



House of Commons
Committee of Public Accounts

The United Kingdom's civil space activities

**Twenty-first Report of
Session 2004–05**

*Report, together with formal minutes,
oral and written evidence*

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The Committee of Public Accounts

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Summary

The Government has identified specific scientific, commercial and social objectives as the most effective way of investing in civil space activities but it does not see the exploration of space as an end in itself. The Government spent £188.6 million in 2003–04 on its civil space activities which are carried out by a Partnership (the Partnership) of 10 Government Departments, Agencies and Research Councils. Their work is co-ordinated by the British National Space Centre (BNSC) at the Department of Trade and Industry (the Department).

Managing risk

Space missions are by nature risky. The Partnership applies risk management techniques, but not consistently across their programmes. In the case of the high-profile Beagle 2 project, the Partnership's capacity to manage risk was constrained by the tight timetable, restrictions placed upon the weight of the lander and unrealistic funding assumptions, amongst other factors. Risks to the project were not explicitly addressed in appraisals of applications for funding.

The cost of space activities

Investing in space is expensive. Around two thirds of the United Kingdom's budget is spent through the European Space Agency (ESA) and EUMETSAT which provides and operates Europe's weather forecasting satellites. The procurement system used by ESA provides for fair returns to contributing nations. We found that the costs of the space programme are increased by this system, which means that contracts are not always awarded to the most cost-effective bidder. It also creates additional administrative costs.

The remaining third of the United Kingdom budget is spent primarily on nationally run space programmes operated by three of the partners. Here we found that cost control was compromised by the limitations of internal information systems.

Maximising the benefits from space

Space exploration can also generate significant commercial and scientific benefits, and there have been notable individual successes in space missions funded by the United Kingdom. But the Partnership does not summarise the benefits across space programmes, nor monitor progress against strategic objectives.

On the basis of a Report by the Comptroller and Auditor General¹ the Committee examined the way in which the members of the partnership manage the risks posed by space exploration, the ability partners have to identify and manage the costs of their space activities and the commercial and scientific benefits which space exploration can generate and the way such benefits are measured.

1 C&AG's Report, *Department of Trade and Industry—The United Kingdom's Civil Space Activities* (HC 359, Session 2003–04)

Conclusions and recommendations

1. **Space projects are expensive and the results uncertain.** The technology, the long timescales of space missions, and the dependence on collaboration all pose risks to successful completion. Some projects, such as Beagle 2, have failed, while many have been delayed.
2. **The Partnership needs to improve its risk management by:**
 - applying sufficient resources at the initial stage of a project to identify and mitigate the technical and construction risks;
 - addressing the risks posed by collaborating with other space bodies, such as ESA and NASA, by reference to recently issued Treasury/OGC guidance on managing risks with partners; and
 - dealing with risks explicitly in appraising funding of projects, and highlighting those that remain after mitigation and management.
3. The loss of Beagle 2, which was due to land on Mars in December 2003, was associated with poor risk management that left it with no real prospect of success. The project suffered from an over ambitious time schedule, punishing weight constraints, poor management and uncertain funding. **BNSC and the Department should only proceed with such ambitious projects if sufficient resources can be committed from the outset to give a reasonable prospect of success, making due allowance for risk.**
4. **The Partnership has strategic objectives for benefiting from the United Kingdom's space programme, such as improving UK productivity, but lacks systems to track progress against these objectives.** The National Audit Office proposed a range of possible performance indicators to remedy the gaps, such as the proportion of industry turnover associated with space-derived products and services, which the Partnership would do well to follow up.
5. **The Partnership has estimated that the benefits for the United Kingdom of having a European satellite navigation system, the Galileo project, rather than depending on those operated by the United States and Russia will be worth £6 billion from an investment of just £78 million.** The Transport Select Committee investigated this project in detail and were “not convinced that the cost and benefits (of Galileo) have been properly assessed”. We agree with their conclusion that BNSC should seek independent validation of their estimates of costs and benefits for the Galileo project.
6. **BNSC should encourage ESA to review its procurement policy of “fair return”,** whereby the value of contracts any member state receives is broadly proportionate to its financial contribution to the Agency. Such systems can increase costs and reduce value for money.
7. **Large firms and some smaller firms which are members of space Trade Associations are aware of the support available from BNSC on competing for**

space contracts, but other small firms are not. Drawing upon its own databases of the space industry BNSC should promote its advice and support services to all segments of the industry.

1 Introduction

1. The Government's space strategy for 2003–06 outlined three objectives for its investment in space:

- To enhance the United Kingdom's standing in astronomy, planetary and environmental sciences;
- To stimulate increased productivity by promoting the use of space in government science and commerce; and
- To develop innovative space systems to deliver a sustainable improvement in the quality of life.²

2. The Government spent £188.6 million in 2003–04 on its civil space activities. This level of expenditure on civil space is small and tightly focused compared to the budgets of several other nations such as the United States, France and Germany. The United Kingdom civil space activities are carried out by a partnership of 10 Government Departments, Agencies and Research Councils (**Figure 1**). These bodies co-ordinate the space policy and programmes through the British National Space Centre (BNSC) Partnership which is housed in the Department of Trade and Industry (the Department).³

Figure 1: Members of the BNSC Partnership and their priorities in space

Partner	Priorities in Space
Particle Physics and Astronomy Research Council (PPARC)	Invests in space in its pursuit of high quality basic research in astronomy, planetary science and particle physics.
Natural Environment Research Council (NERC)	Space data for improving the understanding of the Earth system and reducing uncertainties in environmental prediction.
Office of Science and Technology (OST)	Interests in science policy and funding the Research Councils.
Department of Trade and Industry (DTI)	Focused on increasing productivity in the economy through expanding the use of innovative space products and services, and developing competitive industry to deliver space infrastructure and services in the global market.
Meteorological Office	International space infrastructure for global space data for meeting its key performance targets for weather forecasting and service quality.
Ministry of Defence (MOD)	Effective harmonisation of civil and military investment in space technologies, collaboration on multiple-use items and guidance about opportunities for United Kingdom firms in the space defence sector, especially the United States.
Department for Transport (DfT)	Investing in the development of European satellite navigation services in partnership with DTI and industry.
Department for the Environment, Food and Rural Affairs (DEFRA)	Important user of space services which underpin national environmental priorities such as climate change research and agriculture policy. Has invested directly in the development of space infrastructure and services.
Council for the Central Laboratory of the Research Councils (CCLRC)	Has capabilities and facilities for space engineering at Rutherford Appleton Laboratory.
Foreign and Commonwealth Office	Responsible for some aspects of international cooperation on space activities.

Source: BNSC Headquarters (C&AG's Report, Figure 1)

² C&AG's Report, Executive Summary para 1

³ *ibid*, para 2

3. Exploiting space is expensive, and much of the United Kingdom's activity is undertaken in collaboration with other nations. In Europe the main collaborative body is the 15 member state European Space Agency (ESA) which has been in existence since 1975. Some two thirds of the United Kingdom's annual space budget is spent with ESA and EUMETSAT, an intergovernmental organisation which provides and operates Europe's weather forecasting satellites.⁴ The remainder is spent on the United Kingdom's national programmes principally run by the Department, the Natural Environment Research Council (NERC) and the Particle Physics and Astronomy Research Council (PPARC) partly in collaboration with other nations, notably the United States and Japan.

2 Managing risk on space projects

4. Space based projects are inherently risky. They involve the development and use of advanced technology. Many space missions have life cycles, from development through launch to exploitation, of decades. Many projects involve collaboration with other countries, with multilateral space agencies and companies from other nations, which poses further risks. Effective assessment and management of risk is therefore a crucial determinant of value for money.

5. There are a number of examples where the assessment and management of risk within the UK's civil space programme could have been better. For example, the NAO's analysis of the Department's national space programme showed that many of the business cases supporting the various elements had not addressed factors such as changes in the space market or delays to launches, and they had not developed risk management strategies.⁵

6. The Beagle 2 project which was part of ESA's Mars Express mission to Mars was put together at relatively short notice by ESA to compensate for the failure soon after launch in 1996 of a planned Russian mission to Mars which had incorporated European instruments.⁶ The timescale for putting the mission together was constrained because 2003 represented the best opportunity to send a spacecraft to Mars.⁷

7. A number of factors increased the risks to the project, or hindered their assessment or management.

- ESA originally indicated that a weight allowance of 200kgs would be available for a lander, but subsequently cut that allowance to 60 kg. This necessitated a complete redesign of the lander and took time out of an already short schedule.
- This tight mass limit constrained the ability of the consortium which developed Beagle 2 to manage identified risks. Although the lander that was launched was overweight ESA had not formally given prior derogation from the mass limits.
- Public funding for Beagle 2 proceeded in a series of seven increments because the science and space support budgets were already heavily committed. None of the funding appraisals formally assessed the chances of success for the overall project.
- ESA treated the Mars Express space craft and the Beagle 2 lander as two separate projects. This decision hindered the management of the enterprise not least because ESA undertook no real oversight of the Beagle 2 lander until very late in its development.
- The lander did not include a means of communicating with the Mars Express orbiter.

5 C&AG's Report, para 4.4

6 Q 7

7 Q 16

8. Because of concerns about the development and the funding of the Beagle 2 lander ESA requested an independent review of Beagle 2—the Casani review—which reported in September 2000. The key findings of this review were that:

- there was no margin available in the proposed mass of the lander;
- the contingency in the schedule which the consortium had to meet to fulfil the launch date of June 2003 was inadequate;
- the management of the consortium arrangement was fragile;
- although the project had a risk management plan, risk management in the classical sense would continue to be non-existent unless mass and schedule margins were restored;
- if each of the findings (of the review) were satisfactorily addressed then the design of the lander’s systems and sub-systems would be satisfactory – with the exception of the airbags designed to cushion the landing of Beagle 2 on Mars.⁸

9. The Casani report concluded that if its findings were fully addressed the project was “challenging but eminently doable”.⁹ However, our colleagues on the Science and Technology Committee who have reported on the Beagle 2 project found that having commissioned the Casani review ESA did not take responsibility for implementing all the review’s main recommendations.¹⁰ The Science and Technology Committee also reported that the Director of Science Programmes at ESA had very strong doubts about the lander’s chances of success but that he did not act upon those concerns.¹¹ In these circumstances it is not clear to us that Casani’s findings had been satisfactorily addressed before final decisions to proceed had been taken.

10. Other projects in the United Kingdom’s national space programmes operated by NERC and PPARC also demonstrated the difficulties that can arise on complex projects, particularly those involving partnerships. For example, the project run by NERC known as the High Resolution Dynamics Limb Sounder (HIRDLS), a joint project with NASA designed to measure gases in the earth’s atmosphere, suffered a series of technical and other delays which deferred its launch by six years to 2004.¹²

8 C&AG’s Report Figure 18, Qq 8, 58

9 Q 8

10 12th Report from the Science and Technology Select Committee, *Government support for Beagle 2* (HC 711, Session 2003-04), para 79

11 *ibid*, para 91

12 C&AG’s Report, Figure 20

3 The cost of space and its commercial benefits

11. Investment in space activities is inherently expensive, and some of the management arrangements adopted have contributed to increased costs or weak cost control. For national projects, the current procurement strategy is based on competition, and the contracting strategy uses fixed price contracts to transfer project management risks to the contractor. This approach cannot however be applied to all space projects at all stages. The number of potential contractors may limit competition and fixed cost contracts may not work well at early project definition and development phases.

12. Beagle 2 provides an example where these arrangements were not fully applied. The cost of the lander increased from an estimate of £27 million in April 1998 to an outturn of £45.2 million in 2003.¹³

Figure 2: Costs of Beagle 2

Increment	Commitment date	DTI £m	PPARC £m	ESA £m	DTI/OST £m	Open University £m	EADS Astrium (main contractor) £m	Totals £m
Cost of the Instruments	July 1999		2.7					2.7
The initial ROAME statement	July 1999	5						5.0
Funding the project in lieu of sponsorship being obtained	August 2000				5	3.5	3.5	12.0
ESA support	November 2000			9.7				9.7
Increased funding in lieu of sponsorship being obtained	August 2001				8.3	1.9		10.2
Risk reduction work on the parachutes	July 2002				1.5			1.5
The Planetary Protection Facility	November 2001			1.95				2.0
Post launch support/operations	April 2002		2.1					2.1
Project Total	45.2							

NOTES

- (1) The Open University also received £2.6 million from the Wellcome Trust biomedical research charity to help develop miniaturised mass spectrometer technology with some overlap with Beagle 2. This activity is continuing
- (2) EADS Astrium was the main contractor on the project. They declared a £1.5 million loss on the project.
- (3) Significant but unquantifiable 'in-kind' contributions were made by many further organisations in both academia and industry
- (4) PPARC terminated the operations grant before completion: £1.86 million cost was incurred
- (5) ROAME stands for Rationale, Objectives, Appraisal, Monitoring and Evaluation statement. These statements were produced by the Department as an appraisal and planning tool for most DTI initiatives at their outset.

13. The increase in costs reflected difficulties in estimating costs for a novel project, and the use of cost-plus contracts during the development phase. In the summer of 2001 BNSC made it a condition of providing further funding that Astrium, the main industrial contractor on the project, should take full responsibility for delivery of the Beagle 2 project to cost and schedule under a fixed price contract and secondly that fixed price contracts should be used for all future contracts awarded by the consortium. BNSC and ESA also improved their monitoring of the project. Costs nevertheless increased by a further £5.5 million before the project was finished.¹⁴

14. Cost control has also been hindered by weak management information. PPARC, for example, were not able to provide cumulative cost data for all the projects for which they provided funding in 2003–04.¹⁵ The long life of some space projects provides a compelling reason to monitor their cumulative cost, so that the significance of low levels of annual expenditure over extended periods is not lost. PPARC assured us that the new management information system it is currently installing will enable it to produce comprehensive data about all its current projects.¹⁶

15. Policies adopted by partners also have cost implications. ESA operates a policy of fair return which means that each member state should receive a level of return in work contracts which is proportionate to their contribution to the ESA budget. Experience in the defence area has shown that such an approach can lead to the artificial splitting of work and the allocation of contracts on grounds other than on the basis of best value. It was described by the then Chief of Defence Procurement as a “tax on defence”.¹⁷ The Department acknowledged the risk that the operation of fair return by ESA could reduce value for money.¹⁸

16. The operation of fair return also requires the maintenance of accurate records linking contracts awarded to countries. ESA in 2000 revised their system for tracking returns with the result that for two years they misallocated some contracts to the United Kingdom. This was spotted in 2002 by a British company who brought the matter to BNSC’s attention. This misallocation had the effect of artificially overstating the United Kingdom’s level of return, which might have restricted the ability of United Kingdom firms to bid for and win contracts with ESA. Since 2002, BNSC has been working with ESA to rectify the position which has resulted in ESA reallocating approximately £10 million of contracts from the United Kingdom to other ESA member states.¹⁹ BNSC assured us that all possible steps have been taken to prevent such errors happening again.²⁰

17. British firms in the space industry need to be sufficiently competitive and well informed to take advantage of opportunities that arise. CERN, another pan-European body to which PPARC also pays a substantial annual subscription, does not operate a fair return system. In this case British firms had often not been successful in competitions for contracts,²¹ emphasising the need for all members of the BNSC Partnership to ensure that firms in the United Kingdom are well placed to win international space contracts.

18. The Department’s national space programme, aimed mainly at positioning UK firms to compete successfully for ESA contracts, has been subject to a significant reduction in recent years.²² The Department now does not have a separate national space budget but a more general technology budget within which space competes for resources along with

15 C&AG’s Report, para 4.8

16 Q 106

17 17th Report from the Committee of Public Accounts, *Maximising the benefits of defence equipment co-operation*, (HC 586, Session 2001–02), para 14

18 Qq 60–61

19 C&AG’s Report, para 3.9

20 Q 104

21 Qq 62–63

22 C&AG’s Report, para 3.12, Figure 16; Q 65

many other types of scientific activity.²³ In principle this competitive approach has the merit of directing resources to the most promising technology areas. But its success depends on good quality information on costs and prospects. And there are risks of variable flows of support to a space industry which needs a degree of stability to promote a long-life-cycle business.

19. More generally, the BNSC partnership provides advice and support for firms in the space industry when competing for contracts in ESA. Surveys indicate that large firms find it easier to access such advice than small firms. The Department pointed to a number of general initiatives which it and the Small Business Service has to support small and medium size firms generally, but agreed that there was more they could do to reach out to small firms in the space sector.²⁴

20. BNSC have no performance measures which summarise commercial benefits from space, or which assess progress towards the strategic objective to “stimulate increased productivity by promoting the use of space in Government, science and commerce”. But some insights can be drawn from commercial data sources. For example, despite the United Kingdom’s significantly smaller spending on the space sector the ratio of the turnover of our space industry to national space expenditure is better than either France or Germany, both of which spend significantly more in space than the United Kingdom.²⁵

21. There are a number of examples where BNSC support has assisted United Kingdom firms in developing new products and winning key contracts with ESA and other bodies. For example, the United Kingdom has developed a world leading capability in small satellites which has been supported in part by funding from the Department’s programme for Micro Satellite Applications in Collaboration (MOSAIC) which is designed to encourage the United Kingdom’s small satellite capability. That programme has led to sales worth £50 million with the potential for more to come.²⁶

22. One of the largest current space projects which the United Kingdom is involved in is the Galileo project, a joint initiative between ESA and the European Union designed to provide Europe with its own global civil satellite navigation system. If successful, Europe would no longer have to rely on using the two existing satellite navigation systems owned by the United States of America and Russia. Providing such a system is estimated to cost up to £2 billion in the development phase alone²⁷ but the estimates of the economic benefits that such a system could generate are also estimated to be considerable. The BNSC Partnership is forecasting a likely increase in net economic benefit to the United Kingdom from the introduction of Galileo of £6.3 billion by 2020.²⁸ The House of Commons Transport Committee has recently issued a report on Galileo stating that they “are not convinced that the costs and benefits have been properly assessed”, and that “the Government should not go ahead with the programme until a further, independent, cost

23 Qq 69–71

24 Q 105

25 C&AG’s Report, 1.13

26 *ibid*, Figure 15 and Appendix 3, para 3

27 *ibid*, Figure 8

28 Q 108

benefit analysis has been undertaken”.²⁹ The Committee heard evidence which indicated that some of the benefits being claimed for Galileo should properly be ascribed to an existing smaller European Navigation system.³⁰

29 18th Report from the Transport Select Committee, *Galileo* (HC 1209, Session 2003–04), para 24

30 *ibid*, para 19

4 Maximising the scientific and human benefits from space activity

23. The Government’s third objective for the space programme is “to develop innovative space systems to deliver a sustainable improvement in the quality of life”. The Department acknowledged that while individual partners have processes to enable them to measure the outputs and achievements of their parts of the space programme, the BNSC Partnership cannot measure the overall achievements of the space programme against its objectives.³¹ The Report from the Comptroller and Auditor General contained some proposals from consultants which identified critical performance areas (**Figure 3**) for the BNSC Partnership and a framework of 39 potential measures which could be used to track performance within those areas of performance, and that the Partnership was currently piloting some measures.³²

Figure 3: Critical Performance Areas for the BNSC Partnership

Delivery of world class research
Promotion of space as a source of innovative services in the United Kingdom
Development of technologies to deliver advanced systems and services
Design and development of advanced space systems and services that drive innovation
Effectiveness of BNSC Headquarters in developing relationships across Government
Effectiveness of BNSC Headquarters in acting on behalf of the Partnership on regulatory issues
Delivery of trained people
How effectively the Partnership promotes and supports UK space organisations
Growing the delivery of new services provided by way of space technology
Effectiveness of the BNSC Headquarters in acting on behalf of the Partnership in international forums
Financial management

Source ESYS (C&AG’s Report, Figure 12)

24. BNSC pointed to some important individual scientific advances which have resulted from the United Kingdom’s involvement in space and which could impact on people’s lives. Examples include the monitoring of the thinning of the ice sheet in Western Antarctica and the monitoring of displacements across the fault lines under the Earth’s surface that cannot be obtained from seismology.³³ Such developments help make the benefits of exploring and using space more understandable to the general public and this is further enhanced by projects such as Beagle 2 where it was a condition of grant that Beagle 2 would be used to promote the benefits of space science to the wider population.³⁴ However, it does not take long for the public awareness of such issues as space to fade and if the United Kingdom is to continue to flourish in the space sector it needs to promote awareness to attract skilled people into the sector.

31 Qq 100–101

32 Q 127

33 C&AG’s Report, Appendix 3, paras 12–13

34 Q 89

25. The accurate assessment of the wider benefits from space activities, which may take many years to emerge, depends on comprehensive programme evaluation arrangements. If the lessons identified are to be applied, evaluation results need to be widely disseminated. BNSC referred to a high level evaluation of recent space technology support programmes which came to the conclusion that programmes had been largely successful in meeting their objectives, and helping to win contracts and sell services.³⁵ But the level and quality of evaluations of programmes and of individual projects has to date been erratic.³⁶ The report of ESA's review of the high profile Beagle 2 project was not initially released even to Professor Pillinger and his team, though it has now been published.³⁷

35 Q 27

36 C&AG's Report, paras 4.11–4.12

37 Q 126

Formal minutes

Wednesday 6 April 2005

Members present:

Mr Edward Leigh, in the Chair

Mr Richard Allan

Mr Ian Davidson

Mrs Angela Browning

Mr Alan Williams

The Committee deliberated.

Draft Report (The United Kingdom's civil space activities), proposed by the Chairman, brought up and read.

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

Paragraphs 1 to 25 read and agreed to.

Conclusions and recommendations read, amended and agreed to.

Summary read and agreed to.

Resolved, That the Report be the Twenty-first Report of the Committee to the House.

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

Ordered, That the provisions of Standing Order No. 134 (Select Committees (Reports)) be applied to the Report.

[Adjourned.]

Witnesses

Wednesday 24 November 2004

Page

Sir Robin Young KCB, Department of Trade and Industry, **Dr Colin Hicks FRSC**, British National Space Centre, **Professor Ian Halliday**, The Particle Physics and Astronomy Research Council, and **Professor Colin Pillinger CBE FRS**, The Open University

Ev 1

List of written evidence

Department of Trade and Industry
Professor Colin Pillinger

Ev 16

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Fifth Report	Excess Votes 2003–04	HC 310	(<i>N/A</i>)
Sixth Report	Excess Votes (Northern Ireland) 2003–04	HC 311	(<i>N/A</i>)
Seventh Report	Foreign and Commonwealth Office: Visa entry to the United Kingdom: the entry clearance operation	HC 312	
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The reference number of the Treasury Minute to each Report is printed in brackets after the HC printing number

Oral evidence

Taken before the Committee of Public Accounts

on Wednesday 24 November 2004

Members present:

Mr Edward Leigh, in the Chair

Mr Richard Bacon
Mr David Curry

Mr Brian Jenkins
Jim Sheridan

Mr Tim Burr, Deputy Comptroller and Auditor General, further examined.

Ms Paula Diggle, Second Treasury Officer of Accounts, further examined.

REPORT BY THE COMPTROLLER AND AUDITOR GENERAL:

Department of Trade & Industry:

The United Kingdom's Civil Space Activities (HC 359)

Witnesses: **Sir Robin Young, KCB**, Permanent Secretary, Department of Trade & Industry; **Dr Colin Hicks FRSC**, Director General, British National Space Centre; **Professor Ian Halliday**, Chief Executive, The Particle Physics and Astronomy Research Council; and **Professor Colin Pillinger CBE FRS**, Head of Planetary and Space Sciences Research Institute, the Open University, examined.

Q1 Chairman: Good afternoon. Welcome to the Committee of Public Accounts. Today we are looking at the United Kingdom's civil space activities. We are joined by Sir Robin Young, who is, of course, the Permanent Secretary to the DTI. Would you like to introduce your colleagues, Sir Robin.

Sir Robin Young: Certainly. On my far right we have the well-known presence of Professor Colin Pillinger, Professor of Planetary Sciences at the Open University; on my left is Professor Ian Halliday, Chief Executive of PPARC; and on my right is Dr Colin Hicks, Director General, British National Space Centre, BNSC.

Q2 Chairman: We know, Sir Robin, that our space programme is very different from others in Europe; for instance, we spend about a quarter what the French government does and the German government does, half what the Italians spend, and our space activities are organised in a very different way. If you look at page 12, figure 6, it has different ways of operating a space programme. In this country we have the partnership approach, of course. Is it a fair criticism of the partnership approach that we have that there is no strong national champion for space science?

Sir Robin Young: You have drawn attention, Chair, to table 6 on page 12, which I think fairly brings out the strengths and weaknesses. If I could just pause on the strengths first, I think the bottom five indents there are really quite strong. A clear view

of our UK space activities reinforces the user-led philosophy, which is really quite important, because if I could go then to your question, if you do not like the user-led philosophy, then it would indeed be sensible to go to a NASA-type space agency, because under the weaknesses of NASA there, it has the NASA model at the top right of that table: "increases the likelihood that space is funded as an end in itself." That is the key difference between us as to whether we have a space agency which is there to do space things, or whether, as we do, we have a partnership approach, which is to do those things which the partnership members decide they want to do, and they then have some internal competition with other things they want to do. I see that, as the table does, as a strength of our system, but it is certainly the case that if you wanted to have the thing focusing on space rather than on the partners' objectives and needs, another model would be good. The Report has it right on page 13 at paragraph 1.14. "There is a risk that BNSC Partnership secures a less coherent approach than the alternative. We have found, however, that in practice the Partnership has allowed the UK to present a single face to ESA and other international space forums." So I think your question rightly draws attention to the risk that the partnership approach does not allow a comprehensive view or presence but in practice I think the Report has it right, and we have it both ways; we get the strengths of the partnership approach as detailed in table 6 and the coherent approach in paragraph 1.14.

Department of Trade and Industry, British National Space Centre,
The Particle Physics and Astronomy Research Council and the Open University

Q3 Chairman: Professor Pillinger, do you think that space science could benefit from having a stronger national champion in our governmental agencies?

Professor Pillinger: I actually made this point at the press conference held on the inquiry into Beagle 2, saying that if Britain aspired to having a bigger role in space, the obvious progression was, despite all the excellent work which is being done by the BNSC, that we should be leaning towards a space agency, in which case, we would have the staff and the skills to manage a space project along the lines that the European Space Agency said we were deficient.

Q4 Chairman: Perhaps we can go straight away to Beagle 2, which we can find on figure 18. The history of it is dealt with there on page 27. Dr Hicks, if Beagle 2 was so highly valid in terms of its scientific opportunities, why was it not properly and fully and publicly funded from the start?

Dr Hicks: When the Beagle project was brought forward, it was looked at initially by PPARC to see whether they could accommodate it within their funding, and Ian Halliday may want to comment on that. In the subsequent examinations, it was seen very clearly to have very high prospects, and ESA marked it very highly. We looked very hard at how the project could be taken ahead and we succeeded in taking it ahead on the best basis that was possible at the time.

Q5 Chairman: Were you happy, Professor Pillinger, with this drip funding?

Professor Pillinger: I was not exactly happy with drip funding but I knew that this was going to be the way it was going to happen because I was on the appropriate committee of PPARC at the time, so I knew what the PPARC forward look was predicting in terms of future missions, and I knew that there was no allocation for Mars and there was certainly no allocation for a lander. When Mars Express came upon the community as a surprise mission, because it was put in place to recover a mission that had been lost that had been launched by the Russians, it carried a huge payload from Europe. Unfortunately, there was no British contribution to that payload, but when Mars Express happened, I saw that the time was right and the scientific challenges were there to mean that Europe should be thinking of launching a lander.

Q6 Chairman: I am sorry to interrupt. We are looking at this in terms of the taxpayers' point of view in this Committee. We see that the funding has gone up from £27 million to £42 million. Is that escalation broadly correct, Dr Hicks?

Dr Hicks: It is broadly correct.

Q7 Chairman: If you look at this figure on page 26, if you look at the first column down towards the bottom, it says that "... the written submissions which BNSC put to the DTI and the Office of

Science and Technology to request funding did not include explicit assessment of the risks to the project, nor any quantification of the possible outcomes of the project." Why?

Dr Hicks: When that criticism came forward during the course of the NAO study, I was surprised to find that that was stated to be the case, because throughout the various considerations we made of the case and the discussions we had had with the Minister, we had had extensive discussions with him about the risks of all kinds, and I was entirely satisfied in my own mind that we had presented the Minister with all of the information that he needed, including full assessment of risks. I was surprised when that specific criticism was made, and what it says in the Report is that the written formal submissions did not cover those risks to the extent it should have done. I went back and looked at the formal appraisal submissions and I had to admit, in discussion with the NAO, that they were correct in that specific criticism. I then looked at all the papers and the discussions that we had had with the Minister and the records of the exchanges with the Minister, and what I found well recorded in all of that—and I think this is why the NAO Report mentions the formal appraisal submissions—we had actually given the Minister the information which he needed, and it was an oversight that the formal written submissions did not have that detail within them. But the Minister was in possession of all of the relevant facts and assessment of risks.

Q8 Chairman: If colleagues turn back to page 25, they can see at the bottom in the last column it details the Casani review, and it is quite clear. It says "There was no margin available in the proposed mass (ie the weight) of the lander" and other possible dangers that could arise in the project. It looked like a fairly fragile project. Did you follow up the Casani review?

Dr Hicks: Yes, we did, and that is acknowledged in the NAO Report, where it says they produced and implemented a detailed action plan in response to these findings. The Casani review was an excellent review by an international group who looked in very fine detail at the project and came up with a series of recommendations. It said in fact that the project was challenging but eminently doable—again, I am quoting a phrase that has been picked out in the NAO Report. It talked about the management as being on an unusual basis but it was working. So we had confidence on the basis of the Casani review that, provided we went ahead, dealing with the issues, the project could be completed.

Q9 Chairman: Professor Pillinger, we have the ESA conclusions about this project now. Do you agree with all of them?

Professor Pillinger: I have not seen all the conclusions about this project. I have never seen the final report of the inquiry. I have only ever seen the recommendations.

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Q10 Chairman: Do you agree with them?

Professor Pillinger: The recommendations in some cases are motherhood statements. The team itself drew up a much deeper inquiry and many of the recommendations that ESA came to are the same as the team's, so yes, you could say I agree with them. I do not necessarily agree with the ones which are implying we did things which in fact we did not do.

Q11 Chairman: Would you like to amplify that reply?

Professor Pillinger: There are situations like the mass which is criticised; things like communications with the spacecraft during the entry and descent. We knew that communication was impossible. ESA had told us it was impossible because the priority for the mission was Mars Express, the orbiter, and therefore they could not risk the orbiter in order to turn the antenna towards listening for Beagle 2. So the Beagle 2 team dropped the package that it intended to put on the lander which was done to transmit the signal for the space orbiter to look for. It is self-evident from all other missions that you will gain information if you monitor a lander which is descending to the surface. You will know, if it went wrong, where it went wrong and you can act accordingly. That is a motherhood statement that I would totally agree with.

Q12 Chairman: Sir Robin, from your perspective, is there anything you would do differently in future, do you think?

Sir Robin Young: Yes. We have accepted the recommendations of the ESA inquiry in three rather important respects, and we would never go ahead on the basis that we went last time, where the Beagle 2 lander was treated as a non-integrated part of the overall project, but a lander add-on. There were two projects, the Mars Express project and the Beagle lander project. The inquiry report recommended and I think we accept that really the two should have been integrated right from the start. They were not two separate projects there, and that is a failure which we would never do again. It was an accident of time. It was not our fault. That is a lesson to learn. The second thing is to do with funding. What actually happened was that ESA approved the Beagle 2 application because of its high and exciting quality before they satisfied themselves or could have satisfied themselves that Beagle 2 was funded. So we got approval from ESA to award the project to Colin Pillinger's team, quite rightly, but before we had got the funding sorted. So funding then had to be found after the approval. The recommendation of this Report, which we accept, is that really, we should not approve a project or a project phase if more appropriate until the funding is there, and ESA has checked whether the funding is adequate in light of the risks. Those are two big lessons for us.

Q13 Jim Sheridan: I think you would agree this is somewhat of a technical, anorak's Report and very difficult for some of us. Is Beagle 2 lost to us for ever?

Professor Pillinger: It was only built to survive for 180 days, because dust settling in the Martian atmosphere would land on the solar arrays and therefore we could no longer charge the battery. If you want to find Beagle 2, I suggest you send . . .

Q14 Jim Sheridan: Beagle 3?

Professor Pillinger: No. I suggest you send people to Mars who can search for it.

Q15 Jim Sheridan: Are the Americans not already ahead of us anyway? Maybe the Americans could do that.

Professor Pillinger: In actual fact, in scientific terms, the Americans were not ahead of Beagle 2. The science package on board Beagle 2 was going beyond the American programme, which was to search for evidence of water. We were actually carrying it through into analysing the samples for evidence of life, and what is more, carrying the experiment on to see whether there was life in the past or life in the present. The Americans are not planning to do that until at least 2009.

Q16 Jim Sheridan: Given the close relationship between ourselves and the Americans, why did we go to Mars at the same time as the Americans?

Professor Pillinger: 2003 was the best opportunity to send a spacecraft to Mars for 60,000 years. Every space agency that could get a rocket on the launch pad was doing so. The Japanese had one going, Europe had one going and the Americans had two going.

Q17 Jim Sheridan: Sir Robin, can I take you to page 22, paragraph 3.8 and just ask a very simple question. What is "juste retour"?

Sir Robin Young: It is a most unfortunate French term. In proper language, we would call it the concept of a fair return, whereby we get back by way of contracts to British firms the money we put in. If I could ask you to go back to page 21, you will see a graph on table 14 under the heading "concept of fair return" and you will see that our objective is to get at least 1.0 back. In other words, 1.0 proportion of what we pay in we need to get back for British firms. In the past, 2001–02, we were going well over, and exceeding, or getting an unfairly high return, if I can put it like that. We have since come down a bit. The 2004 figure, if we were to carry on table 14, that graph, would get us to 0.95, so we are very nearly back to equilibrium. This just tracks the return to British business from our contribution to ESA.

Q18 Jim Sheridan: I think it is fair to say that British firms have not done too well out of this.

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Sir Robin Young: No, no, it is not. The opposite. If you look at 1998, 1999, 2000, 2001 and then up till 2002, we have done “too well”. I of course do not mean too well.

Q19 Jim Sheridan: We did well during those years but now we are not doing so well.

Sir Robin Young: We are back to 0.95, so over the period of years we were doing too well in aggregate at the moment, and I am hoping we will go further up still.

Q20 Jim Sheridan: What are we doing to make sure that happens?

Professor Halliday: This return is necessarily rather lumpy. It is driven by contracts being let. It is not an average of thousands of contracts but it bounces around in time with expenditure. In the context of space science, PPARC is trying harder and will try harder to build R&D with firms to position them in a better way to achieve these contracts whilst simultaneously, we hope, getting better science out. Through ESA there are indeed contracts for British firms that position them to get bigger contracts when the actual build contract is let. There is a systematic procedure inside ESA to make this happen, which is basically our money being channelled through ESA. There is also a dialogue between PPARC scientists, and universities typically, and British industry about what projects we want to do in the future. I am sure Colin could tell you details of past examples.

Q21 Jim Sheridan: What kind of firms are involved in these contracts?

Professor Halliday: The big firm is Astrium UK which, of course, is a part of EADS, so it has factories and it has R&D facilities in the UK but it is very much a European firm.

Q22 Jim Sheridan: There is a manufacturing and academic link-up there?

Professor Halliday: They certainly talk to each other all the time.

Q23 Jim Sheridan: Some people do not listen to each other when they talk to each other.

Professor Halliday: No, no. Let me give you an example. The successor to the Hubble space telescope is being talked about, designed and financed. It is not built yet. Britain has a lead responsibility for one of the three instruments that will be critical to success of the Hubble. That is very much an interaction between UK scientists in universities and the scientists and engineers in Astrium which makes that whole thing work. It is very closely tied together.

Q24 Jim Sheridan: One of the questions that is commonly asked of people I know who are directly involved in space projects is “Why are you spending money on space when we cannot sort out

the problems on earth?” What tangible evidence is there that the space projects are making some kind of advance in people’s life on Earth?

Professor Pillinger: Would you like me to try to answer that? The instrument that we built at the Open University to look for life on Mars was a compression of a whole room full of equipment down to about 5.5 kg. The flight model of that instrument was actually funded by the Wellcome Trust on the basis and the understanding that we would use the skills of the team to explore possible spin-off into the areas of interest of Wellcome, which are mostly medical, biomedical, and veterinary.

Q25 Jim Sheridan: Has anything like that happened?

Professor Pillinger: We have that team working on a development project now which is looking into human health, animal health, drug testing, security, the possibility of food storage, six or seven different applications.

Q26 Jim Sheridan: Have you identified or produced anything or are you still working on it?

Professor Pillinger: We are turning the technology into something that could become commonplace, that could be used by skilled technical people as opposed to expert scientists for testing in the workplace, for testing at sources such as airports and so on.

Q27 Jim Sheridan: Finally, has there been any kind of systematic programme of evaluation other than just the commercial impact of these projects? Have you carried out an evaluation?

Dr Hicks: Yes. We have carried out a number of evaluations. The NAO Report refers to what is called the SQW study which reported earlier this year on the investments by the Department of Trade & Industry in space, and it produced conclusions which endorsed what was being done. It said that projects were very largely successful in meeting their objectives, with tangible outcomes in terms of winning contracts, and significant sales of goods and services had arisen from the outputs of the project. There was clear evidence of improved innovation performance. It went on to make a number of recommendations about the future, as always in such evaluations, as to how we could refocus and improve further the returns that we were making. A number of those recommendations have been taken into account in what we are doing, for example, in our recently published technology strategy.

Q28 Jim Sheridan: When will the consumer see any evidence of the taxpayers’ money that has been invested in these projects?

Professor Halliday: To be simple, when you turn on your Sky television. That is coming from a satellite. That did not happen by accident. That is putting it very simply.

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Q29 Jim Sheridan: When you say Sky television is tangible evidence of improvement in people's quality of life?

Professor Halliday: There is the technology.

Professor Pillinger: If you turned the satellites off for a day, you would notice the difference pretty quickly.

Q30 Jim Sheridan: I personally would not notice the difference.

Professor Pillinger: Yes, you would.

Professor Halliday: Your telecommunications would regress substantially, if not collapse.

Q31 Jim Sheridan: So did Sky television contribute to this?

Professor Halliday: No. They are separate.

Q32 Mr Bacon: Professor Pillinger, it says on page 25 of the Report that Beagle 2 was offered alpha plus, the highest rating possible, in January 1999. When that appraisal took place, what was the proposed weight of Beagle 2?

Professor Pillinger: Sixty kilograms for the probe, with 3 kg on the Mars Express orbiter, but PPARC were not assessing the engineering of the probe. PPARC's role here was to assess the quality of the science which was for the instrument package which contributed within the lander to 11.2 kg.

Q33 Mr Bacon: But the total was 63 kg?

Professor Pillinger: The total was 63 kg, and those are for the systems to get you to the surface of Mars.

Q34 Mr Bacon: When were you told that you would have to cut the mass of Beagle 2 in half?

Professor Pillinger: That was in the review that was carried out around March 1998. That was before that time.

Q35 Mr Bacon: In other words, before that assessment, you already knew you would have to cut the mass?

Professor Pillinger: Before the PPARC assessment of the science. The situation was as follows. We were told by ESA that there was probably 200 kg available for landers at Christmas time 1997. We submitted a proposal in early 1998 for 108 kg. In March 1998 we learned that Mars Express could no longer afford 200 kg for landers. They could only afford 60 kg for one lander, and since nobody had bid 60 kg, there was going to be no lander. The Beagle team went into a huddle and after a week's work . . .¹

Q36 Mr Bacon: Just for clarification, when did this week's work start?

Professor Pillinger: This would be April 1998. We went into a huddle at Astrium, which was then called Matra Marconi, and we worked for a week and we came back and said that if we stripped

certain things out of the lander which we had been expecting to put in, because there were other collaborative projects going, then we would just build the lander for 60 kg. We then went back to ESA and said we would build it for 60 kg, and they organised another separate competition so that everybody who wanted to try and bid a 60 kg lander could have a go.

Q37 Mr Bacon: Can I just be clear? Sixty kilograms was the final weight that you had to work with?

Professor Pillinger: That was announced to us as the final weight we would have to work with at the end of 1998.

Q38 Mr Bacon: When it was reported that you were told that you would have to halve the weight, 60 kg was the new halved weight?

Professor Pillinger: That was the new halved weight.

Q39 Mr Bacon: What was the assessment that was done in January 1999 by PPARC done on? Was it done on the design of a 60 kg module or on the older, heavier one?

Professor Pillinger: That was done purely and simply on the instruments that were aboard the 60 kg lander, of which there were 11 kg.

Q40 Mr Bacon: Is it true that you designed the new Beagle 2 on a beer mat? Did you not write in your book on page 104 that you did it on a beer mat?

Professor Pillinger: I can show you a film. We did not design Beagle 2 on a beer mat. We drew Beagle on a beer mat in a bar in Toulouse. We drew how we would open Beagle.

Q41 Mr Bacon: Do you not think that, once you realised the mass was going to have to be substantially cut, it was probably time to call last orders on it?

Professor Pillinger: No, absolutely not, because what we did to get down from 108 kg was to remove a roving vehicle and we came up with a very innovative way of giving movement to Beagle. In fact, it gave better movement in that it would go down under the surface of the planet instead of across it.

Q42 Mr Bacon: It certainly did go down!

Professor Pillinger: You have no evidence of that and neither do I.

Q43 Mr Bacon: We have no evidence at all.

Professor Pillinger: It could be a wire wrong. It could be sitting on the surface trying to communicate with us.

Q44 Mr Bacon: How many people do you think believe that?

¹ Ev 17

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Professor Pillinger: The whole team have been through every system of Beagle and we could find nothing that could not or should not have worked, therefore it could be something as simple as one wire wrong. It could be.

Q45 Mr Bacon: It says on page 25 at the bottom that there was no margin available in the proposed mass, ie the weight of the lander, and in the bottom bullet point on the page it says “although the project had a risk management plan, unless mass (ie weight) and schedule margins were restored risk management in the classical sense, would continue to be non-existent.” Dr Hicks, you said in answer to an earlier question by the Chairman that although it was not done as formally as you would have wished, the Minister was made aware of all the risks. That is a fair representation of what you said, is it not? Are you basically saying that you said to the Minister that once the weight had been cut, this thing had really very little chance of success? That is the reality, is it not? Once the weight was substantially cut, you lost all the margin as far as the mass was concerned, you lost the schedule margin, therefore the risks were then extremely high, and there was, in the classical sense, no risk management; it would be non-existent. Those were the facts. Are you saying that is what you made clear to the Minister and that the Minister, despite being told this had very little of chance of success because it had, classically speaking, no risk management at all, he said, “Fine, we will go ahead”?

Dr Hicks: Our initial assessments were made on this reduced mass, as has been made clear by Professor Pillinger. We made an assessment as to whether this project was doable. Casani said yes, it was doable. We had to take action to restore mass margins. We took action in the course of the project to restore mass margins. It remained tight but, I think as Professor Pillinger will confirm, Beagle was delivered within a very tight mass. I believe it was under 70 kg at the end, when we had secured some release of a little additional mass from the European Space Agency in discussions with the Mars Express team.

Q46 Mr Bacon: Is it true you were told if you went one gram over the permitted mass, you would be thrown off Mars Express?

Dr Hicks: I have no recollection of that statement being made. It may have been made to Professor Pillinger.

Q47 Mr Bacon: Were you told that, or was anyone in the team told if you were one gram over the weight, you would have been thrown off?

Professor Pillinger: At no time were the words “one gram” ever used. We were told that the mass limits of Beagle were 60 plus 3 on the orbiter, the implication being this: it is 60 plus 3, not 60.41.

Q48 Mr Bacon: You denied that the words “one gram” were ever mentioned. Can you tell me what was said to you about tolerances for the weight?

Professor Pillinger: Everyone in the space business knows that the project manager of the whole mission carries a contingency mass.

Q49 Mr Bacon: What is a contingency mass typically?

Professor Pillinger: I would not know the answer to that. It is up to the project manager what he thinks he needs to carry.

Q50 Mr Bacon: This is interesting. Are you saying basically you hoped you had a bit of ceiling room into which you could eat if necessary? Is that what you are saying?

Professor Pillinger: In every space mission there is some ceiling into which you can eat. It was made quite clear to us that Beagle was not going to be allowed to eat into the contingency. It was going to be used for the priority, which was the Mars Express orbiter.

Q51 Mr Bacon: So basically, it was made clear to you that you had to either do it within the prescribed weight that had been agreed, an admittedly reduced weight, which was less than you had originally wanted, or you would not be on the Mars Express?

Professor Pillinger: It was clear to us that that was our limitation, and what John Casani said in his review was not aimed at Beagle; it was aimed at the European Space Agency, saying that these guys should be allowed to have something restored to them in terms of a contingency, otherwise there would be a problem.

Q52 Chairman: But that did not happen.

Professor Pillinger: We never had an official declaration from ESA that we were allowed to go up in terms of mass. We did make an application, and the application went through the system. It eventually was rejected and so we built Beagle to 68 kg, as Dr Hicks has already said, and we delivered Beagle over the mass, the 60 plus 3. So we built Beagle to the mass that we believed that we had to. Every space engineer will tell you that if he can get more mass, he will take it.

Q53 Mr Bacon: You still have not answered my question. Were you told at any point—forget about the one gram [en rule]that if you did not fulfil certain conditions, you might find yourself thrown off Mars Express?

Professor Pillinger: I cannot recall being explicitly told that we will be thrown off, but there was always a statement with a loaded end that our limitation in respect of mass is 60 plus 3 kg.

Q54 Mr Bacon: You have told us that as you were going through the landing phase you could not monitor what was happening because of the antenna.

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Professor Pillinger: We could have sent a radio signal, but there was no asset available to listen to that signal and record it.

Q55 Mr Bacon: I think what happened is this: you were cut back to a level that made it basically impractical but because you wanted to hold on to the dream come what may, you went ahead with a great deal of taxpayers' money that might have been spent better elsewhere on research, knowing it had almost no chance of success, and that it had in risk management terms none whatsoever. You decided to go ahead anyway. Was that not rather a reckless thing to do?

Professor Pillinger: I disagree totally with your interpretation of what we did. The team that built this spacecraft built it to the absolute best of their abilities within the constraints placed on us, which is always the case—

Q56 Chairman: That is not an answer to the question put to you by Mr Bacon. I am sure you did your best. What he put to you was that, once the weight of this was cut down so there was virtually no risk management whatsoever, you were so enthusiastic about this project that you carried on with it and as a result, the taxpayer has lost £42 million.

Professor Pillinger: I am sorry. If the question is that we were wilful after it was cut from 108 kg, the answer to that is that the 108 kg lander was entirely different from the 60 kg lander. The 60 kg lander stood every chance to succeed. It was entirely different from the 108 kg lander. That was designed under an entirely different scheme, so the answer to your question is no. By going down to 60 kg we were actually building a different design.

Q57 Mr Bacon: But a design that had no margins available for mass and no margins available for the schedule. That is right, is it not?

Professor Pillinger: The design was built to 60 kg plus 3 and there was always some little margin available within our project and every space engineer will tell you he wants more.

Q58 Mr Bacon: The words of the Casani review were that there was no margin available. That is what it says on page 25 of the Report to which the Department has signed up. There was no margin available in the proposed mass, and also the contingency in the schedule which the consortium had to meet was inadequate, and that unless the mass and schedule margins were restored, risk management in the classical sense would continue to be non-existent. That is essentially what the Department has signed up to. You cannot just agree to this Report. It is signed off on.

Professor Pillinger: There is no way you can restore anything to the schedule. 2003 was the launch date. There are some space missions you can delay launching because you can just go at another time. Mars was coming round in 2003 as the closest it had ever been in 60,000 years, and that meant that

there would be a mass limit on what we could launch at that particular time, and our allocation was 60 plus 3, and we endeavoured to work to 60 plus 3. When we found we could not, we worked above 60 plus 3, and ESA eventually accepted the spacecraft. So we did not wilfully stay to 60 plus 3; we actually let the spacecraft rise in weight to make sure that we minimised the risk.

Q59 Mr Curry: Sir Robin, this expression "*juste retour*" brings back all sorts of nostalgic echoes, does it not? It does not actually mean "fair return", does it? In this context, it means getting back what you put in, which is not the same as a fair return.

Sir Robin Young: It means at least what you put in. Our objective is to get back what we put in, and we have achieved that objective over the aggregate period there.

Q60 Mr Curry: I can see we have got it, but it is a pretty dodgy concept for running a joint venture, is it not? Is not every single joint venture, whether it is building war ships or aircraft, plagued by this concept of a "*juste retour*" where everybody has to get their bit of the action? Does everything not end up costing a great deal more than it might do if it is all being run on sensible commercial lines?

Sir Robin Young: Colin Hicks will fill me in on this, but, to agree with the underlying thinking behind your question, our part we play in ESA is to ensure that does not happen, so when you look at what we do in the non-mandatory schemes which are somewhere in this Report, page 10, the optional schemes, you will see how careful we are to participate in only those schemes where we think there is real value and when the UK commercial sector benefits. We certainly try and make sure that is the best possible—

Q61 Mr Curry: I can quite see that but the point I am making is this. I have read the Report as well. The *juste retour* was instituted so that small countries might make sure they get something back out of the kitty. My observation is simply that this might be necessary politically but if you are running a business programme, it is not the best way to run a business programme, is it, because you might well end up paying more than you need to because you have a multiplicity of sub-contractors where you might get by with fewer?

Sir Robin Young: In principle, I agree with what you are saying. Dr Hicks is on the board of this thing. Do you want to say how we avoid falling into that trap?

Dr Hicks: Mr Curry, I share your analysis. This is a risk. It is a risk of which we are very well aware. The concept within ESA is that many countries subscribe because they believe they are going to get money back. We subscribe because we believe in the value of a project. The rules are agreed on the basis of a *juste retour*. There is a margin for any particular activity within which the *juste retour* is expected to lie, that is, between 0.9 and 1.1. Every effort, with pressure from us through what is called

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the Industrial Policy Committee, is there to make sure that everything is done as far as possible within the constraints applied by *juste retour* to get competition and value for money.

Q62 Mr Curry: But the two might not necessarily be synonymous in these circumstances.

Dr Hicks: There are very rare examples . . .

Professor Halliday: Can I just interject. In my patch, so to speak, we have the European Space Agency, which has *juste retour*, and there is a certain style interacting with industry. We also have CERN, which does not have *juste retour*, and the UK high-tech industry does not do wonderfully well in the competitive environment, so one has to be slightly careful.

Q63 Mr Curry: That is a very interesting remark. So in a competitive environment, we are not up to scratch?

Professor Halliday: I am just saying in the CERN we are not getting *juste retour*.

Q64 Mr Curry: Having been seduced by all the Chancellor's arguments about how wonderfully competitive Britain is and how much better we are than anybody else, I naturally assumed that in a competitive world we get a lot more than our share, but you are saying the *juste retour* might actually bail us out from getting less, as I understand it.

Professor Halliday: That is a possible scenario.

Q65 Mr Curry: Thank you very much for that. Could I move on. I am not going to continue Mr Bacon's anthropomorphic investigation of Beagle. I am interested in the DTI's national programme, which has come down to £8.4 million. There are areas of London where you cannot buy a house for £8.4 million, are there not? Sir Robin, you may own a house which is worth 25% of the entire national space programme, for all I know. Having been in government and knowing that you have gone through some fairly grizzly public expenditure rounds, and knowing that it is quite difficult nowadays to find anybody who actually thinks the DTI should exist—I may be one of the few, for all I know, but I am old-fashioned in all sorts of respects—would I be right in thinking that when you get to a nasty public expenditure round, the advice comes up to you that “This looks pretty vulnerable, Sir Robin. We could knock this one on the head, the national space programme.”

Sir Robin Young: That is not the discussion we have had.

Q66 Mr Curry: It could be though. If you get down to £8.4 million, the temptation is to say “What on earth are we buying for £8.4 million? What is the point of carrying on?”

Sir Robin Young: Let me refer you to page 30, which breaks down the national programmes of BNSC as between DTI and the two research councils, and obviously we have one research

council here. The table 19 at the top left on page 30 adds up to about 36, and the DTI programmes come to 7, which is about a fifth.

Q67 Mr Curry: That is in the text. I do not dispute that. But the fact is that once our contribution to the European space programme went up, for a number of reasons, of which currency factors was one, the Treasury's response was actually to take it out of the domestic programme, was it not?

Sir Robin Young: Actually, it was the DTI and Treasury response. To talk you through the cuts, you are right. Paragraph 3.13 has it right. We had £2.5 million cut per year as a result of spending round 2002, or whichever spending round it was, which adds up to £7.5 million, that is in paragraph 3.13, to which you add this other figure of £5.8 million, which was the increased subscription to ESA and, as you say, currency fluctuation. That was the reason. We then had a choice of as it were making up that, and we could not, because of overall spending cuts. But I must make the point that BNSC spend as a whole, as per table 19, is going up and will continue to go up as the massive increase in the science budget comes through to research councils. I remind you, the science budget has been doubled in real terms, that is, between 1997 and 2007. It would be amazing if the two research councils concerned did not get some of that. So overall the BNSC budget will go up.

Q68 Mr Curry: So you are confident that this 8.4 is a bottoming out?

Sir Robin Young: I am talking about the overall BNSC, DTI . . .

Q69 Mr Curry: I am talking about the 8.4. Something called the DTI programme is crystallised out at £8.4 million. So you think that is not vulnerable; you have hit the bottom and you are on your way up again?

Sir Robin Young: It will depend on the technology strategy and how much space comes out of the technology strategy, but we are proud of the fact that we do not have a separate space line. We say that business sponsorship should be competitive.

Q70 Mr Curry: I shall refrain from exploiting the verbal possibilities of a space line.

Sir Robin Young: I see what you mean. I beg your pardon. I hope you will refrain from that. We are proud of the fact that if you are looking, for example, at help for the communication sector, you have to compare investment—

Q71 Mr Curry: You are confident then that £8.4 million delivers a multiplier effect which makes it pretty well fireproof against demand for cuts.

Sir Robin Young: We now have a technology budget into which space firms have to compete with other firms, so we are backing business and we are business-led. So if, say, the communications sector puts in investment in broadband ahead of investment in space, broadband might win. So we

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are user-led. That is the point. That is the point of the partnership arrangement. We are user-led. We do not have something called “space”.

Q72 Mr Curry: I thought dear old BT was doing all the investment in broadband and that sort of thing.
Sir Robin Young: BT is certainly a key partner. I used broadband as an example. If a sector said that it wanted to use space for a technological advance, that is a powerful bid. If the same sector said it wanted to use some other technology, nanotechnology for example, that would compete, in my view rightly.

Q73 Mr Curry: Again, looking at value for money, what is the value of the contracts won by British companies which relate to the American space programme?

Sir Robin Young: I do not know the answer to that question.

Dr Hicks: I am sorry. I do not have that figure in my head.

Q74 Mr Curry: Would “substantial” be a correct description of it?

Dr Hicks: I would say no, not substantial.

Q75 Mr Curry: Take our contribution to the European Space Agency. What would you think: would you say the value of what we put into the American programme is comparable, more, less?

Dr Hicks: If we are talking about projects that are won from the European Space Agency, Surrey Satellites has won some contracts from the American government for the development of small demonstrator satellites. They have been very successful.

Q76 Mr Curry: Small satellites is one of our strengths.

Dr Hicks: Small satellites is one of our strengths. The majority of NASA funding though is going to be reserved for American companies. They will only go abroad for technology where it really is unobtainable there. There are occasional contracts won by UK academics for participation, with funding from the US, and quite often PPARC and NERC will be funding UK academics to participate and get value out of American space programmes. We can try to get you a figure, if you wish.

Q77 Mr Curry: What I am trying to do is get an idea of where the real value for money lies in the investment. We all assume that the Government promotes science in order to that it may lead to British firms increasing their capability of winning contracts and therefore providing jobs and providing spin-offs to other sectors of the economy. I am just trying to evaluate what we buy from ESA compared with what the marketplace might buy from the Americans.

Dr Hicks: I can help on that broader question because it is in the NAO Report on page 13, where we have a graph which shows that for the upstream, the UK national investment is multiplied up by contracts which are won by the UK upstream industry to a factor of 1.5. If you include downstream, there is a very much larger factor.²

Q78 Mr Curry: How much of the research which is carried on under the auspices of ESA would then be relevant to our ability to win contracts in other programmes like the American programme or, for that matter, Boeing, the new Boeing airliner or for that matter the Airbus?

Dr Hicks: It may not be from the American programme as such, but winning contracts for communication satellites which are being put on the open competitive market. In the NAO Report at the back there are a number of examples of how Astrium, using funding which came through the ARTES programme, has succeeded in winning contracts, contracts for example of Inmarsat, contracts for other communications satellites, and indeed, the Skynet 5 contracts, which were won in competition by Paradigm against American consortia. So there is a lot of evidence that UK companies are able to win when things are on the open market. Probably the difference—and the reason I was hesitating was the nature of your question, which referred to the American space programme—is that “the American space programme” for the most part is not on the open market. We are very successful in winning when it is on the open market, when it is companies who are doing international procurement, but we do not usually find NASA for example, one of the large programmes, looking out. But the American Air Force, looking for innovative technologies, is prepared to go anywhere in the world, and Surrey Satellites has been successful in that arena.

Q79 Mr Curry: You are part of the management of the European Space Agency programme.

Dr Hicks: I am the UK delegate to the council. I would not say management.

Q80 Mr Curry: You set the strategies.

Dr Hicks: Yes.

Q81 Mr Curry: Are you satisfied that the strategy of the European Space Agency is well founded? Is there an overlap with what the United States is doing? To what extent is there cooperation which might seek to divide the tasks? The Government is frightfully allergic, is it not, to this idea of the Europeans trying to ape the Americans? We had some discussion about meteorological satellites and telecommunications satellites, and there has been some criticism of possible duplication.

Dr Hicks: I do not think there is any evidence of duplication. Whenever we take forward a programme, we are looking at it in the world

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context. You mentioned meteorological, for example. There are enormous efforts to ensure that the information which is gathered by the meteorological agencies from in-situ or from space-based observation is shared. I am on the UK delegation to an initiative called the Group on Earth Observation. That is bringing together now about 55 countries who are seeking an agreement which we hope will be concluded in February next year on improved sharing of the information from global observation, whether it is in situ or satellite. Also, the Chair was involved with CEOS, which is the Committee on Earth Observation Satellites, when he was Minister of the Department in 1992. The Chair has now come back to the UK this year and we are using that forum, trying to ensure that the international organisations, including WMO, FAO and the space agencies, are working together to get the maximum value for money out of the mutual investments. It is easy to look at things and say there must be duplication but actually, there is a great deal of dialogue designed to eliminate duplication. Nobody has money to waste.

Q82 Mr Curry: What would you say were the killer points about the European programme?

Dr Hicks: The jewel in the crown of the European programme is space science, where the investments over the past 20 years have built up a programme which in what it does is first in class. It does not do everything. It does not do the volume but it is first in class. There is Earth observation, where Envisat for example, and Cryostat, which will be going up next year, are again first in class. When Europe does something, it does it to be first in class, not to be in league two.

Professor Halliday: In the space science business, doing astronomy in space, the UK is second to the USA. That would have been impossible if we had been a parasite in NASA. There is the capability that we get by putting European resources together. It is the usual scientific cooperation competition. You probably saw on your television the other night the launch of a NASA satellite called Swift to look at x-ray bursts, which are interesting for astronomy. There are UK instruments on board that that were developed for ESA missions a number of years ago. If you look back and forward at who has the best instruments at any given time, it is a competition between Europe and the USA. This keeps everybody on their toes.

Q83 Mr Curry: Are you satisfied that the strategic decision-making is driven by the science rather than by the politics? The reason I ask the question is because there is a debate at the moment about the future of Thales, which I think was Thompson CSF, and EADS, which is the parent company of Airbus, and the French government apparently wanting to shoehorn one into the other to create a national champion, and of course, we have a major stake in that through Airbus. Is this science-drive

or occasionally do you think to yourself “Hang on. We are being pushed by different political elements”?

Professor Halliday: There is a decision for a given budget about what the best science is. So the decision inside PPARC is whether they are to spend money on space or on ground-based astronomy, and that is a continuous tension, which Colin wins. I think that is a real advantage over the space agency model, in spite of what Colin Pillinger said earlier. Given the budget inside ESA, there is a very strong tension inside ESA about what are the best scientific projects to do, and that is entirely science-driven.

Q84 Mr Curry: But it is a science argument not a political argument?

Professor Halliday: It is science and money. You can have all the wonderful science ideas, but you need to have wonderful science ideas and money behind you to make it happen.

Q85 Mr Curry: Let me put the question the other way. Over the last three or five years, has ESA undertaken a project which you basically felt did not command the priority which was eventually assigned to it, or are you entirely happy with the prioritisation?

Professor Halliday: The UK stable is very happy with the current ESA science programme and the missions on it. They play to our strengths and our interests and so on. We basically have no problem. There are of course tensions and small pressures and niggles, as one would expect in a collaboration across Europe, but basically, we have no problems. The politics is more visible when the ministers meet every three or four years and decide the absolute budget for the science programme. Does Germany have money? Does France have money? Who has money in the science pot to put into this? It becomes more of a money/political driven level as you have tension between ministers, funding agencies and so on. I would separate, given budget, how you decide the science. That is driven by the scientists. But every four or five years there is a big decision about how big a programme we want, which intersects more strongly with the Treasury and finance ministers.

Q86 Mr Curry: The European and the American space programme, one of which you have just said is effectively closed to international competition completely, which is the American one, and we are labouring under this *juste retour*, which is the bid competition. Would we be able to buy a lot more if we were in an open marketplace?

Professor Halliday: Purely in the open market, we would not do well.

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Q87 Mr Curry: Would the programme?

Professor Halliday: If we were asking to spend the same kind of money to piggy-back on an American programme, I think we would be very ineffectual, in the sense that NASA does have a \$15–16 billion annual budget.

Professor Pillinger: Can I comment on that? Many American missions have started and do not actually come to fruition. There is a big drop-out rate for American missions. We would lose out seriously with our budget. The one thing you can be guaranteed with an ESA project is that if it is approved, it will go to completion, and therefore you have not lost the money that you have invested.

Q88 Mr Curry: Professor, coming back to the Beagle—and I do not want to go into the reasons why we had the problems with Beagle—have the consequences of that happening led to problems with the credibility of the UK effort at all or is your disappointment generally shared and your analysis of what went wrong also generally shared?

Professor Pillinger: I would like to leave with the Committee the media report which shows that the media coverage that we had from Beagle up until launch suddenly took off when we launched and went to Mars. However, we have maintained an interest in space science stories, particularly in Beagle itself, within the media which is far greater than at any time than before we launched it. So, my impression is that the public is now recognising that Britain has a space programme and I think this is to all our good in the sense that young people will be recruited to science and technology and engineering courses that eventually will be beneficial to the country as a whole.

Q89 Mr Curry: That is a very important point. We have just seen in the *FT* yesterday that Exeter University are joining in procession with other universities in closing down their chemistry courses. We have seen a whole string of reports of universities closing down various courses. We have seen a lot of reports about people applying to do accountancy with law and no longer doing science and there are various proposals to pay teachers more if they will teach maths and science. So, there appears to be a real crisis in Britain about our mathematical and scientific base. People do not seem to be going into those courses because they do not provide the lucre such as going into Barings, though perhaps that is not a very good example, or going into the city or the law. Are you saying that this programme and the popularisation of it may actually assist us in the reinvention of our interest in science?

Professor Pillinger: In the letter that we received from the DTI when we were given the first tranche of money, it was given to us on the understanding that I would endeavour to promote science amongst the population. I did not restrict myself to young people; after all, I work for the Open University. I went right across the board because I

felt it was important to convince older people because they would have influence over what their children did or their grandchildren did and I truly believe that the payback on Beagle is that it actually has demonstrated a science interest. I walked in here this afternoon and the policeman on the door recognised me instantly as the professor who launched Beagle 2. I bet he does not recognise any other scientist.

Q90 Mr Curry: Professor Halliday, if CERN were to discover the Higgs Boson, would that do even more?

Professor Halliday: Yes.

Q91 Chairman: I am glad you are recognised by the policeman which is more than we are. Well done!

Professor Pillinger: I could tell you an anecdote about that but I will restrict myself.

Q92 Mr Jenkins: Professor Pillinger, I am constantly being told by my son that his job is to push back the frontiers of knowledge and what we do with that knowledge is left to people like me because he is interested in pushing back the frontiers of knowledge. You very find that very often this is the purpose in life. Do you not feel a little constrained at times when you know that the departments that are going to fund it are looking for a return that maybe you cannot put down as pounds, shillings and pence rather than the acquisition of knowledge?

Professor Pillinger: I do not deal in putting down a return in pounds, shillings and pence. I deal in providing a trained workforce for the country as a whole. I believe that, if we do something which is high profile which has a sufficient attraction, then it does convince people that science is a worthwhile career. Not everybody believes that they have to make the maximum amount of money in their career to enjoy job satisfaction.

Q93 Mr Jenkins: I know that! You built the lander at 60 kilograms. What is the smallest that anyone else has built a lander in the world?

Professor Pillinger: That is the smallest lander. There were things called penetrators which were actually smaller than that, but they were designed to actually act like projectiles to hit the surface hard.

Q94 Mr Jenkins: Of the other countries that built landers, what is the smallest?

Professor Pillinger: Very few.

Q95 Mr Jenkins: What is the smallest one?

Professor Pillinger: The Russians and the Americans. The Russians have an advantage over us because they have huge lift capacity rockets and the Americas built Pathfinder which was the lander that went to Mars in 1997 and that was probably about 300 kilograms, so we were a factor of five smaller.

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Q96 Mr Jenkins: So, you were five times larger in your machine. It is an achievement in itself to build a machine, a tremendous achievement, and we must have learned a lot by building the machine. Who owns the intellectual rights to that product, miniaturisation?

Professor Pillinger: Everybody within the project owns his own intellectual property rights. There was not a joint sharing of intellectual property. The way in which Beagle was achieved was an amazing collaboration in which everyone who was involved in the project put their skills at the disposal of the project without a thought really about who was going to benefit. I can give you an example. We used several software companies in Beagle and, when we were looking round as to who would write the software, the companies all came to the early Beagle meetings and they asked who was doing to do the software and we said, "Software is software, how do you want to split this up?" and they went outside the room, came back in and said, "We have agreed a way in which we can all get a share because we believe that Beagle is such an inspirational project for our own staff that it would be wrong of us to try and fight amongst ourselves to get the sole rights to Beagle." So, that is the way in which we worked. We had several software companies and they all worked extremely amicably and people with experience told me that this had never been achieved before.

Q97 Mr Jenkins: Success on many fronts, clearly. Sir Robin, when you read the Report were you quite pleased with it? Were there any surprises there?

Sir Robin Young: No, I thought it was a fair Report.

Chairman: They always say that, Mr Jenkins. I do not know why you ask. They always say that it is a fair Report. They are not going to say that it is a terrible Report.

Q98 Mr Jenkins: And I always ask, which is the best part of the Report? Which part do you feel most pleased with?

Sir Robin Young: It started off not as a Beagle Report and, as time went by, it became more and more of a Beagle Report. When we first saw it, it was less about Beagle and more about our organisation and I thought that original passages were very fair and I liked the recommendations. So, we are fine. If you want me to say anything, it is a very good Report.

Q99 Mr Jenkins: It says that you can assess performance against strategic objectives which your department is going to do or try to do, such as the impact on space, on productivity levels and for the success of partnership in promoting space. How can you do that in the absence of related performance measures?

Sir Robin Young: That is not a good bit of the Report!

Q100 Mr Jenkins: I should have asked you about the bad bits of the Report.

Sir Robin Young: No, it is critical, so it is bad in the sense that it says we have progress to make, so I was being reasonably far and objective about it. If you look at pages 18 and 19, the truth is that the individual partners in the partnership have good performance monitoring systems on their own projects but what the Report rightly says is that when you put their projects together and make the totality of the national space strategy, we do not have an overall monitoring system which looks at the effective strategy as a whole. It made several suggestions, it had useful consultants' reports and we are now adding new performance monitoring systems.

Q101 Mr Jenkins: So, the answer is that you cannot. You cannot assess performance because you do not have anything to measure it against.

Sir Robin Young: The answer is that we can assess the performance indicator on individual projects but what we do not yet have is the methodology for bringing everything together to assess the performance of the overall strategy, but we can assess performance indicators of individual projects.

Q102 Mr Jenkins: So, that is the failure you are putting right.

Sir Robin Young: It is progress, okay. Failure if you want. Piloting a new performance monitoring using the earth observation programme board and we are trying to get an overall picture of the size and totality of the projects.

Q103 Mr Jenkins: When Mr Curry was asking you about this payback from the European side, was there an instance of miscalculation with regard to the amount of payback?

Sir Robin Young: Yes. We were the ones who spotted it and Colin Hicks will now say what has happened as a result of our spotting it.

Dr Hicks: Yes, you are quite right. What happened is that the system within the European Space Agency was changed from the pre-existing system in 2000 and this is well set out in the Report and, when the new system started in 2000, after a few quarters of the report—what happens is that there are reports every quarter on contracts that have been in place—it was brought to our attention by one of the UK companies that there appeared to be a mistake in those returns. We investigated that, the company investigated with the European Space Agency and, yes, it was correct in that sense, the complaint from the company was correct, the European Space Agency had made a mistake in the attribution of certain contracts. We had been driving that through, secured the agreement for the European Space Agency to a programme and that programme is being pushed through. The mistake existed for a relatively short period of time and it

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was a mistake in the implementation of the new system. That has now been washed out of the system but it was picked up very quickly in the UK.

Q104 Mr Jenkins: So, it now will not happen again.
Dr Hicks: You can never guarantee that a mistake will not be made by definition but, as is acknowledged in the Report, procedures have been put in place within the European Space Agency to stop this particular mistake happening again.

Q105 Mr Jenkins: We have a number of small firms in this country obviously and one of the biggest problems with small to medium firms is actually getting involved and getting on board. What work are you doing to ensure that small firms are getting the opportunity to take part in this development?

Sir Robin Young: We have websites, we are working more with the Small Business Service, Business Link and technology advisers. There are a whole raft of things that we in DTI are doing to try to get to small firms, but I acknowledge straight away that what you are saying is right. It will be more difficult for us to get to small firms than it will be for us to get to big firms. Indeed, in Chapter 3 where it says that larger firms are better placed to take advantage of the support from BNSC, we acknowledge that. We work through trade associations, so small firms that are members of trade associations should be okay. The ones we are having real trouble getting to are the small firms who are neither members of trade associations or do not communicate with them and do not communicate with us direct and that is a real challenge for us. The channels of communication that we have are the website businesslink.gov.uk and are RDA-sponsored technology based hubs for small businesses that are around the country and enabling organisations like that. I acknowledge the challenge and we are doing our best.

Professor Pillinger: Beagle 2 claims success in this respect because we attracted quite a number of people who had never worked in space before, big and medium and small people.

Q106 Mr Jenkins: It is always a challenge and we are always trying to find ways of getting small firms linked in and using their expertise. It says in paragraph 4.8 that PPARC was not able to provide detailed costs for all 20 of the projects it supported in 2003–04. Why would they not be able to provide detailed costs in projects that they are supporting?

Professor Halliday: I am afraid the answer will be “not very sure”. There were discussions with NAO about providing data for projects in the 80s and it was agreed, for example, that digging out such historic costs of satellite long launched and exploited would actually not be worth the effort. I think there is a phrase in the NAO Report “PPARC does not currently have a system in place which enables it to readily produce historical data . . .” which is a statement about digging in archives and pulling out a dusty old file. There is an implicit criticism which is that we do not have

a shining computer system that, at the press of a button, will produce all the data about the current project. The correct statement is that we are currently installing a management information system which will do precisely that. So, the criticism is accepted.

Q107 Mr Jenkins: I want to turn now to Galileo. Given the existing GPS systems, what was the need for Galileo?

Dr Hicks: Galileo, just to make sure everybody understands, is the European global positioning system and pre-existing American global positioning system. Galileo was assessed as to whether Europe could use GPS or whether there would be advantage to Europe from having its own global positioning system. First because it meant that we would not be relying upon a system which was controlled by the United States and was primarily for military applications.

Q108 Mr Jenkins: Is that because you do not trust the United States or you felt that maybe they were going to rip you off on costs?

Dr Hicks: I think the second; there was uncertainty about the continued provision. GPS does not have a guaranteed availability and there are a number of services such as aircraft navigation which rely upon guaranteed availability. Although it is provided free at the moment, it does not have guaranteed availability and an uncertain future. When an assessment was made—and this is at the bottom of page 13 and I believe this comes from the Price Waterhouse report—of the increase in net economic benefit to the UK, it was assessed for UK, not for Europe as a whole, of £6.3 billion by 2020 and this is against the background of the existing provision of GPS.

Q109 Mr Jenkins: Can you tell me where they would get the £6.3 billion by 2020. In what areas are we going to benefit by that degree?

Dr Hicks: The global position is a pervasive technology which will produce benefits in many different parts of the economy. If you take the car sector, for example, GPS is already in use in a number of cars simply to provide people with a mapping service and the guidance.

Q110 Mr Jenkins: To stop you getting lost, yes.

Dr Hicks: If you then look at the applications that are coming, there are very large number of sectors which are being investigated, some of them public, some of them private. For example, it is being considered as a means of guiding the emergency services to the scenes of accidents. That will produce possibly a very large saving in life if the emergency services are able, as a result of the GPS location, the Galileo, the—

Q111 Mr Jenkins: If someone dies in an ambulance before getting to hospital, there may be a disbenefit for their family but where is the financial benefit?

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How can you establish financial benefit and a saving in that area? Are these figures not in effect just made up?

Dr Hicks: No, they are not. It is fully set out where they come from. I was just quoting one example and I am not an expert in what is the value of life but I know that there are figures that are placed upon the value of life. To take another example, there are considerations of using global positioning systems to sell a large number of services. One, for example, is car insurance which could be sold by the mile. Services which enable people to know that they are close to something that they actually want. It is likely, for example, that all future mobile phones will have global positioning capability built in and so you will be able to find out information about the locality or information about the services in your locality from your mobile phone. So, a very wide range of services. It just goes on and on through the economy and I have just tried to instance a very narrow example there. The movement of civil aviation—

Q112 Mr Jenkins: This is back to the improvement in quality of life which Sky brings us.

Dr Hicks: . . . the improvement of railway signalling is all being looked at in terms of use of global—

Q113 Mr Jenkins: We are now rewiring our track with (sic) the Victorian signalling system when I talk about GPS which is being done. So, there will be no trains running in Britain by 2020 using GPS systems.

Dr Hicks: If you look at the services market that has been studied in the Report, it comes up with that figure for net economic benefit for the UK based upon an assessment of a very wide range of services.

Q114 Mr Jenkins: The MOSAIC satellites. You had a risk management process in place, a thorough one up to the modern risk management, but the satellites were delayed by over a year; what was at fault?

Dr Hicks: Some of the delay in the satellites was because of a delay in the completion of the commercial contracts from the other organisations that were involved in the funding.

Q115 Mr Jenkins: Does the risk management cover that sort of area?

Dr Hicks: Of course it does. This was assessed, but the fact that you have done a risk assessment does not mean that you can control factors that are outside your control as with the decision making of other people.

Q116 Mr Bacon: Dr Hicks, I have two questions, one on this question of risk and the other on cost. It does not surprise me that somebody like Professor Pillinger would be pushing and pushing and pushing for a project like Beagle 2 and, if you were to send to Central Casting for a passionate

professor, I am sure you would end up with someone like Professor Pillinger who has a real passion for his subject. Equally, if you were to send to Central Casting for somebody who is going to manage the British National Space Centre as an accounting officer with responsibilities to the taxpayer, one very well might imagine someone like you and we have. Your job surely is to weigh the competing claims of passionate scientists with a vision of a mission with the possible risk. I thought I heard you say earlier in response to an earlier question about the Casani Review right at the beginning from the Chairman that the National Audit Office Report concluded that all the Casani Review findings, the key findings listed at the bottom of page 25, had been successfully met. When I turn the page, what I find in the National Audit Office Review is that the written submissions which your organisation put into the DTI and into the Office of Science and Technology to request funding did not include explicit assessments of the risks to the project nor any quantification of the possible outcomes to the project. Indeed, you considered that until the actions that were attached to the funding had been taken, it would not have been realistic to quantify the likely outcomes. Was it your job to assess the potential risks and the benefits and to notice that, once there had been a radical reduction in the weight, the risks so adequately outweighed any potential reward? It says again at the top of the second column on page 26 that the system's mass and the time schedule were still the main areas of concern in March 2002. Was it not your job to say, "I am sorry but the gain is not worth a candle and the money would be better spent elsewhere"?

Dr Hicks: I quote the National Audit Office Report to you in its conclusion where it says that the technical risks surrounding the project were sensibly approached and mitigated. That is an overall statement. What you have been quoting, I think, are a series of statements relating to different phases within the course of the project. We assessed risk at a number of stages in the project. The Casani Review was one of the major reviews which assessed risk. It pointed to a number of things that needed to be done and it says here in the NAO Report that the consortium produced and implemented a detailed action plan in response to these findings. At another stage in this project—and Professor Pillinger may remember this very well—we had a team of I think something like a dozen people in the European Space Agency who spent time in Stevenage and Astrium going through the project in fine detail, looking at the risks associated with the project at a technical level, looking at the scheduling, looking at the mass and looking at all the challenges that were in place and, at the beginning of their study, we were very unhappy about the schedule. We did not believe that there was sufficient margin at the beginning of that schedule, which is why we were having the whole study being undertaken. They worked very closely with the Beagle team, the industry team, the

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academic team and the companies, and they came forward with a number of recommendations which enabled us to get back, at that stage, the schedule risk and measures in place that would ensure that we remained within an acceptable envelope. That is what happened at a series of stages and that is why I think that the NAO Report says that the technical risks surrounding the project were sensibly approached and mitigated.

Q117 Mr Bacon: It does actually say that they were subsequently mitigated but that your assessment was that there was no explicit assessment of risks to the project nor any qualification. I have one other question about costs. Can you just paraphrase what are the total costs. It says £42.5 million in total as a total project cost for the United Kingdom but I am not clear because it talks about additional Open University money and additional BMSC money. What was the absolute total that this project cost?

Dr Hicks: I think the money which went in from the public purse was £24.62 million, if my memory serves me correctly, out of £42.5 million and the money which was coming in from the Open University I believe was that difference between £24.62 million and £42.5 million.

Q118 Mr Bacon: The Open University is public money, is it not?

Professor Pillinger: The Open University is indeed public money; the Open University's contribution was £6.2 million.

Q119 Mr Bacon: It sounded to me like Dr Hicks was referring to £24 million of public money and then some Open University money on top.

Professor Halliday: One should be careful. The Open University is a private organisation.

Professor Pillinger: We charge fees to our students. This is our money.

Q120 Mr Bacon: Can I just be clear: the £42.5 million is the global, as it were, total for the expenditure. Is it possible that you could send us a note of the breakdown of all the costs and where the contributions came from?

Dr Hicks: Indeed.³

Q121 Mr Curry: Professor Halliday and Sir Robin, you both say, "If we did not have a *juste retour*, we would not do very well in the programme." What is wrong with our industry—

Professor Halliday: Hold on, I did not say that. I said that if you do away with *juste retour*, there is a risk of getting extra or less.

Q122 Mr Curry: Sir Robin did say. The record, I am sure, will show that he said that we would not do very well if we did not have *juste retour*.

Sir Robin Young: I do not know what I said but I did not mean to say that. If the CERN precedent, about which I know nothing I should say, is taken into account, then we do not do very well. CERN has no *juste retour* ingredient and apparently we do not very well.

Q123 Mr Curry: I will put my question another way. Are you satisfied that British business is competitive, is well founded scientifically and in terms of engineering and management skills to be a real competitive force in this marketplace?

Professor Halliday: My reading is, yes, to win contracts elsewhere. It is hard to prove in an absolute sense.

Q124 Mr Curry: Sir Robin I think made the remark which I have attributed to him and it just caught my attention.

Professor Halliday: May I just make one off-the-cuff remark? Let me give you a feeling for—

Q125 Chairman: No remarks in this Committee are off-the-cuff! Everything is noted down.

Professor Halliday: Well, not quite focused. I was astonished to discover—and this is what makes it unquantifiable—that Logica is the result of investment by the European Space Agency something like 30 years ago. It is a company that is drawn out of this background out of nurturing from ESA. How much of Logica's success value do you put into ESA's value added and how much is their own efforts? I have no idea how to do that, but there is no question about it, that is the origins of a very substantial British company.

Mr Curry: Let us hope that ESA can help us with identity cards then!

Q126 Mr Jenkins: The Commission inquiry into the Beagle and I read this extract for you and I want you just to then think for a moment. It says that the scope of the inquiry covered a wide range of important issues of concern to the UK, ESA and other Member States in ESA. Some of these matters are necessarily confidential between governments and the Agency and cannot be released. Professor Pillinger said that he had not seen a copy of the Report. Do you recognise the disquiet if we are not in a position to learn from our mistakes on our reports and all the information is not free, open and available to all participants? This is after all public money and I for one would deem it undesirable to have reports that may be missing information to be held back out of the area of public domain.

Sir Robin Young: I certainly recognise that issue. It is currently being reconsidered by Lord Sainsbury, the Minister, in response to a recommendation from the Science and Technology Committee whose report perhaps I should mention anyway. They reported on 2 November. Incidentally, in response to Mr Bacon, they said, "We commend the Government for being enthusiastic about the Beagle 2 project. It was an exciting scientific

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**Department of Trade and Industry, British National Space Centre,
The Particle Physics and Astronomy Research Council and the Open University**

opportunity with the potential to put the UK at the forefront of space exploration. The Government should not be shy about taking risks in science if potential benefits are there. In our view, this was a risk well worth taking.” So, in addition to that report, they then said at least can we see this secret inquiry and we put that to Lord Sainsbury and that is where it lies. As you rightly said, the authors of the inquiry report said that some of it was confidential. So, that is the issue which went to ministers and is now with the Minister in response to the Select Committee’s report.

Professor Pillinger: The Beagle team conducted their own inquiry which ran to 268 pages and 270 recommendations and I can lodge a copy of those with the Committee. It is on the web if you want to read them.

Mr Jenkins: I am not concerned about the technical aspect, what I am concerned about is the openness of Government and making sure that if the Government or Agency bring the shutter down and say that this is confidential, they have to have very, very good reasons for not telling us why and how they spent public money and I know that we will be mentioning that in our report.

Q127 Chairman: Sir Robin, we have had reference to the commercial delegates and they are set out, as we have heard, in Appendix 3 at page 36. If you look at paragraph 2.18 which you find on page 19, there is some argument there and some discussion there about how you summarise the scientific evidence arising from space activities. I am just wondering whether you have adequate systems to summarise, assess and come to conclusions on the scientific and commercial benefits and what you do.

Sir Robin Young: They are not good enough and that is why, in answer to Mr Jenkins, I hope I have made that clear. What we have is good performance indicators for the ingredients of what the partners do in their space work. What we do not have—and that is why the Report is right about this—is a way of looking at the overall performance of the whole space strategy, in other words the totality, the sum of the parts. The consultants who work with the NAO gave us lots of

good suggestions about how we should track these critical performance areas in that box on table 12 on page 18 and they have given us a framework of 39 potential measures to track our performance, the performance of the totality in these performance areas. We are actually piloting that now. I should say that, as paragraph 2.19 which you referred to says, it is not easy to work out how space activity leads through into productivity and competitiveness but it is an exam question which we are on the case in answering.

Q128 Chairman: Dr Hicks, I think I remember you were kind enough to refer to the brief and glorious period when I had ministerial responsibility for your organisation.

Dr Hicks: I well remember it.

Q129 Chairman: I was quite enthusiastic about working towards an International Space Agency. Whatever happened to that idea? Was it quietly dropped after I left?

Dr Hicks: I think what we should say is that, just as with the partnership approach within the BNSC, we are trying to generate that partnership approach for international space activity. So, I think you can be proud at the idea that we should be working together, but it is not being pursued by a single agency but by strong cooperation between agencies.

Chairman: Gentlemen, thank you very much. It has been a very interesting hearing. Mr Sheridan said that it was an anorak’s Report but it is very important.

Jim Sheridan: I take that back.

Q130 Chairman: Professor, thank you for all you have done to enthuse the British public about your work—we are very grateful—even though it has cost £42 million.

Professor Pillinger: That works out at about four minutes each per year at the minimum wage that a person can earn.

Chairman: That is obviously a line you were determined to get out, so I have given you that opportunity. Thank you very much, gentlemen.

Supplementary memorandum submitted by the Department of Trade and Industry

Question 77 (Mr Curry): Comparison of Value of US vs European Business Contracts

At the recent PAC Hearing on UK Space Activities, members were interested in the relative value of space-related business won by UK organisations from institutional customers in US and Europe.

The table below is reproduced from “*Size and health of the UK space industry 2003 update study*”, published by BNSC. It provides a breakdown of the value of space-related business (upstream and downstream) done by UK organisations both in terms of customer types and world regions. As can be seen during 2002–03, UK organisations performed £126 million worth of business for UK institutions (space agencies, Government and military). In comparison they performed £112 million of business for European institutions and £27 million for institutions based in the Americas. Of the latter (ie £27 million from the Americas) the largest portion of the business will have been received from US institutions.

Table 1

BREAKDOWN OF CUSTOMERS BY TYPE AND REGION—2002–03

<i>Turnover (£ Million) 2002–03</i>	<i>Space agencies</i>	<i>Government</i>	<i>Military</i>	<i>Commercial (business market)</i>	<i>Commercial (consumer market)</i>	<i>All customers</i>
UK	30	26	70	359	2,277	2,762
EU (exc UK)	98	7	7	399	147	658
America	4	2	21	298	16	343
Africa and M East	4	1	12	48	0	65
Asia	3	2	0	80	0	85
All regions	140	38	110	1,185	2,440	3,913

Question 120 (Mr Bacon): Beagle costs

<i>Increment</i>	<i>Commitment Date (£million)</i>	<i>DTI (£million)</i>	<i>PPARC (£million)</i>	<i>ESA (£million)</i>	<i>DTI+OST (£million)</i>	<i>Open University (£million)</i>	<i>EADS Astrium (£million)</i>	<i>Totals (£million)</i>
Instruments	Jul–1999		2.74					2.7
Initial ROAME statement	Jul–1999	5						5.0
Underwriting	Aug–2000				5	3.5	3.5	12.0
B2 elements—ESA	Nov–2000			9.7				9.7
Increased	Aug–2001				8.3	1.9		10.2
Underwriting								
Parachute risk reduction	Jul–2002				1.5			1.5
Planetary Protection Facility	Nov–2001			1.95				2.0
Post launch support/ operations	Apr–2002		2.08					2.1
Project Total (£ Million)								45.2

NOTES

(1) OU also received £2.6 million from Wellcome Trust biomedical research charity to help develop miniaturised mass spectrometer technology with some overlap with Beagle 2. This activity is continuing.

(2) EADS Astrium declared a £1.5 million loss on the project.

(3) Significant but unquantifiable “in-kind” contributions were made by many further organisations in both academia and industry.

(4) PPARC terminated the operations grant before completion: incurred cost was £1.86 million.

8 December 2004

Supplementary memorandum submitted by Professor Colin Pillinger

I would like to take this opportunity to clarify the situation concerning the mass of the Beagle 2 spacecraft because, following the oral evidence session on 24 November, I am concerned that there is a great danger of a misunderstanding arising about the significance of the mass reductions made by ESA in 1998. The original Beagle 2 proposal for the 108 kg lander was completely different from the 60 kg version which eventually flew weighing 68 kg. It may be helpful if I recap the events involved and their chronology.

1. The first mention of the possibility of a lander or landers becoming a part of Mars Express (MEx) was 18 April 1997. No specific mass allocation was discussed.

2. By 23 September 1997 it had become apparent that three groups were interested in the science which would be forthcoming from landers. These were the Beagle 2 team led from the UK, a French/Finnish-led consortium and a German/Russian collaboration. It is important to understand at this point that the French/Finnish bid required the establishment of a network of three or four geophysical stations on Mars.

The Germans wanted the lander to have mobility (they had developed two roving vehicles). The UK wanted a lander which could undertake geochemical and exobiological analyses. In September 1988, ESA were talking in terms of more than 200 kg being available for a lander(s). It was made clear, in a private meeting involving the potential bidders, that ESA would view favourably scenarios in which the desires of all contenders could be satisfied. This accords with the principles of *juste retour* which were examined by the Committee.

3. By 17 December 1997, when ESA briefed in respect of the Announcement of Opportunity, negotiations had established how the three potential bidders could share the mass and other resources available. The French/Finns would bid to make two landers for their network, the British would bid to make one lander carrying the experiments wanted by the UK, plus additional equipment (to be supplied from France/Finland) to complete their network, ie the UK would act as the third station. The UK lander would also be large enough to carry one of the German roving vehicles since a rover would provide a greater variety of samples for our instrument package. According to this scenario the British lander had to be considerably more massive than necessary to satisfy the UK's primary science goals, in fact it would need to be just over 108 kg. Bids were submitted to ESA accordingly by three groups on 24 February 1998. Incidentally, the Italians, who were not part of any of the three lander bids, backed all the horses by offering to supply the telecommunications package on the orbiter to handle the data from any or all of the landers as required.

4. After submission of the bids it was realised by ESA that the mass resources available on Mars Express had been hugely over estimated. In the first week of May the Beagle 2 team received notification that only 60 kg could be available for a single lander. Since no one had bid a single 60 kg lander, there would be no lander.

5. The attitude of the Beagle 2 team to the news that MEx could carry one lander only, and it had to be less than 60 kg, was that ESA had moved the goal posts. The UK team assembled at Matra Marconi (Astrium) and concluded that the UK lander was ruled out because it was accommodating items from the other bids in order to meet the ESA *juste retour* principles. We concluded that if we stripped off the equipment required by the French/Finnish network and removed the German rover then the lander could be shrunk dramatically. Our very rapid appraisal of the situation was that the UK payload could be carried on a smaller lander and the entry descent and landing systems needed to deliver it to the surface could be reduced in parallel to meet the 60 kg limit. We offered the package to ESA in time for the Science Programme Committee meeting on 20 May.

6. Only the UK had come up with a proposal which met the new requirements; neither the French/Finns or the Germans/Russians had. But instead of approving the UK bid, ESA organised a new competition for a 60 kg lander. This gave everyone a chance to submit revised proposals but on a very short timescale without the opportunity of carrying out any full redesign work. Whilst the second proposal was under review the Beagle 2 team realised that it could further improve its 60 kg lander design by changing from a pyramidal to a pocket-watch or barbecue shape. The flat sides of the pyramid were no longer needed because there was no rover to drive off. The new shape was stronger, lighter and more efficient; the idea was explained to other members of the team with the aid of a sketch on the back of a beer mat (Fig 1). It was universally adopted by the team and became the subject of a great deal of design work which was eventually explained to ESA and helped convince them the 60 kg concept was viable. The final pocket watch design of Beagle 2 is shown in Fig 2.

7. Although ESA never relaxed the 60 kg allowance for the lander, the UK team realised that being constrained to 60 + 3 kg (the latter for 3 kg of components needed to attach the lander to the orbiter) would mean much higher risks. We built a lander which we felt would be fit for purpose. It weighed in at 68.84 kg + 4.88 kg on the orbiter. So that the lander could not be rejected on the grounds that it was too heavy to be carried on Mars Express, Astrium (Stevenage) did additional work on the orbiter to increase its load carrying capacity.

8. At no time did the Beagle 2 team add unnecessary risk to the mission by building a lander that had no chance of success. Every part of the lander was separately tested and capable of surviving the trip to Mars. The fact that we were ignoring the 60 kg limit was known to BNSC, ESA and to every review committee. John Casani endorsed the Beagle 2 team's view. Ultimately ESA accepted the total 73.72 kg package in its flight acceptance review conducted by independent experts in March 2003. The mass of the actual lander was 33.2 kg close to the original mass conceived; the growth in mass from 60 kg to 68.84 kg being attributable mainly to the entry and landing system which was revised upwards to reduce risk.

9. For the committee's information I am enclosing a copy of the Beagle 2 lander technical description which details the exact masses of all the Beagle 2 subsystems and shows clearly the tremendous technological achievements made by the Team in building a lander incorporating the highest ratio of science to systems mass ever.¹ This development has placed UK space engineers and space scientists in a very competitive position. In space missions the ability to miniaturise is of paramount importance since the final mass delivered to the destination is scaled up many times in terms of rocket lift capacity and fuel load.

¹ Not printed here.

I hope the above comments help to clarify a situation which may have caused confusion.

Fig 1

SCHEMATIC OF "ROUND" 60 KG LANDER

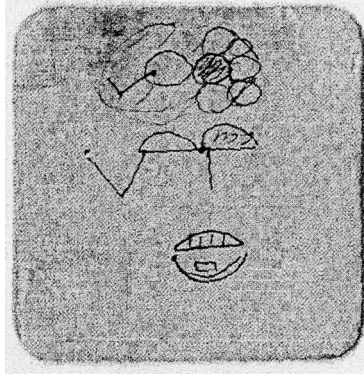
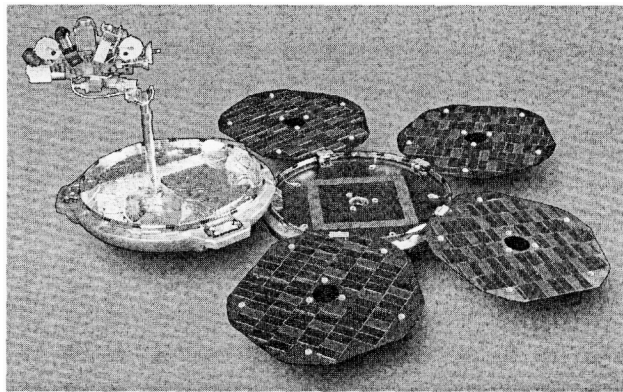


Fig 2

THE FINAL DESIGN OF BEAGLE 2



29 November 2004