House of Commons

Committee of Public Accounts

Big Science: Public investment in large scientific facilities

Sixtieth Report of Session 2006–07

Report, together with formal minutes, oral and written evidence

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The Committee of Public Accounts

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Powers of the Committee of Public Accounts are set out in House of Commons Standing Orders, principally in SO No 148. These are available on the Internet via www.parliament.uk.

Publication

The Reports and evidence of the Committee are published by The Stationery Office by Order of the House. All publications of the Committee (including press notices) are on the Internet at http://www.parliament.uk/pac. A list of Reports of the Committee in the present Session is at the back of this volume.

Committee staff

The current staff of the Committee is Mark Etherton (Clerk), Philip Jones (Committee Assistant), Emma Sawyer (Committee Assistant), Pam Morris (Secretary) and Alex Paterson (Media Officer).

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Summary

Since 2000, the Department of Trade and Industry (the Department) and the Research Councils have allocated over £860 million to constructing 10 new large scientific facilities and have earmarked £270 million for five more projects. These facilities range from the construction of a new Antarctic Research Station (budget £26.2 million) for monitoring climate, ozone and space weather, to the erection of a new Diamond Synchrotron (£383.2 million), which will produce intense X-rays and shorter wavelength emissions for examining structures at molecular and atomic level.

The first two projects, the Diamond Synchrotron (Phase I) and the Royal Research Ship James Cook, were operational by Spring 2007. Performance against the approved capital budgets has been mixed with, for example, the first two projects being delivered broadly to time and budget but with some of the other projects forecast to exceed their initial budgets. In addition, project teams have significantly underestimated the likely costs of operating the new facilities once they are up and running.

Research Councils have encountered difficulty in recruiting people with the necessary project management expertise to manage projects. The Research Councils need to improve the way they share lessons learned and project management.

Every two years the Research Councils publish a road map of facilities which they consider UK scientists may need and, with the Department, select which projects should receive funding. The road map approach adopted in the UK has been commended in evaluative reviews by the United States National Science Foundation as well as reviews commissioned by the Australian and Canadian governments. But the wider scientific and industrial communities do not have an opportunity to scrutinise, challenge or contribute to the prioritisation before the earmarking of funds.

The value of large facilities, in terms of expanding the scientific knowledge and economic benefits generated for the United Kingdom, will depend on selecting the best bids from research teams wishing to use the facilities, and on the effective exploitation of that knowledge by public policy makers and industry. Project teams have identified potential success factors for their facilities but, in most instances, these have not been specified in a way that would readily facilitate measurement.

If the UK is to maximise the value of these facilities it needs to attract more young people into science to make good use of the research capacity now being built and exploit the results.

On the basis of a Report by the Comptroller and Auditor General,[1] the Committee examined how large scientific facilities are delivered and the how their value is assessed. The Committee took evidence from the Department of Trade and Industry and the Science and Technology Facilities Council. Since the hearing, the Government has transferred responsibility for these activities to the new Department of Innovation, Universities and Skills. Our conclusions and recommendations are therefore directed to the new Department.

1 C&AG's Report, *Big Science: Public investment in large scientific facilities*, HC (2006–07) 153

Conclusions and recommendations

1. **The first two projects, the Royal Research Ship James Cook and the Diamond Synchrotron (Phase 1), have been delivered largely to time and budget but other projects still at an early stage are forecasting slippage.** The Department, working with the Research Councils, should require project teams to study and apply the lessons learned from existing projects, for example by using incentives in contracts, and effective risk sharing. Project teams should be required, through the Gateway process, to consider explicitly these issues when taking forward new projects.

2. **Five of the six most mature projects have forecast significant increases in the initial estimates for operating costs, two in excess of 80%.** Research Councils should draw upon wider experience in the private and public sectors, for example in the Ministry of Defence, and require the preparation of more robust estimates of whole-life costs at an early stage. They should give explicit consideration to through-life costs when approving the design of new facilities.

3. **The Research Councils have had difficulty recruiting the project management expertise needed to deliver some projects.** Research Councils should have regard to the significant impact such expertise can have on the achievement of value for money overall, and the high cost of using consultants should direct recruitment fail. Research Councils should jointly develop a cadre of project management expertise and seek to share these skills as new projects are taken forward.

4. **The 10–15 year road map of facilities which the Research Councils expect to be needed provides a structure for identifying priorities, but at present there is limited input from the wider scientific community and industry.** There is a risk of leaving decisions on the selection of new facilities in the hands of a small group of scientists without input from the wider community. The Department and Research Councils should draw upon expertise available in the broader scientific community and industry, to contribute to key points in the decision-making process.

5. **Research Councils have not always sufficiently evaluated options for locating new scientific facilities.** If there is a choice of location, the Department should be explicit about the criteria to be used by Research Councils in assessing potential options.

6. **Research Councils have sometimes had difficulty in attracting a sufficient number of bidders for contracts to help build new facilities.** Research Councils should educate potential suppliers on the opportunities likely to be available in assisting the construction of new facilities. To overcome misplaced or unnecessary concerns about the technical demands of such projects, they should brief them on the varied content of the available work, and where possible package the work so as to broaden the range of potential contractors.

7. **Little is known, in the UK or internationally, about the economic impact of hosting large scientific facilities.** The Department and Research Councils should place greater emphasis on assessing both the immediate benefit to the local economy and the potential impact on the national pool of technical skills. The Department

should track the economic impact of the current group of large-scale facilities and draw lessons for the development of future facilities.

8. **Performance indicators used by the Research Councils and project teams for monitoring the success of these facilities are not always sufficiently comprehensive or measurable.** Before approving the business case for a new facility, the Department and Research Councils should establish indicators to enable the success of the project to be measured. Measures should include the extent to which available capacity is utilised.

9. **Research Councils need to make better use of the potential these facilities offer to inspire the next generation of scientists.** The Department and the Research Councils should have plans in place specifying how these facilities might bring the wider community into contact with science and encourage the choice of scientific studies, qualifications and careers.

1 Managing the delivery and operation of large scientific facilities

1. Since 2000 the Department has allocated over £860 million for the construction of 10 new large scientific facilities and has earmarked a further £270 million for five more facilities. The projects range in size from the construction of the Diamond Synchrotron in Oxfordshire (£383 million for phases I and II)[2] to the construction of a new light source for studying matter, the Energy Recovery Linac Prototype (£21.3 million). A list of the first ten projects is at **Annex A**.[3]

2. The Office of Science and Innovation, part of the Department of Innovation, Universities and Skills, in consultation with the Research Councils, is responsible for overall science policy. The Research Councils are the main public investors in civil research in the UK. Each Research Council is responsible for deciding the research priorities and for overseeing the provision of the large facilities within their remit. By July 2007 there were eight research councils: the Biotechnology and Biological Sciences Research Council, the Economic and Social Research Council, the Engineering and Physical Sciences Research Council, the Medical Research Council, the Natural Environment Research Council, the Science and Technology Facilities Council, and the Arts and Humanities Research Council.

3. The Office and the Research Councils aim to strengthen the UK's science base, and maximise its contribution to UK economic development. The Office has created a Large Facilities Capital Fund to meet part of the cost of funding new facilities; and the Government has established a Science and Technology Facilities Council, partly to create a more integrated approach to providing large facilities.[4] The Council was formed from the merger of two previous Research Councils, the Central Laboratory of the Research Councils and the Particle Physics and Astronomy Research Council.

4. There has been evidence of some good project management in the delivery of large facilities but signs of slippage amongst some projects yet to be delivered. The RRS James Cook was delivered within three months of the original target date and within its original budget. Three projects, however, which were at the build stage or were finalising their procurement strategy, were running a year behind schedule and for five the latest forecast capital cost exceeded the initial budget (**Tables 1 and 2**). The Diamond Synchrotron (Phase 1) had cost £10 million more than its business case budget, which had however included no element for contingencies. The Science and Technology Facilities Council reported that in general the cost increases had reflected changes in the scope of individual projects.[5]

2 This figure includes £53.6 million from The Wellcome Trust

3 C&AG's Report, Figures 1 & 2

4 C&AG's Report, paras 1.2, 1.5

5 Qq 21, 22; C&AG's Report, Figures 7 & 9

Table 1: Project progress against planned delivery dates

Project	Year project approved	Planned completion date	Actual or forecast date of completion as at March 2007	Number of months delayed
Diamond Phase I	2001	Sept 2006	Jan 2007	4
RRS James Cook	2002	May 2006	August 2006	3
ISIS second target station with first suite of instruments	2003	Sept 2008	Oct 2008	1
Energy Recovery Linac Prototype (Note 1)	2003	March 2006	Oct 2007	19
Halley VI operational	2003	Antarctic summer 2008–09	Antarctic summer 2009–10	12
HECToR	2004	Dec 2006	Sept 2007	9
Muon Ionisation Cooling Experiment Phase 1	2004	End of 2006–07	Nov 2007	8
Laboratory of Molecule Biology	2005	June 2009	May 2011	23
Institute for Animal Health	2006	Nov 2009	Dec 2009	1
Research Complex	2006	March 2009	June 2009	3

Source: National Audit Office

Table 2: Project progress against approved capital budgets

Project	Stage of completion at March 2007	Approved budget £ million (see note)	Latest reported forecast of capital spend as at March 2007 £ million	% change
Diamond Phase I	Operational	253.2	263.2	4
Diamond Phase II	Being built	100.0	120.0	20
RRS James Cook	Operational	40.0	40.0	0
ISIS second target station with first suite of instruments	Being built	133.1	145.6	9
Energy Recovery Linac Prototype	Being built	12.9	21.3	65
Halley VI	Investment decision taken and construction due to start in December 2007	34.0	38.0	12
HECToR	Being built	65.0	59.4	-9
Muon Ionisation Cooling Experiment Phase 1	Being built	9.7	9.7	0
Laboratory of Molecule Biology	Preparing procurement strategy	155.0	164.0	6
Institute for Animal Health	Prepared procurement strategy and preparing for investment decision	121.0	121.0	0
Research Complex (excluding infrastructure)	Prepared procurement strategy and now preparing for investment decision	26.4	26.4	0
Total		**950.3**	**1008.6**	**6**

Note: Budgets and estimates are on a consistent cost basis for individual projects. There are, however, differences in cost bases used between projects.

Source: National Audit Office analysis of Research Council data

5. The Research Councils are forecasting significant increases in operating costs for five of the six most mature projects, for two of them more than 80% over the figure appearing in the original business case (**Table 3**). The Science and Technology Facilities Council will bear most of the impact totalling about £27 million per year. The Research Councils will have to bear the cost of any increased spending. The Department believed that where

facilities had been built to date, Research Councils had the resources to operate them. But if there were a shortfall in resources for operating new facilities, Research Councils might have to make serious choices about using them.[6]

6. The Department accepted that the estimation of likely operating costs had not been satisfactory and there should be better benchmarks to predict costs. In the defence field, for example, such calculations were more sophisticated.[7] Project teams had to abide by the Treasury's Green Book on Project Appraisal and Evaluation and follow best practice.[8]

Table 3: Changes in estimated annual operating costs since project approval

Project	Expected life years	Estimate in approved business case £ million (see note)	Estimate at March 2007	% change
Diamond Phase I and II	25	24.4	46.1	89
RRS James Cook	25	2.8	3.5	25
ISIS second target station	15	5.4	9.9	83
HECToR	6	5.4	8.2	52
Muon Ionisation Cooling Experiment	3	1.6	1.8	12

Note: Estimates are at 2006–07 prices and exclude depreciation and capital charges;

Source: National Audit Office

7. Some project teams have encountered difficulties in recruiting people with the right project management expertise. For the RRS James Cook, for example, the team employed a consultant at a cost of £1 million to help manage the design and delivery phases because it needed specialist project management skills for this project. The Research Councils were trying, however, to move away from hiring one-off project managers for each project. The Science and Technology Facilities Council intends to establish and maintain a cadre of experienced people to provide the generic project management skills required. The cadre will also be tasked with capturing and sharing best practice across the Research Councils.[9]

8. The Wellcome Trust is contributing £53.6 million to the cost of the Diamond Synchrotron but, in general, the taxpayer rather than the private sector is meeting most of the capital cost of these facilities, even though the Research Councils expect them to benefit the economy at large. Taking the example of the Synchrotron, the Science and Technology

6 Qq 8, 24, 25; C&AG's Report, Figure 8

7 Qq 1, 23

8 *The Green Book: Appraisal and Evaluation in Central Government – HM Treasury Guidance 2003*

9 Qq 10, 11, 21, 56; C&AG's Report, para 2.6

Facilities Council believed that its economic benefits would be too far into the future for industrial companies to take an immediate interest. But industry could buy into the facility, and the team managing this project had earmarked around 5% of its initial capacity for industrial companies willing to pay, rising to 10% at a later stage.[10]

10 Qq 3, 6, 31

2 Choosing new scientific facilities and measuring their impact

9. The facilities are intended to meet longer term scientific needs across the range of scientific disciplines. It is not easy to predict future needs or where investment will have the biggest benefit. The Office of Science and Innovation and the Research Councils have worked together to draw up and prioritise a road map of new or replacement facilities that United Kingdom scientists will need over the next 10 to 15 years. They published the first road map in 2001 and updated it in 2003 and 2005.[11] Before 2000, proposals for investments in large scientific facilities had been prepared and submitted to the Department by individual Research Councils as part of the spending review process. There was no explicit means of deciding priorities between the various bids. Since 2000, the road map has been prepared by the Office of Science and Innovation and the Research Councils on the basis of submissions from individual Research Councils with priorities decided collectively. The Office considers the recommendations and, if the proposals are approved by Ministers, earmarks resources from the Large Facilities Capital Fund.[12]

10. The UK's road map approach has been commended by evaluative reviews by the United States National Science Foundation as well as the Australian and Canadian governments. These studies commended the process as a vehicle for decision-making, including analysis of scientific opportunities and the objectives for large facilities.[13]

11. The number of new project proposals in the road map has risen from 14 in 2001 to 20 in 2005. Following the prioritisation of the 2005 road map, and earmarking resources accordingly, the Large Facilities Capital Fund was fully allocated for four years to 2009–10. Sufficient funds had been allocated in the current spending review as long as future bids were prioritised rigorously.[14]

12. The Research Councils are not always meeting the guidelines in the Treasury's Green Book, for example to consider all the potential economic impacts that might arise from investment in individual facilities. The Department acknowledged that not enough work had been done to examine some of the spill-over effects but emphasised that the primary purpose of these facilities was scientific. The assessment of potential economic benefit was particularly complex. There were likely to be three forms of impact: the economic effect of the research at the facility; the direct benefit to the local economy; and the development of a trained workforce and pool of technical skills. The Research Councils were trying to get a better assessment of these benefits. The Department had invited tenders to develop a better model of whole-life benefits.[15]

11 The latest road map was published in November 2005: Research Councils UK, *The large facilities road map*

12 C&AG's Report, para 1.7

13 C&AG's Report, para 1.9

14 Q 17

15 Qq 29, 30, 64

13. Neither the large facilities road map as a whole nor the prioritisation of projects is the subject of direct consultation with bodies representing industrial interests in government science policy or with the wider scientific community. The Department accepted that the prioritisation process should be more transparent and that there should be scope for consultation with industry. The roadmap was a relatively new process and further refinement was needed.[16]

14. Research Councils can be faced with a choice of where to locate a new facility, including using facilities overseas, though there may not always be a viable choice, for example where an existing facility is being extended. For the minority of projects to date with a realistic choice of location, the supporting options analysis has either been insufficiently independent or it has been late. For the Diamond Synchrotron, for example, the analysis of options occurred late in the design process and delayed the decision to proceed. The Department accepted that where options existed, experts independent of the project team should be employed to analyse them.[17]

15. The majority of business cases examined by the National Audit Office described success factors which could be used to help judge the worth and success of projects. But the value of some of these factors was reduced as they were not specified in a way that could be measured. Relatively few measures were proposed for either the extent of scientific activity to be undertaken on a new facility once it was operational or, the most difficult area to capture, the degree of exploitation by industry and public policy-makers. The Department acknowledged that it needed to get better at assessing these benefits. The Science and Technology Facilities Council saw the need to develop a broader range of measures.[18]

16. The Department accepted that the UK had not been as good as some other countries in exploiting its scientific discoveries for practical benefit, but believed that the situation was now changing. The Government had made it easier to file patent applications and the number, for example from the university sector, had increased significantly. Academic institutions now employed commercial officers to look for opportunities for commercialisation. The top 25 university spin-out companies had a market capitalisation of £1.5 billion. The Department considered that this level of development would bear comparison with the United States, taking account of relative size.[19]

Inspiring the next generation of scientists

17. To maximise the benefit, there will need to be sufficient scientists to use these facilities. The Department believed that there would be enough qualified staff to use the facilities being built. The UK was second only to the United States in terms of scientific citations. Over the last decade, there had been a large growth in the number trained scientists in the UK, though almost entirely in the biosciences and biological sciences. There had been no growth in mathematics, physics, chemistry, engineering or computer science. The supply

16 Qq 7, 31, 32, 77

17 Q 35

18 Qq 54, 55

19 Qq 73, 74

of scientists in 20 to 30 years' time was less certain, though applications for university places for October 2007 were up in maths, physics and chemistry.[20]

18. The programme of large new scientific facilities could play a valuable part in inspiring the next generation of scientists. The Department is giving priority to engagement with the community and encouraging the interest of young people. The Research Councils have programmes to engage the interest of local people. But the Department cannot easily assess the success of initiatives, such as opening the doors of the Diamond Synchrotron to the local community, compared to other approaches such as through television and direct contact with schools. It has therefore commissioned the Tavistock Institute to look at how success might be measured.[21]

20 Qq 16, 37, 41, 60, 62, 63

21 Q 15

Annex 1: The ten projects supported by the Large Facilities Capital Fund

Diamond Synchrotron (lead by Diamond Light Source Ltd)

The Diamond Synchrotron is a light source producing intense x-rays and shorter wavelength emissions for research in the biological, physical, environmental and engineering sciences. The light can be used to examine the structure of materials at molecular and atomic level. The synchrotron is being built by, and will be operated by, a joint venture company Diamond Light Source Ltd, 86% owned by the new Science and Technology Facilities Council and 14% by the Wellcome Trust. It comprises a linear accelerator, booster ring, storage ring and up to 40 beamlines each of which can support their own programmes of scientific experiments. Diamond will replace the Synchrotron Radiation Source (SRS) at Daresbury in Cheshire.

Location: Harwell Science and Innovation Campus, Oxfordshire

Budget and Funding: £383.2 million for Phases 1 and 2, with £308.6 million from Large Facilities Capital Fund, £53.6m from the Wellcome Trust, £7.0m from the former Council for the Central Laboratory of the Research Councils and the remainder (£14.0m) from other Research Councils.

Delivery: Phase I, including the first seven beamlines, began operations in January 2007 and Phase 2, including the next 15 beamlines, is due to be completed in 2011

Research Ship James Cook (lead by Natural Environment Research Council)

The RRS James Cook is a replacement for the RRS Charles Darwin and is sponsored by the Natural Environment Research Council. Its users will be marine scientists based, for example, at UK universities and the Research Council's National Oceanographic Centre in Southampton. It will be one of two such vessels in the NERC fleet, the other being RRS Discovery. It will be used to conduct oceanographic and marine studies and is equipped to launch and recover heavy marine equipment such as submersible or towable sensing or monitoring devices. It has a dynamic positioning system, on-board laboratory space, data analysis facilities and berths for 32 scientists.

Location: Worldwide but mainly Atlantic waters – built in Poland and Norway

Budget and Funding: £40 million, of which £25 million will come from the Large Facilities Capital Fund and the rest from Natural Environment Research Council

Delivery: The ship was delivered to the National Oceanographic Centre in August 2006

ISIS Neutron Source, Second Target Station (lead by Science and Technology Facilities Council (since April 2007), previously the Council for the Central Laboratory of the Research Councils)

The ISIS Neutron and Muon Scattering Facility is the world's most powerful neutron producer of its kind (a pulsed source rather than a continuous reactor). The first phase of the project involves supplementing the existing facilities with a second target station and the installation of a first suite of instruments. It will enable the ISIS science programme to attract new users from the key research areas of soft matter, advanced materials and bio-science.

Location: Harwell Science and Innovation Campus, Oxfordshire

Budget and Funding : £145.6 million for the first phase, with £127.9 million from the Large Facilities Capital Fund, £7.0m from the EU, £3.0m from Spain and the rest (£7.7m) from the Council for the Central Laboratory of the Research Councils (now the Science and Technology Facilities Council).

Delivery: The experimental programme is set to begin in October 2008.

Energy Recovery Linac Prototype (lead by Science and Technology Facilities Council (since April 2007), previously the Council for the Central Laboratory of the Research Councils)

The Prototype is phase one of the 4th Generation Light Source (4GLS) project. The project will use free electron lasers and synchrotron radiation covering the terahertz to soft X-ray energy frequencies for studying matter. The first phase has been designed to address some of the principal technical challenges that would be faced in a full 4GLS facility.

Location: Daresbury Science and Innovation Campus, Cheshire

Budget and Funding: £21.3 million, with £10.1 million from the Large Facilities Capital Fund, £2.9m from the North West Development Agency, £0.3m from the EU and the rest (£8.0m) from Council for the Central Laboratory of the Research Councils.

Delivery: At the time of the C&AG's Report the project was aiming to achieve full operational energy recovery by April 2007. The project team have now informed the National Audit Office that the facility will be fully operational by October 2007.

Halley VI Antarctic Research Station (lead by Natural Environment Research Council) The project involves the building of a new relocatable Halley VI Antarctic research station and the removal of the existing station, Halley V. Halley VI provides a unique facility for monitoring climate, ozone and space weather and forms a key part of the UK's regional presence. The primary users of Halley VI will come from within the British Antarctic Survey, an institute of the Natural Environment Research Council. Occupation of Halley V would become increasingly unsafe after 2010. Location: Antarctic Ice Shelf Budget and Funding: £34.7 million budget for both construction of Halley VI and decommissioning of Halley V. The Large Facilities Capital Fund is providing £20 million for construction with £14.7m allocated by the Natural Environment Research Council. Delivery: Delivery of Halley VI and decommissioning of Halley V by end of 2009/10 Antarctic summer.	**High End Computing Terascale Resource (HECToR) (lead by Engineering and Physical Sciences Research Council)** HECToR is the next generation of high performance computer. It is the responsibility of Engineering and Physical Sciences Research Council and will succeed existing services. Users will span several fields of science including computational chemistry, physics and climate modelling. Location: Dependent on tenderers' proposals Budget and Funding: £65 million capital budget in total; £52 million from the Large Facilities Capital Fund, £9.0m from Engineering and Physical Sciences Research Council and the rest (£4.0m) from other Research Councils. Delivery: Phase I scheduled to start in September 2007.
Muon Ionisation Cooling Experiment (MICE) (lead by Science and Technology Facilities Council (since April 2007) Previously the Particle Physics and Astronomy Research Council was the lead Council with the experiment hosted by the Council for the Central Laboratory of the Research Councils) The Muon Ionisation Cooling Experiment (MICE) is a step towards the possible creation of a neutrino factory which would aid the understanding of the properties of neutrinos—one of the fundamental particles which make up the universe. MICE seeks to demonstrate that "muon cooling"—making a tightly focused muon beam—is possible through a process of ionisation. Location: Harwell Science and Innovation Campus, Oxfordshire Budget and Funding: Phase I of MICE will cost £22.7 million. Of this, the UK will fund £9.7 million, of which £7.5 million will come from the Large Facilities Capital Fund, £1.3m from Council for the Central Laboratory of the Research Councils and the rest (£0.9m) from Particle Physics and Astronomy Research Council. Delivery: Phase I is set to be complete by November 2007.	**Laboratory of Molecular Biology (lead by Medical Research Council)** The Laboratory of Molecular Biology opened in 1962 and is acknowledged as one of the world's leading biochemical laboratories with users from the fields of immunology, cancer biology and biotechnology. The Laboratory of Molecular Biology project will provide a new, modern laboratory building on the current hospital campus. Location: Addenbrooke's Hospital Site, Cambridge Budget and Funding: £155 million, of which £67 million will come from the Large Facilities Capital Fund and the rest (£88m) from Medical Research Council. Delivery: building due to be available May 2011

Institute for Animal Health (lead by Biotechnology and Biological Sciences Research Council)	**Research Complex (lead by Medical Research Council) and essential infrastructure (lead by Science and Technology Facilities Council (since April 2007), previously the Council for the Central Laboratory of the Research Councils)**
The Institute is responsible for research, diagnostics and surveillance on epizootic (fast spreading) viral diseases of farm animals. The project involves building a new laboratory for the Institute's staff and employees of the Virology Department of the Veterinary Laboratories Agency (part of the Department for Environment, Food and Rural Affairs). Location: Pirbright, Surrey Budget and Funding: Current approved cost is £121 million with £31 million from the Large Facilities Capital Fund, £67 million from Department of Environment, Food and Rural Affairs and the rest (£23m) from Biotechnology and Biological Sciences Research Council. Delivery: The main laboratory building is scheduled for delivery in December 2009.	The project will provide a research laboratory, hostel accommodation and other infrastructure to enable scientists to make optimum use of the Diamond Synchrotron, ISIS and other facilities at Harwell. Location: Harwell Science and Innovation Campus, Oxfordshire Budget and Funding: £33.5 million for the Complex and infrastructure, with £32.4 million from the Large Facilities Capital Fund, and the rest (£1.1m) from the Council of the Central Laboratory of the Research Councils. Delivery: The new hostel for visiting scientists was delivered in July 2006; the Research Complex is set for completion in June 2009.

Source: C&AG's Report, Appendix 3 updated where Research Councils have reported significant changes since the Report was published in January 2007

Formal minutes

Wednesday 10 October 2007

Members present:

In the absence of the Chairman, Mr Alan Williams was called to the Chair

Mr Richard Bacon
Angela Browning
Mr David Curry
Mr Philip Dunne
Mr Austin Mitchell
Mr Don Touhig

Draft Report

Draft Report (Big Science: Public investment in large scientific facilities), proposed by the Chairman, brought up and read.

Ordered, That the draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 18 read and agreed to.

Conclusions and recommendations read and agreed to.

Summary read and agreed to.

Resolved, That the Report be the Sixtieth Report of the Committee to the House.

Ordered, That the Chairman make the Report to the House.

Ordered, That embargoed copies of the Report be made available, in accordance with the provisions of Standing Order No. 134.

[Adjourned until Monday 15 October at 4.30 pm.

Witnesses

Wednesday 9 May 2007

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Fifteenth Report	The termination of the PFI contract for the National Physical Laboratory	HC 359 (Cm 7077)
Sixteenth Report	The Provision of Out-of-Hours Care in England	HC 360 (Cm 7077)
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Oral evidence

Taken before the Committee of Public Accounts

on Wednesday 9 May 2007

Members present:

Mr Edward Leigh, in the Chair

Mr Philip Dunne
Mr Austin Mitchell
Dr John Pugh
Mr Don Touhig
Derek Wyatt

Sir John Bourn KCB, Comptroller and Auditor General and **Peter Gray**, Director of Trade and Industry Value for Money Audit, National Audit Office, were in attendance and gave oral evidence.

Paula Diggle, Treasury Officer of Accounts, HM Treasury, was in attendance.

REPORT BY THE COMPTROLLER AND AUDITOR GENERAL

BIG SCIENCE: PUBLIC INVESTMENT IN LARGE

SCIENTIFIC FACILITIES (HC 153)

Witnesses: **Sir Brian Bender KCB,** Permanent Secretary and **Professor Sir Keith O'Nions**, Director General of Research Councils, Department of Trade and Industry and **Professor Keith Mason**, Chief Executive, Science and Technology Facilities Council, gave evidence.

Q1 Chairman: Good afternoon. Welcome to the Committee of Public Accounts where today, we are considering the Comptroller and Auditor General's Report, *Big Science: Public investment in large scientific facilities,* we welcome back Sir Brian Bender, the Permanent Secretary at the Department of Trade and Industry, who is appearing before us as the Accounting Officer, Sir Keith O'Nions who is Director General of Science and Innovation at the Department and Professor Keith Mason, who is the Chief Executive of the new Science and Technology Facilities Council established only in April 2007. Mr Dunne and I had a very interesting morning this morning when we went to the Diamond Synchrotron at Harwell, which is certainly a fantastic piece of science and we all pay tribute to what has been achieved there in terms of putting us at the cutting edge of science in the world. Having said that, if you look at figure 8 on page 21 you will see Diamond Phase I and II, which we were visiting this morning, and the forecast operating costs and the percentage change, you will see 89%. It is not very good, is it? I wonder why these forecast operating costs for these large scientific facilities are so consistently underestimated.
Sir Brian Bender: It is not satisfactory. The answer to your question, as you would expect, is for slightly different reasons in different cases. As may have been explained to you this morning, in the case of Diamond the early estimates were based on the running costs of the previous machine at Daresbury and those doing those estimates had not taken sufficient account of the greater scale of sophistication of Diamond.

Q2 Chairman: You would have thought that would have been fairly obvious, would you not?
Sir Brian Bender: They should have done it. Cutting straight to the chase, we absolutely accept the NAO findings that we need to improve our understanding of how the operating costs might grow in proportion to more realistic estimates of future demand.

Q3 Chairman: You have these big pharmaceutical companies which will come in and use Diamond, which is really a giant microscope which shines light at 10 times the brightness of the sun onto cells and things like that. Mr Dunne understood it all; I was struggling a bit more. One of the things I asked them this morning was that if you have pharmaceutical companies coming in and using these facilities and presumably making huge profits for the future, how can we divert more of this for the benefit of the UK taxpayer? After all the taxpayer paid around 80% of the cost of this facility. I just wonder whether there is sufficient cutting-edge economic expertise at these facilities to try to ensure that we get back to us, the taxpayer, what we put into these things.
Sir Brian Bender: First of all may I just say that it is primarily a science facility and therefore there is going to be some competition for use of it, as may have been explained to you. As I understand it, the plan that the operators have—and Professor Mason as the Chief Executive may want to say more about it—is over its first phase for 5% of its use to be by the private sector and they pay something close to the economic cost of that; that would rise at a later stage to 10%. Neither the Government nor the Research Councils would want that figure to be very much higher because it is there as a research tool and alsoa benefit to industry rather than an industry tool. Getting that balance right is quite important.

Q4 Chairman: If this is going to be of such benefit to the UK economy, and presumably that is why it is doing that, it rather begs the question. You can say this is complete nonsense, I do not mind, but if it is so economically justifiable, why can this money not be raised in the market in the normal way? Why can we not privatise these decisions?
Sir Brian Bender: You are not asking about private finance initiatives, are you? So far, none of these projects has gone down the road of a private finance initiative.

Q5 Chairman: I know that was not very successful at Teddington at the National Physical Laboratory, but we were told this morning that that was a good reason for not going down the PFI route.
Sir Brian Bender: None of them so far—

Q6 Chairman: I am not talking about PFI but private finance.
Sir Brian Bender: Just raising the money; exactly. The purpose of it is essentially science rather than wealth creation and therefore there is a public policy objective. One of the experts on either side of me can elaborate if you want.
Professor Mason: It is important to realise that what we are doing here with Diamond is primarily a facility for cutting-edge science. Much of the research that will be done in it will not deliver economic benefit immediately; it will downstream, but there is this long lead-time research aspect to it, which the machine is designed to fulfil. Our anticipation is that it will be fully subscribed with high quality research of that type. In order to make its capabilities more widely available, we will be allowing some fraction of near-term industrial use, up to 10% after the first five years, and you probably saw this morning that there is actually space for 45 beam lines around the Diamond and not all will be occupied for many years to come, so if industry were to wish to utilise that capability, they could in principle buy into the machine.

Q7 Chairman: The reason I asked was that if you look at paragraph 1.17, you will see it says there "Neither the large facilities road map as a whole, nor the prioritisation of projects within it, is the subject of direct consultation with bodies representing industrial interest in government science policy". What I am worried about is whether this is just one scientific elite choosing another scientific elite.
Professor Sir Keith O'Nions: There is certainly more scope for consultation with industry. In this particular case, there was experience from Daresbury, interest from the pharmaceutical companies, and indeed aerospace companies. The 5% was arrived at as a realistic level of use that business might want. With other facilities, we are in a regime where we are looking much harder in all sorts of aspects of spend, in science and innovation for industrial use and business benefit and I have no doubt in the future we will be looking much closer in those places where it is appropriate to do so.

Q8 Chairman: Sir Keith, if you look at paragraph 2.16, I have asked about this increase in operating costs, but what happens in the future if a research council cannot afford to run its facility at planned capacity? What do you do then if you run out of money?
Professor Sir Keith O'Nions: Let me first say that it has not happened so far and we have not been in a situation where facilities have been built where research councils cannot afford to run them and, of course, they have to justify to us that they can afford to run them at the time of gateways. However, the question is fair inasmuch that given the inadequacy of estimating costs of ownership or through-life costs of these large projects, you could envisage a time when there was a shortfall in funds and research councils had to make very serious choices about utilisation of them. We propose to follow very closely the recommendations in the NAO Report which are very helpful and we will put much more effort into more rigorous estimates of through-life costs and hopefully move away from the position—

Q9 Chairman: Why do you not always have Gateway reviews? It says here in paragraph 2.4 on page 16 "The Energy Recovery Linac Prototype business case had not been subject to gateway review in its own right". Why was that?
Sir Brian Bender: There was a particular reason. May I again cut to the chase at the end? About a year ago Sir Keith reached the view that gateway reviews were not being used sufficiently rigorously and consistently and wrote a letter then to all the Chief Executives making clear how they should be applied and making clear they were mandatory. In that particular case, as I understand it, it was seen by the Research Council as an exception because it was a development of another project that had already passed gateway 0 and gateway 1. That is arguable and we have closed that stable door.

Q10 Chairman: Lastly, I was very surprised to read in paragraph 2.6: "The RRS James Cook project, for example, following an abortive attempt at direct recruitment due to the lack of suitably qualified candidates, procured a project manager from a consultancy company at a cost of approximately £1 million for the design and delivery phase". Do you have nobody in your Department or any of these research facilities who could do this work? Why did you pay £1 million for a project manager?
Professor Sir Keith O'Nions: This particular research ship is not just a ship but it is a very complex ship. I do not want to go into the technicalities but it can sit very stably in the ocean and make all sorts of observations; it is a very unconventional type of ship. Individuals that actually have project management skills, design skills for ships of that sort are actually in quite short supply. It is not obvious that you would have people even in the MoD with those sorts of skills. There was really no option and the right decision was made to get somebody in from outside. It is an arguable question as to whether the costs versus the benefits are appropriate. However, this is rather a good example of where this particular

project, which is quite a complex project, came in on cost and on time. I would say it has probably been the right investment. We may not build another ship of this complexity for another 10 or 15 years.

Q11 Chairman: So there is no point asking you whether this expertise will now be passed on within the research councils or the Department.
Sir Brian Bender: That expertise will not, but what the new Research Council that Professor Mason is Chief Executive of is looking at and is doing is making sure that there is much better spreading of best practice on project management and on procurement.

Q12 Chairman: I should have said in welcoming you Sir Brian that you are in fact a graduate of Imperial College and a PhD, are you not?
Sir Brian Bender: I was.

Q13 Chairman: So you know about science.
Sir Brian Bender: I did.

Q14 Chairman: What did you do your PhD in?
Sir Brian Bender: Physics, optics, colour vision.

Q15 Mr Dunne: Despite the Chairman's generous remarks, I am not a scientist and was very impressed by what we saw this morning at Diamond, mostly because I did not really understand what was happening inside the machinery. However, I do have an interest and a concern about the state of scientific knowledge within our youngsters coming out of education. For that reason the work that you are doing is very valuable, but I would like you to tell me how you assess how valuable it is when you look at the impact on the wider scientific community in this country from these projects?
Professor Sir Keith O'Nions: You have put your finger on an extremely important point here: the way in which we use our investment in science to engage the next generation and actually how we manage those benefits. In looking at Diamond—and I will certainly not explain how it works to you, I will go straight to the chase—it is a very good example where you can excite young people and the research councils have very good programmes of getting engagement of local people and so on, as they are in the astronomy area. Engagement with the community and developing the next generation of scientists is a high priority in what we do. The bigger challenge is to know how effective we are in doing that. We have had quite a lot of work going on over the last two years. We have had the Tavistock Group trying to look at methodologies to measure the success of particular types of public engagement outcomes that you and everybody else are looking for. It is actually quite difficult to unpick what was the benefit of opening the doors on Diamond and getting lots of people in, *vis-à-vis* a television programme, *vis-à-vis* science ambassadors and so on. I do not have the quick smart answer to it, but it is an extremely important area and it is one that is quite high on our agenda and one on which our ministers are quite focused.
Sir Brian Bender: One of the best things we do is a science and technology ambassadors' programme for schools which currently has about 13,000 young business people from companies like Rolls-Royce and others going around and trying to inspire kids at school.

Q16 Mr Dunne: I am pleased to hear it because the current evidence suggests that there is a looming crisis in the development of chemistry and physics graduates. My understanding is that in the last two years five chemistry departments have closed in universities and over the past 10 years university chemistry enrolment is down by 18% and physics down by 7%.
Professor Sir Keith O'Nions: May I offer you a little bit of good news? We are obviously enormously concerned about this and the sustainability of physics, chemistry, mathematics and training of youngsters. I very much hope it is not a blip, but applications to universities for October 2007 are significantly up in maths, physics and chemistry. One very much hopes that it is a sign of turning the corner, but there is quite a substantial increase for October 2007 applications.

Q17 Mr Dunne: I am pleased to hear that. We touched briefly this morning on how the Diamond project won out in terms of the bidding for these large funding projects. We were directed to you to explain to us how this process works. The NAO Report provides a chart of the gateway process, but could you just briefly outline where you are going to take this because it looks as though you have effectively used up your funding for these projects for at least the next four years? What is happening in bidding through the comprehensive spending review to maintain some access for capital projects to money going forward?
Professor Sir Keith O'Nions: I will try to be brief. The road map process that we have set in place seems to be quite a pioneering approach which others are adopting, so we believe this is a good process. Prioritisation within that road map is key and there are some NAO recommendations that we need to improve upon. It is a fact that we are committed to the maximum allocation at the moment and there is no headroom in that road map. In terms of the Comprehensive Spending Review, we looked quite carefully at what level of capital we felt we needed over the 2008–09 to 2010–11 period, building into that an understanding that we would probably be prioritising more rigorously than we have in the past now this is at a steady state. I do not have the numbers in my head but I believe the notional number that has come as part of the settlement letter to the DTI has an adequate amount of money in that roadmap to meet future aspirations as long as we rigorously prioritise and re-prioritise as recommended by the NAO. I hope I am in the right area in responding to you.

Q18 Mr Dunne: Am I right in thinking that only last month the Government cut £98 million from the ring-fenced science budget to pay for overspends elsewhere?
Sir Brian Bender: Yes Mr Dunne, you are correct, but let me just explain. What we did was to take £98 million of accumulated end-year flexibility from the science budget. These were decisions by ministers to deal with pressures on the DTI budget that had not been foreseen at the time of the 2004 Spending Review. That was less than 1.5% of the 2004 Spending Review allocation for science over the three years. It still left a cumulative underspend in the Budget and then, straight after that at the time of the Budget, the Chancellor announced, you may recall, a settlement for science, both DfES science and DTI science, over the next three years which together comes to a 2.5% real-terms growth over the three-year period. The money is going to continue to grow, but there was this one-off taking from the accumulated underspend, as you say.

Q19 Mr Dunne: That reduction you have just described will not affect any of these projects which are currently under construction in terms of either capital or ongoing support for operating costs.
Professor Sir Keith O'Nions: There are no capital implications.

Q20 Mr Dunne: As far as the operating costs are concerned?
Professor Sir Keith O'Nions: We are content that the settlement that we have had from the Treasury, which is 2.5%, 2.7% real, so 5.4% cash year on year, will provide enough flexibility to fund the commitments that we have and we envisage at a level that many of our international competitors would enthuse over.

Q21 Mr Dunne: If I may turn to the specifics for a moment of the build costs, a lot of the focus of this Report has been on delivering on budget and on time. The projects, by their very nature, are very individual and very specific and the Chairman touched on one issue highlighted by the NAO in finding a procurement officer, which was clearly very challenging. A couple of reports here indicate that the performance against time and budget has varied, perhaps not surprisingly but quite significantly. What can you do at the department to try to learn from the experience of those projects which have completed to provide some consistency in approach?
Sir Brian Bender: One of the benefits of setting up this new Research Council would be to bring together more of the expertise on the larger projects. We will be working as a Department with that Research Council and with some work the NAO themselves are doing on a handbook to provide greater guidance on some of these difficult issues to try to get better at these things over the future and make sure, for example, that best practice is spread across the piece, that best practice on procurement is used each time, and so on.
Professor Sir Keith O'Nions: Formally we expect Professor Mason's Research Council to take a leadership role in procurement issues and project management issues, given the very large number of projects they are responsible for. We have already established a working group with Research Councils UK and we are minded to embed within STFC (Science and Technology Facilities Council) a project management office that will draw together best practice and actually be accountable for ensuring that that is captured and spread across the research councils working with the procurement office that already exists.
Professor Mason: If you look at the history of the projects that we are currently engaged in, none of these cost increases has been "uncontrolled". They have been for specific reasons which are well understood, where key decisions were made, for example about the scope of the project and what it should deliver. Diamond is a case in point and the ISIS Second Target Station are cases in point where we essentially expanded the capabilities of the machine on the basis of consultations early in the lifetime of the project. One of the difficult areas that we need to come to grips with in these large projects is the fact that costings cost money to produce reliably and there is inevitably some sort of toing and froing at the beginning of the project where you are both defining the cost and the scope at the same time. It is that process that we need to bring under control, but it is not a trivial thing to do. We intend to put the best expertise that we have to this and I am sure we will make a better fist of it in the future.

Q22 Mr Dunne: The NAO, on page 19 table 7, identified some cost overruns being as a result of the addition of contingency, which suggests that unless contingency is being used to cover expansion of scope, which I would rather doubt, not enough proper thought was put into the original budgeting exercise. Contingency is a problem we have noticed in other departments through this Committee: it tends to get cut and added in after the project has started when some people realise they are going to run out of money.
Sir Brian Bender: I would agree that it is wrong, for example, for Diamond not to have had a contingency when it was first set up. That was an error which was then corrected. If you are saying projects should have a sensible and prudent amount of contingency in them, then I very much agree with that and it will be one of the lessons we will make sure is learned.
Professor Mason: That is one of the skills that we can bring to bear, which is to assess risk and assign a contingency accordingly to various segments of a project.

Q23 Mr Dunne: My final question goes back to operating costs. Page 21 table 8 shows the increases and paragraph 2.16 refers to five of the six most mature projects having to revise their approved business case estimates of annual operating costs. We were told this morning that there seems to be a much more rigorous review of build cost, capital

cost and a much laxer approach to analysing what the operating costs of these facilities are going to be. Do you think that is a fair comment?
Professor Mason: Assessing operating costs is not something that is straightforward and it is not something you can really do before you know the scope of the project. The way it is usually done is by a parametric estimation, in other words you find a facility that has an analogous function and you compare it against that facility. With the experience that we now have with these large facilities, we will be in a much better position in the future to have more accurate analogues and therefore to be able to estimate the running costs more precisely at an earlier stage in the project.
Professor Sir Keith O'Nions: There is not much wriggle room for us here. We can offer an explanation of each of these, but one has to say this is an under-performance that concerns us and there is experience, certainly in Government, and there are very clear things in the Treasury Green Book that we really must put into place. In defence, cost-of-ownership calculations are done with a higher level of sophistication than we have used. We are determined to adopt best practice, abide by the Green Book and do exactly the things that Keith is talking about.

Q24 Mr Dunne: If an overrun occurs in your estimation, does it fall back to your budget or does it come out of other research councils for which you are not responsible?
Professor Sir Keith O'Nions: The way we have tended to handle that sort of risk in capital costs and operating costs is that a certain allocation is made centrally from the Office of Science Innovation for a three-year period; there is a capital allocation on the roadmap. We have then, in effect, transferred any residual risk to the Research Council, which we believe should engender best practice in putting the risk for overrun with the research council itself. To first order, that is the right way to do it.

Q25 Mr Dunne: That is on the capital cost but what about the operating cost?
Sir Brian Bender: And on operating cost.
Professor Sir Keith O'Nions: And on operating cost.

Q26 Mr Touhig: The Comptroller and Auditor General's Report expresses concern that the economic benefits of research facilities do not get the same level of consideration as the scientific benefits. Would you accept that?
Sir Brian Bender: Yes, I accept there is more for us to do on that.

Q27 Mr Touhig: Why is that so?
Sir Brian Bender: The answer is not terribly satisfactory but it is that the primary purpose of these projects is for science and the analysis of what economic benefit flows from that science is less mature. We have actually just put out some economic analysis work for tender to give us a better model of looking at some of the whole-life benefits that flow from some of these projects. It is a less mature area to work out what the benefit of R&D spend is generally and in particular what the spin-off benefit of these is. We are working on it and we have not done enough of it yet.

Q28 Mr Touhig: Do you think it is right to emphasise the scientific benefits and look at those first before any economic benefits?
Sir Brian Bender: The purpose of building a project like the Diamond facility that the Chairman and Mr Dunne saw this morning and these other ones is science. The overall cost-benefit analysis of proceeding needs to take account of the economic benefit as well as the scientific benefit, but if it were only economic benefit and there were no real science benefit, then my own view is that we should not be proceeding; it would actually come back probably to one of the Chairman's earlier questions about why the taxpayer should be paying if there is an economic benefit, whereas if it is to help the scientific infrastructure of the country that the private sector will not pay for, then there is every reason why the taxpayer should pay for that.

Q29 Mr Touhig: Looking at paragraphs 1.14 and 1.17 on pages 13 to 14, it says that the analysis of potential economic impact is less detailed. Why should that be?
Sir Brian Bender: The answer to that is what I have tried to describe already, that we have not done enough sophisticated work on some of the spill-over benefits.
Professor Sir Keith O'Nions: What we know quite a lot about is the social rate of return from overall spending of government R&D. There has been a lot of economics work on that. We have been doing considerable work over the last few years in the DTI with our own economists on the economic impact of the overall science budget, the £3.4 billion we spend in science and we are making good headway on that *vis-à-vis* other nations that are trying to do it. What we have not done is the specific and that is to try to look at the economic impact of the investment in these large facilities independent of other parts of the spend. We entirely can see that it is time to do that and we have just put out to tender for an attempt to get an analysis and some econometrics of that particular thing, so it is appropriate to do it. Without question we have concentrated in the past on the high quality of the science, knowing something about the social rate of return of R&D investment overall.

Q30 Mr Touhig: But that is not sufficient. You have to do better than that.
Professor Sir Keith O'Nions: We accept that.
Sir Brian Bender: We have to do better. I would say in slight mitigation of us, no-one in the world does this very well. We are seen to be pioneers in this area but we have to do better, as you are saying.
Professor Mason: Just to illustrate the complexity of the problem, in very general terms you can separate the economic benefit of a facility like this into at least three components: there is the economic benefit of the research done on the machine; there is the

economic benefit of hosting it into the local economy; and probably the largest impact is the impact of the trained manpower that is produced by that facility and the pool of knowledge. Tracking those latter impacts in particular is actually a very complex thing to do which we are trying to get a handle on but it is a difficult process.

Q31 Mr Touhig: The Chairman pointed out paragraph 1.17 and I will read it again: "Neither the large facilities road map as a whole, nor the prioritisation of projects within it, is the subject of direct consultation of bodies representing industrial interest in government science policy". The right hand is not talking to the left.
Professor Mason: That is certainly a true statement and there are reasons for it, primary amongst them is the lead time on these facilities. Diamond, for example, was built rather quickly in four years but many of these take much longer to build and then to operate. So the lead time between actually doing the research and actually getting the industrial benefit is too long for industrial companies to take an interest at that level. Now that we have the facilities up and running we have, for example in Diamond, a thing called DISCo which is an advisory body which is specifically composed of industrialists who go out and look at the capabilities and how it might map into today's industrial needs. We are doing that on a timescale that industry actually need but they are not interested in engaging in 10 to 20 year timeframes as to what they might need in the future.
Sir Brian Bender: I also would not want to leave the impression that there have not been very good industrial uses of this sort of machine in the past. The predecessor of Diamond, the synchrotron at Daresbury, led to some very good work by the pharmaceutical and drug industry which they paid for to help protect their patents or develop new drugs or whatever. We are not dealing with an untilled field here; it is a question of how we can maximise it.

Q32 Mr Touhig: That is the thrust of what I am trying to get at. The assessment of scientific benefits used by research councils focuses on the likely scientific benefit. Is that too narrow? You really do have to expand it somewhat.
Professor Sir Keith O'Nions: For the world that we are in now, yes it is. We will formalise the process not only of discussions with business at an early stage but also, and I will not go over the economic impact analysis we try to do, you are absolutely right and this in effect maps off our agreement with the PSA target with the Treasury to get more emphasis and better understanding of the economic impact of the science budgets overall. We must be slightly cautious. There are few facilities here. Building a Halley IV base floating on ice in Antarctica is unlikely to attract a great deal of business interest beyond constructing it.

Q33 Mr Touhig: With your wider responsibilities Sir Brian, do you think that these sorts of decisions should be left to research councils or does the department get much more involved?
Sir Brian Bender: The decisions ultimately are for ministers as I understand it. The research councils have the prioritisation exercise which is described in the Report. The Director General oversees that, but any business case that is then actually approved is approved by a minister; there is a matter of policy and political judgment. Clearly the ministers do not second-guess the scientific advice, but they make a public policy decision on the basis of the business case and the overall advice put to them.

Q34 Mr Touhig: The Report tells us that sometimes the analysis supporting the choice of location has not been timely or independent.
Sir Brian Bender: For some of these projects there is not much choice of location: clearly Halley is going to be in Antarctica; the Institute of Animal Health building will be there. The only ones where there have been real choices were Diamond and whether that should be in Daresbury or at Harwell, and the computer project HECToR (High End Computing Terascale Resource): those decisions are based on an analysis of what the options are with, again, the science being the predominant consideration.

Q35 Mr Touhig: Can we ask the Comptroller and Auditor General what is meant in the Report when it says that this analysis has not been independent?
Mr Gray: In the context of location, clearly research teams may already be working in a particular part of the country. What we are suggesting is that people independent of the project look at the location options that are there. As the Accounting Officer has explained, in some instances it may be self-evident that a particular location is the prime one to choose, but on other occasions there will clearly be options and we suggest that people independent of the project should analyse those options.
Sir Brian Bender: We would accept that.

Q36 Mr Touhig: Could we just step back a little bit? Is there a conflict between science and the wealth creators in the way you approach, in the sense that it seems to me, from what you have said, the whole essence of what you are doing is science and research based and so on, but there is an economic impact which would roll from some of the work that you do? Is there that sort of conflict there between looking at ways in which we can exploit and create wealth as an economy, as a country, as a society, as opposed to just pure science and research?
Sir Brian Bender: I will ask Sir Keith to supplement what I am about to say if I may, but the purpose of the Government's very significant investment in science over a long period, 5.4% growth in real terms under the previous spending review, is basically quality of life and scientific infrastructure. What we are coming quite rightly under pressure to look at as officials is how to maximise the economic spin-off and wealth creation spin-off from that and also, as part of a separate DTI programme, the technology

programme, how to maximise the technology and business pull-through from these programmes. There is not a conflict in all this, but what we do need to get better at—and we have done quite a lot of work on it so Sir Keith can say a bit more on that in a moment—is understanding where the wealth creation does come from and how to maximise it from what is the right science. The starting point should be the right science that the nation needs.

Q37 Mr Touhig: I can just perceive that there is some conflict then. You have your political masters who are saying you really just need to see how this is going to benefit our economy and your scientists are saying you need to do this in terms of research.
Professor Sir Keith O'Nions: The bottom line is that there is not a significant conflict and actually it is being handled in a very intelligent way. Let me just put a gloss on that. Our job, in terms of meeting PSA targets with the Treasury, is really to deliver three things: one is world-class science in the UK and I will not go into that but we are second only to the US and holding our own very, very well; then two other outputs, one of which is for public good and this will be climate change, environmental things, healthcare, national security, things that do not immediately create wealth; and wealth creation. These are very clearly understood. There is clearly scope there for producing conflict of investment—why not put all your money into business?—but that has not arisen. We have quite a sophisticated way of managing it and it is being managed by ministers in a very intelligent way and in a way that is something of an exemplar internationally. I accept that there is always a risk but it is not one we are dealing with day to day.

Q38 Mr Touhig: When I was a minister and I was responsible for a research and science facility, we needed a chief executive and all the advice I had was that I must appoint a scientist, yet the organisation operated in a commercial market and I believed it needed a commercial manager and that is what they got Was I right?
Sir Brian Bender: I do not want to second guess the precise circumstances. For any of these organisations you need someone who can manage and someone who is scientifically literate and the question of which may be more important and which can be secondary would depend on the case. I certainly would not dare to say you were wrong on it.

Q39 Mr Touhig: My civil servants did.
Sir Brian Bender: I would not want to appoint a chief executive of, was it the Met Office you were talking about? I would not want to appoint a chief executive who was a brilliant scientist who had no management competence at all, because they need to motivate a significant number of people. Striking a balance would be my answer, without knowing the details of the specific case.

Q40 Chairman: Did you say we are second only to the US in science?
Professor Sir Keith O'Nions: Yes, in science overall.

Q41 Chairman: What about Germany?
Professor Sir Keith O'Nions: We are second only to the US. In terms of any measure of productivity, that is bang for the buck, we are by far ahead of the other G7/G8 nations in productivity. In some areas of science, particularly in the biomedical area of science, in the real cream, the most highly cited part of that science, we actually lead the United States in absolute terms. It is a huge success story which sometimes goes a little unnoticed.

Q42 Dr Pugh: May I take you back to Mr Touhig's question about the Diamond Synchrotron? I have not had the advantage of a tour around it, but I have a suspicion that it would work just as well in Cheshire as it would in Oxfordshire. Am I correct in that supposition? It is now doing splendid stuff at Harwell science and innovation campus but there is no reason why it should not work in Cheshire. There are no fears about the water there.
Professor Sir Keith O'Nions: As a piece of physics it could.

Q43 Dr Pugh: You said there was a scientific reason.
Sir Brian Bender: May I just perhaps explain the rationale for the decision to locate it in the one rather than the other? Lord Sainsbury was the minister at the time. He received a number of bits of advice from various sources and he did in fact write to the then Chairman of the Science and Technology Committee in 2000 and identified that there was little to choose between the two sites but there were five particular reasons which pointed to Harwell rather than Daresbury: there was potential for synergy with other facilities at the site; there was potential to make a world-class international research centre; there was sharing of support and technical functions; there was the proximity to the biosciences expertise at Oxford; and, importantly, there were also the views of the partner because there was a private sector partner, Wellcome, on this. On balance those were the five reasons that Lord Sainsbury gave at the time.

Q44 Dr Pugh: The interest of the private sector in this has obviously got to be weighed, if they are involved in a co-funding relationship, but I understood from Sir John Bourn and the way he put it that the research community basically did not want to vacate attractive Oxfordshire and move to a really rough area like Cheshire.
Sir Brian Bender: There was a synchrotron already in Cheshire.

Q45 Dr Pugh: Yes, but it would be fair to say that the balance of scientific activity at the moment is going on in the Oxford/Cambridge area.
Sir Brian Bender: The other thing that the Government announced in the 2006 Budget was that Daresbury would be an important part of national science and innovation campus policy. It would certainly be wrong if I were to leave the Committee with the impression the Government had vacated

the North West for science and moved down to Oxford. Daresbury is an important science and innovation campus with a lot of good activity going on there.

Q46 Dr Pugh: In terms of your decision-making process, do you take into account the differential effect on the economies of those areas? Obviously you are spending an awful lot of public money and there is an impact which can be to a greater or lesser extent for the public benefit. As part of the equation did they look at the impact of building up the hi-tech base at Daresbury as opposed to adding to the already substantial hi-tech base in the Oxfordshire/Cambridgeshire area?
Professor Sir Keith O'Nions: Going back over the decision-making process which was crystallised in Lord Sainsbury's letter to the Science and Technology Committee, the regional economic impact of developing that facility was not a significant part.

Q47 Dr Pugh: Why not, seeing that it was using a substantial amount of public money?
Professor Sir Keith O'Nions: That is a question to be addressed to Lord Sainsbury.

Q48 Dr Pugh: He is not here and you are.
Sir Brian Bender: The best way I can answer is to come back to the earlier answers I gave that the primary rationale for these decisions is science. The economic benefits do need to be taken into account. The other point I would repeat is that Daresbury—

Q49 Dr Pugh: The reasons are as much social; they are to do with the community, they are to do with who is already there, what firms. They are not actually scientific reasons. They are good sociological reasons possibly.
Professor Sir Keith O'Nions: Just to move the point on. There are two areas in the UK that are designated as science innovation campuses which have been designated for the natural benefits of those regions: one is Harwell and the other is Daresbury and Daresbury has all sorts of benefits in terms of high quality, lots of universities—Manchester, Liverpool, Lancaster—good access to airports and so on. The Daresbury Science and Innovation Campus is actually developing at a pace and one has to say the North West RDA has added a great deal. It is current government policy that if we built a fourth generation light source, that is something which follows and complements Diamond, it is quite likely to be either at Daresbury or Harwell.

Q50 Dr Pugh: You will be aware we are trying to decentralise.
Professor Sir Keith O'Nions: The key thing is that it has not got conflated with regional policy.

Q51 Dr Pugh: I agree. However, the key thing, what I am trying to tease out here, is that in terms of decentralising government functions in this country, a huge deadweight we have to counteract is the fact that civil servants in large numbers already live in London and the South East and wish to stay there and a similar thing could happen with the research community. Even though it is an international enterprise, they might simply have a preference for that. May I change the focus of the question? Accepting that science is an international enterprise, when you commission these activities, say for example a muon scattering facility, you must ask yourself the question, I guess, as to whether or not you actually need this. It is not self-evident that every country needs a muon scattering facility and other possibilities are to do as astronomers do, rent capacity in other areas of the world and so on. As part of your evaluation of the exercise, of whether it is worth doing, whether it is worth spending public money, can you discount absolutely the sheer prestige element, the element that the research community says, whether or not we need to have one, we want to have one because that affects our standing?
Professor Sir Keith O'Nions: I was formerly a practicing scientist, it would be incorrect to say that scientists are disinterested in prestige and scientific facilities. I believe the way things have operated, and are operating, pure chest-beating prestige is not a factor. But it may well be a factor to be the first into a particular area which has great scientific merit and where we have a natural advantage. Coming to the muon ionisation device, that is an area working with neutrons where we have really had a world lead for a long time; there is a very big area of physics there in neutrinos. There are very few places in the world where you could do this. This has built on a natural advantage that is there, but, properly so, it has investment from other countries, from international sources in there too. I am trying to be reassuring by going into those details.

Q52 Dr Pugh: As long as the questions are asked.
Sir Brian Bender: They are.

Q53 Dr Pugh: Can we lease it elsewhere? Can we share it with somebody else? If we cannot, then we must build.
Professor Sir Keith O'Nions: It is a fair question.

Q54 Dr Pugh: One thing that surprised me in the Report is the fact that the NAO say you have objectives and measures of success, but they say the value of some of these factors was reduced because they were not specified in a way which would readily facilitate measurement. Here we have institutions which make the finest, most refined, most exacting measures of very, very small particles and the like, but the whole project cannot be measured in any quantified way or its success cannot be. Does that slightly disturb you?
Sir Brian Bender: It comes back to one of the points maybe the Chairman or Mr Dunne was asking earlier. We do need to get smarter at assessing the overall benefits of some of these projects and that is where we agree with the NAO. We do quite a lot to assess the benefits and measure them, but actually

we do not do enough. We need to get better at that and I would only be repeating one or two of the points I made earlier if I carried on along this line.

Q55 Dr Pugh: In terms of the obvious measures, one measure is counting the number of research papers that are generated. You clearly would not accept that as a viable way of measuring the success of a project, the fact that it generates hosts of scientific articles, because scientists will generate that for themselves anyway, will they not?
Professor Sir Keith O'Nions: In terms of the success of the investment in one of these projects, there have to be measures of its pure scientific success, whether this is world class science, whether it has actually generated any economic benefits and whether the people who have trained there have also gone off and generated economic benefits. In terms of measuring the scientific success, that is generally worked in quite well. What we completely accept, and again will not go over the same things again, is that,the overall economic impact, both specifically of investment in that project and of the people that have been trained in it, is something where we do not have a good enough understanding.

Q56 Dr Pugh: I accept that it is extraordinarily difficult to assess success. Given that it is a very tricky business and you are hiring project managers for what are by and large one-off projects, maybe unheralded elsewhere in the world, is the whole process of hiring a project manager a very high risk process?
Professor Mason: One of the things we are trying to move away from is having to hire one-off project managers for each one of these projects and one of the elements that a new research council brings is a great deal of experience in managing large projects. What we intend to do is to maintain a cadre of expertise in those areas of project management generally of large projects. For individual future projects we will need to supplement that with appropriate expertise in the specific areas that we are dealing with, but what we can provide are the generic project management skills and the experience of having managed several large projects previously. We will absolutely agree that we need to move away as far as possible from hiring one-off managers whose expertise we then lose.

Q57 Derek Wyatt: I wonder whether I could move the debate a little bit to the international perspective. As I understand it, the Prime Minister has set up UKIERI, which is the UK India higher education relationship. I wonder how you feed into that.
Professor Sir Keith O'Nions: It is an initiative with the Office of Science and Innovation and it is the Office of Science and Innovation's resources that are matching Indian resources in that. How does this particular initiative feed into it? Not in a particularly direct way, but if you see UKIERI as part of an initiative to engage further with India, more deeply with Indian science—and the same would be true for China as well but that is another story—then one would expect these facilities to become part of that in scientific engagement and so on. Some of the facilities that Keith is responsible for, international facilities where we would be contributors in CERN, have a panoply of engagement including India and China.

Q58 Derek Wyatt: On the science side do we have MoUs (Memoranda of Understanding) currently with the senior research bodies in India and China?
Professor Sir Keith O'Nions: We have a great many MoUs. We do have formal agreements in medical research with China and neutrons with India, but let me just take the opportunity—
Sir Brian Bender: We can provide you with a note on some of the international relationships.

Q59 Derek Wyatt: No, no. Mr Dunne asked about the science and in computer science in Britain fewer people qualified this year than in 1997. On my visit to Bangalore a couple of years ago I was astonished at the quality of the graduates, so I am equally going to be astonished at what is coming out of Shanghai and Beijing and other cities.
Professor Sir Keith O'Nions: Yes.

Q60 Derek Wyatt: I am really keen to understand what it is they are doing that we are not doing and better understand whether in their science centres—ours seem to be independent of university but sort of attached—there is something going on beyond the American, Australian, British model that somehow makes science so attractive and the commitment of the state of India and China so phenomenal. We have done well as a government and I applaud what the Chancellor of the Exchequer is doing, although you are saying it is very difficult to understand the economic impact of some of these things. You said we are second and I just want to understand we are definitely second and India and China are not threatening us in this area.
Sir Brian Bender: We are definitely second at the moment on areas like citations and so on, on objective measures that other scientists would accept. Secondly, this Report self-evidently only concerns a particular type of large facility and quite a lot, in fact a large part of the Government's investment in science over the last few years has gone into the facilities at universities including facilities in infrastructure. Thirdly, as you will have seen in India and possibly also in China, those governments are putting massive resources into scientific facilities in those countries and we are not at all complacent about the speed with which they are catching up.
Professor Sir Keith O'Nions: Just to take that point. In terms of international competitiveness—and let me stick with scientific excellence because it is even more difficult to look at economic impact internationally—and scientific excellence, the UK is second only to the US. Germany is performing quite strongly and keeping track of us. China is actually coming up quite rapidly and if 1.3 billion people achieve the level of *per capita* income that we have, we must expect them to be a very strong player. India is now off the runway. France is limping a little bit in terms of that league table. Just to give you a picture.

Q61 Derek Wyatt: The impact of some of these things that we are creating here is 10 and 15 and 20 years away, but I suppose my real concern is that in that time the number of people who will study science may decline further. Despite your optimism about this particular year, that is not the case at A level currently and if you go to 2010 when we review how much we should charge students, the top 20 are already lobbying us to let them charge what they like and they are talking about £6,000 or £8,000 or £10,000 a student. You can see that a decision would have to be made on science, that we have four chemistry departments, Exeter University and Sussex University were two of them, but I cannot remember the other two. The state would have to say: "Hold on, the future wealth of the country is based on science and technology and we cannot allow a free expression of an open system, we will somehow have to do something to the science". What I am interested in is that India has already got there in that area.

Professor Sir Keith O'Nions: You are into a very big area of government policy and obviously it extends massively beyond the remit we have here.

Q62 Derek Wyatt: I know, but are you confident we have enough scientists coming through the system who will make good use of these facilities?

Professor Sir Keith O'Nions: No, I am not. I am confident that all of the evidence that we have suggests that we will be well enough staffed for the facilities that we are building at the moment. Realism says that when you ask whether we are totally confident on present trends that our supply in 20 or 30 years time from indigenous sources of those who are seven years old or eight years old today and in 20 years time will be the scientists of the future will be adequate, the answer has to be no. If you go to the US, they will make exactly the same comment.

Sir Brian Bender: Looking back to one of Dr Pugh's questions, another player in all of this are the Regional Development Agencies which are working with the universities to help boost science and innovation in different regions of the country. So, for example the Manchester region, coming back to the North West, now has world-class university facilities and scientists in certain disciplines. Driving further at that and also partnering India and China and other countries has to be part of the answer. The Civil Service and ministers are not complacent about the area that you are asking about.

Q63 Derek Wyatt: If I were Pfizer or Abbott's Laboratories, which are two American companies which have big bases here, in fact Abbott's are in my constituency and Pfizer is just down the road in Sandwich, why would I want to come here?

Sir Brian Bender: Last year, Amgen, a big American biotech company, made a significant inward investment here and I happened to see the UK Managing Director the next day and I asked him why. He said it was because of the brains, because of the quality of bioscience in British universities. So in the case of the pharma industry and the biotech industry, we are right up there and indeed in some respects ahead of America. The issue is how to ensure that we have the quality of science, particularly in the universities, which will continue to act as a magnet for investment, and part of the policy of UK Trade and Investment now is to try to link in much more with the science base of the country.

Professor Sir Keith O'Nions: There has actually been a large growth in trained scientists in the UK over the last decade, both at the undergraduate, the graduate and the post-graduate level. The growth however has been almost totally in the biosciences and the biological sciences and, rather interestingly and welcome, much of that growth has been with women entering the biosciences. It is unsurprising that a Pfizer or an Amgen is seeing a very high quality output and is responding to it by investing here. Where we have not seen growth in output, despite the number of undergraduates that has increased remarkably, is in mathematics, physics, chemistry, engineering, computing science. That is where we are flat in output numbers but there has been a big growth overall in scientists and in the biological sciences.

Q64 Mr Mitchell: Forgive me for taking the populist line, even if it comes naturally to me. I find it extraordinary that paragraph 1.17 of the Report says: "Such analysis of economic impacts as is currently undertaken relies heavily on assertions of potential for direct industrial use, industrial use through industry-university collaborations or knowledge transfer". Surely, practical applications and the spin-off for the economy should be paramount in deciding on these projects?

Sir Brian Bender: I was with you until your last sentence Mr Mitchell. The spin-off to the economy should not be paramount. In making the investment decision in science, the paramount aspect should be the quality of the science, but taking account of what the spin-off will be. As we said in response to earlier questions, there is much more we need to do to harden up the analysis of the economic impacts and some of the broader impacts, particularly of having trained scientists using these facilities and that is the sort of area where the National Audit Office were justifiably criticising us.

Q65 Mr Mitchell: When it comes to the evaluation of one project against another, both of them costing a lot of money, surely the economic impact and the economic benefit for the economy should be the paramount in choosing.

Professor Sir Keith O'Nions: Yes and no. It needs to be properly considered and balanced against other outputs of that investment. Let me take the absurd comparison. Let us take Diamond, which is the type of facility that we know the pharmaceutical industry will use and have used and let us look at building the Halley base in Antarctica. In terms of economic output, "diddly-squat" from Halley base floating on the ice; Diamond, yes, pharma wants to use it. Actually the justification is strong in both cases because measurements of the physics of the

atmosphere from Halley base discovered the ozone hole; physics of the upper atmosphere there will be a very key part of climate change.

Q66 Mr Mitchell: But there is no return for the British taxpayer.
Professor Sir Keith O'Nions: Are you interested in climate change or the ozone layer? I am sure you are.

Q67 Mr Mitchell: I am sure there is a lot of information about climate change; it is coming out of my ears.
Professor Sir Keith O'Nions: What I am saying is that perfectly good investment on key issues like that is recognised as an appropriate part of the investment, as would be the synchrotron. Yes, economic impact is extremely important but not to preclude investments in things that may have enormous public good benefits.

Q68 Mr Mitchell: Even some of the benefits from Diamond look somewhat hypothetical to me. Here is a document the expedition captured this morning: 10 things we could not have done without synchrotrons. Number one is the development of the anti-flu drug, Relenza, but when we come down to number seven it says that following the crystallisation of pure cocoa butter in real time the results showed the optimum conditions for chocolate manufacture. This is stretching things incredibly far.
Sir Brian Bender: It was an industrial benefit that the chocolate manufacturer paid for.
Professor Mason: The important point there is that for the particular chocolate manufacturer in question, it was of huge economic benefit because otherwise they would have had to produce something totally different.

Q69 Mr Mitchell: You have the project so you are going to have to produce some benefit from it even it is minimal in terms of solidifying chocolate.
Professor Sir Keith O'Nions: That list there is to indicate the breadth not necessarily the priorities. In terms of things that impressed me most, it is much more around drug discovery, health benefits and things that aerospace have done on composites and so on, but chocolate and how well it melts in your mouth is an unexpected benefit.

Q70 Mr Mitchell: So you would not accept the point that economic spin-offs should have a higher weighting in consideration of these projects.
Professor Sir Keith O'Nions: Quite.
Professor Mason: May I put another gloss on this? You have to consider the timescale of the economic benefit and we were talking a few minutes ago about the investment that China and India are making in these areas and the importance for our economy of maintaining our position at the forefront in the knowledge stakes. China and India have no better idea of the quantitative economic spin-off from their facilities than we do, because nobody has solved that problem yet, but they still invest because they understand—

Q71 Mr Mitchell: Why I am asking is because of Sir Brian's point that the starting point should be what the right science is. Why should that be the starting point? The starting point should surely be the benefits to the British economy. Our problem has always been that we have been very good at pure research, at winning Nobel prizes, at developing this and that and we have not been any good at the practical applications of science.
Sir Brian Bender: The primary purpose of the investment in science is basically the scientific infrastructure of this country, whether it is for the public good, whether it is defence, whether it is environmental or whatever, and then we need to get other tools that will maximise the wealth creation and technological—

Q72 Mr Mitchell: My point is that it becomes a self-perpetuating thing. We are good at pure science, therefore we invest money in these kinds of projects encouraging pure science, therefore we encourage more people into pure science, and the practical applications lag behind. We never see the benefits.
Professor Mason: That is an incorrect analysis because what we actually are investing in is not necessarily pure science: we are investing in the intellectual capacity of our country, attracting the best brains to our country and from that flows economic benefit. A wise man once said: "If you think knowledge is expensive, try ignorance".

Q73 Mr Mitchell: When I was a university teacher I was giving exactly the same sermon as you are giving me now, but it is a matter of practice surely, talking about intellectual benefit, that the Germans and the Japanese have been much more cunning in the applications of science and that is our main problem.
Professor Mason: That is a charge you could level at the UK in the past and I agree with you. What we are saying here is that we are changing that and it is not a matter of pure science or economic benefit: economic benefit comes from pure science. What we have to do is maximise the benefits that we get from that, rather than only looking at the economic benefit because the economic benefit always accrues.
Sir Brian Bender: A lot of work has been done in the last few years, spearheaded by some work that Richard Lambert did, to make it easier to have patent applications; the number of patent applications filed by universities has increased significantly over the last few years. Secondly, almost every university has a kind of commercial officer to go round, look at the research being done and look at where it could be commercialised. Thirdly, the DTI does provide some funding for knowledge transfer partnerships to try to get various economic players, businesses and universities together, again to get the knowledge out there into business areas. It is not an either/or, but the primary purpose of the investment in science is actually for the science base. The challenge is how to make sure we get enough wealth creation from it.

Q74 Mr Mitchell: You made the point about Halley VI, because Halley V is about to sink beneath the waters with all those polar bears and penguins dragged down with it. What is the economic benefit? I can see the benefit for science but somebody else is going to finance that, a country with more money than we have.
Professor Sir Keith O'Nions: Let me offer you a statistic. On the initial point that you made as to whether in the past we were good at pulling world-class science through to economic benefit, there is rather good evidence that we were lagging. Things have improved a great deal in the last half a dozen years. Let me just give you one measure and there are many measures: university spin-outs over the last three years. The top 25 university spin-outs that have reached IPO have a market capitalisation of £1.5 billion, which is now getting to be serious money. If you normalise that to the United States, population size, money going in, it starts to bear pretty good comparison with the United States and university performance, but it is deeper than that. I just give you one example. The Medical Research Council licensed a drug called Humira that it discovered and that was £120 million income. If you look at the trend, it is getting respectable and going in the right direction. I just hope that most of what you have heard is convincing you that economic impact is actually a very high priority.

Q75 Mr Mitchell: I am interested in the argument over location. Why not get the regional development agencies bidding for location? You put a gloss Sir Brian on the location of the Diamond by saying it was an argument between Cheshire, which Dr Pugh was representing, and Oxfordshire. Is not the truth of the matter that Wellcome said they would pull out unless it went to Oxford?
Sir Brian Bender: At a certain point they were very much in favour of Oxford, there is no doubt, but of the five reasons I gave, that was the fifth and there were four others also in Lord Sainsbury's letter. Certainly the RDAs do have an important role in the investment in science and innovation in the English regions and that is a key part of their role.

Q76 Mr Mitchell: Why should they not finance these organisations to attract them to their area?
Sir Brian Bender: If you are talking about these really big facilities, then most of them are not that mobile: clearly the computer is; Halley obviously is not; for the synchrotron it was only really a choice between two locations. The RDAs undoubtedly do have a role in the scientific infrastructure and innovation capability in each region and part of the aim of the department and the Government is to get them even better at that.

Q77 Mr Mitchell: Why is the scientific community not more involved in prioritising? The Report says there is a gap there and surely if we are talking about pure science, the best people to evaluate priorities are the scientific community.
Professor Sir Keith O'Nions: We would accept that the NAO and you do have a point there. I do not have difficulty with the research councils themselves making those priorities, but there is an argument that we fully accept that this should be more transparent at the time and probably more consultative in terms of reaching those priorities. We accept that. This is not making too many excuses, but remember the roadmap is a relatively new exercise, something which was pioneered in the UK, we are still finding our way, it is clearly the right way to do it and that is a tuning we accept we should make.

Q78 Mr Dunne: A question on Mr Mitchell's and Dr Pugh's point about the location. Can you confirm that, based on the scientific evidence that you gave us earlier, a decision was held up to start that project by approximately a year by the Secretary of State seeking to make a political decision about the location rather than one based on scientific evidence?
Sir Brian Bender: I have no knowledge of exactly what happened at the time beyond the criteria I described. There was a delay before the decision was made and then the reasons given were the ones that I outlined earlier that were in Lord Sainsbury's letter to the Science and Technology Committee. I do not know whether there is anything you can add to that.
Professor Sir Keith O'Nions: I can add nothing.

Q79 Chairman: Who was Secretary of State at the time?
Professor Sir Keith O'Nions: Stephen Byers.

Q80 Chairman: Where is his constituency?
Sir Brian Bender: In the North East.
Professor Sir Keith O'Nions: I cannot shed further light on that but there is one additional complexity which is that initially the French Government were involved in this as this was going to be a joint project between the UK and France and obviously that added greater complexity.

Q81 Dr Pugh: I do not want you chaps to go away thinking we are not all very supportive of scientific research but it does not follow that we are wholly supportive of every single big project. It may be idle curiosity, but it does strike me that there are many huge bits of apparatus around still which, whatever they did, can now effectively by simulated by a PC. In the history of big projects, there must be a history of obsolescence and things being remaindered and white elephants. Are there such big scientific projects in recent history that are now essentially obsolete and, if there are any, have we learned anything from it?
Professor Sir Keith O'Nions: I will give you some examples of where obsolescence has crept in and the facilities have gone. If you just think in terms of building aircraft, you used to make a model, you used to put it in a wind tunnel and blow air over it and see how it behaved and tweak it and go and build some different wings. That now can be mostly

simulated in a computer. We had a lot of those sorts of facilities in the UK; we now have a minimum of them, that is computational—

Q82 Dr Pugh: But that is in the private sector.
Professor Sir Keith O'Nions: No, it was very much government. It just happened to be more perhaps in defence, but it was certainly big government expenditure on facilities which have now gone. That is just one example where computation has really passed on. There are numerous others. They will probably come in drug discovery before long; the ability to simulate what goes on at the molecular level in drugs and how drugs behave in your body is getting more and more sophisticated.

Q83 Dr Pugh: Learning from that experience, is there no way we can anticipate that sort of development?
Professor Sir Keith O'Nions: Not the timescale of it. The question is: are we spending a load of money at the present time on keeping useless facilities going? Our budget is a bit too lean and mean to contemplate that.

Q84 Chairman: We were told this morning that the capacity of the modern Ipod you have in your pocket, if it had been in a computer system in 1957, would have covered the entire five square kilometres covered by Diamond Synchrotron. I want to ask you something Sir Brian, and I think Mr Mitchell had a point. You were in the DTI in 1993 when Mr Heseltine was there. Do you not remember him saying that we were very good at producing Nobel Prize winners in science but quite useless at translating this into business opportunities? Paragraph 1.16 on page 13 says: "It is more difficult to assess the longer term economic impact of a new facility: the science is by its nature uncertain and the economic benefits can be difficult to estimate. Internationally, there have been few evaluations of the extent to which advances in scientific knowledge supported by large facilities in general, or a particular large facility, are converted into commercial innovation". I find that amazing by the way. It goes on to say "The Council for the Central Laboratory of the Research Council's neutron strategy published in 2006, has acknowledged this gap in relation to the benefits of hosting international facilities, and has proposed a study". Why are we just proposing a study now? Why were you not doing this 20 years ago?
Professor Mason: This comes back to the point we discussed earlier. This is actually a very difficult thing to get to grips with and nobody in the world has. There is lots of empirical evidence that large facilities like this do lead to huge economic benefit, but what we are trying to do is to turn that empirical evidence into something quantitative. As we have said, we accept the point that we need to do better in economic impact. One of the main reasons for creating the Science and Technology Facilities Council is to deliver on that aspiration, to bring business in, to make business aware of the sort of things that we are doing in science, and vice-versa, because we can learn from the business community as well, and to take that agenda forward. Part of that agenda is developing quantitative metrics for the benefits that accrue. We are actually leading the world in trying to produce those but we still have a long way to go.
Sir Brian Bender: What you have quoted Mr Heseltine as saying, the same sort of thing as Mr Mitchell said, has undoubtedly been the case: we have not been as good as we should be at translating the science and using the inventions as we need to be. Several steps have been taken over quite a period to get better at that and it is a key part of the DTI's and the Government's innovation policy to help translate the science into wealth creation. Where I still would not agree with Mr Mitchell is in asserting that therefore we should be putting much more of the money into applied science rather than the basic science.

Q85 Chairman: But it does beg the question: what is the DTI for? You must be aware of all this debate about whether your Department really serves any purpose. Part of your budget is now devoted to science. Presumably you are going to say that the point of having science in your Department is that there is this synergy between the wealth creators in your Department.
Sir Brian Bender: Yes.

Q86 Chairman: Well that begs the question: why have you not been more successful in using all the economic expertise you have in your Department to inform these decisions of these scientists?
Sir Brian Bender: Some of the figures I gave earlier about patents, about knowledge transfer partnerships, about the innovation programme are designed very much to exploit the synergies of having science in the same place as the department that deals with business.

Q87 Chairman: So will you continue to make progress on this many years after Mr Heseltine was talking about the failures of your Department?
Sir Brian Bender: We are making progress; we need to continue to make progress.
Chairman: Excellent. Thank you very much gentlemen, it has been a very interesting hearing and we are very grateful. Personally I would rather spend £300 million on a Diamond Synchrotron than waste another £1 billion on Tax Credits' overpayments.

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