) (24 October 1995)

Glaxo Wellcome is a pharmaceutical company which is to a large degree dependant upon its ability to harness developments in those fields of science and technology which are relevant to the discovery, development and the manufacture of new medicines which are efficacious, safe and offer real advance in the treatment of serious or common human diseases. We regard the maintenance and development of a strong, and well informed, public sector science base, capable of reacting to the needs of industry and commerce and willing to work in partnership with industrial scientists, technologists and engineers, as of great importance to the economic and social well-being of the United Kingdom. We thus welcomed the establishment of the Technology Foresight Programme (TFP) and have encouraged the active participation of the Company's staff in the process. We believe however that the real success of the Programme will lie in the degree to which the findings of the Panels are assimilated and acted upon by both large and small companies, academia and Government departments.

1. WHAT, IF ANYTHING, WILL YOUR COMPANY DO AS A RESULT OF THE TECHNOLOGY FORESIGHT INITIATIVE?

Technology Foresight has long been a part of the research and development culture of our industry which of necessity must work with long time horizons. Many of the recommendations contained in the reports of the "Health and Life Sciences" Panel, and to a lesser extent "Chemicals" Panel, which are most relevant to us, are what we would have expected and we are already active in some of the areas identified for action. We would endorse the need for concerted and focused research in the fields of neurodegenerative diseases and the diseases, disorder and other problems of ageing. We also regard identification of gene products and definition of their function as of great importance. These fields are ones in which progress can only be made through collaborative research and Glaxo Wellcome is actively developing research programmes in these areas involving colleagues in academia. The reports from panels which are not central to our R&D interest are also being studied within different parts of the Company.

Both Glaxo and Wellcome have had long traditions of collaboration with research groups in both UK and overseas universities. The new company will continue to develop our existing collaborations and create new initiatives which will bring academic and industrial science and technology together in partnership. Currently

Glaxo Wellcome spends about £10 million each year on collaborative research projects with academic groups and Postgraduate studentships. This sum is in addition to the very significant funds—over £12 million per annum—we have committed to our major collaborative initiatives such as “*action TB*”, the Glaxo Institute for Applied Pharmacology and the Edward Jenner Institute for Vaccines Research.

The reports from panels which are not central to our R&D interests will also be studied within different parts of the Company.

2. HAS YOUR BOARD DISCUSSED FORESIGHT, OR WILL IT DO SO IN THE FUTURE?

It is not considered necessary to discuss Foresight at the level of Glaxo Wellcome's Board. The reason for this is that the reports from the “Health and Life Sciences” and the “Chemicals” Panels—are already well known to those groups in the Company who are best placed to take the findings of the panels into our own activities. The outcomes of the TFP are also being drawn to the attention of managers in areas of the Group outside the Research and Development company. We believe that this is the most effective way of achieving understanding of the results of the Programme and their incorporation into our activities where relevant. As active members of CEST we are also using the organisation's initiative to assist in this process.

3. WHAT EFFECT DO YOU EXPECT THE TRANSFER OF OST TO DTI TO HAVE ON THE IMPLEMENTATION OF THE TECHNOLOGY FORESIGHT INITIATIVE?

One of the potential benefits of the transfer of OST, who have initiated and managed the TFP, into the DTI is that it should now be well placed to take the outcomes of the Programme into UK companies. For the realisation of the Programme's full potential the new developments in science and technology, the opportunities they afford and the needs identified by the TFP panels must be appreciated by industry and commerce. They must therefore become incorporated into the strategic planning of UK companies so that full advantage may be taken to use new scientific knowledge and technological advances for the economic good of the nation. The Small and Medium-size Enterprise (SME) business sector is the one in which there are probably the greatest gains to be achieved through the harnessing of Science and Technology. This sector is, however, generally less well able, and often also inadequately resourced, to understand and utilise the potential of science and technology for their activities compared with the larger corporations. However, in some industrial and commercial sectors even the large companies have little or no scientific or technological capability. The DTI's experience of industry and commerce should add value to the efforts of OST and should be brought to bear on the dissemination and implementation of the output of the TFP. The Department has the organisational structures which OST does not have, such as its Industry sector Units, the Innovation Unit and the national network of “Business Links” (“One stop shops”), which should foster these processes. The OST does however have control over the Research Councils, which themselves have now been reorganised to give greater emphasis to the needs of industry. They also have direct access through their programme and project funding mechanisms to the academic research community in the universities and other public sector research Institutions and can influence these. Thus, together these two government Departments should be able to achieve a valuable degree of synergy in the next stage of the TFP by bringing about implementation of strategies within an environment in which both academic and industrial scientists may be engaged as partners in science and technology for mutual benefit and ultimately the good of the Nation.

4. COULD WE HAVE CONTINUED WITHOUT SOME EXERCISE SUCH AS THE TFP?

As mentioned above the pharmaceutical industry is one that must of necessity take a long-term view and so Technology Foresight has for some years been an integral part of its R&D activities. As far as this Company is concerned awareness of developments in relevant fields of science and technology is a feature of our strategic planning with respect to the research and development activities in our laboratories and in the projects and programmes we develop which involve collaborations with academia. We would therefore have been able to continue had the TFP not been carried out. We can provide two examples of some of the initiatives that we have developed with both academia and the Government before the TFP was established but which reflect our own technology foresight capability.

Our major international research programme “*action TB*”—involves Glaxo Wellcome scientists and colleagues in Universities in the UK, South Africa and Canada. It arose out of:

- Our perceived need for novel medicines for use against the TB organism which is developing resistance to existing antibiotics.
- The need for a new effective vaccine for control and prevention of the disease in communities; and
- The new opportunities now available through advances in molecular biology, immunology and genomics which make the meeting of these needs a real possibility.

The Edward Jenner Institute for Vaccines Research, recently established at Compton, Berks, is a new initiative which involves a partnership between Glaxo Wellcome, the Department of Health and two Research Councils (MRC and BBSRC) and which will ultimately also involve support for academic research groups through collaborative projects. This Institute arose out of the need to develop novel vaccine approaches to the control or treatment of infectious or malignant diseases and we, and our partners, believe that this can now be achieved through the focused harnessing of developments in the fields of cell and molecular biology, immunology and biotechnology.

One of the main benefits of the TFP must be the focus that it should bring to the funding of research in the public sector and in Government Departments. The Programme has highlighted some major areas of opportunity for exploitation of advances in science and technology for the UK. However the number of such opportunities almost certainly exceeds our funding abilities and so there must now be further effort to prioritise and then direct funding.

5. WAS THE PROCESS OF THE TECHNOLOGY FORESIGHT INITIATIVE HELPFUL TO YOU? IF SO, IN WHAT WAYS?

An important element of the TFP process was the degree of networking that was created through the various TF workshops, forums and seminars. These did have the effect of bringing together individuals from various industrial sectors and scientific disciplines who would not otherwise have come into contact. This was found to be valuable to those members of Glaxo Wellcome's staff who attended these functions. Although they had the effect of the broadening vistas, how far these networks will translate into real benefit in terms of results and outcomes remains to be seen.

6. WAS ANY PART OF THE PROCESS UNHELPFUL OR WEAKER THAN THE OTHERS?

The weakest part of the TFP was undoubtedly the Delphi process. Those members of our staff who received Delphi Questionnaires, either from the "Chemicals" or the "Health and Life Sciences" panels found them to be tedious and time consuming. Many of the questions on the forms did not address issues that could be regarded by us of importance. Some of our colleagues in the commercial areas of the company found the questions to be too technical and difficult to answer as well as being irrelevant to their business interests. There was no feed back on the second Delphi round concerning the additional issues that were raised by the recipients of the forms and thus effort put into providing these comments seem to have been wasted. It appears that the Delphi process has served very little use in the overall TFP process.

In retrospect it is becoming apparent that the Panel deliberations were confined too strictly to the matters of direct concern to the particular panel interests. There seems, with a few exceptions, to have been little cross panel discussion although there are clearly cross-panel issues that arise out of the TFP. It is to be hoped that as the TFP is taken further, this deficiency will be remedied.

7. SHOULD THE EXERCISE BE REPEATED? IF SO, WHEN?

Clearly before this question can be answered we need to see what the present TFP delivers in terms of results.

A key function of the process should be the encouragement of closer involvement of UK companies with science and technology and the development of new opportunities to harness new developments across a wide range of businesses, some of which at present have little or no tradition in this field. The Programme should draw out the opportunities for enhancing existing industrial and commercial processes and activities and also to point to opportunities for creating new businesses to meet emerging needs. Part of this process will involve the creation of new collaborations and partnerships between the companies and the public sector science base to mutual advantage. However there is an emerging tendency to see the implementation of the TFP in terms of creating new schemes to obtain research funding for academia from industry and commerce. Obviously this will be one outcome from the TFP but it should not become seen as the driver for implementation. Those companies that will most benefit from the TFP are likely to be in the SME sector, and they are unlikely to be able to afford the "entrance fee" for schemes such as the Foresight Challenge and so may be excluded.

The first TFP is still ongoing and the Panels are continuing to meet in their original or, in some cases, revised form. This we believe to be the correct way of progressing the process. It has the capacity to continue the networking and dialogue begun during the first phase of TFP: it also allows the Panels to be involved in the implementation of the outputs from their reports and to monitor progress. The experience they gain in this process should be of value in any future Programme. Before deciding when the next TFP should take place the value and effectiveness of the process must be established. We must be able to identify what it can deliver by way of tangible benefits and so be in a position to design a programme to provide the required outputs. If there are little or no tangible benefits of the process in the eyes of the stake holders, then it is unlikely they will be

prepared to invest time and resources in another TFP. Thus we need to know how effective the current Programme has been before planning the next: a process likely to take at least 3-5 years.

**Letter to the Clerk of the Committee from Rhône-Poulenc Chemicals Ltd (TFC 76)
(1 November 1995)**

I have recently come across a letter you sent earlier this year to my predecessor, Dr Humphreys, which asked for comments on the Technology Foresight initiative. Although quite some time has gone by since your enquiry I would nevertheless like to put our views on record.

Rhône-Poulenc welcomes the opportunity to comment on Technology Foresight which we consider has been a timely and valuable means of focusing attention on those sciences and technologies which are important to the profitability of the Chemical Industry. It has also helped to raise the national profile of science and the need to create a climate where innovation can flourish.

Company action as a result of Foresight

The findings of Foresight as applied to the Chemicals Industry have been presented to the board of *Rhône-Poulenc Chemicals Ltd* and a presentation of Foresight was included in a recent internal conference attended by our research scientists.

Foresight will be discussed within the Company on a continuing basis including reference to how the findings are relevant to our own technical priorities. We will participate in appropriate collaborative research programmes with the universities which emerge from the implementation of Foresight.

Transfer of OST to DTI

We believe that transfer of OST to the DTI is a positive move since it will bring together Government Departments with responsibilities for the science base and industrial competitiveness and thus help to facilitate the implementation of Foresight.

However, we are concerned that this merger should not lead to a shift of university research towards near market projects since we consider that the role of the universities is to undertake basic fundamental science on which the applied research in industry can be built.

We feel strongly that the outcome of the implementation of Foresight should be to ensure that the universities are given the financial support they need to carry out research of key importance to industry to the highest international standards.

In this connection we would like to recommend that more industrial scientists are given the opportunity to contribute to the setting up of scientific programmes by the Research Councils, both strategically and through the peer review system.

We would also like to suggest that the move of OST to DTI would provide an opportunity to simplify the LINK scheme. This very useful scheme, which has done much to support research at the interface between industry and academia, is to some extent hampered by complex administrative and budget arrangements resulting from the fact that the scheme is shared between the DTI and the Research Councils. If the process could be simplified to provide a single application form for projects together with a single annual payment by industrial participants its value to industry would be much enhanced.

Could we have continued without an exercise such as Foresight?

The Foresight process was urgently needed since failure to recognise adequately support and develop key areas of science and technology would undoubtedly have placed UK industry at a very serious competitive disadvantage. This can only be done effectively as a national exercise with full co-operation between government, industry and academia.

Was Technology Foresight helpful to us?

The process has been helpful in focusing attention to the areas of science and technology which are important to the success of our Company. However, the true value will only be realised as Foresight plans are implemented.

Weaker aspects of Foresight

We consider that the rather hurried way in which the Foresight process was carried out, although producing rapid results, may have led to the omission of significant finding that might have emerged had a longer period of consideration been given.

We also have some reservation about the Delphi procedure. Although this produced some interesting and challenging ideas for scientific advances leading to new products in the future, it inevitably involved a considerable amount of guesswork, for example, in the timespans required for realisation of the results, and these findings must be interpreted with some caution. A continuing review and update of these results as Foresight develops will undoubtedly enhance their value.

Should the exercise be repeated?

We would suggest that there should be provision for introduction of new ideas and material as Foresight develops and a repeat of the full scale exercise at five yearly intervals.

Memorandum from PREST (Policy Research in Engineering Science and Technology), University of Manchester (TFC 77) (31 October 1995)

1. PREST would like to submit some comments on the Technology Foresight Programme (TFP). As a centre of expertise in the study of foresight in the United Kingdom and abroad and as one of the principal contractors engaged in supporting the Programme, our comments largely concern the *methodology* used in the UK Programme.

2. We would wish, though, to state our *general support for the TFP*, and in particular the beneficial effects it is likely to have in bringing together the science base and industry to develop a common view of the future, to form networks for future action and to stimulate the development of a Foresight culture in the UK. *With industry increasingly dependent upon external sources of knowledge (both from academic sources and from other firms), it is essential that the strategies of UK firms are informed about the expectations and likely actions of their future collaborators.* Firms can and should develop their competitive advantage by carrying out their own specific Foresight activities but a national programme such as the TFP provides them with a reference frame within which to situate themselves.

3. *PREST's involvement in the TFP* began with a feasibility study prior to the White Paper, "Realising Our Potential", and continued through the Programme with support for:—

- The initial consultation activity (the Focus on Foresight seminars).
- The co-nomination process used to generate names of participants.
- Design of a methodology for setting priorities.
- Conducting briefing/training seminars for Panel Members.
- Conducting an initial consultative survey designed to generate issues for the panels to consider; and
- Executing the Delphi survey.

However, since the other activities are generally uncontroversial and are deemed by most to have worked well, we will focus our comments on the Delphi process.

4. *The Delphi method*, originally developed by the RAND Corporation in the USA, is well established in technology foresight and other future-oriented studies. In essence, it involves asking a group of experts to respond to questions on a series of statements or about the future (for example, asking when the topic of the statement is likely to occur, how important it is, etc.). In one or more subsequent rounds, the experts are given the aggregate results and invited to modify their views in the light of other experts' views.

5. *In international terms*, Delphi is now the most widely used instrument in Technology Foresight. Since 1971 the Japanese Government's Science and Technology Agency has carried out five such exercises, most recently in 1991, and is currently preparing a new round. This work underpins an extensive network of more specific foresight activities in Japanese firms and agencies. A survey of participating firms showed that they found the exercise "very important and useful" as an input to planning for R&D and business projects.

6. *European use of Delphi* in national foresight began in 1991 when the German Ministry for Research and Technology commissioned a study which used a translation of the Japanese survey in Germany. The aim was to compare the views of German and Japanese experts. *Despite vociferous complaints from the German scientific community at the time, the survey has become a best seller and is widely used by German firms* (many of whom have commissioned their own more specific follow-ups, for example in pharmaceuticals). Most recently, France has also replicated the Japanese survey.

7. *The decision to use Delphi in the UK Programme* was influenced by its success elsewhere and by support for the approach from the UK pilot study and the consultative seminars held around the country during the Pre-Foresight phase. However, it was never intended that the use in the UK would entail a further iteration of

the Japanese questions. These were considered to reflect the agenda of Japanese industry and scientists and would not necessarily correspond to the aims of the UK Programme.

8. *The objectives of the UK application of Delphi were threefold:*

- To access the business and S&T communities' views on future developments in markets and technologies.
- To assist in achievement of commitment and consensus on developments; and
- To inform the wider business and S&T communities about the major issues being addressed in the TFP and how their peers assess those issues.

These three objectives emphasised the interactive approach. As well as the most obvious function of gathering opinions for the panels, the Delphi survey also aimed to involve large numbers of experts who would otherwise be excluded, and hence to widen significantly the constituency of participants feeling ownership of the results and a consequent commitment to their implementation. The third objective relates to dissemination. Receipt of the questions gives the respondents early feedback on the topics deemed to be of interest by their peers on the panels. The second round form extends this feedback by providing early access to the views of all respondents on these topics. Experts are able to benchmark and re-appraise their own views. For example, a firm may learn that most respondents expect a particular technology to be available five years earlier than it had thought. It may well then wish to revise its plans.

9. *The survey produced 2,960 responses*, about the same number as in Japan and with the same response rate (31 per cent) as the German and French exercises. An average of 65 experts (defined as being at least familiar with the topic) replied to each statement. In a very few cases the response dropped to nine experts for a topic (still substantially more experts than were likely to be on the Panel). Thus it is clear that very much larger numbers of people were consulted through the Delphi than was possible by any form of direct contact.

10. *The UK Delphi differed from international practice in that the Panels were given a high degree of control over the process.* Thus statements were all formulated by the Panels and they could and did reject technical advice about the suitability of some topics for this format. The Panels also insisted upon including the maximum number of statements (typically 80 as opposed to the recommended 50) and upon increasing the number of variables (the questions asked about each statement). Panel secretaries also specified the format in which they wished to receive the results (which included all the analyses performed by the Japanese). This degree of involvement undoubtedly produced Delphi questionnaires which were less user-friendly (although the layout design was far superior to international practice). However, *these disadvantages were outweighed by the key advantage that these were not questions formulated as part of an academic exercise but rather they related directly to the Panel's concerns and priorities.*

11. *The greatest problem was the extremely compressed timescale.* The desire to deliver results from the TFP in time for the 1995 public expenditure round had advantages in terms of momentum and maintenance of interest and commitment. However, it placed all participants under great pressure, giving the Panels a short time in which to draft their questions, and imposing upon our team a timetable far more stringent than that of the overseas programmes. Nonetheless, all target dates were met. This was not sufficient as the overall schedule meant that the results were delivered when the Panels were at an advanced stage of drafting their reports.

12. *All of the reports relied to some extent upon the Delphi findings.* Contrary to public statements by a few Panellists who were not involved in the report-drafting process, inspection of the reports (and independent confirmation by Panel secretaries) shows that the Delphi was used in their production. Its main function was to give confidence and endorsement to conclusions reached internally—a principal objective of this application of Delphi. Two key topics in the Steering Group report, benchmarking the UK's position and the relative significance of various constraints upon development, were directly supported by evidence from the survey, and it is also cited as an input to the prioritisation process. Many Panellists cited the process of producing Delphi statements as providing a useful focus for their Panel's activities.

13. *Criticism of the Delphi falls into three categories:*

- First, those who simply did not like filling in time-consuming forms. This was a high demand on busy people but the complex issues involved in a wide ranging national exercise were bound to demand time from those consulted by whatever means.
- Second, those who did not like or understand the choice of statements. In part this criticism could have been allayed by the Panels providing a background document which explained why these topics had been selected for consultation. However, it is also true that it was only in the Delphi that highly specific topics were addressed in the TFP. It is easy to agree on broad trends but much more difficult to do so on matters of detail. In any event, there was a space by each statement for comments and all of these were fed back to the Panels.
- Third, those who do not believe that useful answers can be obtained from a structured format at all. This group give credence only to views of Panel members or to the small number of people whose views they solicited directly, often those with whom they were already networked. (Some of this group also believed, quite mistakenly, that the Delphi should have had applied to it complex

statistical methods, despite over twenty years of Japanese experience and the technical incorrectness of this view). The views of the existing network are of course valid and useful, but it is get away from the practice of small elite groups suggesting priorities without wide consultation that systematic approaches to technology foresight were developed. Delphi is not a substitute for hard thinking by Panels but a rigorous aid to stimulate such thinking.

14. *In conclusion*, we believe that many lessons can be derived from this first application of the Delphi approach in a UK TFP. Those of a technical nature are already documented. The broader lesson is that, despite the achievements in this cycle, future applications must be simpler, substantially more time must be allowed, and greater interaction between the Panels and those operating the Delphi must be designed into the process. Despite the difficulties described above, we contend that the Delphi was fundamental to the success to date of the TFP. Publication of full results and analysis in November 1995, together with the data in an electronic format, will provide a resource which will support and stimulate the continued development of the Foresight culture in the UK.

Letter to the Clerk of the Committee from the Natural Farmer's Union (TFD 78) (22 November 1995)

As you are aware, the membership of the Technology Foresight Steering Group has been amended recently. The NFU considers that the role of the Steering Group should be to provide a balance between all sectors of British industry and was therefore alarmed to discover that two biologists have been removed from the panel and there is no intention at this stage that they should be replaced. The contribution of biological sciences to the agricultural industry and to the British economy is substantial and is likely to become increasingly more important in the next century. We are very concerned that this important area is not going to be given the representative voice on the committee that it clearly deserves.

We have raised our concerns with Professor May, Head of the Office of Science and Technology. In his reply, he sought to reassure us by telling us that the Steering Group members do "represent quite a diverse body of opinion both within academic and industrial communities" and that he does not anticipate that the areas of agriculture and biological sciences should suffer as a consequence of their lack of representation. In spite of this reassurance, our concerns remain.

Please do not hesitate to contact me if you require any further information.

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