House of Commons
Science and Technology Committee

2007: A Space Policy

Seventh Report of Session 2006–07

Volume I
Report, together with formal minutes

Ordered by The House of Commons
to be printed 4 July 2007
The Science and Technology Committee

The Science and Technology Committee is appointed by the House of Commons to examine the expenditure, administration and policy of the Office of Science and Innovation and its associated public bodies.

Current membership

Mr Phil Willis MP (Liberal Democrat, Harrogate and Knaresborough) (Chairman)
Adam Afriyie MP (Conservative, Windsor)
Mrs Nadine Dorries MP (Conservative, Mid Bedfordshire)
Mr Robert Flello MP (Labour, Stoke-on-Trent South)
Linda Gilroy MP (Labour, Plymouth Sutton)
Dr Evan Harris MP (Liberal Democrat, Oxford West & Abingdon)
Dr Brian Iddon MP (Labour, Bolton South East)
Chris Mole MP (Labour/Co-op, Ipswich)
Dr Bob Spink MP (Conservative, Castle Point)
Graham Stringer MP (Labour, Manchester, Blackley)
Dr Desmond Turner MP (Labour, Brighton Kemptown)

Previous Members of the Committee during the inquiry

Mr Brooks Newmark MP (Conservative, Braintree)

Powers

The Committee is one of the departmental Select Committees, the powers of which are set out in House of Commons Standing Orders, principally in SO No.152. These are available on the Internet via www.parliament.uk

Publications

The Reports and evidence of the Committee are published by The Stationery Office by Order of the House. All publications of the Committee (including press notices) are on the Internet at www.parliament.uk/s&tcom
A list of Reports from the Committee in this Parliament is included at the back of this volume.

Committee staff

The current staff of the Committee are: Dr Lynn Gardner (Clerk); Dr Celia Blacklock (Second Clerk); Dr Chris Tyler (Committee Specialist); Ana Ferreira (Committee Assistant); Christine McGrane (Committee Secretary); and Jonathan Olivier Wright (Senior Office Clerk).

Previous Committee staff during the inquiry

Dr Anne Simpson (Committee Specialist); Dr Sarah Bunn (Committee Specialist); and Robert Long (Senior Office Clerk).

Contacts

All correspondence should be addressed to the Clerk of the Science and Technology Committee, Committee Office, 7 Millbank, London SW1P 3JA. The telephone number for general inquiries is: 020 7219 2793; the Committee’s e-mail address is: scitechcom@parliament.uk
# Contents

## Report

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summary</strong></td>
<td>5</td>
</tr>
<tr>
<td><strong>1 Introduction</strong></td>
<td>7</td>
</tr>
<tr>
<td>Our inquiry</td>
<td>7</td>
</tr>
<tr>
<td>Relevant recent reports</td>
<td>9</td>
</tr>
<tr>
<td>Structure of Report</td>
<td>10</td>
</tr>
<tr>
<td>Does space matter?</td>
<td>10</td>
</tr>
<tr>
<td><strong>2 Civil space policy in the UK</strong></td>
<td>12</td>
</tr>
<tr>
<td>Current UK space policy</td>
<td>12</td>
</tr>
<tr>
<td>UK investment in space</td>
<td>12</td>
</tr>
<tr>
<td>UK Space Strategy 2003-2006 and beyond</td>
<td>14</td>
</tr>
<tr>
<td>Space Strategy 2007-2010</td>
<td>17</td>
</tr>
<tr>
<td>Vision</td>
<td>18</td>
</tr>
<tr>
<td>Horizon scanning</td>
<td>18</td>
</tr>
<tr>
<td>Co-ordination with other strategies</td>
<td>19</td>
</tr>
<tr>
<td>Conclusion</td>
<td>19</td>
</tr>
<tr>
<td><strong>3 The BNSC</strong></td>
<td>21</td>
</tr>
<tr>
<td>The partnership model</td>
<td>22</td>
</tr>
<tr>
<td>A user-driven approach to space</td>
<td>24</td>
</tr>
<tr>
<td>A UK space agency?</td>
<td>25</td>
</tr>
<tr>
<td>Strengthening the partnership</td>
<td>28</td>
</tr>
<tr>
<td>BNSC’s profile &amp; status</td>
<td>28</td>
</tr>
<tr>
<td>A leadership role for BNSC headquarters</td>
<td>30</td>
</tr>
<tr>
<td>Reporting</td>
<td>31</td>
</tr>
<tr>
<td>The co-ordination role of BNSC headquarters</td>
<td>32</td>
</tr>
<tr>
<td>Resources at BNSC headquarters</td>
<td>33</td>
</tr>
<tr>
<td>Relationship with partners</td>
<td>34</td>
</tr>
<tr>
<td>Cross-governmental links</td>
<td>36</td>
</tr>
<tr>
<td>Involving the space community</td>
<td>38</td>
</tr>
<tr>
<td><strong>4 International relations</strong></td>
<td>40</td>
</tr>
<tr>
<td>European Space Agency</td>
<td>40</td>
</tr>
<tr>
<td>Investment in ESA</td>
<td>41</td>
</tr>
<tr>
<td>Future developments</td>
<td>49</td>
</tr>
<tr>
<td>European Union and European Commission</td>
<td>51</td>
</tr>
<tr>
<td>Bilaterals</td>
<td>53</td>
</tr>
<tr>
<td><strong>5 The UK space industry</strong></td>
<td>56</td>
</tr>
<tr>
<td>Overview</td>
<td>56</td>
</tr>
<tr>
<td>Government support for the space industry</td>
<td>59</td>
</tr>
<tr>
<td>Industrial funding through ESA programmes</td>
<td>60</td>
</tr>
<tr>
<td>Support at a national level</td>
<td>62</td>
</tr>
</tbody>
</table>
Space tourism 122
   Overview 122
   Environmental impact 123
   Government support & regulation 124
Launched 126

11 Education & outreach 129
   Impact of space 129
   Space in education 131
      Current activities 131
      Co-ordination 132
      National Space Education Initiative 133
      ESA's ESERO project 134
      Space education materials 135
   Outreach 136

12 Conclusion 137
   Conclusions and recommendations 138
   Abbreviations used in this report 148

Formal minutes 151
Witnesses 152
List of written evidence 154
List of Reports from the Committee during the current Parliament 157
Summary

Space is a highly significant area of science policy and it is necessary for the Government to take a strategic approach to space activities such as robotic exploration, satellite navigation and Earth observation. The forthcoming civil space strategy should inspire and motivate the UK space sector and emphasise the UK Government’s commitment to space. The strategy is an opportunity for the British National Space Centre to outline clearly its vision and ambition for space.

We support the UK’s user-driven approach to space, which focuses on activities which will enhance scientific knowledge and bring benefits to the UK economy and society. There are problems with the current partnership arrangement but if existing levels of expenditure persist, the Government should not establish a space agency but should continue its current approach to space. The partnership should be strengthened by improving its profile, leadership, co-ordination and perhaps a change of name. We recommend that the wider space community be involved through a space forum and that the British National Space Centre Headquarters be provided with a small budget of its own.

The space sector has great economic potential. The UK space industry is ambitious and focused. Despite its health state, the industry relied upon Government seedcorn funding. We recommend that the Government review its subscriptions to ESA programmes that support industry through seedcorn funding and establish mechanisms to increase support for SMEs. The space industry is high tech and requires highly skilled workers. We are concerned that there is a skills shortage in the space industry and a broad programme of incentives may be necessary to ensure a continued flow of people into the industry.

The UK has world-leading space scientists and technologists. Space science both depends on technology and can drive technology developments. The current lack of a domestic programme to support early stage technology development places the UK at a disadvantage. The proposed National Space Technology Programme could fill this funding gap and we urge the Government to provide appropriate funding for this initiative. We welcome the creation of the Science and Technology Facilities Council and recommend that it ensure that there are no gaps in funding for research in space science.

Approximately two thirds of UK investment in space is channelled through the European Space Agency. The UK’s involvement in ESA is worthwhile and the establishment of an ESA centre in the UK would be beneficial. ESA and the EU have been developing two projects: Global Monitoring for Environment and Security (GMES), and Galileo for satellite navigation. The Government has concerns that the GMES programme does not meet user objectives and policy requirements. If these concerns are addressed by the European Space Agency, the Government should consult industry regarding the level of subscription to the programme. There are currently problems in the Galileo programme and we urge the Government to work at a European level to clarify the situation.

The UK does not fund launchers to any significant level or participate in human spaceflight programmes. Exploration is crucial to improve knowledge and understanding of space. The Government’s stance should be flexible enough to ensure that the best science
can be funded, whether that be undertaken by manned or robotic exploration. Funding for space medicine should be provided by the Medical Research Council and not through a special funding stream. The space tourism industry should be supported by appropriate regulation and there should also be no “in principle” block on funding the development of launchers in future.

We suspect that unfortunately the public is still unaware of the variety, breadth and importance that space activities play in their everyday lives. We welcome the plans for the establishment of a European Space Education Resource Office contact point in the UK and hope that this will be the start of a truly national education project. Although there are weaknesses in the organisational structures, funding and co-ordination of space activities, the sector is characterised by an enthusiasm for discovery, research and experimentation. A strong political lead is essential for the UK research and industrial sectors. There are opportunities for the UK to lead developments in areas such as exploration, satellite navigation and Earth observation. It is crucial that the Government increases funding for space programmes now in order to benefit future generations.
1 Introduction

1. Space has intrigued and inspired humankind for centuries. The unexplored vastness of space tempts questions, such as whether life exists elsewhere or whether humans could survive without the Earth. Over the last fifty years, humankind’s relationship with space has changed dramatically. Technological advances mean that people no longer have to be content observing space from the Earth but can actively explore it. Since the first man-made object Sputnik 1 was launched in 1957, men have walked on the Moon and lived aboard spacecraft, satellites have been launched, scientific missions have explored the planets in our solar system, and the Hubble Space Telescope has discovered new planets in the Milky Way. Humankind’s increasing activity in space is demonstrated by the more than 100,000 objects that are currently orbiting the Earth. However, building up knowledge of nearby planets and stars has only served to emphasise how little humankind knows about the universe beyond. People’s imaginations have filled in these knowledge gaps, producing novels such as *The War of the Worlds* or *The Hitchhiker’s Guide to the Galaxy*, television programmes like *Battlestar Galactica* or *Star Trek*, and musical works such as *The Planets*. The idea of space, its potential and its unknowns, will continue to tempt scientists to explore and all to speculate.

Our inquiry

2. The UK is involved in numerous space activities, ranging from robotic exploration to satellite navigation to Earth observation. We undertook this inquiry in order to discover the ways in which the space sector can benefit the UK by helping to deliver services, by contributing to the economy, and by inspiring young scientists. Our inquiry has been particularly timely for two reasons. First, the Government is currently undertaking a Comprehensive Spending Review and the recommendations we make here will, we hope, feed into that process. Second, the British National Space Centre, which co-ordinates the space-related activities of Government departments and Research Councils, launched a consultation on its new strategy in January 2007. The strategy is expected to be published in the autumn.

3. On 19 July 2006 we announced an inquiry into UK civil space policy. We invited evidence on the following points:

- The impact of current levels of investment on space-related activities on the UK’s international competitiveness in this sector;
- The benefits and value for money obtained from participation in the European Space Agency and other international programmes;
- The maximisation of commercial benefits and wealth creation from UK space-based technologies through innovation and knowledge transfer;

---


• The delivery of public benefits from the space-related activities of different Government departments (eg. DEFRA, MoD, DTI, DfT), and the co-ordination of these activities; and

• Support for space-related research and the UK skills base.

We received a total of 121 memoranda in response to this general call and to later specific requests for written evidence, and we thank all those who contributed to the inquiry in this way. We acknowledge the work of the House of Commons Scrutiny Unit in helping to provide economic analysis of some evidence. We would also like to thank our specialist adviser, Professor Mike Cruise, Pro-Vice-Chancellor (Research and Knowledge Transfer) at the University of Birmingham.

4. We held seven evidence sessions, hearing from industrialists, knowledge transfer specialists, the British National Space Centre, European Space Agency, organisations involved in space education, industrialists and academics in the field of Earth observation and satellite navigation, space scientists, space medicine and space tourism experts. Details of the witness panels are provided at the end of the Report. The final evidence session was held with the then Minister of State for Science and Innovation, Malcolm Wicks MP and Dr David Williams, Director General, BNSC. We are grateful to all those who gave oral evidence during this inquiry. Transcripts of the oral evidence sessions are published alongside this Report, together with written evidence submitted to the inquiry. We would like to note the helpful and open approach that BNSC has taken to our inquiry, in particular providing supplementary material to a tight timescale. In addition, the space industry has been very supportive of this inquiry. However, we have been subjected to inappropriate and excessive lobbying by those representing certain parts of the industry, which could easily have proved counterproductive to the strong story the UK space industry has to tell.

5. During the course of this inquiry we held two informal briefing meetings and undertook two visits. On 8 November 2006, we held a private informal seminar with Mr Raj Sivalingam, Director of Space Policy and Europe, BNSC, Miss Paula Freedman, Director of DTI Space within BNSC, Professor Martin Barstow, University of Leicester, Professor Michael Rowan-Robinson, President of the Royal Astronomical Society, Colin Paynter, Managing Director of EADS Astrium, Sir Martin Sweeting, Chief Executive of Surrey Satellite Technology Limited, and Mr Rupert Pearce, General Counsel, Inmarsat. On 29 November 2006, we held a private meeting with the NASA STS-121 Space Shuttle crew, including British-born astronaut Piers Sellers. On 30 January 2007 we visited the University of Leicester Space Research Centre and the National Space Centre in Leicester, and held an oral evidence session in the Shuttle Suite at the National Space Centre. On 6 March 2007 we visited ESA Headquarters in Paris and discussed our inquiry with ESA representatives. On 27 March 2007 we visited the Space Science and Technology Department at the Rutherford Appleton Laboratory. Our thanks go to those who arranged and participated in these informative meetings.
6. Our inquiry has focused on the civil rather than military uses of space.\(^3\) We have found, however, that there is an increasing overlap between the uses of space for civil and military purposes and many spacecraft technologies and applications can be used in both sectors. We may return to the military use of space and so-called ‘dual use’ systems in the future.

7. Since completing the oral evidence sessions for this inquiry, there have been changes in the machinery of government that have resulted in the splitting of the responsibilities of the Department of Trade and Industry and the Department of Education and Skills into three new departments: the Department for Business, Enterprise and Regulatory Reform, the Department for Innovation, Universities and Skills, and the Department for Children, Schools and Families. Given that the DTI and DfES were both members of the BNSC partnership, this Report presumes that the BNSC will continue to work with these new departments. The BNSC, previously hosted by the Department of Trade and Industry, has moved to the new Department for Innovation, Universities and Skills.

**Relevant recent reports**

8. The space sector, particularly the BNSC, has been the subject of numerous reports over the past decade outlined in Box 1.

<table>
<thead>
<tr>
<th>Year</th>
<th>Report Title</th>
<th>Author(s)</th>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>UK Space Policy</td>
<td>House of Commons Trade and Industry Select Committee</td>
<td>Government increase its expenditure on civil space and review the BNSC</td>
</tr>
<tr>
<td>2001</td>
<td>Evaluation of Funding for Civil Space Activity</td>
<td>BNSC</td>
<td>Recommended the development of a space strategy and evidence-based decision making</td>
</tr>
<tr>
<td>2002</td>
<td>Review of Budgetary and Organisational Arrangements for BNSC</td>
<td>Dr Pippa Goldschmidt, DTI</td>
<td>Recommended PPARC and NERC assume responsibility for funding space science and Earth Science</td>
</tr>
<tr>
<td>2004</td>
<td>The United Kingdom’s Civil Space Activities</td>
<td>National Audit Office</td>
<td>Recommended greater emphasis be given to long-term issues, performance management, and the needs of small firms.</td>
</tr>
<tr>
<td>2005</td>
<td>The United Kingdom’s Civil Space Activities</td>
<td>House of Commons Public Accounts Committee</td>
<td>Recommended that BNSC improve its risk management, support small firms and develop performance management.</td>
</tr>
</tbody>
</table>

9. As well as these general inquiries, a number of reports have focused on individual programmes. In November 2004, our predecessor Committee produced a report on the Government’s involvement in the ill-fated Beagle 2 robotic mission to Mars.\(^4\) Three months later, the ESA/UK Commission of Inquiry produced their report into the loss of

\(^3\) More information on the UK’s military use of space can be found in Military Uses of Space, POST note 273, Parliamentary Office of Science and Technology, December 2006.

\(^4\) Science and Technology Committee, Twelfth Report of Session 2003–04, Government support for Beagle 2, HC 711
Beagle 2. In November 2004, the House of Commons Transport Select Committee published a report on Galileo, the European satellite navigation system, which expressed concern regarding the costs and the timescale of the project.

Structure of Report

10. In the following chapters of this Report, we take an overview of space activities in the UK. We consider first the current UK space policy and the forthcoming space strategy. In Chapter 3, we focus on the way in which space activities are organised in the UK through the BNSC partnership and we discuss whether this partnership should be replaced by a space agency. Chapter 4 explores international relations, the UK’s role in ESA, the European space policy and the opportunity for bilateral missions. In Chapter 5, we move on to the way in which the Government supports the space industry in the UK through the ESA programme, national programmes and alternative funding mechanisms. In Chapter 6, we focus upon space science and technology and in chapter 7 we consider the ways in which the development and exploitation of technology could be improved. Chapter 8 looks at Earth observation programmes such as the ESA Global Monitoring for Environment and Security (GMES) programme. In Chapter 9 we concentrate on satellite navigation, particularly the Galileo programme, and telecommunications. We then move on to discuss robotic and manned exploration, space tourism and launchers in Chapter 10. Finally in Chapter 11 we present our observations and recommendations on the impact of space in education, the co-ordination of space activities and outreach work.

11. Throughout this Report BNSC is taken to mean the BNSC partnership. References to BNSC Headquarters will be specified when it is the Headquarters’ function that is relevant.

Does space matter?

12. In his foreword to the consultation on the UK’s space strategy, the Minister for Science and Innovation states that “Space matters. Year by year, it forms an ever greater part of everyone’s life.” Space is becoming an increasingly important sector for the UK. Satellites are able to aid navigation, supply data about the Earth and its climate, deliver mobile communications and broadcasting, and provide vital information for disaster relief and humanitarian aid. The exploration of space is increasingly able to answer questions not only about other planets but also about the Earth. Technologies that have been developed initially for use in space have been applied in other sectors such as security, healthcare or defence. When one answers the phone, watches the television, uses GPS in the car, makes a financial transaction, or searches for a map on the internet, one might be benefiting from space. Looking ahead, space may be used to provide remote healthcare, to warn of natural disasters, or even as a holiday destination. Space is also seen to be inspirational, a point we will return to later on.

13. During this inquiry, we have been aware that the evidence that we have received has been self-selective and that we have heard from people who have tended to take the
importance of space for granted. We are conscious that some critics will argue that space is high risk and costly. There are numerous examples of projects that have not gone to plan. Cryosat, the satellite that was intended to monitor sea ice thickness, crashed shortly after its launch in October 2005. In 2003, scientists lost contact with the Beagle 2 Lander on the Martian surface. The Apollo 1 and Challenger disasters are also stark warnings of loss of human life as well as significant financial resources. In June 2005, the BBC asked the general public their views on human exploration to the Moon or Mars. Approximately 20,000 votes were cast. Of these 20,000 votes, 3370 people added written comments, with 61% of these comments in favour of human exploration and 26% against. Of the 26% that were opposed, “the commonest reason given was that resources should be better spent tackling more immediate problems like poverty in Africa, the funding of the NHS etc.”

14. In fact, the Government currently spends only £207.61 million (0.038% of its overall budget) on space, for which the political rewards are myriad, both for UK subjects and for the wider world. There is much to learn from the exploration of space. **We believe that space is a highly significant area of science policy. As other countries continue to exploit and explore space, it is crucial that the UK is also involved in this sector and it is necessary for the Government to take a more strategic approach to space.**

---


2 Civil space policy in the UK

Current UK space policy

15. Space policy in the UK is co-ordinated by the British National Space Centre (BNSC). The BNSC is a partnership of Government departments and Research Councils: the Science and Technology Research Council (STFC), the Natural Environment Research Council (NERC), the Department for Innovation, Universities and Skills (DIUS), the Met Office, the Ministry of Defence (MoD), the Department for Transport (DfT), the Foreign and Commonwealth Office (FCO), and the Department for Environment, Food and Rural Affairs (Defra). The activities of the partnership are overseen by BNSC Headquarters, a group of staff seconded from the various partners.

16. The UK pursues a user-led approach to space in which each partner “considers the merits of using space against other means of achieving its policies, or assesses the relative merits of space-related and other proposals for research funding.” The UK consequently invests in space programmes selectively when space activities are the most effective way to meet scientific or commercial objectives. At present the UK does not fund launchers to any significant level or participate in human spaceflight programmes. The expensive nature of space projects means that the UK pursues many of its space activities through the European Space Agency (ESA) or similar bodies such as the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT).

UK investment in space

Graph 1: UK civil space spend, 2005-06 prices, £million

Source: BNSC

10 It is currently unclear as to whether the Department for Business, Enterprise and Regulatory Reform and the Department for Children, Schools and Families will be partners.

11 Ev 123
17. In 2005-06, the UK spent £207.61 million on space activities. The UK’s investment in space over the past fifteen years has been variable (see graph 1). Spending increased during the early 1990s but has gradually decreased in the last ten years. The then Minister for Science and Innovation, Malcolm Wicks MP told us that “I am not going to sit here and say £207.61 million is absolutely the right figure […] but there should be appropriate investment […] there may well need to be more investment in the future.” We will consider the appropriateness of the UK’s level of investment throughout this Report.

18. Funding for space activities is split between the BNSC partners as follows:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>DTI</td>
<td>87.76</td>
<td>87.73</td>
<td>90.89</td>
<td>87.50</td>
<td>85.06</td>
<td>34.10(^\text{14})</td>
<td>38.70</td>
<td>42.45</td>
</tr>
<tr>
<td>PPARC</td>
<td>38.71</td>
<td>38.96</td>
<td>41.30</td>
<td>42.50</td>
<td>48.96</td>
<td>73.86</td>
<td>66.20</td>
<td>76.36</td>
</tr>
<tr>
<td>Met Office</td>
<td>23.16</td>
<td>27.11</td>
<td>24.06</td>
<td>23.27</td>
<td>13.89</td>
<td>22.39</td>
<td>31.84</td>
<td>30.00</td>
</tr>
<tr>
<td>NERC</td>
<td>11.10</td>
<td>11.00</td>
<td>11.00</td>
<td>10.50</td>
<td>9.99</td>
<td>51.00</td>
<td>52.20</td>
<td>53.80</td>
</tr>
<tr>
<td>MoD</td>
<td>6.82</td>
<td>6.35</td>
<td>6.11</td>
<td>5.00</td>
<td>2.30</td>
<td>2.30</td>
<td>2.00</td>
<td>2.00</td>
</tr>
<tr>
<td>DfT</td>
<td>16.04</td>
<td>1.04</td>
<td>3.50</td>
<td>0.41</td>
<td>0.00</td>
<td>5.00</td>
<td>7.00</td>
<td>3.00</td>
</tr>
<tr>
<td>Defra</td>
<td>1.40</td>
<td>0.43</td>
<td>0.52</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>184.99</td>
<td>172.62</td>
<td>177.38</td>
<td>169.18</td>
<td>160.20</td>
<td>188.65</td>
<td>197.94</td>
<td>207.61</td>
</tr>
</tbody>
</table>

*Source: BNSC*

In 2005-06, 67% of the UK’s investment in space, or a total of £139.63 million, was channelled through ESA. Of this, £101.9 million was contributed by the Research Councils. In 2005-06, subscriptions to the European Space Agency were the largest area of expenditure by the Research Councils. By comparison, the second largest item of expenditure was the subscription to CERN at £79.1 million. The importance of ESA to UK space policy is demonstrated by Table 2. UK spend through ESA outstrips spend at a national level in all areas.

---

12 Ev 114
13 Q 666
14 The DTI’s expenditure reduced in 2003-04 because responsibility for Earth science shifted to NERC and ESA subscriptions for the mandatory programme relating to science moved to PPARC.
15 HC Deb, 8 January 2007, col 317W
Table 2: Spending by subject area in 2005-06

<table>
<thead>
<tr>
<th>Area</th>
<th>Spending at national level /£ million</th>
<th>Spending through ESA/£ million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earth Observation</td>
<td>37.10</td>
<td>45.20</td>
</tr>
<tr>
<td>Sciences</td>
<td>22.08</td>
<td>46.26</td>
</tr>
<tr>
<td>Telecomms/Navigation</td>
<td>1.6</td>
<td>21.40</td>
</tr>
<tr>
<td>Technology</td>
<td>2.00</td>
<td>2.25</td>
</tr>
<tr>
<td>Transportation</td>
<td>0</td>
<td>5.0</td>
</tr>
<tr>
<td>General Budget</td>
<td>5.2</td>
<td>19.52</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>67.98</strong></td>
<td><strong>139.63</strong></td>
</tr>
</tbody>
</table>

Source: BNSC

19. This table also illustrates the UK’s relatively heavy investment in space science and Earth observation and its minimal investment in transportation such as launchers. The BNSC argues that this selective approach to space projects means that there is greater focus upon the selected areas. David Williams, Director General of BNSC, explained to us that “when you decide how much money you spend on science in general and how much money you spend on space, you have to be selective about what you do, so you do what you do well. The UK has been very, very good at being selective.”

**UK Space Strategy 2003-2006 and beyond**

20. Current UK space policy is outlined in the *UK Space Strategy 2003-2006 and beyond.* The strategy emphasises that the UK uses space when it is the most appropriate solution, rather than considering the development of space technology as an end in itself. It states that the Government’s vision is that “The UK will be the most developed user of space-based systems in Europe for science, enterprise and environment. UK citizens will provide and exploit the advanced space-based systems and services which will stimulate innovation in the knowledge-driven society.” Furthermore, the strategy outlines the UK’s ambition “to secure world-beating science and the technologies needed to deliver it, and to achieve greater use and market acceptance of all types of space services, addressing regulatory, technical or market issues as appropriate.”

21. The *UK Space Strategy 2003-2006 and beyond* articulates three main objectives of the UK’s involvement in space:

   i. Enhancing the UK’s standing in astronomy, planetary and environmental sciences;

---

16  Q 122
18  As above, p 11.
19  As above, p 12.
ii. Stimulating increased productivity by promoting the use of space in government, science and commerce; and

iii. Developing innovative space systems to deliver sustainable improvement in quality of life.  

22. The strategy expands upon these objectives by highlighting areas such as the UK’s lead in small satellites, the use of environmental science, support for key technologies, the development of global markets and the UK’s involvement in international partnerships. In the strategy the BNSC partnership outlines how it will meet and deliver the three objectives and how activities will develop in the future. Case studies focusing on the satellite Inmarsat 4 and the Martian lander Beagle 2 punctuate the strategy, illustrating what the partnership has already achieved.

23. The space strategy also provides a basis for assessing the BNSC partnership’s success in meeting the vision and strategic objectives in the future. It breaks the three main objectives into eight outcomes that the space strategy should deliver (Box 2). These strategic national outcomes give some indication of the breadth of the UK space policy, ranging from space science to satellite services to the provision of space technologies.

Box 2: Space Strategy 2003-06 and beyond: strategic national outcomes

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Performance Indicator</th>
<th>Broad Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased supply of science, engineering and technology skills to underpin the UK</td>
<td>• Increase in graduates and postgraduates qualified in science, engineering and</td>
<td>• Further inclusion of space into education in schools at all levels and raised</td>
</tr>
</tbody>
</table>


24. These strategic outcomes are then tabulated against performance indicators and broad actions. By illustration, the third strategic outcome is aligned with the following performance indicators and actions:

Box 3: Strategic national outcome 3, associated performance indicators and actions.

ii. Stimulating increased productivity by promoting the use of space in government, science and commerce; and

iii. Developing innovative space systems to deliver sustainable improvement in quality of life.  

20 As above, p 7.
<table>
<thead>
<tr>
<th>Outcome</th>
<th>Performance Indicator</th>
<th>Broad Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>knowledge base as UK scientists lead world-class collaborative space projects.</td>
<td>technology disciplines including space as an element of their qualification</td>
<td>awareness among young people of careers in space (scientific and industrial)</td>
</tr>
<tr>
<td></td>
<td>• Number of UK Principal Investigator positions won against international competition</td>
<td>• Increased opportunities for graduate and postgraduate research in all aspects of space—technologies, science and applications</td>
</tr>
<tr>
<td></td>
<td>• Number of UK scientists invited to participate in international advisory and peer review committees and give topical reviews at international meetings</td>
<td>• Public education and awareness raising</td>
</tr>
<tr>
<td></td>
<td>• Visitor numbers to BNSC and Partner space websites. Recognition of key space ‘brands’ in surveys</td>
<td>• Establish Champions for space in UK centre of excellence (Higher Education Institutes and Research Institutes) so that our best scientists become more visible leaders nationally, supported and better positioned to win international competitions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Promote UK credentials internationally</td>
</tr>
</tbody>
</table>

Source: BNSC Space Strategy 2003-2006 and beyond, p 45

The *Space Strategy 2003-06 and beyond* states that the tables “detail high level performance indicators which the Director General of the BNSC headquarters and the Space Strategy Council will rely upon to gauge the progress of the overall Partnership towards achieving the strategy. Management use of these indicators necessitates establishing a baseline of evidence.”\(^2\) This approach to performance assessment was recommended by the National Audit Office in its report on civil space policy. It suggested that the BNSC partners should “measure their performance against the objectives laid down in the new Space Strategy, filling the gaps in their information base and building on the framework produced by our consultants.”\(^2\)\(^2\)

25. The *UK Space Strategy 2003-2006 and beyond* developed a system of performance indicators. In its report in June 2005 the House of Commons Committee of Public Accounts noted that “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.”\(^2\)\(^3\) Since publishing the strategy, the BNSC has not published evidence tracking its performance against the performance indicators or outlining the actions taken. We were told by BNSC that information relating to the individual performance indicators was not kept but that the BNSC had undertaken a mid-term review some two years ago.\(^2\)\(^4\) Despite recommendations by the National Audit Office, the BNSC has still not developed a robust performance management system. We are disappointed that the BNSC failed to take advantage of the opportunity to

---

\(^{21}\) BNSC, *UK Space Strategy 2003-2006 and beyond*, p 43

\(^{22}\) National Audit Office, *The United Kingdom’s Civil Space Activities*, March 2004, HC 359, p 6

\(^{23}\) Committee of Public Accounts, Twenty-First Report of Session 2004–05, *The United Kingdom’s Civil space Activities*, HC 47, conclusion 4

\(^{24}\) Ev 382
establish a performance management system offered by the implementation of the UK Space Strategy 2003-2006 and beyond. The new strategy should outline how the partnership will track its performance and BNSC Headquarters should ensure that performance monitoring is undertaken.

**Space Strategy 2007-2010**

26. The BNSC launched a consultation on its Space Strategy 2007-2010 on 8 January 2007. The consultation invited comments on the vision and focus of the new strategy, space science, earth observation science, international collaboration, societal benefits, wealth creation, technology programme, education, security and dual-use, the delivery structures, trade promotion and new opportunities. The consultation noted that “In the existing programme of activities, the UK believes that there is an adequate market capable of ensuring access to space for the UK and hence support for launchers is minimal. There are no current plans to become involved in the International Space Station or manned space activities, as no funding partner currently believes that the potential benefits justify the costs involved.”

27. The new strategy proposed three primary objectives similar to those in the current strategy:

a) “Delivering world-class science by exploiting the UK’s space activities and expertise;

b) Delivering public benefits in partnership with Government bodies and institutions to exploit the full potential of space activities;

c) Maximising the potential for wealth creation from space activities by facilitating a progressive business environment.”

28. The consultation closed on 2 April 2007. The then Minister for Science and Innovation, Malcolm Wicks MP told us that “we have had a good consultation” with 130 responses and that the plan was to publish the space strategy in the autumn. The Director General of BNSC, David Williams, commented that “dramatic changes tend to mean extra funding and changes in the funding base, so it will be difficult to say that things will change dramatically.” The then Minister anticipated that objectives governing the strategy were unlikely to change radically.

29. This downward management of expectations is extremely disappointing. We hope the BNSC will keep an open mind regarding the strategy and take our recommendations into account given the strength of support that exists for a more ambitious approach to UK space policy. The then Minister acknowledged that he would be interested in our views on the structure of BNSC and the BNSC has said that it “will consider the recommendations

---

25 BNSC, A Consultation on the UK Civil Space Strategy 2007-2010, p 9
26 As above, p 8.
27 Q 641
28 Q 118
29 Q 645
of the Committee prior to publication in mid-2007.”

We make specific recommendations relating to the strategy throughout the Report but take this opportunity to raise some overarching issues.

**Vision**

30. Throughout this inquiry we have been told that the UK has not articulated fully its ambitions in space. Professor Keith Mason, Chief Executive of the then PPARC, told us that “I would like to see more ambition in the space agenda. […] the space arena is going to be incredibly important to all of our futures, and if the UK is to be seen as an attractive place to invest generally then it has to have ambition”. Colin Paynter, Managing Director of EADS Astrium, said that he “would like the UK really to recognise the importance of space and to determine what ambition it needs to have in space”. Malcolm Wicks MP, the then Minister for Science and Innovation told us that his ambition was to see “Britain as a major player in space”.

**Horizon scanning**

31. As well as focusing on current projects and taking stock of past achievements, the space strategy should look forward for future opportunities. It is important that the UK has appropriate mechanisms for horizon scanning in the space sector and related areas. Professor Keith Mason told us that “we need a mechanism of doing that horizon scanning, and horizon scanning across the whole partnership rather than just within individual members.” The BNSC acknowledges that it needs to develop horizon scanning activities, noting that these might relate to “new commercial opportunities deriving from technological development and the emergence of new space-faring nations; new areas of policy that might be addressed by space, such as health; and the potential impact of scientific developments arising from space activity.” We have heard that developments such as small satellites or space tourism that were considered as a “mild form of lunacy” are now becoming mainstream. Policymakers should keep an open mind about topics raised by witnesses, such as space-based solar power, space elevators or orbital towers, the extraction of Helium-3 from the lunar regolith (soil), and reflectors around the Earth to reduce the heat from the Sun.

32. Long development timescales are characteristic of the space sector. Professor Mason asked “‘Where do we want to be in 20 years’ time?’ That is the sort of timescale we have to think about. We have to ingrain that in government and in society as a whole.”

---

30 Q 606; Ev 123
31 Q 179
32 Q 39
33 Q 573
34 Q 182
35 Ev 124
36 Q 17
37 Ev 270, 337
38 Q 179
context, the three year timespan of the BNSC strategy is quite short. The *UK Space Strategy 2003-2006 and beyond* does contain a “high level road map” that extends to 2015. It notes that

Most of the achievements of the next three years will be built on past investments and policy decisions made over the previous decade. For example, when the European lander Huygens parachutes into the atmosphere of Saturn’s Moon Titan, early in 2005, it will complete a journey begun in October 1997 and first conceived 15 years earlier. In the same way, decisions taken over the next three years, in pursuit of the strategy objectives, will have a long-term impact.39

We would like to see this extended in the new strategy.

**Co-ordination with other strategies**

33. The current space strategy, *UK Space Strategy 2003-2006 and beyond*, provides a broad overview of the UK’s involvement in space. It does not contain a high level of detail about the actions of individual partners or particular programmes because of overlap with other strategies. In December 2004, NERC published an Earth observation strategy.40 The MoD published its *Defence Industrial Strategy* on 15 December 2005 and its *Defence Technology Strategy* in October 2006, both of which related to its space activities.41 STFC is currently developing a space science strategy and Defra is creating an Earth observation strategy. We are concerned by the lack of detail in the existing main space strategy, despite concerns regarding overlap. The new strategy should note the existing documents that complement it. The BNSC should create a strategy webpage that provides links to all strategy documents relating to space such as the space strategy, the long-term roadmap and appropriate publications by BNSC partners.

**Conclusion**

34. The new strategy is an opportunity for BNSC to outline clearly its vision and ambition for space. The strategy should inspire and motivate the UK space sector and emphasise the UK Government’s commitment to space. If the UK is to realise fully its potential in this sector, it is necessary for the Government to identify emerging areas of interest at an early stage so that industry and academia have time to position themselves internationally and develop the relevant skills. **We are concerned that there is a lack of co-ordinated horizon scanning within the BNSC partnership.** We recommend that BNSC Headquarters assume responsibility for horizon scanning and informing partners of emerging issues. The BNSC should liaise with the Foresight programme within the Department for Innovation, Universities and Skills on approaches to horizon scanning. Horizon scanning should be an activity that is integrated fully into the policy-making process and it should be understood to be an extension of BNSC’s existing long-term roadmap. **We recommend that alongside the Strategy 2007-2010 the BNSC develop a**

long-term roadmap from 2010-2050. This roadmap should complement the short-term strategy by providing a flexible indication of where the space community is heading. The roadmap should be seen as an active document to be displayed on the BNSC website and updated at regular intervals incorporating policy changes or the results of horizon scanning activities.
3 The BNSC

35. The BNSC partnership was established in November 1985. It began with four partners: DTI, MoD, NERC, and the Science and Engineering Research Council. By 2003, its membership had grown to ten partners who were interested in various aspects of space (Box 4). Recent machinery of Government changes outlined in paragraph 7 mean that there have been some changes to the membership, however BNSC continues to work as a partnership of Government departments and Research Councils.

Box 4: The BNSC Partners

- DTI—Focuses 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
- NERC—Space data is vital for improving understanding of the Earth system and reducing uncertainties in environmental prediction
- OSI—Responsible for science policy and funding the Research Councils
- Met Office—Relies on international space infrastructure for global data to meet its key performance targets for weather forecasting and service quality
- MoD—Ensures effective harmonisation of civil and military investment in space technologies, collaboration on multiple-use terms and guidance about opportunities for UK firms in the space defence sector, especially in the United States.
- DfT—Interests in space to meet transport policy needs and is investing in the development of European satellite navigation services in partnership with the DTI and industry
- Defra—Invests directly in the development of space infrastructure and services to underpin national environmental priorities such as climate change research
- STFC—Invests in space in pursuit of high quality basic research and as a provider and user of space facilities in support of other Research Councils, universities, space agencies and industry
- FCO—Responsible for foreign policy and the development of international relations in pursuit of international co-operation

Source: BNSC, Space Strategy 2003-06 and beyond, p 8

36. The BNSC partnership is designed to enable Government departments to take a co-ordinated approach to space policy at a national and international level. The work of coordinating the work of the partners is undertaken by BNSC Headquarters. According to the BNSC, the key policy roles carried out by staff at BNSC Headquarters are: advising the Science Minister; developing the UK Space Strategy; overseeing and reviewing implementation of the Strategy; liaising across government bodies; fostering the strengths of the UK space community; developing industrial policy and liaising with industry; leading at the European Space Agency Council and its Boards, and with the space interests of the European Commission; providing international representation and developing cooperation, and promoting awareness of space through education and publicity.42
37. The governance of the BNSC was reorganised in 2005 to distinguish between the management and advisory functions. The current structure is shown in diagram 1.

Diagram 1: Governance Structure of BNSC

- Space Science Advisory Board
- Earth Observation Advisory Board
- European Space Project Advisory Board
- Space Technology Advisory Board
- Telecommunications Advisory Board
- Space Advisory Council
  Provides advice to Space Board and Director General. Representatives from BNSC partners, chairs of advisory boards, industry, and academia
- UK Space Board
  Provides guidance to BNSC and takes a strategic steering role. Representatives from STFC, NERC, DTI, Met Office, and MoD.

38. There had traditionally been a close relationship between the BNSC and DTI. The DTI explained that “With the setting up of BNSC in 1986 it was agreed that the Centre should be hosted by the DTI who would also provide the majority of the core staff including its first Director General. This provides a strong anchor for the Government’s interest and involvement in civil space.” The then Minister described the DTI as “the parent department” and DTI described itself as the “anchor Government department”. During the course of this inquiry, the BNSC was in the remit of the Office of Science and Innovation within the DTI and the Minister with responsibility for the BNSC was Malcolm Wicks MP, the Minister for Science and Innovation. The abolition of the DTI and creation of the Department of Innovation, Universities and Skills has thus had an impact upon the BNSC. The BNSC is now in the Department of Innovation, Universities and Skills. The Director General of BNSC, David Williams, is in the line management of this department, working for Professor Sir Keith O’Nions, Director General of Science and Innovation (DGSI). We presume that the close working relationship between BNSC and DTI will continue between BNSC and DIUS.

The partnership model

39. In 2004, the National Audit Office outlined the strengths and weaknesses of the UK’s partnership approach to space (Box 5).
Box 5: Strength and weakness of the UK partnership approach to space

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Clear and coherent view of the United Kingdom’s space activities provided to ESA</td>
<td>• The authority of the BNSC Partnership is limited; it cannot override the decision making processes of any individual Partner</td>
</tr>
<tr>
<td>• Reinforces the user led philosophy of the United Kingdom</td>
<td>• Focus on uses/users may lead to missed opportunities in developing research/technology areas</td>
</tr>
<tr>
<td>• Low headquarters overheads</td>
<td>• Space investment is long term yet may be affected by short term departmental considerations when prioritised with other non-space related options</td>
</tr>
<tr>
<td>• Consultation with users is likely to be more far reaching, transparent and cost effective than alternatives</td>
<td>• Focus on uses/users may lead to missed opportunities in developing research/technology areas</td>
</tr>
<tr>
<td>• Space projects compete against other non-space strategic priorities for departmental funding therefore are subject to broader competitive pressures</td>
<td>• Space investment is long term yet may be affected by short term departmental considerations when prioritised with other non-space related options</td>
</tr>
</tbody>
</table>


40. The evidence that we have received during this inquiry broadly supports the NAO’s conclusions. We have heard positive comments about the partnership regarding its ability to present a co-ordinated UK position internationally and its focus on value for money. ESA told us that “BNSC is able to represent UK interests with a single voice and coherent positions.”46 David Williams, Director General of BNSC, told us that the partnership “really highlights the fact that what you have to do is demonstrate that the satellite system or the space system which is being developed really has value.”47 The then Minister told us that “BNSC has been a success and I think it is an important partnership”.48 We have also heard negative comments about the partnership, particularly in relation to funding. UK Space has said for example that “the user departments of government, such as DfT, DEFRA, the Home Office and the FCO struggle to find funding for space as it is seen as too long term and early stage, in spite of the considerable potential benefits downstream.”49

41. Those closely involved in the BNSC have concluded that the partnership has been a success, given the constraints within which it has worked. The Director General of the BNSC told us that “I believe at the present time, within the constraints of a partnership and within the constraints that individual spends go through individual departments, we are working together and we are working harder to improve that inter-relationship between us and it is driving forward and going well”.50 Professor Keith Mason, Chair of the UK Space Board, told us that “I think the BNSC does a very good job within the constraints of its set-up and make-up”.51 It is difficult however to ascertain the success of the BNSC partnership given the lack of information regarding performance management (paragraph 25).

46 Ev 338
47 Q 99
48 Q 606
49 Ev 133
50 Q 109
51 Q 169
A user-driven approach to space

42. The way in which the partnership works reflects the UK’s user-driven approach to space, which focuses on activities which will enhance scientific knowledge and bring benefits to the UK economy and society. As David Williams of the BNSC explained, “we are doing things not just because it is a satellite system or a space system, but because it is useful in the area of application that is being applied”.

43. Undertaking projects because of their practical use, rather than their prestige, means involving the end user at an early stage to define requirements. The BNSC partnership works on the principle of defining lead partners for activities such as ESA programmes. The Space Board agrees which partner will lead on a programme. We were told that to date, agreeing on which partner has the primary user interest and hence should lead in defining requirements has not been an issue. Where more than one partner has an interest the issue is around how the cost of the ESA programme is shared taking into account the use each partner will make of the programme and the level of technical innovation and uncertainty in the development.

44. Once the lead partner has been agreed, work then proceeds on the basis of co-operation between the partner and BNSC headquarters. Policy direction, defining what is required and resulting expenditure is determined by the Ministers and/or governing bodies of the partners involved. Technical expertise and liaison with ESA is provided by BNSC Headquarters. In relation to the European satellite navigation programme Galileo, for example, the Department of Transport decides the policy direction and BNSC Headquarters acts as the technical interface to the European Space Programme. In relation to the European programme for Global Monitoring for Environment and Security (GMES), led by Defra, we were told that “it is BNSC headquarters staff working for me [Dr David Williams] who have engaged with ESA on the debate. Some of them are Defra staff on secondment and some are NERC staff on secondment.” BNSC thus represents the Defra view at the ESA Programme Board. In the European Commission (EC) GMES Advisory Council, the forum that discusses the programme structure in an EC context, Defra is supported by BNSC Headquarters.

45. We have three main concerns about the way in which this complex user-driven partnership approach works. First, an approach combining technical expertise from BNSC Headquarters and policy direction from the BNSC partner requires an understanding of space issues on both sides. We are concerned that lead partners might not have sufficient expertise or understanding of space in order to engage fruitfully with policy decisions regarding requirements. ESA told us that “For mature users of space, such as PPARC, NERC and Met Office this system works very well, but for developing users such as
DEFRA it seems too intense and rapid a transition for them.”

Second, we are concerned that problems can occur when a programme does not fall solely to a single lead partner and funding is split between several partners who have an interest in the programme. Defra has said in relation to GMES where funding is split between four partners that “there is no UK funding model for this type of programme and this is a major challenge that BNSC and its partners need to address urgently.”

We will deal with the specifics of the GMES programme in more detail later (paragraph 243). Finally, it is difficult for the partnership to insist that users should prioritise funding for long-term space programmes, particularly when in the short-term the benefits from such programmes are primarily industrial. Colin Paynter from EADS Astrium told us that “the issue of asking the user departments to prioritise what is essentially for the first three or four years a technology programme and it is in only years five, six and seven where they will start to draw beneficial use to themselves out of it is quite a difficult thing to ask.”

46. It has been suggested that the partners that are end-users such as Defra should be separated from the main funding partners such as DIUS or STFC. We believe that to do this would weaken the partnership rather than strengthen it and would not provide support for end-user partners such as Defra that are funding programmes. Greater central co-ordination is crucial for the success of the user-driven partnership approach, particularly as programmes are likely to become increasingly complex and involve more partners in the future. We believe that where departments are identified as having a particular interest in projects rather than being designated as ‘lead’ departments, they should be called ‘primary users’ and BNSC headquarters should be perceived as the ‘lead’. One option would be to develop this system further to incorporate ‘secondary users’ and to specify agreed responsibility for funding at different stages of a programme eg. ‘primary user/phase 1 secondary funder/phase 2 primary funder’. The breakdown of users and funders for each programme could be published on the BNSC website with the responsibilities for each partner in relation to that programme outlined. We support the UK’s user-driven approach to space but are concerned that user Departments might start leading programmes without sufficient expertise or skills. We recommend that in the early stages of programmes BNSC headquarters provide the skills and expertise to enable user departments to engage with space solutions and that BNSC headquarters be responsible for building up understanding of space within Departments. BNSC headquarters should be perceived as leading projects in conjunction with primary and secondary user partners. The BNSC should explain in its forthcoming strategy how funding models in the future will work for projects involving many partners.

A UK space agency?

47. The question of whether the UK should have a space agency has arisen at several points during our inquiry. Internationally, organisational forms range from large space agencies to partnerships to Government departments responsible for space. There are space
agencies, for example, in Canada (CSA), Germany (DLR), Japan (JAXA) and India (ISRO). In Switzerland space is the responsibility of the State Secretariat for Science and Research in co-operation with other offices and organisations with an interest in space. In Sweden, the National Swedish Space Board is within the Ministry of Industry, Employment and Communication. In several countries, responsibility for space activities is combined with other areas. In the Netherlands responsibility for space is combined with aircraft and air transport, whilst in Spain involvement in ESA is managed by the Centre for the Development of Industrial Technology alongside other European programmes such as CERN and Eureka. Despite this variety, however, when one thinks of a powerful, focused space programme, the US agency NASA inevitably springs to mind.

48. There are many different arguments for an agency instead of the BNSC partnership. An agency could have increased power, a centralised budget, the ability to make longer term investments, greater visibility, a single strategy, and centralised control and decision-making. An agency could be a hub for national and international activities and might hold greater sway at the international negotiating table. The case for an agency has been made by numerous parties during this inquiry. The Royal Society has argued that a space agency is needed if the UK is to seize proactively the opportunities that currently exist. It says that an agency should “have a significant budget to fund research and applications; be able to speak with authority and advise Government on priorities for research and exploitation in UK space science; engage on a more equal footing with the ESA and with national agencies in other countries; and generally enable the UK to play a stronger international leadership role in space science.”62 Professor Len Culhane, Chairman of the UK Space Academic Network told us that “a space agency funded and with constitutional powers to run a coherent national programme would be of enormous benefit and I believe that is absolutely lacking at present.”63 The University of Leicester also said that the BNSC “should be replaced with a national space agency similar to the DLR, CNES and ASI in Germany, France and Italy.”64

49. There would, however, be potential problems with the creation of a space agency. If the UK’s space policy continued to be user-driven, then the agency would still have to liaise with users and be governed by their requirements. There is no evidence that, if political will to drive a project were lacking in the partnership, this political will would appear with an agency. Jean-Jacques Dordain, the Director General of ESA, told us that “BNSC is the image of your political position […] You cannot compare, for example, with the fact that there is an agency in France because the French policy is very different from the British policy.”65 Unlike the UK, France is willing to pursue prestige projects and consequently spends significantly more on space activities.

50. One of the main benefits of the partnership that derives from its user-driven focus and insistence that partners fund programmes is that space programmes have to be justified with reference to terrestrial approaches. This comparison between space solutions and alternative arrangements could easily be lost in a stand-alone agency. The Director General
of the BNSC told us that “The main reason that we have a partnership rather than an agency at the moment is that one of the things we wish to do with space is to keep the tension across why we do things using satellite systems as opposed to other mechanisms”.66 The NAO emphasised in 2004 that “the partnership approach is a cost effective way of securing the benefits of national and international co-operation on space programmes. This is because it ensures that partners consider the benefits of expenditure on space against alternative investments, while also avoiding duplication.”67

51. The creation of an agency would not be any guarantee of extra money for space activities. Several witnesses have told us that extra funds would be necessary to make a space agency worthwhile and successful. Sir Martin Sweeting from SSTL told us for example that “An agency would be appropriate if the scale of space activity in the UK were to grow probably ten-fold. I think at the level of the current scale and distribution of the funding, the Centre does a good job”.68 Colin Paynter from EADS Astrium told us that “I do not think space is given the importance that it needs to be given in Government, so just creating probably an ill-funded agency would make the issue worse”.69

52. The partnership structure of BNSC has the benefit of bringing together Departments and Research Councils interested in space. To be successful, a space agency would still have to develop these links: creating an agency would not create such links automatically. The then Minister, Malcolm Wicks MP, explained that “in an era where we all talk about joined-up government BNSC since 1985 has very much been a forerunner of how we bring different bits of government together.”70 PPARC said that “the BNSC partnership arrangement (especially if developed to its full potential) is an appropriate model for the UK as it ensures a more customer focused approach.”71 ESA told us that “the structure of BNSC is in one sense ‘ahead of its time’: it puts user departments in the lead which is positive.”72

53. There appears to be a lack of enthusiasm for an agency within Government. The then Minister told us, “I do not get as excited as some about organisational structures or departmental reorganisations”. He did say, however, that he was “open-minded, to be blunt, about the future.”73 Dr David Williams told us that “There is no doubt it [the BNSC partnership] is not perfect, but I am not sure that the agency would be any more perfect; it would have different problems”.74 We agree that there are difficulties with the BNSC partnership and understand why witnesses suggest that an agency might be able to provide those qualities such as leadership, co-ordination, and visibility, that the partnership lacks. Nevertheless, we do not believe that an agency would be a “silver bullet” and to suggest it would not necessarily be a practical solution. The creation of an agency would require extra

66 Q 94
67 NAO, The United Kingdom’s Civil Space Activities, March 2004, HC 359, p 3
68 Q 39
69 As above.
70 Q 606
71 Ev 197
72 Ev 338
73 Q 606
74 Q 102
funding for space in order to be successful but there has to be concern that such a change might be seen by departments as an opportunity to economize and reduce funding for space, rather than to increase funding in this area. If current levels of expenditure in space persist, the Government should not establish a space agency but should continue to pursue the partnership approach to space. If expenditure is substantially increased, the question of an agency should be reviewed. However, we believe that there are problems with the current partnership arrangement and that it should be strengthened appropriately. We detail ways in which this could be achieved below

Strengthening the partnership

54. There are several difficulties with the BNSC partnership: a low profile, a lack of leadership, poor co-ordination, low levels of resources, and variable levels of involvement by partners and the space community.

BNSC’s profile & status

55. Throughout our inquiry we heard formally and informally that the BNSC had a relatively low national and international profile. Lord Rees of Ludlow, President of the Royal Society, told us that “BNSC, although functioning effectively within its limits, has too low a profile. There should be some effort given to somehow enhancing its profile”. He explained that “I think there is a problem that, if you ask the average person in the UK, “What is the BNSC?”, they will not have heard of it. They will have heard of NASA, they might even have heard of ESA, but they certainly will not have heard of BNSC.” The Space Foundation told us that “You cannot point to the “British Space Programme” with the kind of clarity that you can point to the US space programme, or even the Chinese, Indian, or Japanese space programmes.” The University of Leicester added that “No matter how able and well-organised BNSC staff may be, the worldwide perception is of an organisation with no budget and therefore without power, whose consultative nature renders it ineffectual in the promotion of UK space interests.”

56. Part of the problem with the BNSC’s profile is its status as a partnership because there is difficulty as to whether successes should be credited to the partner or to the BNSC. Dr Williams explained to us that “you have always got the presentation of where does the credit go”. The BNSC is aware of the problem and on 21 March 2006 the UK Space Board agreed that a common branding and a strapline for partnership activities were needed. Since then the BNSC has developed a communications strategy for its approach to activities during 2007. This strategy deals with target audiences, vehicles for communication, branding and resources.

75 Q 425
76 Q 456
77 Ev 145
78 Ev 164
79 Q 109
80 UK Space Board, Minutes of Seventh Meeting, 21 March 2006
57. An issue that concerned us during this inquiry was that BNSC was not sufficiently separated from DTI and that the DTI had the potential to overshadow the work of BNSC Headquarters. The nature of the relationship between the DTI and BNSC was raised in the Goldschmidt review of BNSC in 2001 and resulted in the transfer of funds from DTI to NERC and PPARC. Pippa Goldschmidt wrote that "BNSC is physically located in DTI offices and appears in the DTI organogram as a DTI directorate. Within BNSC, it is difficult to distinguish BNSC policy from that of DTI in most areas." Dr David Williams explained to us that "We are directly linked into the Department of Trade and Industry mechanisms for access to, if you like, the financial regimes. Something like 80% of the total budget of the BNSC comes through the Office of Science and Innovation in the Department of Trade and Industry." 

58. We heard that the BNSC was thought to be overly influenced by the DTI. Professor Keith Mason, the then Chief Executive of PPARC, told us that the BNSC “was perceived (I am not sure it actually was) as a child of the DTI in some quarters”. Professor Howard Dalton, Departmental Chief Scientific Adviser (DCSA) at Defra, told us that “we are wondering in many respects whether or not the agenda that has been set by BNSC is coming from DTI or from the membership as a whole. That has been a concern of ours. […] I do not think it is very sensible to have BNSC associated with any government department particularly.”

59. The BNSC had attempted to make itself more explicitly independent of DTI. On 2 February 2005, the UK Shadow Space Board considered “how to move from the current position where a majority of core BNSC partnership costs fell to DTI to a position where the partners on the Space Board shared responsibility for the costs.” We asked BNSC what the current situation was regarding core BNSC partnership costs. The BNSC responded that “the administration and staff costs associated with the BNSC ‘corporate activities’ (hosted in DTI) fall mainly to DTI. These cover the office costs of all London staff, salaries of the DTI staff acting across the partnership and some core communications activities.” In 2006/07 these costs would have amounted to £1.6 million for DTI. NERC, STFC, and MoD cover the salary and travel costs of their staff working in BNSC. BNSC explained that the current arrangements continue until the end of the 2007-2008 financial year. It said that the UK Space Board needed to address how to share these costs in relation to the current Comprehensive Spending Review.

60. An overarching weakness in the current BNSC partnership is the status of the BNSC itself. The BNSC partnership should be more than merely the sum of the activities of the partnership. The partners within BNSC should be contributing to an organisation, the

---

81 Pippa Goldschmidt, Review of BNSC, December 2001, p 10
82 As above.
83 Q 95
84 Q 171
85 Q 349
86 UK “Shadow” Space Board, Minutes of First Meeting, 2 February 2005
87 Ev 361
88 Ev 375
89 Ev 361
BNSC, which is able to provide leadership and direction within the space sphere. The BNSC should be perceived as an independent entity to which the partners contribute. The BNSC has explained that, due to the nature of the partnership, “each partner brings relevant resources as appropriate for programme activities. BNSC provides the framework and overall strategy for these programmes.”90 BNSC Headquarters should be the focus for these programmes, not merely the framework: it should be the core of the BNSC and a focus for ambition. We recommend that the BNSC partners work towards strengthening the status and profile of BNSC Headquarters. As part of this, the BNSC should review the effectiveness of its brand internationally and nationally, including the possible impact of a change of name. Projects should be associated firstly with BNSC and secondly with the partner involved. The relationship between the BNSC partners and BNSC Headquarters should be clearly outlined in the forthcoming strategy. The recent machinery of Government changes provide BNSC with an ideal opportunity to establish a clear separation from DIUS. The BNSC should emphasise its independence from DIUS by splitting the costs of its administration between its partners or covering its own costs in order to become a clearly defined entity.

A leadership role for BNSC headquarters

61. We have heard differing opinions regarding the BNSC’s ability to lead and promote space activities. Matthew Stuttard, Chairman of the British Association of Remote Sensing Companies (BARSC) told us that “there has been very good leadership in BNSC but the amount they are allowed to lead is constrained”.91 The Royal Astronomical Society presented an alternative view, stating that “the failure of BNSC to lead the space community has had a deadening effect on our world position. Many opportunities have been lost.”92 Professor Richard Holdaway, the then Head of Science Programmes at CCLRC told us that the BNSC has difficulty with lobbying.93 David Williams of BNSC denied these claims saying that “we do have a quiet lobbying mechanism and it is called the line management system in government rather than a public lobbying system”.94

62. The BNSC has set up an initiative, Government Information from the Space Sector (GIFTSS), in order to promote the use of information from satellites across Government. Sector facilitators introduce space data to project managers from Departments or agencies as a possible way of improving their work using existing technologies. The overall programme activity is small, with typically two projects costing approximately £60k each running at any time, co-funded by the BNSC and the user Departments.95 The most recent project in partnership with Lancaster City Council is using satellites to monitor the areas of salt marsh in Morecambe Bay in order to understand flooding and conservation issues.96 We welcome the Government Information from the Space Sector (GIFTSS) initiative.

90  Ev 375
91  Q 370
92  Ev 209
93  Q 175
94  Q 95
95  Ev 356
96  As above.
We believe that there is further scope for BNSC Headquarters to provide leadership in the space sector and to promote the use of space within Government through initiatives such as GIFTSS. We believe that BNSC Headquarters would be well-placed to provide leadership for the space community, if empowered to do so.

63. In a partnership such as the BNSC it is crucial that the strength of individual partners does not undermine or weaken the whole partnership. There must be central co-ordination to ensure that there is a balance between the UK’s overall strategic approach to space and the activities of individual partners. The current space strategy, *UK Space Strategy 2003-2006 and beyond*, states that “It is for each Partner to decide how they will contribute to the eight outcomes defined in this strategy. They will determine their own priorities for work and budget, relative to their broader mission statements and business or operating plans.”97 The Strategy then includes a table showing which of the eight outcomes are relevant to each Partner.98 This approach is high-level and extremely broad. It does not outline which partners are involved in funding which programmes, which partners are expected to lead on programmes, or how programmes interact. Indeed it acknowledges that “The strategy is therefore not prescriptive in defining what the individual Partners should do in space but is intended to provide guidance on where combined partner decision and action in space could provide additional benefits for the UK”.99

64. We believe that BNSC Headquarters on behalf of the partnership as a whole should expect partners to commit to projects and to the BNSC partnership. We have heard several times that there is a lack of political will in relation to space in the UK.100 If the BNSC is to have “teeth” and be able to lead space activities in the UK then it is necessary to have a level of public commitment from its partners to different programmes. Dr David Williams told us that the BNSC’s approach to the CSR had been to create a document that all the partners submitted as a cover document for their own programme. He said that it shows that departments are “working within a framework of the overall space activity and this is what we are trying to achieve overall”.101 We recommend that the BNSC use the new strategy to set firm, specific goals agreed with the BNSC partners, as well as providing a general overview of aspirations in different areas. BNSC partners should prepare and publish an implementation plan for their part in delivering the strategy.

**Reporting**

65. The partnership status of the BNSC and the fact that the BNSC is not an executive agency means that it does not produce its own annual report and accounts because these are produced by each partner. In response to a request by the Trade and Industry Select Committee in 2000, the BNSC reports on its activities in its annual ‘Space Activities’ report.102 In *Space Activities 2006*, the BNSC outlines developments in space science, international collaboration, satellite navigation, satellite communication, industry,

---

98 As above, p 41.
99 As above, p 43.
100 Qq 536, 170, 43
101 Q 102
102 Trade and Industry Committee, Tenth Report of Session 1999-00, *UK Civil Space Policy*, HC 335, p 1
licensing, education and publicity.\textsuperscript{103} The report provides a broad overview of the breakdown of funds by partner and subject area.\textsuperscript{104} However, the Space Activities reports do not provide a high level of detail about space funding, for example subscriptions to ESA programmes, and it is difficult - in some cases impossible - to find this information in the annual reports and accounts of the individual partners.

66. BNSC Headquarters would serve a useful purpose by bringing this financial information together into one document. There is also little correlation between the Space Activities reports and the Space Strategy. The Space Activities reports provide an opportunity for BNSC to return to the outcomes, performance indicators and actions outlined in the strategy to update them and record progress against them (paragraph 25). \textbf{We recommend that BNSC Headquarters produce an annual report and accounts, with a breakdown of funding by partners into national programme, subscription to individual ESA programmes and administration costs. BNSC Headquarters could then use this report to highlight positive or negative trends. The report should also report on performance linked to the space strategy. Such a report would give a clear focus to UK space activities and act as a branding exercise for BNSC. The report would also be a source of information for the space community and enhance scrutiny of UK space policy across the board.}

\textit{The co-ordination role of BNSC headquarters}

67. One of the main responsibilities of BNSC Headquarters is co-ordination of the partnership. The then Minister told us that BNSC Headquarters “is a centre of expertise and it co-ordinates.”\textsuperscript{105} Co-ordination is key to the success of the partnership and it is important that all relevant user departments are involved in programmes.

68. We have heard, however, that the Headquarters is not able to co-ordinate space activities as successfully as it might. Professor Howard Dalton, Departmental Chief Scientific Adviser, told us that “we [the BNSC] have not necessarily co-ordinated together as well as we ought […] we do need much better co-ordination.”\textsuperscript{106} The Royal Astronomical Society reiterated this, saying that “BNSC has not effectively coordinated the various sectors of the space community”.\textsuperscript{107} The trade association UK Space also argued that “the UK’s excellent user-based strategy is not properly co-ordinated across Government, with slow and complicated decision processes that have compromised competitiveness and wealth creation.”\textsuperscript{108} BT has said that “there appears to be poor coordination across government despite BNSC efforts.”\textsuperscript{109}

69. We note that the then Minister was taking some steps to tackle this problem. He was planning to hold informal meetings with fellow ministers in different departments with an
interest in satellite technology to ensure that there was not unnecessary duplication and to ensure that issues were tackled effectively.\footnote{Q 609} Nevertheless, we are concerned that there is insufficient co-ordination across the BNSC partnership. We recommend that the BNSC include in the response to this Report the steps that they will take to address this shortcoming.

**Resources at BNSC headquarters**

70. The staff that work at BNSC Headquarters are seconded from the BNSC partners and from industry.\footnote{Ev 375} Dr David Williams told us that "we have got a good collection of people who represent the different working departments and we have secondees from industry, so we have a team which works together in a very good way and very well".\footnote{Q 109} This secondment arrangement means that the partners are closely involved in the processes at BNSC Headquarters but it also means that BNSC Headquarters does not have a strong independent profile.

71. Staff at BNSC Headquarters fulfil numerous roles such as providing advice, overseeing co-ordination on programmes such as GMES that involve a number of partners, representing the UK internationally, drafting the space strategy, and providing technical expertise. In 2004, the NAO recognised the variety of skills that were required within the Headquarters. It noted that “the staff in BNSC Headquarters have a good range of scientific, technical and administrative skills. The Headquarters would benefit, however, from having more staff skilled in strategic planning, commercial activities and marketing”.\footnote{NAO, The United Kingdom’s Civil Space Activities, March 2004, HC 359, p 3} We note that since the publication of the NAO report, the skills gaps highlighted by the NAO have been filled by the appointment of eight staff.\footnote{Ev 375} We have heard during this inquiry however that there may still be a lack of skills at BNSC Headquarters. The CCLRC told us that BNSC “has little in-house scientific or technical expertise.”\footnote{Ev 190} Professor Keith Mason, the then Chief Executive of PPARC told us “We need to look at the skills set within BNSC, particularly the technical skills which it has to deploy in marshalling the arguments and controlling the programmes that are under its remit”.\footnote{Q 178} Given the number of tasks that staff at BNSC Headquarters are expected to undertake we are concerned about increasing its status and responsibilities, for example requesting that it undertake horizon scanning (paragraph 34), without ensuring that it is staffed appropriately. Indeed there is a question as to whether 43 staff is sufficient to deal with its current workload. Keith Mason told us that “BNSC does an excellent job with very limited resources”.\footnote{Q 182}

72. A recurrent question throughout this inquiry has been whether BNSC Headquarters should have its own budget. The BNSC is currently not legally recognised and therefore

\begin{flushleft}
\footnote{Q 609}{Q 609}
\footnote{Ev 375}{Ev 375}
\footnote{Q 109}{Q 109}
\footnote{NAO, The United Kingdom’s Civil Space Activities, March 2004, HC 359, p 3}{NAO, The United Kingdom’s Civil Space Activities, March 2004, HC 359, p 3}
\footnote{Ev 375}{Ev 375}
\footnote{Ev 190}{Ev 190}
\footnote{Q 178}{Q 178}
\footnote{Q 182}{Q 182}
\end{flushleft}
unable to enter into contracts. Budgets and finances are dealt with by the individual partners. Until June 2007, the budget for BNSC Headquarters was allocated via the DTI which made BNSC dependent upon DTI (paragraph 57). The budget will now presumably be allocated by the DIUS. One of the main weaknesses of BNSC Headquarters is its dependency upon the partners for funds. We have heard that it has to work by “cajoling its partners” and that it has no real budget it has responsibility, power or authority.\(^{118}\) It could be argued that to provide BNSC Headquarters with a budget would undermine the partnership and essentially create an agency. We believe, however, that a budget covering its overheads and a national programme would empower BNSC Headquarters. This idea has been supported by various submissions to our inquiry. For example, Professor Keith Mason, the then Chief Executive of PPARC told us that “I would like to see it have a budget which it can control for technology development” and UK Space suggested that “a cross-departmental budget be provided to BNSC’s DG for the development of applications with the greatest public benefit.”\(^{119}\)

73. The BNSC partnership is currently applying to the Treasury for funds in the region of £18 million for a National Space Technology Programme.\(^{120}\) The then CCLRC made a bid to the CSR for the funding for the project. The programme will be managed by BNSC Headquarters on behalf of all the partners and the operational management including technical and financial progress aspects will be undertaken by the STFC, which replaced CCLRC on 1 April 2007. We believe that it would be simpler if the National Space Technology Programme were solely under the care of BNSC Headquarters.

74. We are concerned that BNSC Headquarters currently works under several constraints including limited resources and dependency upon its partners for funds. We recommend that BNSC Headquarters be provided with a small budget of its own, following the necessary changes to its legal status. BNSC Headquarters should use this budget to cover its own overheads and to run the National Space Technology Programme. We recommend that BNSC Headquarters review its staffing and skills needs and that additional resources are provided where necessary.

**Relationship with partners**

75. The BNSC partnership involves ten Government departments and Research Councils. The relationship between BNSC Headquarters and the different partners varies. BNSC Headquarters appears to have a close relationship with DTI, STFC and NERC but the nature of the relationship with other partners such as DfES and MoD has been less clear.

**DfES and the Department for Children, Schools and Families**

76. DfES joined the BNSC partnership on 16 December 2004 as a consulting partner “offering strategic advice to help move the BNSC educational work forward.”\(^{121}\) DfES does not seem to have been closely involved in the partnership. The Director General of BNSC,
David Williams told us that “I have had no direct interaction with DfES. It is a weakness that we recognise and acknowledge and it is an area that we want to address going forward… I think [the Secretary of State for Education and Skills] recognises that space has a role to play in promoting science, but we have had no direct interaction.” Ms Julie Bramman, Divisional Manager for School Curriculum at DfES told us that the department had “not been as active as it has been in the past, say two or three years ago […] I would certainly be happy to say that we need to strengthen our links over, say, the last year or so.”

77. BNSC and DfES had both acknowledged that there was room for improvement. David Williams told us that “we could do more, I think, on the education side and on the skills and science side”. DfES stated that “We recognise the need to continue to work in close partnership with the BNSC, and will be meeting with BNSC colleagues in the near future to explore how we can build on our existing relationship.” There had been contact between the BNSC and DfES at ministerial level. Machinery of Government changes have meant that the responsibilities of DfES have been split between the DIUS and the Department for Children, Schools and Families. We were very concerned about the attitude of DfES towards the partnership and hope that the new Department for Children, Schools and Families engages positively with the BNSC partnership. We strongly recommend that the Department for Children, Schools and Families joins the BNSC partnership.

MoD

78. The MoD has been a partner in BNSC since the establishment of the partnership in 1985. Space has become an increasingly important tool for the MoD as demonstrated by its inclusion in the Defence Industrial Strategy (2005), the Defence Technology Strategy (2006) and the RAF’s Future Air and Space Operational Concept (2006). The Defence Technology Strategy emphasises, for instance, the importance of the development, design and payload integration of small satellites. The UK’s traditional dependence upon space data from the United States could be reduced if the UK had an independent small satellite capability. The Assistant Chief of the Air Staff, Air Vice-Marshal Chris Moran, has thus been nominated as a small satellite champion with responsibility for developing this area. The involvement of the MoD in the BNSC partnership is crucial, given the rising importance of dual-use technologies, particularly satellites, which can be used for civil or military applications. The MoD notes that “Access to common R&D in the form of dual-use technologies, capable of delivering militarily useful capability, are harnessed by the MOD maintaining its close links and partnership with BNSC.” It is important that the
BNSC partnership ensure that duplication of expenditure in space is not occurring between civil and military fields.

79. The relationship between MoD and BNSC is much closer than that between DfES and BNSC. Two MoD staff are seconded into the BNSC Headquarters. Air Vice-Marshal Chris Moran is a member of the UK Space Board. He told us that “being a member of the board allows me to see the context of where space in general is moving inside the UK, and where we can find areas to work together.”130 The MoD has run several projects with other BNSC partners. DTI and MoD provided joint funding for the Micro-Satellite Applications in Collaboration (MOSAIC) project between 2000 and 2005 that supported three demonstration small satellite missions. The MoD and PPARC (now STFC) have recently produced a call through the PPARC Industrial Support Scheme (PIPPS) for funding projects related to the Defence Technology Strategy.

80. We have heard that the relationship between BNSC and MoD could be strengthened. Colin Paynter, Managing Director of EADS Astrium, told us that “I would strongly welcome much more involvement from the Ministry of Defence in the BNSC. I think their involvement is fairly low both in financial terms and in commitment terms”.131 Sir Martin Sweeting, Chief Executive of SSTL, told us that the MoD has historically focused on national communications capabilities and relied upon the US for other space services.132 Colin Paynter and Sir Martin Sweeting both mentioned that there had been recent meetings regarding space between the previous Minister for Science and Innovation, Lord Sainsbury and the Minister of State for Defence Equipment and Support, Lord Drayson.133 The BNSC told us that the then Minister for Science and Innovation, Malcolm Wicks MP met Lord Drayson on 17 April 2006 to discuss the National Aerospace Technology Strategy Group but that space issues were not specifically discussed.134 We can see significant value in greater contact between BNSC and MoD at ministerial and official level. We recommend that the BNSC and MoD evaluate how dual use technologies might be of benefit across the BNSC partnership and include dual use technologies in the forthcoming BNSC strategy.

Cross-governmental links

81. The BNSC has various relationships with departments or Research Councils that are not part of the BNSC partnership. Dr David Williams, Director General of BNSC, told us that “What I want to do is work more with what I call the departments which are not fully funding space, but where we believe they have an interest, to try and strengthen the cross-departmental links in government where we see societal needs that space can answer”.135 The then Minister agreed, saying that “we can be more proactive in approaching other

130 Q 186
131 Q 45
132 As above.
133 Q 45 (Mr Paynter, Sir Martin Sweeting)
134 Ev 381
135 Q 108
departments and other agencies to at least introduce them more to the possibilities as opposed to other tools and mechanisms in terms of fulfilling policy objectives.”

82. We here focus upon the relationship between BNSC and three bodies that might use space applications in the future: the Department for International Development (DFID), the Home Office and the Economic and Social Research Council (ESRC).

**DFID**

83. On 10 January 2007, Dr Williams, Director General of BNSC, told us that “I personally at the moment have not had very much interaction with DFID… There has been, I have to say, not a lot of direct discussion, but that will start in the next two or three months because it is an initiative in an area which is recognised as important.” Since 10 January 2007, BNSC has held initial discussions with DFID about their involvement in the International Charter “Space and Major Disasters”. DFID is one of two UK agencies authorised to activate the Charter. BNSC says that “The Charter aims to provide a unified system of data acquisition and delivery from Earth observation satellites in organisations in eight member countries, in support of efforts related to natural or man-made disasters.”

84. The BNSC is working with DFID on holding a seminar to provide information on the current and potential space applications in support of disaster and humanitarian aid efforts. DFID is also a member of the UK GMES steering group and is involved in cross-Government work on GMES. BNSC told us that "DFID is not currently planning to join the BNSC partnership.” DFID declined to contribute evidence to our inquiry. **We are disappointed by DFID’s lack of response to this inquiry. The use of space has clear relevance for DFID in the field of disaster monitoring and other environmental applications. We recommend that the BNSC strengthen links with DFID in relation to the use of space for environmental and disaster monitoring.**

**Home Office & Ministry of Justice**

85. Dr David Williams told us that BNSC had had discussions with the Home Office Scientific Development Branch at St Albans about the tagging of prisoners. The BNSC explained that staff from BNSC and the Home Office Scientific Development Branch met in August 2006. The Home Office provided an overview of the challenges that they faced and the BNSC explained the UK strengths in space and the potential for space to provide solutions. The areas that were covered included satellite positioning for offender tracking, Earth observation for border security and operational surveillance, and “Google-Earth” style tools for data presentation. The BNSC has scheduled a further meeting for June 2007 following Home Office reorganisation and it is maintaining a “watching brief” on these areas.

---

136 Q 638
137 Q 113
138 Ev 356
139 As above.
140 Q 637
141 Ev 381
86. Responsibility for monitoring offenders has recently passed to the newly-created Ministry of Justice. The Ministry of Justice has told us that the National Offender Management Service undertook three satellite tracking pilot programmes in Greater Manchester, West Midlands and Hampshire between September 2004 and June 2006. Over 500 offenders were tracked by satellite during the programmes. The Ministry of Justice recognised during the pilot programmes that satellite tracking cannot guarantee complete coverage of an offender’s movements, but noted that technology continues to advance.\footnote{Ev 407} We recommend that the BNSC continue to develop a close relationship with the National Offender Management Service, the Ministry of Justice and the Home Office Scientific Development Branch. These organisations should continue to monitor possible applications of satellite technology in offender management and security.

**Economic and Social Research Council and NHS Research**

87. The then Minister, Malcolm Wicks MP drew our attention to a further area of policy that could benefit from satellite technologies. He suggested that there might be a need “to develop another strand of our thinking to see whether some of the issues we face in terms of our society and social policy could not be helped by the development of suitable satellite technology and monitoring.”\footnote{Q 599} He gave the example of monitoring elderly or frail people, such as those with Alzheimers.

88. We understand that work in this area is in a very early stage. The then Minister told us that there was not specific funding for research in this area and that BNSC has not had the opportunity to discuss this issue with the Research Councils or the health sector.\footnote{Q 600; Ev 381} The BNSC later stated that it intends “to take this forward in the next months.”\footnote{Ev 381} More research is needed to understand how space applications might provide solutions for social problems. We recommend that BNSC work with ESRC and NHS Research to develop research funding calls, possibly in conjunction with STFC and with reference to the Foresight programme within DIUS, focused on the social and potential health applications of satellite technologies.

**Involving the space community**

89. The space community in the UK is diverse, encompassing industrialists, scientists and academics working in numerous areas. The BNSC currently involves representatives of the space community on its advisory boards and Space Advisory Council. The trade association for UK industry suggested that industry should be a full partner in the BNSC partnership, telling us that “Industry is confident that BNSC would operate with more effectiveness and cohesion if industry was a full partner.”\footnote{Ev 134} Colin Paynter, Managing Director of EADS Astrium, explained that

\begin{itemize}
  \item \footnote{Ev 407}
  \item \footnote{Q 599}
  \item \footnote{Q 600; Ev 381}
  \item \footnote{Ev 381}
  \item \footnote{Ev 134}
\end{itemize}
we could help have a voice in shaping policy, in shaping and understanding technology that lies five or 10 years out and we could help articulate that. Whether we need to be a full partner to do that, I am not sure, to be fair, but it would be useful to have more of a voice.\footnote{Q 40}

The Director General of BNSC countered that industry is able to interact with BNSC in a number of ways from the industry group to representation on the advisory bodies.\footnote{Q 102} We believe that it would unusual and inappropriate for industry to be a partner in the BNSC partnership.

90. There is, however, scope for the development of a new forum that would take account of the views of the numerous stakeholders within the civil space sector. We agree with the Royal Society’s observation that “it is important that there is input from the grass roots research community into directing UK space strategy.”\footnote{Ev 222} We acknowledge that the BNSC has a series of advisory bodies, but believe that there is a need for an ongoing forum where the space strategy and the activities of the BNSC can be discussed by the wider community. Such a forum would provide an outlet for many of the opinions that have been expressed in evidence to this inquiry. The then CCLRC suggested that “An independent Space Council, with representatives from industry and academia, could […] be constituted to advise both BNSC and government at ministerial level on the performance and strategy for a UK space programme.”\footnote{Ev 190} The Royal Astronomical Society suggested replacing the existing Space Board and Advisory Council with a Space Board “with representatives nominated by Academia, Industry, Research Councils, Government and relevant Learned Societies […] an independent body with an overview of the country’s space portfolio would be able to point out lacunae and bad practice as well as celebrating successes and reporting independently to ministers”.\footnote{Ev 208} We are attracted by this idea and believe it would complement the existing structures. We recommend the creation of a Space Forum whose membership would include representatives appointed by the Secretary of State from industry, education, and academia. We suggest that this should be a dynamic small body with a maximum membership of fifteen, staffed by a small independent secretariat. The Forum should meet several times a year to scrutinise space policy and should report annually to the Secretary of State on the work of BNSC.
4  International relations

91. The UK spent £197.94 million (approximately $392 million) on civil space activities in 2004-05. In contrast, in 2004 the United States spent approximately $16 billion on civil space, Japan spent $2.5 billion, Russia spent $≈0.5 billion, and France spent €1690 million (~$2278 million) on civil space activities. Consequently, whilst other nations such as the US are able to pursue space projects independently, it is necessary for the UK, along with many other countries, to form international partnerships.

European Space Agency

92. The European Space Agency is an international space agency whose aim is to pursue and strengthen European co-operation in space research, technology and applications. It was founded in 1975 with the signing of the ESA Convention. ESA now has seventeen Member States. Hungary and the Czech Republic have officially requested to become members.

93. Membership of ESA benefits the UK in several ways. First, it enables UK scientists to take part in missions that would not otherwise be possible. It is this aspect which led PPARC to describe membership of ESA as “of fundamental importance to UK space science.” Second, ESA allows the UK to take a flexible and selective approach towards space programmes. Jean-Jacques Dordain explained that “The flexibility of ESA is a fantastic asset because in this type of organisation we can make the best compromise between the common and the national interest.” Third, through ESA the UK can align itself strategically with the space activities of other European countries. Finally, by selecting programmes carefully, the UK has an opportunity to be a major player in a programme. This would not necessarily be the case in a bilateral partnership with another space agency such as NASA where the UK could not direct the programme and would be a junior partner.

94. The UK plays a central role within ESA, particularly in space science and Earth science. Jean-Jacques Dordain, the Director General of ESA, told us that “ESA could not exist without the UK”. The UK’s user-driven, selective approach to space extends to its involvement in ESA programmes. This means that the UK does not participate in all programmes and when it does fund programmes, it seeks value for money. ESA provided us with several examples of when the UK has taken a steering or decisive role, such as when

153 Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the UK.
154 Ev 194
155 Q 543
156 As above.
157 As above.
158 Q 532
working towards a reduced programme budget in Toulouse in 1996 or when ESA set up the Herschel/Planck review in 2004.159

95. Links between ESA and the UK are maintained through regular meetings between staff from BNSC Headquarter and BNSC partners and staff at ESA. The Minister for Science and Innovation told us that he thought that the UK has a “very good relationship” with ESA and that he planned to visit the agency.160 Mr Dordain told us that he had met Lord Sainsbury and was planning to meet Malcolm Wicks MP.161 We are surprised that there has been no contact and believe that in future there should be regular meetings between the Minister responsible and ESA. The UK’s involvement in ESA is worthwhile. It enables UK scientists and engineers to take part in programmes that would otherwise be beyond their reach. Given the UK’s level of investment in ESA, we urge the Minister with responsibility for space to sustain ongoing contact with the Director General of ESA.

**Investment in ESA**

96. ESA’s budget for 2007 is €2,975 million (approximately £2 billion). This budget is relatively small when compared to NASA’s budget of over $17 billion (over £8 billion). Member States have to contribute towards ESA’s mandatory programme and may choose to contribute to optional programmes. Contributions to the mandatory programme are made at GDP level and cover the space science programme, general administration and basic technology. Contributions to optional programmes, covering Earth observation, satellite navigation, satellite communications, launchers, and exploration, can be made at any level.

97. The UK contributes to the mandatory programme at 17.7% of the budget. It is the second largest contributor in this area behind Germany. Chart 1 illustrates the contributions by Member States to the mandatory programme in 2005.

98. The UK’s selective approach to space means that it does not invest in all of ESA’s optional programmes. Chart 2 illustrates the average contribution of Member States to optional programmes in 2005.

---

159 Ev 338
160 Qq 583, 582
161 Q 528
Chart 1 Contributions by Member States to the ESA mandatory programme in 2005 (%)

Source: ESA Annual Report 2005, p110

Chart 2 Contributions by Member States to the ESA optional programmes in 2005 (%)

Source: ESA Annual Report 2005, p 110
99. When averaged across all ESA programmes, the UK’s total spend is relatively low compared to other Member States such as France, Germany and Italy. On average, Jean Jacques Dordain told us that France invests in ESA at twice the level corresponding to its Gross National Product (GNP), Germany and Italy invest the corresponding level and the UK invests half.\textsuperscript{162} Table 3 shows the different levels of investment by France, Germany, Italy and the UK.

Table 3: Annual total investment in ESA by key Member States

<table>
<thead>
<tr>
<th>Years</th>
<th>UK /€</th>
<th>Italy/€</th>
<th>France/€</th>
<th>Germany/€</th>
</tr>
</thead>
<tbody>
<tr>
<td>1997</td>
<td>158,019,971</td>
<td>310,405,356</td>
<td>741,442,044</td>
<td>531,870,182</td>
</tr>
<tr>
<td>1999</td>
<td>182,743,659</td>
<td>298,183,832</td>
<td>578,537,747</td>
<td>550,452,256</td>
</tr>
<tr>
<td>2000</td>
<td>164,230,925</td>
<td>303,683,929</td>
<td>641,797,551</td>
<td>576,381,054</td>
</tr>
<tr>
<td>2001</td>
<td>146,775,085</td>
<td>369,700,717</td>
<td>645,742,325</td>
<td>557,898,955</td>
</tr>
<tr>
<td>2002</td>
<td>165,786,736</td>
<td>357,785,429</td>
<td>687,721,345</td>
<td>617,195,930</td>
</tr>
<tr>
<td>2004</td>
<td>190,204,663</td>
<td>284,397,173</td>
<td>686,659,000</td>
<td>528,064,665</td>
</tr>
<tr>
<td>2005</td>
<td>219,290,696</td>
<td>371,813,465</td>
<td>743,284,635</td>
<td>576,256,085</td>
</tr>
<tr>
<td>2006</td>
<td>207,620,143</td>
<td>346,525,668</td>
<td>758,931,258</td>
<td>566,654,000</td>
</tr>
<tr>
<td>Total</td>
<td>1,804,965,575</td>
<td>3,272,864,129</td>
<td>6,855,222,882</td>
<td>5,671,207,315</td>
</tr>
</tbody>
</table>

Source: ESA, Ev 339

100. Within ESA, the UK’s level of investment has been described as an “anomaly”.\textsuperscript{163} ESA has raised the question of “whether such an important Member State as the United Kingdom, with such high standing in the domains of space research and development, should not further enhance its funding support in comparison to the other main shareholders.”\textsuperscript{164}

101. Spend through ESA is, however, quite a high proportion of the UK’s overall spend in space. The following table shows that between 50% and 70% of the UK’s budget has been spent on ESA activities since 1998. The BNSC notes that in 2006, its spending was further weighted to ESA programmes, thus reducing the proportion of national programme spending.\textsuperscript{165}
Table 4: BNSC spend nationally and through ESA

<table>
<thead>
<tr>
<th>Year</th>
<th>Spend nationally/£ million</th>
<th>Spend through ESA/£ million</th>
<th>% of budget on ESA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998-99</td>
<td>55.17</td>
<td>129.82</td>
<td>70.1</td>
</tr>
<tr>
<td>1999-00</td>
<td>65.54</td>
<td>107.08</td>
<td>62</td>
</tr>
<tr>
<td>2000-01</td>
<td>79.38</td>
<td>98</td>
<td>55</td>
</tr>
<tr>
<td>2001-02</td>
<td>72.05</td>
<td>97.13</td>
<td>57</td>
</tr>
<tr>
<td>2002-03</td>
<td>70.52</td>
<td>89.68</td>
<td>56</td>
</tr>
<tr>
<td>2003-04</td>
<td>54.7</td>
<td>133.95</td>
<td>71</td>
</tr>
<tr>
<td>2004-05</td>
<td>68.94</td>
<td>128.99</td>
<td>65</td>
</tr>
<tr>
<td>2005-06</td>
<td>67.98</td>
<td>139.63</td>
<td>67</td>
</tr>
</tbody>
</table>

Source: BNSC

102. We have heard concerns that the balance between national expenditure and expenditure through ESA is wrong. The CCLRC told us that it is critical to achieve this balance.\(^{166}\) SSTL noted that the “preponderance of UK government funding for space is spent through ESA” and that it is important for the UK to develop a strong national space programme.\(^{167}\) The UK Space Academic Network argued that it is important for there to be balance between spend through ESA and spend nationally so that scientists can develop mission concepts nationally that might lead to major ESA missions.\(^{168}\)

**Mandatory programme**

103. Subscriptions to the mandatory programme cover both the general budget and the space science programme. Since 2003, the UK’s subscription to the general budget, covering general administration, corporate costs, education activities and technology transfer, had been split between PPARC (40%), NERC (36%) and DTI (24%). We presume that DIUS will now take responsibility for funding the DTI share.

Table 5: Contribution to the ESA General Budget/€ million

<table>
<thead>
<tr>
<th>Year</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPARC</td>
<td>11.04</td>
<td>11.32</td>
<td>11.52</td>
<td>13.56</td>
<td>13.56</td>
</tr>
<tr>
<td>NERC</td>
<td>9.936</td>
<td>10.188</td>
<td>10.368</td>
<td>12.204</td>
<td>12.204</td>
</tr>
<tr>
<td>Total UK contribution</td>
<td>27.6</td>
<td>28.3</td>
<td>28.8</td>
<td>33.9</td>
<td>33.9</td>
</tr>
</tbody>
</table>

Source: PPARC

166 Ev 191
167 Ev 272
168 Ev 178
104. The ESA science programme includes solar-terrestrial science, fundamental physics, astrophysics and the exploration of planetary bodies other than the Moon or Mars. PPARC covers the subscription to this programme. Its subscription levels are as follows:

Table 6: PPARC Subscriptions to ESA Science Programme/€ million

<table>
<thead>
<tr>
<th>Year</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007 *</th>
<th>2008 *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subscription</td>
<td>51.0</td>
<td>52.4</td>
<td>62.4</td>
<td>64.0</td>
<td>65.7</td>
<td>71.1</td>
<td>73.0</td>
<td>74.8</td>
</tr>
</tbody>
</table>

Source: PPARC * estimated level

Optional programmes

105. ESA optional programmes cover a range of different topics. In 2005, the optional programmes accounted for 72% of ESA’s overall expenditure. Member States decide at ESA Council meetings at Ministerial level which programmes they wish to fund and at what level. These so-called ‘Ministerials’ take place every few years. There were meetings, for example, in Berlin in 2005, in Paris in 2003 and in Edinburgh in 2001. The next Ministerial is expected to take place at the end of 2008.

106. ESA encourages countries to subscribe to optional programmes in proportion to their GDP. On these terms, the UK should subscribe at a 17.7% level to optional programmes. ESA estimates that on average the UK contributed at a 5% level. The main programmes to which the UK subscribes are:

- the Aurora programme, which is Europe’s plan for the robotic and human exploration of the solar system focusing initially on Mars;
- the Advanced Research into Telecommunications programme (ARTES), which is the main way that ESA supports applied technology development for space and ground segment equipment;
- the Global Monitoring for Environment and Security programme (GMES), which will use observation data received from Earth observation satellites and ground-based information in order to inform action on environment and security;
- Galileo, which is a European-built satellite positioning system designed to complement GPS;
- the Earth Observation Envelope Programme (EOEP), which supports science missions for environmental monitoring and Earth observation, and
- Ariane, the European launcher programme.

The UK currently subscribes to the following programmes:

169 ESA, Annual Report 2005, p 108
170 Ev 339
The UK takes a selective approach to ESA optional programme in line with its user-led approach. In relation to launchers for example, the UK subscribes to two out of ten possible options in this area. In the exploration area the UK contributes to the Aurora programme but not human spaceflight or microgravity programmes. The UK’s selective approach means that its overall spend through ESA is much less than that of other Member States. Launcher and exploration both have significant budgets within ESA. In 2005, approximately 21% of the total ESA budget was allocated to the launchers programme and 19% was allocated to the human spaceflight, microgravity and exploration programme.\(^\text{174}\) Although there are individual optional programmes where investment could be increased, as discussed separately in chapters four and seven, we support the UK’s...
selective approach to ESA and we believe that the UK has maintained on average a reasonable level of investment in ESA programmes.

**ESA’s industrial policy**

107. ESA is the single biggest source of civil public sector contracts for the European space industry. When ESA was created there was a desire to ensure that industrial returns from its programmes were spread between the Member States. The ESA Convention sets out four objectives of ESA’s industrial policy:

   i. Cost-efficiency
   
   ii. Competitiveness of industry
   
   iii. Equal distribution of activities or *juste retour*
   
   iv. Competitive bidding.\(^{175}\)

The importance of the third principle, the equal distribution of activities or *juste retour*, has been particularly highlighted during this inquiry. This is intended to ensure that Member States receive a return in work contracts proportionate to their contribution to the ESA budget. It is designed to ensure that contracts are not consistently awarded to larger countries with more developed space industries. The result is that Member States are often under pressure from their industries to contribute to programmes in order to ensure industrial contracts. Defra told us that it was interesting to see other Member States increasing their commitment to the GMES, driven by “commitment to their respective national space industry”.\(^{176}\) Many of the arguments we have heard from industry for increased funding for programmes such as GMES, Galileo, and ARTES are linked to the return that they could expect from ESA under the *juste retour* principle.\(^{177}\)

108. In June 2005, the ESA Council agreed a hierarchy of return rules where the overall return to a Member State prevails over the individual rules established at programme level. The minimum overall return is fixed at 0.94 at the end of the next five year period. If the UK invested £1 in ESA, it should expect 94p in industrial contracts to the UK.\(^{178}\) The principle of fair distribution is not applicable to programmes implemented by ESA for third parties, or for the share of programmes which include non-ESA contributions.

109. Given the long-term nature of space projects and the programme subscriptions extended over several years, ESA monitors the return to Member States in five year cycles. There is inevitably a small amount of variation on an annual basis. The UK has, however, seen significant changes in its return. The graph below, provided by ESA, shows the varying levels of return coefficient and surplus deficit. The return coefficient is the industrial return divided by the level of subscription. If the subscription and industrial return were equal, the return coefficient would be 1.

\(^{175}\) ESA Convention Annex V, www.esa.int/convention

\(^{176}\) Ev 284

\(^{177}\) Ev 131

\(^{178}\) Ev 341
The graph illustrates that the UK received significant over return between 2000 and 2003 and has since suffered from an under return. The over return between 2000 and 2002 was due to the misallocation of contracts to the UK, as explored by the NAO in its report in 2004.179

110. ESA has told us that at the end of 2006 the current under return to the UK was approximately €78 million. There are several reasons for this under return. First, the increase in the UK’s GDP has meant that its subscription level for the mandatory programme has risen from 13% to 17%. Industrial return should have increased proportionally but this has taken time to filter through. Second, UK industry has undergone significant restructuring. In 1994, British Aerospace Space Systems was acquired by Matra Marconi Space. In 1998, Matra Marconi closed its space facility at Filton, Bristol. Matra Marconi subsequently merged with Marconi Electronic Systems to create BAE Systems. In 2000, BAE Systems merged with the space division of DaimlerChrysler Aerospace to form Astrium. The landscape in the UK has consequently changed and it has been difficult for ESA to place industrial contracts with companies in the UK. Finally, in 2003 ESA’s Eddington space science programme was cancelled, reducing industrial return in an area of UK interest.180

111. The BNSC, PPARC and ESA have all taken action in relation to the under return. BNSC told us that the Director General of ESA, the then Minister of Science and Innovation Lord Sainsbury and the Director General of BNSC had been involved directly.181 The BNSC has studied the individual year returns and worked out where the

179 NAO, *The United Kingdom’s Civil Space Activities*, March 2004, HC 359, p 22
180 Q 590
181 Ev 359
deficit had been created. PPARC and BNSC are currently monitoring the placement of ESA contracts.\textsuperscript{182} ESA has acted by “a procedure of identifying at the beginning of new programmes the fraction that the prime contractor has to put into UK work.”\textsuperscript{183} In Gaia and Bepi-Columbo programmes for example, ESA has agreed with the Prime contractor, Astrium, that 25-26% of contracts should be awarded to its UK branch. ESA has also adapted its procurement approach in new programmes so that UK contributions match industrial capacity and hence return.\textsuperscript{184} Dr David Williams explained that ESA will “release tenders where the UK will be specifically over-returned to try and re-establish the pattern of funding so that we get the right level.”\textsuperscript{185}

112. David Southwood, the Director of Science programmes at ESA, told us on 19 March 2007 that “the UK has come back and is now around 20 million deficit so we are within our requirement which is 94% return”.\textsuperscript{186} He had been worried by the under return two or three years ago but now felt that the UK was “on an even kilter”.\textsuperscript{187} He reassured us that there was not a fundamental structural problem in the UK. Dr David Williams supported this assessment, saying that “It is an issue that was really from 2002 to about 2004 where the problem arose in specific years and it shows in the statistics.”\textsuperscript{188} We have been told that the process of rebalancing will take time because contracts have to feed through the system and the UK’s selective approach to space means that there is less scope for immediate corrective action.\textsuperscript{189} The BNSC predicted that the under return would have disappeared by 2009-2010.\textsuperscript{190} We acknowledge that all involved have taken action in order to remedy the under return to the UK. We recommend that the BNSC develop a strategy with ESA over the next year in order to ensure that this situation does not recur.

\textbf{Future developments}

113. When ESA was created it had 11 Member States. The membership has risen to 17 without any changes in the structure. The Director General of ESA, Jean-Jacques Dordain, told us that in five years time ESA is likely to have a membership of between 22 and 25 states.\textsuperscript{191} Programmes will have to be split between more countries and there is greater likelihood of dissension during decision-making. Member States will have to be more selective about their participation in programmes. David Williams of BNSC told us that as Europe expands, it will be impossible for every nation to be involved in every mission and Europe will need to be more collegiate about how it approaches satellite and satellite systems and space systems. Therefore, the concepts of subsets of Europe

\begin{itemize}
\item \textsuperscript{182} Ev 121, 195
\item \textsuperscript{183} Q 560
\item \textsuperscript{184} Ev 342
\item \textsuperscript{185} Q 590
\item \textsuperscript{186} Q 560
\item \textsuperscript{187} Q 561
\item \textsuperscript{188} Q 590
\item \textsuperscript{189} Ev 359
\item \textsuperscript{190} Q 592
\item \textsuperscript{191} Q 523
\end{itemize}
being involved in one area and subsets in another area will have to become more and
more the vogue as you move to 27 countries because you cannot split a programme
up 27 ways sensibly and efficiently.\textsuperscript{192}

An increase in the number of Member States would also have an impact upon \textit{juste retour}
because it would be difficult to ensure that all countries involved in a programme had some
level of industrial return. Dr Williams told us that the \textit{juste retour} principle would probably
disappear if the membership increased to 25.\textsuperscript{193} The UK could be well-placed in this
environment due to its experience of selecting ESA programmes.

114. The UK has played a key role in encouraging ESA to consider the impact of
enlargement. Mr Dordain told us that he was “expecting a lot from the UK” in relation to
discussion on the new organisational framework and wants “the full support of the UK in
helping me to change the decision making process”, to decrease the number of decisions by
unanimity and perhaps introduce weighting factors for decisions concerning budgets and
procurement.\textsuperscript{194} At the moment three contributing states already represent two-thirds of
the budget. 14 Member States represent only one third.\textsuperscript{195} A decision on voting could be
taken as early as 2008.\textsuperscript{196} \textbf{We recognise the work that BNSC has undertaken helping ESA
with the reform of its processes and encourage the BNSC to continue working in this
area.}

115. ESA has a number of centres and research facilities throughout Europe: its
headquarters are in Paris, the Astronauts centre is in Cologne, the astronomy centre is near
Madrid, the space operations centre is in Darmstadt, the Earth observation centre is near
Rome and the Research and Technology Centre is in the Netherlands. Indeed, the UK is
the only major contributor without an ESA centre, but this may change.\textsuperscript{197} In October
2006, Lord Sainsbury suggested that an ESA centre might be established in the UK and in
February 2007, following a formal discussion between BNSC and ESA, a joint ESA/UK
working group was set up to evaluate the options and make recommendations.\textsuperscript{198} Mr
Dordain told us that the working group would report on 31 May 2007. If it recommended
that an ESA centre should be established in the UK, the final decision would be made by
the ESA Member States, probably at the ESA Ministerial in 2008.\textsuperscript{199}

116. The ESA has made it clear that the proposal for a centre would have to fulfil several
criteria: serving UK interests, serving ESA interests, avoiding duplication with existing ESA
centres, and making best use of and creating synergies with technical expertise already
existing in the UK.\textsuperscript{200} There are several areas that a UK centre could focus upon, such as the
study of samples from planets, science programming or applications.
117. We are hopeful that a UK centre of the ESA will be established. Dr Williams told us that “Politically and psychologically, it is a done deal. I think we have to identify something we can bring in, in a tangible way which will bring benefit to the UK without overloading the system in the UK”. The then Minister, Malcolm Wicks MP, told us that a facility in the UK would “be very important and indeed would show our commitment to ESA”. The Director General of ESA told us that he supported the proposal. We believe that the establishment of an ESA centre in the UK would be beneficial and recommend that the BNSC pursue this aim as a priority.

**European Union and European Commission**

118. The UK is increasingly becoming involved in space-related projects at an EU level as well as through the ESA. For several years the EU and ESA have been developing a framework for managing future space-related activities in Europe through a European Space Policy. The policy was first outlined in a Green Paper in January 2003. In November of that year, the European Commission adopted a White Paper on space, *Space: A New European Frontier for an Expanding Union*. In June 2004, a panel of experts on space, security and defence was established to consider the key points that should be covered in a European space policy. The panel reported in March 2005, and in May 2005 the Commission released a draft document, *European Space Policy—Preliminary Elements*. In June 2005, EU and ESA Ministers responded to the draft. Finally, on 26 April 2007, the Commission adopted the *European Space Policy*.

119. The *European Space Policy* states that Europe needs an effective space policy to enable it to exert global leadership in selected policy areas in accordance with European interest and values. It aims to establish coordination of national and European space activities, to increase synergy between defence and civil space programmes, and to create a joint international relations strategy in space. It seeks to develop and exploit space applications, to meet security and defence needs, to ensure a strong industry, to contribute to the knowledge-based society and to ensure unrestricted access to new technologies. The focus is upon using space to provide services, rather than developing space projects driven by prestige. This approach is in keeping with the joint initiatives that are already being pursued by the Commission and the ESA: Galileo and GMES. Galileo is intended to

---

201 Q 147
202 Q 588
203 Q 563
208 As above, p 4
provide satellite navigation data to aid transportation and GMES will provide Earth observation data for security and environment.

120. The UK Government has emphasised that the European Space Policy should focus on the uses of space, rather than the development of space as an end in itself. When Malcolm Wicks MP was Minister for Energy, he responded to a debate in Westminster Hall on space policy, saying that:

The EU is an increasingly important user of space, and we support an approach in which Commission directorates use space when that is the best means to achieve policy goals. It should not seek to enhance its status by prestige projects, however. ²⁰⁹

This message has been reiterated recently by the BNSC who stated that “the ESP should aim to use space to provide services to EU citizens where it makes economic sense to do so and not as an end in itself.”²¹⁰

121. The policy aims of the European Space Policy will be supported by research and development through the EU’s Framework Programme 7 (FP7), which will run for seven years from 1 January 2007. The programme is open to European public and private entities of all sizes and incorporates provision for the participation of non-EU countries. Participation is on an internationally collaborative basis with proposals being evaluated by panels of independent experts against set criteria. The broad objectives of FP7 have been grouped in to four categories: co-operation, ideas, people, and capacities. Within the co-operation programme, there are ten thematic areas. Unlike its predecessors, FP7 includes a thematic priority for space, which will provide €1.4 billion. The majority of this funding will go to support research related to the GMES programme (paragraph 240). Proposals for the development of applications relevant to Galileo are eligible for funding under the Transport theme of FP7: €4.1 billion has been earmarked for funding transport research over the seven-year duration of FP7 and emphasis will be given to aeronautics, air transport, sustainable surface transport and support for Galileo. According to DfT, the Commission is planning to spend €350 million over seven years on Galileo-related research under FP7, covering exploiting Galileo’s full potential, providing tools and creating the environment, allowing infrastructure evolution and adapting receives.²¹¹

122. The BNSC has been closely involved in the development of FP7 and the European Space Policy. Dr Williams said that “We have people dedicated to work on that [FP7] and, on the European space policy, I spend quite a bit of my time going to the meetings and being involved, so the answer is that we are very strong and we are very positive”.²¹² The then Minister, Malcolm Wicks told us he was “very excited” by FP7 and said that he anticipated UK space scientists receiving more than the national share of the budget.²¹³ We note that the BNSC is “seeking to ensure that UK organisations will have maximum opportunity to access available research funds.”²¹⁴ Our predecessor Committee drew

²⁰⁹ HC Deb, 23 November 2005, col 437WH
²¹⁰ BNSC, A Consultation on the UK Civil Space Strategy 2007-2010, p 23
²¹¹ Ev 290
²¹² Q 158
²¹³ Q 648
²¹⁴ Ev 121
attention to the importance of Government support for applicants to the Framework programmes in its report, *UK Science and Europe: Value for Money.*\(^{215}\) **We welcome the European Space Policy and the inclusion of space in Framework Programme 7.** We recommend that BNSC Headquarters in partnership with DIUS or the STFC hold a series of workshops in order to inform the space community about recent developments. The BNSC should advertise opportunities for scientists and companies arising from FP7 and should provide advice on applications where necessary.

**Bilaterals**

123. As well as pursuing space programmes through European collaboration, the UK has undertaken several bilateral projects. Bilateral missions have several advantages. First, they can be tailored to specific UK needs where opportunities are not available within ESA. Second, they can assist UK companies in securing access to new markets. Third, they can facilitate access to specific projects for UK scientists and finally, they develop good relations internationally. According to PPARC, the UK “is seen as a desirable international partner [...] largely due to the quality and expertise of UK space scientists and engineers.”\(^{216}\)

124. The UK has undertaken numerous negotiations with countries outside ESA. In relation to science missions, PPARC’s principal partners for bilateral missions have been the USA and Japan.\(^{217}\)

**Box 6: Recent UK negotiations with countries outside ESA**

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHINA</td>
<td>January 2005</td>
<td>Memorandum of Understanding signed by Lord Sainsbury and China National Space Administration Administrator</td>
</tr>
<tr>
<td></td>
<td>March 2006</td>
<td>Space Technology Workshop in China</td>
</tr>
<tr>
<td></td>
<td>November 2006</td>
<td>UK-China Space Science &amp; Technology Working Group met in the UK</td>
</tr>
<tr>
<td></td>
<td>March 2007</td>
<td>UK-China Space Science &amp; Technology Working Group met in Shanghai</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RCUK plans to open an office in China and BNSC will work with this office</td>
</tr>
<tr>
<td>INDIA</td>
<td>1997</td>
<td>Memorandum of Understanding signed by BNSC and India Space Research Organisation (ISRO)</td>
</tr>
<tr>
<td></td>
<td>September 2004</td>
<td>Joint Prime Ministerial Declaration agreed to expand co-operation in civil space</td>
</tr>
<tr>
<td></td>
<td>March 2006</td>
<td>British High Commission and ISRO held workshop on Earth Observation for Weather and Climate</td>
</tr>
<tr>
<td></td>
<td>Current</td>
<td>BNSC and FCO engaged in supporting a specific industry initiative in India</td>
</tr>
<tr>
<td></td>
<td></td>
<td>BNSC and ISRO to hold a bi-lateral meeting in September 2007</td>
</tr>
<tr>
<td>TURKEY</td>
<td>November 2006</td>
<td>Bilateral workshop to identify opportunities for collaboration in space Technologies</td>
</tr>
<tr>
<td></td>
<td>Current</td>
<td>BNSC in discussions regarding a Memorandum of Understanding</td>
</tr>
<tr>
<td>KOREA</td>
<td>October 2002</td>
<td>OSI and Korean Ministry of Science and Technology agreed a framework Memorandum of Understanding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Series of workshops on space science and technology in Korea and UK</td>
</tr>
</tbody>
</table>

---

215 Science and Technology Committee, Sixth Report, Session 2002-03, *UK Science and Europe: Value for Money?* HC 386-I

216 Ev 195

217 As above.
## UNITED STATES
- **July 2006** Director General of BNSC met NASA Administrator and agreed to develop closer contact
- **November 2006, April 2007** Minister of Science and Innovation met NASA Administrator

## ALGERIA
- **July 2006** Lord Sainsbury and Algerian Space Agency signed a framework Memorandum of Understanding to develop cooperation in civil space

## RUSSIA
- **1987** UK signed civil space co-operation with USSR subsequently adopted by Russia
- **Current** BNSC considering whether agreements with Russia could enable lower cost access to launchers

## JAPAN
- **April 1997** BNSC and Japanese Space Agency signed Memorandum of Understanding on Earth Observation.
- **July 2006** Discussions on further bilateral cooperation
- **May 2007** Space technology Workshop

## BRAZIL
- **2007** UK-Brazil Year of Science and Innovation. Space Science and Technology event in November

## ARGENTINA
- **October 1998** BNSC and Argentinian Space Agency, CONAE, signed Memorandum of Understanding

---

125. Several submissions to our inquiry emphasised the growing importance of China and India. A recent ESA report noted that “China has achieved mastery of all space technologies, including human spaceflight […] and […] India is already at the leading edge of environment monitoring.”\(^{218}\) The Director General of ESA emphasised that “Using the current technology, China will be more competitive than any other space power in the world.”\(^{219}\) The BNSC has maintained its relationship with the India Space Research Organisation (ISRO) and has been working to develop its relationship with the China National Space Administration. It has developed a UK-China space science and technology working group.

126. The UK has historically had a close connection with NASA. As NASA is beginning to undertake a $100 billion lunar exploration programme, there may be new opportunities for US/UK collaboration. The UK’s relationship with NASA is demonstrated by the fact that “over the last 10 years NASA has established over 900 international agreements with organizations from 68 countries. Ten partners account for 75 percent of these agreements and the UK is one of those 10 partners.”\(^{220}\) This connection with NASA has been strengthened in recent months. On 30 November 2006, Malcolm Wicks MP, the then Minister for Science and Innovation met Dr Michael Griffin, NASA’s Administrator to discuss possible avenues for collaboration. On 19 April 2007, Dr Griffin and Professor Sir Keith O’Nions, DGSI, signed a joint statement of intent for cooperation in the field of

---

\(^{218}\) “ESA Council Meeting at Ministerial Level”, *ESA News*, 5 December 2005

\(^{219}\) Q 557

\(^{220}\) Ev 404
space exploration, stating that there would be “technical discussions on potential cooperative lunar exploration activities.”\textsuperscript{221} We will deal with the specifics of a potential collaborative project in Chapter 10 on exploration. The level of NASA’s budget (paragraph 91) means that the UK would inevitably be a minor partner in any collaboration. NASA, however, told us that this level of contribution need not be a barrier because “A key longstanding guideline for NASA’s international cooperation has been that contributions from any partner need not be equivalent.”\textsuperscript{222}

127. Funding is a key problem in pursuing bilateral missions because the majority of UK funding is channelled through the ESA (paragraph 18). Professor Len Culhane from the UK Space Academic Network told us that “The key issue which is involved here is the comparatively small volume of our national programme as distinct from that which is directly related to ESA.”\textsuperscript{223} He emphasised that “we could get much more bang for buck, so to speak, if we were able to choose from a broader spectrum of partners.”\textsuperscript{224} The University of Leicester stated that “the small scale of UK national funding relative to our mandatory ESA contribution does not easily allow participation in bilateral missions with non-ESA partners.”\textsuperscript{225}

128. There is also the question of whether the UK should undertake bilateral missions on a strategic basis, for example collaborating with China now because China will be a leader in the space field in the future, or whether missions should continue to be decided purely on an assessment of their scientific benefits in the short term. Professor Rowan-Robinson from the Royal Astronomical Society supported the latter option, saying that “you should go for the best scientific missions […] I am not so much in favour of saying, ‘Let’s do a mission with Nigeria’ just for the sake of it because it is cheap; it has got to be good science.”\textsuperscript{226} PPARC states that its “primary rationale for investment in space is to yield scientific return” but it notes that “other countries (eg. Within Europe, Italy) and elsewhere (China and India) are placing increased priority on investment in space science activities as part of strategic national policy.”\textsuperscript{227}

129. We acknowledge the BNSC’s work in encouraging collaboration with other countries such as China and welcome the recent joint statement of intent with NASA. However, the development of new opportunities must not be undertaken if there will be a reduction in scientific quality. We recommend that the BNSC outline its current activities and future intentions in international collaboration in the forthcoming strategy.

\textsuperscript{221} BNSC & NASA, Joint Statement of Intent for Cooperation in the Field of Space Exploration, April 2007 (www.bnsc.gov.uk)
\textsuperscript{222} Ev 403
\textsuperscript{223} Q 432
\textsuperscript{224} As above.
\textsuperscript{225} Ev 164
\textsuperscript{226} Q 433
\textsuperscript{227} Ev 195
5 The UK space industry

Overview

130. The UK space industry can be divided into upstream and downstream sectors as illustrated in Diagram 2. The upstream encompasses the provision of technology such as space prime contractor, contract R&D, space component supplier, and space subsystems. The downstream covers the exploitation of technology such as satellite broadcast services, Earth observation, financial services and satellite communications. The most dominant area in terms of economic value is satellite communications and the UK has particular strengths in Earth observation, navigation and positioning.

Diagram 2: The UK Space Sector

131. The downstream industry in the UK is in money terms approximately five times as large as the upstream industry.228 In 2004-2005 the downstream sector had a turnover of £4.1 billion compared to the upstream sector turnover of £725 million.229 But many submissions drew attention to the importance of the link between the upstream and the downstream, i.e. between the technology providers and the users. UK Space told us that “The downstream business benefits strongly from having a vibrant upstream sector in the UK, as this enables the UK community to influence market direction, definition and

Source: BNSC, Size and health of the UK space industry 2006: Executive Summary, p 4

228 Oxford Economic Forecasting, The Case For Space: The Impact of Space Derived Services and Data, June 2006, p 8
adoption of standards and regulatory controls, and to be positioned to recognize and move rapidly to exploit new business opportunities.” QinetiQ emphasised that it was important for the UK to maintain capabilities in both sectors, saying that “downstream activity (such as commercial satellite operators) and associated skills will over time relocate to where the upstream activity is.”

132. The industrial landscape has changed in the UK over the last decade (paragraph 110). The UK upstream is now characterised by one large pan-European company, Astrium, with a base in the UK, and a number of SMEs. In Britain, Astrium directly employs more than 2,500 people at its key sites in Portsmouth, Poynton and Stevenage. This is more than half of the total direct manufacturing workforce in UK space. The downstream is similarly dominated by one company: BSkyB.

133. There have been several recent reports on the state of the UK industry. Since 1991, the BNSC has undertaken surveys of the size and health of the UK space industry, the latest of which, undertaken by Bramshill Consultancy Ltd. was published in January 2006. The BNSC has also undertaken a Space Sector Mapping Study in order to gain a comprehensive picture of the nature of UK space industry. This study will be complemented by an economic evaluation of the impact of past DTI investments in space and a paper focused on forward strategy. In June 2006, Oxford Economic Forecasting produced a report commissioned by EADS Astrium, which was subsequently publicised as the Case4Space in a summary report and executive summary produced by the trade association UK Space.

134. These reports have all contributed towards building an accurate picture of the UK space industry on which we can draw. Oxford Economic Forecasting stated that:

the UK space industry directly contributed around £2.4 billion to UK GDP in 2004/05. This means that it is comparable in size with the web design industry and larger than the market research industry, or software publishing.

UK GDP in 2004-05 was £1,200 billion. The space industry thus directly contributed approximately 0.2% to GDP. In addition, the industry helps to facilitate improvements in other sectors that also contribute to the economy. These effects are referred to as ‘spillover’. Examples of spillover include the impact of the use of satellites in weather forecasting, communications and navigation. According to the DTI, the latest estimate indicated that the UK space industry supported a value-added contribution to GDP in the region of £5.2 billion.

135. Due to the variety of potential applications for space technologies, in particular satellites, the space industry is experiencing a period of growth. The global downstream industry, for example, was valued at over $100 billion in 2005 and is growing at around...
10% per annum. The Oxford Economic Forecasting report states that the UK space industry has also grown “by around 10% a year since 1999/00.” The table below shows how that growth has been divided between upstream and downstream sectors.

Table 8: Evolution of upstream and downstream real space turnover

<table>
<thead>
<tr>
<th>Year</th>
<th>Downstream turnover/£ million</th>
<th>% change</th>
<th>Upstream Turnover/£ million</th>
<th>% change</th>
<th>Total</th>
<th>% change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999-00</td>
<td>2,489</td>
<td></td>
<td>480</td>
<td></td>
<td>2,969</td>
<td></td>
</tr>
<tr>
<td>2000-01</td>
<td>2,970</td>
<td>19.3</td>
<td>470</td>
<td>-2.1</td>
<td>3,440</td>
<td>15.9</td>
</tr>
<tr>
<td>2001-02</td>
<td>3,292</td>
<td>10.8</td>
<td>539</td>
<td>14.7</td>
<td>3,831</td>
<td>11.4</td>
</tr>
<tr>
<td>2002-03</td>
<td>3,602</td>
<td>9.4</td>
<td>531</td>
<td>-1.5</td>
<td>4,133</td>
<td>7.9</td>
</tr>
<tr>
<td>2003-04</td>
<td>3,885</td>
<td>7.9</td>
<td>700</td>
<td>31.8</td>
<td>4,585</td>
<td>10.9</td>
</tr>
<tr>
<td>2004-05</td>
<td>4,102</td>
<td>5.6</td>
<td>725</td>
<td>3.6</td>
<td>4,827</td>
<td>5.3</td>
</tr>
<tr>
<td>Average % change</td>
<td>10.5 %</td>
<td></td>
<td>8.6%</td>
<td></td>
<td>10.2%</td>
<td></td>
</tr>
</tbody>
</table>

Source: BNSC Size and Health of UK Space Industry 2006

136. The average change across the downstream and upstream has been 10.2%. It is worth noting, however, that the overall average percentage change in the upstream industry is 8.6% and that the annual turnover has been slightly erratic, with growth in 2001-02, 2003-04 and 2004-05 but reductions in 2000-01 and 2002-03. Furthermore, although the downstream market has increased on average by 10.5%, the rate of year-on-year growth has slowed each year since 2000.

137. The space sector is a high-tech industry that employs highly skilled workers. In 2004-05, the UK space industry employed 17,560 people, with an average GDP per worker of £135,000. Of the overall space workforce, 57% are graduates. There is a concern that the UK is not able to supply enough skilled workers to the sector, especially given its anticipated growth. The BNSC report, The Size and Health of the UK Space Industry, noted that “Almost half of the companies reported a shortage of specific skills. The main shortages identified were in a range of engineering disciplines, and physics.” We return to the issue of skills in more detail in the following chapter (paragraph 180).

138. The space industry also contributes to the UK’s spend on R&D. In 2004-05, R&D spend in the space industry was £300 million. The BNSC found that upstream companies spend on average 2.5% of turnover on R&D from their own resources. When externally funded R&D is included, this figure rises to 14.1%. Downstream companies are

---

237 Ev 114
238 Oxford Economic Forecasting, The Case For Space, June 2006, p 4
239 As above
240 As above, p 8
242 Oxford Economic Forecasting, The Case For Space, June 2006, p 4
less R&D focused, spending 3.1% of turnover on average themselves and 4.3% when external resources are included.243

139. We have been impressed during this inquiry by the ambition and focus of UK industry. Astrium claimed that “The UK Space industry is a leader in one of the most strategic hi-tech sectors in the world.”244 Mr David Williams of Avanti told us that “in areas of space technology we are genuinely world-beaters”.245 He explained that in order to be competitive the UK had had to focus on the high-tech areas of the market because it could not compete against countries like China in the low cost, lower tech areas because of labour costs.246 The then Minister for Science and Innovation, Malcolm Wicks MP told us that he thought that the industry was in a healthy state and that it was necessary “to make sure that Britain has its fair share and perhaps more than its fair share commercially of this very, very, exciting market.”247 We are impressed by the range of activities undertaken by the UK space industry and by its ambition to remain world-leading. We welcome the work that BNSC has undertaken in this area in order to track the health of the industry and recommend that such studies continue.

**Government support for the space industry**

140. Despite its healthy state, the space industry has several characteristics which lead it to rely upon Government seedcorn funding. First, space technologies are often high risk and there is a long lead time between initial R&D and wealth-creation.248 Sir Martin Sweeting, Chief Executive of Surrey Satellite Technology Limited (SSTL) explained that “It is only the Government really that has the opportunity to provide that initial seedcorn to try to de-risk it to the level where 10 years later, possibly then, the financial markets and the market itself start to take over”.249 Second, because of the value of space technology applications and the status of the space industry as high tech, many countries such as the US and France are investing strategically in their space industries. To remain competitive it is necessary for the UK also to invest strategically and in this climate, the UK space industry describes Government support as “critical”.250

141. During this inquiry we have come across some examples of successful outcomes from seedcorn funding. David Williams, Chief Executive of Avanti told us that “a tiny amount of ARTES funding eight or nine years ago resulted in the creation of a company whose forecast revenues over the next 15 years are £600 million based on just a first satellite”.251 The Chief Executive of SSTL related the history of his own company:

---

244 Ev 184
245 Q 9
246 Q 10
247 Q 602
248 Q 2
249 Q 17
250 Ev 130
251 Q 22
In the 1980s, the research councils invested a small amount of money into investigating the possibilities of small satellites at a time when satellites were getting bigger and bigger and small satellites were considered, at the very best, a mild form of lunacy, so that investment of about £3/4 million over a period of 15 or more years have created a new small satellite industry which is now within the UK generating something in the region of about £120 million in exports.252

These examples indicate that seedcorn funding can successfully stimulate business development. We also note, however, that the nature of seedcorn funding means that other projects may not be as successful as these examples and we have not received sufficient evidence to comment on the ratio of success to failure in this area. At present, there are a number of different funding mechanisms by which the Government can enable such funding, which we explore below.

**Industrial funding through ESA programmes**

142. Under ESA’s industrial policy, the UK space industry can expect a return from investment in ESA programmes (paragraph 107). Industry is thus keen that the UK Government invest as heavily as possible in such programmes, two key examples of which are ARTES, which has relied on investment from industry and DTI, and Alphasat, which is reliant upon public investment through RDAs.

**ARTES (Advanced Research into Telecommunications)**

143. The Advanced Research in Telecommunications Support (ARTES) programme was established by the ESA in the mid 1990s and is the main way that the ESA supports applied technology development for space and ground segment equipment. The UK, through investment originally made by the DTI, currently participates in four elements of ARTES:

i. ARTES 1—strategic studies and identification of future technologies

ii. ARTES 3—fixed and mobile multimedia/broadband/broadcast technologies

iii. ARTES 4—improvement of industrial competitiveness in telecommunications technology and services

iv. ARTES 8—large telecommunications platform

Under the ARTES rules, investment by the Government can be matched by industry but industrial contributions cannot exceed government contributions.

144. ESA told us that ARTES “is widely recognised as an effective tool for the support and benefit of the UK and its industry”.253 The DTI highlighted several successes due to funding from the ARTES programme: for example, ARTES investment in processing technology enabled EADS Astrium to offer a competitive advantage to Inmarsat during the procurement of Inmarsat-4 satellite, “one of the most complex satellites ever built”.254 The

---

252 Q 17
253 Ev 339
254 Ev 117
ARTES programme often provides seedcorn funding for projects such as Avanti’s ABARIS project which delivers multimedia content to consumers via satellite. In 1998 the company had fewer than 15 employees and now the screenmedia service itself employs approximately 90 staff. Avanti told us that “ARTES has been found to be far superior to participation in the EC’s Framework Programmes as it is more responsive and targeted more closely towards the market’s needs.”


Table 9: ARTES funding 2000-2006 (£ million)

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARTES 1</td>
<td>0.97</td>
<td>0.68</td>
<td>2.05</td>
<td>1.83</td>
<td>1.18</td>
<td>3.59</td>
<td>2.11</td>
<td>2.8</td>
<td>2.0</td>
<td>1.1</td>
<td>0</td>
<td>12.41</td>
</tr>
<tr>
<td>ARTES 3</td>
<td>15.86</td>
<td>7.24</td>
<td>17.60</td>
<td>14.46</td>
<td>3.48</td>
<td>16.06</td>
<td>14.90</td>
<td>17.7</td>
<td>9.9</td>
<td>10.1</td>
<td>9.8</td>
<td>89.60</td>
</tr>
<tr>
<td>ARTES 4</td>
<td>5.30</td>
<td>3.13</td>
<td>13.29</td>
<td>8.33</td>
<td>7.59</td>
<td>9.16</td>
<td>11.64</td>
<td>7.7</td>
<td>7.5</td>
<td>7.6</td>
<td>7.4</td>
<td>58.44</td>
</tr>
<tr>
<td>ARTES 8 257</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.89</td>
</tr>
<tr>
<td>Total</td>
<td>22.13</td>
<td>11.95</td>
<td>32.93</td>
<td>24.62</td>
<td>12.25</td>
<td>28.81</td>
<td>30.54</td>
<td>29.6</td>
<td>20.3</td>
<td>19.8</td>
<td>17.8</td>
<td>162.34</td>
</tr>
</tbody>
</table>

Source: BNSC, Ev 360, 382

146. Colin Paynter from EADS Astrium told us that the level of subscription that was agreed in December 2005 “was very disappointing to me because it is an area that has shown tremendous return and all the indications are that there could be really strong wealth-creation returns in the future”. Astrium pointed out that the UK’s subscription of €22.7 million is low compared to the €112 million subscribed by France, €75 million by Spain, €70 million by Italy, and €56 million by Belgium. UK Space has claimed that ARTES generates returns of 7:1 and that if investment in ARTES is reduced, then the impact will be the loss of UK technology capability, direct and indirect job losses, and a threat to UK competitiveness in this area.

147. EADS Astrium has recommended that the Government increases funding for ARTES to £30 million (approximately €44 million) a year. Colin Paynter from EADS Astrium explained that the space industry had developed this figure by looking at spend profile and technology developments over the next five years and working backwards to a corresponding level of investment in ARTES. The request was supported by Avanti, who argued that “a reinvigorated UK participation in the programme will continue to bring

255 Ev 259
256 As above.
257 A further €45 million has been subscribed to ARTES 8 (sub-element 2) to cover Alphasat funding. It is not yet clear how, and in which years these funds will be called up by ESA.
258 Q 18
259 Ev 187
260 Ev 131
261 Ev 186
exceptional returns for UK industry and provide further significant opportunities for exports in space products and services."

148. The ARTES programme is important to the UK space industry because it provides vital seedcorn funding for high-risk, early stage R&D. Investment in this programme should produce high returns. We recommend that the Government review its subscription to the ARTES programme before the end of the year.

**Alphasat**

149. Within ARTES increasing priority is given to large programmes such as Alphasat, which is designed to develop the next generation of telecommunication satellites from 2010 onwards. Alphasat will use an ESA-developed satellite platform known as Alphabus, and ESA is offering European operators the opportunity to fly a payload of their choice on the platform alongside commercial and technology demonstration payloads. It is therefore free for the successful operator. Inmarsat is proposing a satellite that would support new and improved broadband services, particularly to developing countries. For Inmarsat’s proposal to be eligible, the UK has to inject £35 million into the programme over a four year period. Inmarsat told us that “The £35 million of public money invested in this ESA programme would generate an immediate benefit of €100 million (~£70 million) from the free Alphabus platform.” The BNSC has said that the proposal, if accepted, would put the UK at the forefront of satellite telecommunications activities world-wide.

150. If Inmarsat were to be successful in its bid, operational revenues would flow into London and the surrounding regions. The BNSC has taken a novel approach to funding this and has worked with relevant Regional Development Agencies (RDAs) on supporting the project. The three RDAs involved - the South East England Development Agency (SEEDA), the East of England Development Agency (EEDA), and the London Development Agency (LDA) - have agreed to commit £12 million each over a three year period. These contributions will be supplemented by an investment of £6 million from DTI.

151. We congratulate the BNSC on its innovative approach to finding funding for the Alphasat programme. We recommend that the BNSC involve RDAs in funding ESA missions in future when there is likely to be specific regional benefit.

**Support at a national level**

152. Until 2003, the DTI had a national programme, with funds delegated by DTI to BNSC, to support technology, including some work to enable UK industry to prepare for ESA programmes through initiatives such as MOSAIC and SatCom. In 2001/02, for example, the DTI provided support for Applications Technology Support (£7 million), Microsatellite Applications in Collaboration (£7.6 million), a National Satellite
Communications Programme (£3 million), and a National Earth Observation Programme (£2.2 million).266

153. In 2001, the DTI undertook a review of its business support schemes. This recommended that the numerous small technology support schemes within DTI should be channelled into the Technology Strategy budget held and disbursed by the Technology Strategy Board. As illustrated in Table 10, this left the DTI with a small budget for national expenditure, “principally directed towards the provision of technical support and advice to BNSC on a range of issues covering UK civil space interests where capability was not available in-house.”267

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Expenditure £ million</td>
<td>18.2</td>
<td>20.2</td>
<td>26.7</td>
<td>5.5</td>
<td>6.6</td>
<td>4.9</td>
<td>3.1</td>
<td>82.1</td>
</tr>
</tbody>
</table>

Source: BNSC, Ev 361

154. The shift of funds from the DTI national programme to the Technology Strategy budget was explored in November 2004 by the Public Accounts Committee. Sir Robin Young, the then Permanent Secretary at DTI, told the Committee that

> 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.268

It appears that this change has not benefited the space industry. Since 2004, there have been no projects with space as the primary exploitation route in the Technology Calls managed by the DTI Technology Programme.269 The DTI’s evidence noted that small and medium-sized enterprises have suffered in particular.270

155. The lack of a national programme was raised as a matter of concern by industry. ABSL Space Products told us that “the lack of a BNSC National Programme during the last few years, that in the past supported the risky early development activities needed to compete for the ESA programmes, has reduced UK companies’ competitiveness.”271 UK Space commented that “The UK has no portfolio of national space projects to help maintain its indigenous technology leads, unlike many competitor nations, and the BNSC has little or no discretionary funding to allow it the flexibility to support technology projects.”272

266 Ev 378
267 As above.
269 Ev 384
270 Ev 115
271 Ev 260
272 Ev 367
The BNSC has plans to develop a National Space Technology Programme to meet its concerns that “current activities are both too dispersed and that the overall annual funding level is insufficient.”\footnote{Ev 379} The CCLRC, now STFC, put a bid into the Comprehensive Spending Review 2007 for £18 million for this programme.\footnote{Ev 374} The BNSC then aims to align the new fund with existing national programmes to create a coherent overall programme. We deal with the particulars of this programme in Chapter 6. However, here we note that we are concerned by the impact upon the space industry of the shift of funds from the DTI national programme to the Technology Strategy Board. We welcome the attempts by the BNSC to address this problem through the National Space Technology Programme and hope that industry and academia make the most of this programme.

### MOSAIC (Micro-Satellite Applications in Collaboration)

The MOSAIC programme has been held up as an example of good cross-Governmental working to support development at a national level. MOSAIC used funding from DTI and MoD to provide £15 million between 2000 and 2005 to fund three demonstration missions that tested small or micro-satellite technology. Funding from the MOSAIC programme led to the development of three families of satellites: the Disaster Monitoring Constellation (DMC) for Earth observation and disaster management, TopSat for surveillance, and Gemini for telecommunications. DMC created a network of five Earth observation satellites in the UK, China, Algeria, Nigeria and Turkey that can provide imaging on a daily basis. The TopSat mission demonstrated that a micro-satellite could provide responsive high-resolution imaging. Gemini showed that a small geostationary communications satellite could be used to support a range of services such as telephone, television and radio.

These projects have all been successful. The DMC has been accepted to operate within the International Charter for Space and Major Disasters.\footnote{Ev 271} The success of Gemini positioned the UK to win the GIOVE-A satellite contract for the Galileo programme.\footnote{Ev 276} TopSat has shown that it can provide the required images and has demonstrated that dual-use small satellites have great potential.\footnote{Q 196} SSTL, who were involved in all three projects, estimate that the £15 million invested by DTI has resulted in at least £80 million of economic activity in the UK.\footnote{Ev 271} Sir Martin Sweeting, Chief Executive of SSTL, told us that “the MOSAIC programme was very good at not getting bureaucratic tape wrapped around the opportunity and hence allowing the UK to make the very most of it and to create something which actually has not yet been emulated anywhere else in the world”.\footnote{Q 29}

SSTL emphasised to us the importance of using missions to drive technology development and suggested that the Government plan another MOSAIC initiative.\footnote{Ev 271}
Vice-Marshal Chris Moran, Assistant Chief of the Air Staff, told us that MoD were looking to see how the TopSat programme could be developed further. He said that “We are going through a process now of evaluating just how successful that [TopSat] has been, and we have already started a dialogue inside the MoD as to what we might want to do beyond the TopSat programme. We might develop a radar sensor capability.” MOSAIC was clearly seen as a success by both Government and industry. **We recommend that the DIUS and MoD initiate another programme as a successor to the MOSAIC programme within the next year.**

*Alternative funding mechanisms*

160. Government support can also be linked to private funding. The most commonly cited example is Avanti, a public company listed on the Alternative Investment Market of the London Stock Exchange, built on a starting capital of £2,500 to create a company that is valued in excess of £76 million. This was achieved through combining funding from ESA’s ARTES programme with private investment from shareholders in order to develop its Highly Adaptable Satellite (HYLAS) project. The HYLAS programme is a potential solution to the problem of unequal access to the internet through broadband in Europe. HYLAS could affect 3 million households by 2015. Avanti used a £23 million investment from ARTES 3 to raise over £50 million from private investors. Avanti explained that “the HYLAS project is a unique initiative which combines ARTES funding with a large private investment from Avanti’s shareholders. The ARTES funding covers half of the costs of the research and development activities on the payload, while Avanti’s investment will pay for the satellite platform, the launch and insurance.”

161. The ARTES funding reduced the risk of the project and provided credibility. David Williams, Chief Executive of Avanti told us that “It was very difficult for me in the early days to persuade venture capitalists that they should be investing in technology that was on a drawing board and fundamentally unproven…what we have managed to do is to get the Government to take out some of that blue-skies risk. In my own problem, it was not just the money, it was the fact that the European Space Agency and the experts of the British National Space Centre, for example, had put their imprimatur of quality on to the technology that I was buying that got the capital markets interested.”

162. The BNSC plans to encourage this approach. Dr David Williams, Director General of BNSC, told us that “One of things I would like to do to improve it is to get more private venture into funding space.” He said that “I think we need to work more on getting industry to recognise that you have to get to the point where private venture is a recognisable source of money for the development of space systems rather than it just always being government money.”

---

281 Q 196
282 Ev 259
283 Q 11
284 Q 104
285 Q 108
163. There are, however, potential barriers to private investment in space technologies. First, space technologies often require a long lead time and are high risk. David Williams from Avanti told us that “The people who deploy capital want to see return today and they would far rather see some cash today than highly speculative returns in the future.” Secondly, the complexity of space technologies can make them difficult for external investors to understand. Dr Cross from e2v told us that “it is easy for people within the industry and with an interest to forget just how complicated this technology is; so there is an understanding issue as well as the venture capital short-term horizon on returns.”

164. The investment of private finance in the space industry is crucial and Government co-investment at a seedcorn level would help to attract private finance and venture capital. We acknowledge that the BNSC is already working with industry in this area. We recommend that the BNSC seek ways in which to stimulate the increase of private finance and venture capital in the field of space in its forthcoming strategy. The BNSC should elect a co-ordinator who can work with the venture capital industry in order to help companies to explain their technologies.

**Targeted support for SMEs**

165. The UK space-industrial landscape is characterised by one large company and numerous SMEs. The DTI and the ESA both acknowledged the importance of SMEs in this sector. Miss Paula Freedman, Director of DTI Space within BNSC, described SMEs as “very important”, whilst the DTI evidence elucidated that SMEs are a key part of the knowledge transfer chain and a substantial contributor to the high level of competitiveness. Their inherent flexibility means that they can adjust quickly to take account of emerging technologies and develop products to address new markets.

The ESA told us that the traditional strengths of SMEs, such as innovation, ability to react and cost effectiveness, were important in the space sector and that the role of SMEs is illustrated by the fact that on average 20% of ESA R&D contracts were awarded to SMEs. We recognise that the flexibility of SMEs means that, as well as being able to contribute to the civil space programme, they are also able to add to military space programmes.

166. There have been problems, however, in involving SMEs in large-scale space programmes. David Williams, Chief Executive of Avanti told us that “Traditionally, it has not been possible for small companies to play a big role in the space industry”. Dr Williams from BNSC explained that SMEs needed to develop certain skills such as systems management in order to be major players in ESA programmes.
167. The DTI accepted that it had been less successful in providing support to SMEs since the establishment of the Technology Strategy budget. The then Minister, Malcolm Wicks MP told us that “there is always an issue about how we can support SMEs.”292 He acknowledged that “one never wants to appear complacent given the real issues facing quite small companies in competing.”293 However, there have been recent efforts to address the problem. David Williams from BNSC told us that “On the SME side we work as hard as we can. We have recently done a lot of work to help SMEs get into the bidding structures” of the ESA.294 To overcome the lack of systems management skills often found in SMEs, BNSC has married SMEs to companies that can provide those skills. ESA also has several schemes that support SMEs. It provides an Innovation Triangle initiative, bringing together developers, inventors and customers; it invites SMEs to propose technologies to fulfil Agency needs; and it uses the ARTES programme to encourage SME contributions.295

168. We note the importance of SMEs in the space industry and believe that it is crucial that they receive appropriate support. We are concerned that in the past SMEs in the space industry have lacked non-financial as well as financial support from the DTI. We recommend that SMEs be represented on the Space Forum and that the Government establish mechanisms to increase support for SMEs.

_Licensing & space monitoring_

169. The space industry in the UK is governed by regulations derived primarily from the Outer Space Act 1986. This Act requires UK individuals or organisations to apply for a licence from DTI whenever they launch or procure the launch of a space object, operate a space object or carry out any other activity in outer space. The licensing process ensures: the financial health of licensees; that activity does not pose risks to public health, safety or security; an unlimited indemnity from the licensee to HMG against any proven third party costs resulting from activities; and third party liability insurance (to a minimum of £100 million) during the launch and while the satellite is in operation.296 The Government is required to maintain a public register of space objects launched by UK individuals.

170. Sir Martin Sweeting from SSTL told us that the requirement to provide third party liability insurance was a burden on industry. He explained that “as spacecraft are getting smaller and lower cost the insurance for this […] does not actually shrink and the standing burden of the regulatory side in the Space Act does become a larger proportion of these activities.”297 He noted that the burden created by regulation and insurance had a significant impact upon SMEs and could suppress entrepreneurial activities.298 The BNSC acknowledged that “Industry have often argued that the potentially unlimited liability and

292 Q 596
293 As above.
294 As above.
295 Ev 343
296 Ev 373
297 Q 49
298 Q 50
the requirement to obtain insurance cover during the operational phase (following launch) are too onerous and anomalous compared to the other main space faring countries.”

171. In 2006, the DTI commissioned a review of the licensing of space from Moreton Hall Associates and JRA Technology. The review noted that there is “a need to update and enhance the operation of the system.” The BNSC explained that it “highlighted the treatment of liabilities for UK space activity and licence fees, that could disadvantage UK companies.” As a result, the BNSC is considering “Possible future options for handling liability” and “the appropriate licence fee (currently a single charge of £6500 per application) which has remained unchanged while the costs of processing have increased.” In its consultation on the new strategy, the BNSC states that “Increased clarity in regulatory regimes is an important priority and the UK needs to continue to pursue discussion with regulators in other key countries to establish the scope for cooperation to minimise costs and regulatory burdens under the Outer Space Act so as to maintain the UK as an attractive base for space operations.” The BNSC envisages undertaking a public consultation later this year on its proposals. We are concerned that the current licensing regime impedes enterprise. We welcome the review of licensing and look forward to the public consultation on BNSC’s proposals. We recommend that the BNSC pay particular attention to the needs of SMEs in this area.

172. The Government is also responsible for monitoring objects in space. There is an increasing amount of space debris orbiting the Earth. Space Insight told us that

“The environment within which Earth orbiting satellites operate is becoming increasingly crowded. Each year, launches have added new objects to the resident space population of man-made objects faster than the rate of attrition by atmospheric decay.”

Debris in orbit below 600km normally falls back to Earth, whilst that at 800 km tends to stay in orbit. In 2004, the BNSC stated that there were over 9000 tracked objects larger than 10 cm orbiting the Earth and over 100,000 objects between 1cm and 10 cm. Given the large number of objects in space, there is a risk of collisions. In 1996 the French satellite Cerise collided with a piece of debris from an Ariane launch vehicle. The Space Shuttle has had to undertake several avoidance manoeuvres to avoid collisions with debris.

173. Space monitoring is necessary to ensure compliance with regulations and adherence to standards that will reduce space debris. Space Insight argued that “Because satellites are

---

299 Ev 374
300 BNSC, Space Activities 2006, p 43
301 Ev 360
302 Ev 374
304 Ev 116
305 Ev 330
306 BNSC, Space Debris, July 2004, p 1
307 Ev 331
308 Q 49
being made ever-cheaper by a wide range of manufacturers, standards to minimise debris production and to specify de-orbiting timescales are essential for the protection of the space environment.”  

309 Monitoring space also provides information that can be useful for governments or satellite operators. The primary source of data is currently a catalogue produced by US Space Command but according to Space Insight, this catalogue is “of limited accuracy, and is deliberately incomplete.”

310

174. The BNSC is working on this problem at international and national levels. Internationally, the UK participates in the Inter-Agency Space Debris Co-ordination Committee and United Nations bodies such as the Committee on the Peaceful Uses of Outer Space. At a national level, the BNSC announced in November 2006 that it had awarded a £75,000 contract to a space surveillance project and a £33,000 contract to a space debris re-entry prediction project. The company that won these contracts, Space Insight, foresaw that ESA and the EU may bring forward proposals for a space surveillance network at the ESA Ministerial in 2008. We welcome the BNSC’s funding for space surveillance. We recommend that future plans for this area, particularly in relation to a possible European project for space surveillance, be outlined in the new space strategy.
6 Space science and technology

Overview

175. Space science and technology encompasses a number of disciplines such as space-based astronomy, planetary science, solar and solar-terrestrial physics and fundamental physics in space. The UK has taken lead roles in many space science missions including:

- XMM-Newton which has advanced understanding of black holes and active galaxies;
- SOHO which is increasing knowledge of the solar surface and interior;
- Cassini-Huygens which provides the first direct information from Titan, and
- Cluster which is allowing the full three dimensional study of space plasmas.

Future missions in which the UK is playing a lead include:

- the James Webb Space Telescope which will replace the Hubble Space Telescope;
- GAIA which will map the motions of stars in our galaxy;
- Planck which will study the radio echoes of the Big Bang, and
- LISA which will search for gravitational waves from distant black holes.

These scientific projects increase human knowledge of the local and distant universe and allow scientists to test their understanding of the physical laws which govern its origin and evolution. Major space projects take 10 to 15 years from inception to launch and data gathering. Consequently, space missions currently producing results are the product of funding decisions taken over a decade ago.

Health of space science and technology in the UK

176. The UK has world-leading space scientists and technologists, especially in instrument design, detector development and imaging systems. Professor Richard Holdaway, the then Head of Science Programmes at CCLRC, told us that “We have absolutely outstanding space scientists in this country”.311 In 2005, the Institute of Physics reported that the UK enjoys a “high standing in astrophysics and solar system physics. The best departments and individuals have outstanding international reputations”.312 PPARC (now STFC) told us that UK space science is “amongst the best in the world—second only to the USA in terms of the numbers of publications and citations.”313 It notes that in open competition UK scientists have secured the highest utilisation of the joint ESA/NASA Hubble Space

---

311 Q 213
313 Ev 194
Telescope, and UK scientists have led two out of the three instruments on the ESA XMM-Newton X-ray telescope which is yielding peer-reviewed papers at rate of one a day.\textsuperscript{314}

177. We have, however, heard differing opinions about the health of space science in the UK. The then Minister of Science and Innovation said that “the academic base is a strong one” and indicated that the UK had strengths in astronomy, small satellites, robotics, IT, data analysis and instrumentation.\textsuperscript{315} David Southwood, Director of Science at ESA also told us that the UK has a “strong space science community.”\textsuperscript{316} In contrast, the University of Leicester has said that “The health of UK space science is currently fragile, as expertise is shrinking.”\textsuperscript{317} Furthermore it stated that “The number of UK research groups which are competent to build major space experiments within, for example, the ESA context, is decreasing.”\textsuperscript{318} Similarly, the UK Space Academic Network told us that

In the roughly five decades that have elapsed since its early beginnings, UK space science has thrived because of its innovative approach to the development of front line techniques. This has been coupled with an ability to play a leadership role in a well chosen series of both ESA and bi-lateral projects. Our capacity to function effectively in both of these spheres is increasingly under threat.\textsuperscript{319}

178. It is difficult to ascertain the health of the field by considering the number of students studying at undergraduate or postgraduate level because a variety of subjects, such as physics, astronomy, or technology, can lead into academic careers in this area. There is no central collation of the numbers of students in this field and using existing data focusing on different areas can create contrasting pictures. If one considers the statistics provided by STFC (Table 11) regarding numbers of postgraduate students funded by them in the area of astronomy, the picture seems positive, with the number of students increasing, but these figures cover all astronomy, not just space-related studies.\textsuperscript{320}

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of new studentships</td>
<td>107</td>
<td>102</td>
<td>102</td>
<td>107</td>
<td>103</td>
<td>108</td>
<td>108</td>
</tr>
<tr>
<td>Existing total</td>
<td>322</td>
<td>321</td>
<td>335</td>
<td>329</td>
<td>346</td>
<td>347</td>
<td>350</td>
</tr>
</tbody>
</table>

Source: BNSC, Ev 377

If one looks, however, at graphs presented in the Royal Society’s recent report, \textit{A degree of concern? UK first degrees in science, technology and mathematics}, these show that the

\textsuperscript{314} Ev 194  
\textsuperscript{315} Qq 577, 578  
\textsuperscript{316} Q 534  
\textsuperscript{317} Ev 162  
\textsuperscript{318} Ev 163  
\textsuperscript{319} Ev 179  
\textsuperscript{320} These figures do not take account of the division between ground-based and space-based astronomy, neither do they include postgraduates funded by other Councils, universities and private funds.
number of students at undergraduate level is decreasing in subjects that could feed into space science such as environmental science, physics, chemistry, and electronic and electrical engineering.\textsuperscript{321} This report also found that the numbers of students entering A-level physics and maths had declined from 1991 to 1996.\textsuperscript{322} The Royal Society suggested that “Measures to tackle the declining numbers of A-level physics and mathematics students and teachers are required to ensure the UK space science community retain its world class reputation in the long term.”\textsuperscript{323}

179. In the light of the contrasting views on the health of space science and technology in the UK, we recommend that the BNSC undertake research in this area and commission a study on the size and health of the space science and technology field.

Skills

180. It is important that the academic areas of space science and technology are healthy because this also has an impact upon the space industry. Industry relies upon universities, particularly research groups, to train students and equip them with the skills necessary to pursue a career in the space sector. The Royal Society notes that “A major role for universities is to provide a constant stream of highly trained staff for industry.”\textsuperscript{324} We are concerned that there is a skills shortage in the space industry. The BNSC study, Size and Health of the UK Space Industry 2006, stated that the main shortages are in a range of engineering disciplines and physics.\textsuperscript{325} The Education and Skills Case for Space concluded that “The space industry has both skills gaps (within its existing workforce) and skills shortages (recruitment problems)”.\textsuperscript{326} Evidence suggests that this situation could worsen. The Education and Skills Case for Space states that the space industry is faced with problems caused by an ageing workforce and a decline in the standard of new recruits.\textsuperscript{327} The Institution of Mechanical Engineers told us that “The future skills base is one of the biggest concerns within the industry”.\textsuperscript{328} QinetiQ said that “The quality and number of students pursuing science and engineering subjects to A-Level, degree and post-graduate levels is a source of concern not just to the high end businesses but to employers as a whole.”\textsuperscript{329}

181. A skills shortage in the space industry could be caused by a lack of UK students studying relevant subjects or a reduction in the numbers of students choosing a career in the industry. We have heard that there is not a demand pull from space science and engineering degrees within UK universities into industry. Lord Rees of Ludlow, President of the Royal Society, said that “it is very important to ensure that the careers which are

\textsuperscript{321} Royal Society, A degree of concern? UK first degrees in science, technology and mathematics, October 2006, p 33.
\textsuperscript{322} As above, p 18.
\textsuperscript{323} Ev 220
\textsuperscript{324} Ev 222
\textsuperscript{325} BNSC, The Size and Health of the UK Space Industry 2006: Executive Summary, January 2006, p 11
\textsuperscript{326} Graham Hulbert & Paul Spencer, The Education and Skills Case for Space, June 2006, p 37
\textsuperscript{327} Ev 306, Graham Hulbert & Paul Spencer, The Education and Skills Case for Space, p 34-36
\textsuperscript{328} Ev 215
\textsuperscript{329} Ev 264
perceived to be on offer, not just in academia but in industry, are attractive to people.” 330 He explained that “many of those who are graduating in engineering are then going on to work in the City or management consulting.” 331 The Education and Skills Case for Space argues that there is low overall awareness of the UK space industry and that there is a lack of careers information, advice and guidance. 332 One solution offered by the Government is a competition for undergraduates to design and build instrumentation for a satellite would stimulate interest in the space industry. 333 This proposal seems to be a rather nominal attempt to tackle the skills crisis.

182. Some industrialists with difficulties with recruitment are filling the gap by recruiting internationally. Sir Martin Sweeting from SSTL explained that “we tend to recruit not just of course from the UK, but worldwide and we see differing skills coming from different nationalities, different problem-solving skills, different numerical and mathematical skills and perhaps different practical skills...but it is quite a struggle”. 334 David Williams from Avanti told us that “I think 70 to 80% of our highly qualified satellite engineers have come from China or India in the last two years”. 335 We recognise that there is likely to be a degree of international mobility in a high-tech industry such as the space industry. However, we also note the Minister’s view that “we have got to produce more home-grown expertise.” 336 We believe that it is important that the UK continues to seek ways to attract and retain the brightest and best international scientists and engineers in the field of space. This approach will include attracting scientists from abroad as well as nurturing existing talent within the UK.

183. We are concerned that there is a skills shortage in the space industry. Potential space scientists and engineers may be moving into other sectors due to the low profile of the industry. Although the UK is currently able to attract and retain international scientists and engineers to fill the gap left by a lack of “home-grown” talent, we are concerned that this situation is not sustainable, particularly if the number of overseas students entering UK universities declines. We believe that a broad programme of incentives may be necessary to ensure a continued flow of people into the space sector from UK universities and from abroad. We recommend that the BNESC work with DIUS, HEFCE, individual universities and industry in order to develop a ‘people’ strategy to address the skills shortage.

Creation of the Science and Technology Facilities Council

184. On 22 March 2006, the Government announced a consultation on a proposal to merge CCLRC and PPARC to create a Large Facilities Council. It was also suggested that PPARC’s grant-giving function might be transferred to the EPSRC. The details of the consultation were announced in the Science and Innovation Investment Framework 2004-
2014: Next Steps. 125 responses were received by the deadline. On 25 July 2006, the Government announced that the new Council would go ahead but that it would retain PPARC’s grant-giving powers and would be given responsibility for nuclear physics research, previously in EPSRC’s portfolio. The Council commenced work on 1 April 2007.

185. Professor Keith Mason reassured us that the establishment of the new council was not intended as a cost-cutting measure. He told us that “if we are to make a success of this new council and realise its full potential we need to resource it appropriately, and that requires some increase—a modest increase.” The Regulatory Impact Assessment relating to the creation of STFC stated that the budget of the new organisation for 2007-08 would be the sum of the constituent parts and thus in the region of £530 million. In our recent scrutiny report on the Office of Science and Innovation we recommended that funding for the STFC from the CSR round be an increase over the combined existing budgets of its component parts. We await the Government response.

186. There have been concerns that funding for large facilities could reduce the funding available for basic science. The Regulatory Impact Assessment noted that “there is a risk that funding may be diverted away from grants to support facilities management and that Universities could also be disadvantaged in favour of Government-run facilities as a result.” Lord Rees, President of the Royal Society, told us that “There is indeed a tension between the big facilities and the small science”. We also received a submission from a group of interested scientists, raising concerns that programmes funded through PPARC’s solar system sub-panel (SSSP) might not be funded in future, “as more pressing large facilities costs eat into basic science spend.” When we put these concerns to Professor Mason, he reassured us that “We are putting in place mechanisms through peer review and strategy teams which will be capable of looking across the whole patch and making sure that balance is achieved.”

187. Investment by STFC in space science research should be balanced between pure and applied research. The quest for knowledge is important in its own right and should be at the heart of scientific endeavour. There is the possibility that given the potential for commercial exploitation of space activities, the promise of future applications rather than science could drive the space agenda. The University of Leicester has told us that “Past Government policy which favoured the exploitation of space in terms of satellite communication and the return from Earth Observation, has left pure Space Science

337 On 18 October 2006, the Government announced that Professor Keith Mason, the then Chief Executive of PPARC, would be Chief Executive of the new council. On 9 November 2006, in response to concerns about the focus on large facilities in the proposed name of the council, it was announced that the new council would be called the Science and Technology Facilities Council (STFC). The statutory instrument creating the STFC was debated on 11 December 2006.

338 Q 208

339 Regulatory Impact Assessment on the Science and Technology Facilities Council Order 2007 (RIA), para 20


341 Regulatory Impact Assessment on the Science and Technology Facilities Council Order 2007 (RIA), p 5

342 Q 461

343 Ev 228

344 Q 206
somewhat underfunded in comparison with the major space-faring nations of Western Europe”.345 We are pleased that the Government has outlined its commitment to basic science. The then Minister for Science and Innovation Malcolm Wicks stated in the debate on the establishment of the STFC that it is “very important that […] the Government and the research councils spend large proportions of their budgets on what some people call pure or basic research. We do not want a situation in which everything must have a commercial pay-off within a few years”.346

188. Several witnesses emphasised that the creation of the STFC could help to strengthen the BNSC partnership. The Royal Astronomical Society argued that “The merger between CCLRC and PPARC into the Large Facilities Council may provide the opportunity to reform BNSC into a new, technically-aware guiding structure for space in the UK.”347 Keith Mason, the Chief Executive of the STFC told us that the STFC “will be an even stronger partner of BNSC. We are certainly looking, as part of the evolution of BNSC […] to see how the creation of the STFC can support that and take the agenda forward in a coherent way.”348 The then Minister emphasised that the creation of the STFC improved opportunities for space science and technology.349

189. Although the STFC is responsible for funding many fields of space science and technology, it is important that it works with other Research Councils, such as NERC, BBSRC, and EPSRC, recognising the multi-disciplinary nature of space activities. Scientists funded by the STFC studying the climate and atmosphere of Mars, for example, may be grappling with the same issues that face scientists funded by NERC studying the Earth’s climate. It is also important that the STFC and NERC establish whether their funding remits cover all areas of space science and technology. The Royal Society has told us that “there may be gaps in the funding remit of research councils related to space science. Given the current restructuring of CCLRC and PPARC to the LFC, it is important to ensure that the full range of is covered in the remits of other relevant research councils.”350 Dr David Tsiklauri from the University of Salford, the British Antarctic Survey, and the University of Leicester all suggested that funding for space weather research and for work relating to the ionosphere may have fallen into the cracks between Research Council remits.351 The British Antarctic Survey noted that the area of space weather, which refers to conditions such as solar eruptions that can adversely affect technological systems, does not receive significant funding from ESA either, because it falls between science and applications programmes.352 Professor Alan Thorpe, Chief Executive of NERC told us that space weather research was not currently part of its directed and strategic research programme.353

345 Ev 163
347 Ev 209
348 Q 205
349 Q 615
350 Ev 222
351 Ev 300, 301, 163
352 Ev 302
353 Q 355
190. We welcome the creation of the STFC and were pleased to hear assurances from the Chief Executive that the STFC will not favour funding for large facilities over basic science. We recommend that the STFC work with NERC and EPSRC to ensure that there are no gaps in funding for research in space science.

**Current levels of investment**

191. PPARC told us that it invested on average over one quarter of its annual budget on space science and it is unclear how this budget will be affected by the creation of STFC.\(^{354}\) PPARC, now the STFC, is responsible for paying the ESA general subscription (paragraph 103), paying the subscription to the ESA Aurora programme and also maintaining funding at a national level. The ESA science programme contribution within the general subscription funds the development of the satellite platform, the launch and the data recovery aspects of missions. National funding is necessary for scientists to build the instrumentation and analyse the data. The funding from PPARC for space instrumentation (the sensors and telescopes that deliver the science outcomes) is shown in Graph 3.

**Graph 3: PPARC Funding for Space Instrumentation**

192. The funding in this area has been variable but in real terms at 2005-06 funding for space instrumentation is now approximately 33% below the level of a decade ago when the missions currently producing data were developed. The financial preparation for future mission instrumentation is therefore substantially below the level of past investment which has built the UK’s current strong position in ESA and with international partners. This is demonstrated by the UK’s involvement with the Bepi-Colombo mission, which will explore Mercury. Professor Mason told us that, due to the results of the Spending Review 2004, PPARC did not have sufficient resources to fund the programme appropriately and that the UK was funding Bepi-Colombo “only at half the rate that we thought we really needed to.”\(^{355}\) The University of Leicester echoed this.\(^{356}\)

---

354 Ev 194
355 Science and Technology Committee, Chief Executive of the Particle Physics and Astronomy Research Council: Introductory Hearing, HC 808-i, 18 January 2006, Q 20
356 Ev 163
193. Over the last decade, PPARC has invested more resources into data analysis and interpretation. This has been required because the UK’s success in funding, developing and building instruments in the past has generated substantial quantities of data that need to be analysed. PPARC funding to support data analysis and interpretation has therefore increased by more than 8% per annum (see table 12).

Table 12: PPARC funding for data analysis and interpretation

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Funding/£ million</td>
<td>9.6</td>
<td>9.0</td>
<td>9.8</td>
<td>11.2</td>
<td>11.4</td>
<td>12.7</td>
<td>12.3</td>
<td>14.5</td>
<td>14.2</td>
</tr>
</tbody>
</table>

Source: PPARC, Ev 376

194. The increasing spend on data analysis means that, despite the reduction in funding for space instrumentation, there has been an increase in overall funding for space research by PPARC between 1999-2000 and 2005-2006 (from £16.2 million to £21 million). There is, however, concern that there will be long-term effects of the decline in investment in instrumentation. For example, the UK Space Academic Network argued that “the decline in resource in the past decade for the national programme means that we are living on past investment.” PPARC agreed, stating that “The UK is currently in a reasonably good competitive position because of investment decisions taken some years ago. But our position for the next 20 years is not as certain.”

We are concerned that investment in space science instrumentation has reduced over the last decade. We recommend that the STFC increase funding for space science instrumentation.
7 The ‘technology food chain’

Technology development

195. Space science both depends on technology and can drive technology developments, which can lead to future applications outside space science. Lord Rees of Ludlow, President of the Royal Society emphasised:

the interconnectedness of all aspects of space. Even the purer science depends on technology and has often been used to pioneer technology which has led to applications, so there is an interlinking between the industrial side, the scientific side and also the public outreach side.359

The relationship between academics and industrialists is particularly crucial in the context of ESA space programmes as shown in Table 13. For the technology food chain to work successfully, scientists and industrialists have to establish shared goals.

Table 13: Typical phases in an ESA Space Project

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Source of Funding</td>
<td>RC University Industry</td>
<td>RC University Industry</td>
<td>RC University Industry</td>
<td>RC University Industry</td>
<td>Satellite – Agency Sensor- RC</td>
<td>Ground segment- Agency Data analysis - RC</td>
</tr>
<tr>
<td>Duration</td>
<td>3-5 years</td>
<td>2 years</td>
<td>1 year</td>
<td>1-2 years</td>
<td>5-7 years</td>
<td>5 years</td>
</tr>
<tr>
<td>Scale of funds for UK activity</td>
<td>£300-500k</td>
<td>£200k</td>
<td>£300k</td>
<td>£200k</td>
<td>£35 million</td>
<td>£8 million</td>
</tr>
<tr>
<td>Income to UK</td>
<td>£100-200k from ESA contracts</td>
<td>£100k from ESA contract</td>
<td>-</td>
<td>Possible ESA study contract ~£1 million</td>
<td>17% share of £200 million project (~£35 million)</td>
<td>17% share of £50 million operations (~£8 million)</td>
</tr>
<tr>
<td>Outputs</td>
<td>1-2 PhDs, 1-2 patents, 5-6 papers</td>
<td>Designs, Patents, Results for proposals</td>
<td>Proposal</td>
<td>Mission specifications, Technical specifications</td>
<td>Satellite, Sensor package, Subsystems</td>
<td>Data Publicity, Public engagement</td>
</tr>
<tr>
<td>Collateral benefits for the UK</td>
<td>Applications outside space</td>
<td>Applications outside space eg. spin-out</td>
<td>Start of leadership position in mission</td>
<td>Knowledge of specifications and technical challenges. Positioning for major contracts</td>
<td>Engineering reputation, skilled jobs, replacement plant, designs for next mission</td>
<td>Science Commerce, Government</td>
</tr>
</tbody>
</table>

359 Q 425
196. In the ESA context, developing scientific, technical or commercial objectives at an early stage and undertaking preparatory proof of concept work nationally helps a country to be well-placed to obtain ESA funding. Nathan Hill from Qi3 explained that “Getting a national step with technology competence then allows you to leverage ESA or EU money in, which gets you to the next step of being able to supply ESA with the goods, which then gives you the technology capability that provides you with the opportunity to transfer the technology, and it is this leverage game that needs the initial steps”.

197. We have heard that the links in this technology food chain are not as strong as they could be and that there can be a lack of co-ordination between scientific objectives and industrial aspirations. For example, the Royal Astronomical Society argued that "Better alignment between the industrial aspirations and the scientific objectives must be sought. Other countries, notably France, excel at this and thereby benefit much more from ESA than we do.”

198. The BNSC has tried to ensure that industry and science is well-aligned for future projects such as Aurora. The ABOTTS report studied the technology capabilities that would be developed through participation in Aurora and what outcomes these would have for the UK space industry. As a result PPARC has invested in key technologies areas. Professor Keith Mason, the then Chief Executive of PPARC, told us that:

> The Aurora programme is a perfect example of that where, right from the outset we were talking to industry about what the requirements were, what their capabilities were, how we might match those, how we might make a credible bid […] what we intend to do is to do that much more widely for all of these programmes so that industry is then geared up to take advantage of the opportunity.

We welcome PPARC’s approach to the Aurora programme and recommend that the BNSC develop mechanisms to increase the co-ordination between industry and academia at early stages in technology development, if necessary on a mission by mission basis.

**Funding and the National Space Technology Programme**

199. The main barrier to successful technology development in the UK is funding. Professor Richard Holdaway, the then Director of Science Programmes at CCLRC told us that the technology food chain begins with “research, then conceptual design, then the development of the technology and then the spacecraft, and it is the early stages of that where we have a real funding crisis in this country.” Dr Cross from e2v Technology told us that “we need to boost the real technology development resource pool”.

---

360 Q 78  
361 Ev 207  
362 Qi3 & BNSC, Abotts Knowledge Transfer from Space Exploration: Prospects and Challenges for the UK, April 2005  
363 HC [2005-06] 808-i, Q 60  
364 Q 181  
365 Q 93
200. This early stage technology development was originally carried out by the DTI national programme but as explained earlier (paragraph 153) this has been subsumed into a broader technology budget. Dr David Williams, Director General of BNSC, said that on joining the BNSC “The most surprising thing for me was probably the decline in national activity […] we had lost some capability of the national programme […] and this is beginning to impact on our ability to prepare ourselves to work with the European Space Agency”.366

201. Numerous submissions have recommended the creation of a domestic programme to support early stage technology development and concluded that the lack of such a programme in the UK places the country at a disadvantage. Professor Keith Mason, for example, told us that

every other major European country, in addition to supporting space through ESA, has a large domestic programme, which feeds ESA programmes and also develops capabilities that the ESA programme does not. The UK is alone in not having such a domestic programme, and that is what puts us at a disadvantage because it is that sort of early stage investment nationally that positions us to win international contracts.367

The National Physical Laboratory provided more detail saying that “the success of nations such as Germany and France can often be attributed to the underpinning support of strong national programmes, which allow critical mass and expertise to be developed and maintained in the interim periods between the larger ESA missions”.368

202. In order to meet this funding gap the BNSC has decided to create the National Space Technology Programme (NSTP), which would bring together all existing programmes. It would coordinate existing activities to establish critical mass and manage the generic technology aspects of the UK aspects of the UK’s user-led approach to space. Dr Williams told us that the aim of the NSTP is “to ensure that over a period of years we can maintain a basic capability in the UK so that we can exploit science space systems to the commercial and public good and that we can engage at the European Space Agency level because, in going to the European Space Agency with a proposal, you have got to have done some homework, you have got to have shown it is viable and that is where the national technology programme will come in”.369 The CCLRC agreed that the technology programme “addresses the imbalance between the UK space programme and the ESA space programme. If successful, it would also enable UK industry to position itself more favourably for participation in future ESA missions”.370

366 Q 105
367 Q 214
368 Ev 232
369 Q 139
370 Ev 189
203. The BNSC has outlined the core activities in the NSTP as follows:

a) To identify opportunities for knowledge transfer, and the exploitation of established and emerging space technologies, including the extent to which they can address the requirements of individual BNSC partners.

b) To perform “proof of concept” and technology risk reduction to establish the viability of candidate technologies and systems.

c) To exploit opportunities for collaboration and technology demonstration, including flight heritage, and to stimulate private finance investment.

d) To coordinate and provide formal reports and other advice to partners to inform their investment and the delivery of services.371

204. The BNSC has suggested that the benefits of the programme would be:

a) A more competitive UK industry better positioned to participate in activities that directly contribute to the three overarching objectives and to participate in international programmes, enabling the UK to maximise the benefit of its investment in those programmes;

b) Increased knowledge transfer and innovation through improved exploitation of the UK science and technology base;

c) Increased and accelerated private investment in the space value chain;

d) Quantified socio-economic benefits of individual emerging technologies across the three objectives;

e) Greater scientific return to the UK space science community;

f) A more stable supply of trained scientists and engineers for the wider economy;

g) Ability to respond strategically to a range of issues of national interest such as climate change, natural hazards, space weather and infrastructure security;

h) Increased confidence for Partners and the public in the quality of the decisions made on the use of space enabled systems.372

205. The general arrangements for the management of the NSTP were agreed by the UK Space Board in October 2006. BNSC will manage the NSTP on behalf of all the partners. The operational management including technical and financial progress aspects will be undertaken by the STFC. The Chief Executive of the STFC will be the formal Accounting Officer and he will delegate full responsibility to the Director General of BNSC.373 BNSC says that “the detailed mechanisms are still being discussed”.374 The Programme Advisory

371 Ev 374
372 BNSC, A Consultation on the UK Civil Space Strategy 2007-2010, p 19
373 Ev 380
374 Ev 361
Board, reporting to the Director General of BNSC, would have members from BNSC partners, Government organisations, academic, industrial and NGO representatives. The interim surrogate Programme Management Team is made up of representatives from BNSC, STFC, the Defence Science and Technology Laboratory, NPL and Cranfield University.375

206. The CCLRC, now STFC, has put a bid into CSR 2007 for £18 million for the NSTP. The budget according to Dr Williams is “quite small, but, as a percentage of the space spend, it is significant”.376 In the longer term other funding sources will be explored, such as ESA, the Commission, other Research Councils and industry.377 The NSTP will select programmes for funding based on their innovation, value for money and socio-economic potential. Proposals that establish or reflect a UK global lead in a capability will be prioritised. The BNSC acknowledges that “ensuring transparency and impartiality in the allocation of funds to specific projects and groups is a key issue.”378

207. The creation of the NSTP is linked to the announcement in the Science and Innovation Investment Framework: Next Steps that Harwell and Daresbury are to become science innovation campuses.379 Dr David Williams explained that “Harwell will become a focus for the UK activity of national technology, we will use it to work across the UK, and it will not all be done there, but we will do it in a good e-science mode by which the work will be done where the skills are rather than bringing it into Harwell”.380

208. The exact details of the NSTP are still being settled. The work of the NSTP will have to be co-ordinated with the work of the Technology Strategy Board and the NERC Centre for Earth Observation Instrumentation. In relation to the Technology Strategy Board, the BNSC states that “there is at present no formal plan setting out the ongoing relationship, including whether the TSB should be responsible for funding aspects of space activity. Discussions are ongoing on how the relationship may develop, but a close working relationship is envisaged.”381 It is also necessary for the BNSC to establish how the success of the NSTP should be measured.

209. We welcome the proposal for the National Space Technology Programme and urge the Government to provide appropriate funding for this initiative. Information about the detailed mechanisms of the programme and clarification regarding its performance management and anticipated interaction with other bodies should be published in the forthcoming strategy. We recommend that the BNSC lead and manage the operational aspects of this programme. Arrangements should be altered so that the Director General of BNSC can be the Accounting Officer without the need for delegation of responsibility from the STFC.

---

375 Ev 380
376 Q 141
377 Ev 379
378 Ev 361
379 HM Treasury, Science and Innovation Framework; Next Steps, March 2006, p 26
380 Q 105
381 Ev 380
Knowledge transfer

The process

210. The NSTP will identify opportunities for knowledge transfer in the field of space. The process of knowledge transfer is often portrayed as the one way flow of information from academia into industry. The reality is more complex, with technologies spinning into academia and spinning back out into industries in the space sector and beyond. The following diagram developed in relation to the Aurora programme illustrates how many different organisations can be involved in the knowledge transfer process.

Diagram 3: The Knowledge Transfer Process

Source: BNSC, Knowledge Transfer from Space Exploration: Prospects and Challenges for the UK, p 7

211. There are many mechanisms in the UK for knowledge transfer and we touched upon many of these in our previous report in this area.382 The DTI supported Knowledge Transfer Partnerships (KTPs), which enable companies to obtain knowledge, technology and/or skills from the further/higher education sector. In relation to space, the DTI supported the Location and Timing Knowledge Transfer Network (KTN), managed by the National Physical Laboratory. These schemes will presumably now be run by the DIUS. PPARC, now STFC, runs several schemes including the PPARC Industrial Support Scheme (PIPPS), which focuses on knowledge transfer from academia into industry, Co-operative Awards in Science and Engineering (CASE) studentships, which place students in industry, and the KITE Club, which runs workshops and events. NERC runs similar schemes, some of which focus directly upon Earth observation such as the recent conference with BARSC.

382 Science and Technology Committee, Third Report of Session 2005-06, Research Council Support for Knowledge Transfer, HC 995-I
Several partnerships between individual universities and companies have also developed in the space sector. The University of Leicester Space Research Centre established a partnership with EADS Astrium in Stevenage.\textsuperscript{383} The University of Leicester explained that this arrangement profits both parties: “The benefit to the Industrial partner arises from access to fundamental understanding of mission requirements, a prerequisite in the preparation of proposals for mission studies; the University side gains from studentship support, consultancies and direct influence in the accommodation of the science payloads.”\textsuperscript{384} A similar arrangement, supported by PPARC, has developed between e2v and Brunel University. In March 2005, the University opened the “e2v centre for electronic imaging”. E2v has committed £100k a year to Brunel to cover six CASE studentships and Brunel matched this funding. The arrangement has been in place for three years and e2v states that “the group has secured leading roles in a number of space instruments including support work for GAIA and a lead in some AURORA Mars mission instrument concepts.”\textsuperscript{385}

**Facilitating knowledge transfer**

There are several organisations involved in the facilitation of knowledge transfer including the individual Research Councils, DIUS and knowledge transfer brokers. PPARC’s knowledge transfer activities have been organised for over five years by Qi3 in Cambridge. Qi3 has made an effort to join up disparate funds and is now also responsible for ESA’s knowledge transfer programme and DTI’s Sensor Knowledge Transfer Network for DTI.\textsuperscript{386} Nathan Hill from Qi3 explained that “The job of brokering knowledge transfer—at least to understand the technology—is to encourage and motivate the transfer because technology transfer is almost always executed through people. The downsides, of course, are that if technology transfer operatives like myself are not knowledgeable enough or become a gateway rather than a facilitator, then they can actually block the route.”\textsuperscript{387}

PPARC has been relatively swift to recognise the importance of knowledge transfer and we hope that PPARC’s lead in this area is continued by STFC. The PPARC Delivery Plan 2005/06-2007/08 stated that PPARC would double the volume of brokerage activity by October 2007.\textsuperscript{388} Awareness of the potential impact of knowledge transfer has also spread gradually through Government. Nathan Hill from Qi3 told us that “In terms of the government action both BNSC partners, research councils and industry, I think have woken up a lot to knowledge transfer in the last few years”.\textsuperscript{389} This sentiment was echoed by Dr Trevor Cross, Chief Technology Officer at e2v who told us that “a lot of organisations, the research councils particularly, have woken up a lot in the last few years to finding better ways of stimulating knowledge transfer, but I do think there is still

\textsuperscript{383} Ev 164
\textsuperscript{384} As above.
\textsuperscript{385} Ev 310
\textsuperscript{386} Q 73
\textsuperscript{387} Q 66
\textsuperscript{388} PPARC, *PPARC Delivery Plan 2005/06-2007/08*, p 18
\textsuperscript{389} Q 60
215. There is also increasing recognition of the opportunities presented by knowledge transfer between sectors. The breadth of work undertaken in the space sector means that it is often relevant to work undertaken elsewhere; for example, in defence, aerospace, healthcare, telecommunications and engineering. Knowledge from one sector can spin into another sector and change perceptions or approaches. Nathan Hill told us that knowledge transfer between sectors “could always be better, but there is a fair amount of joint working”. Dr Cross said that “I think there is more to do but it is in people’s minds that it should be something we are doing more of”. BNSC partners are beginning to take the initiative in this area. The STFC, MoD, the Research Acquisition Organisation (RAO), and Defence Science and Technology Laboratory (DSTL) have recently put out a joint call for funding through the PIPPS programme in areas of technology relevant to security and defence.

216. In our report on Research Council support for knowledge transfer, we found that an oft-cited barrier to knowledge transfer within academia is the pressure of the Research Assessment Exercise (RAE). This issue recurred during this inquiry. Professor Duncan Wingham explained that the pressure of the RAE means that universities focus upon their core activities of research and publication rather than activities such as knowledge transfer that “diffuse effort away from one’s central focus”. We hope that changes within the planned metrics system will take greater account of and thus encourage knowledge transfer activities undertaken by academics.

Technology spin-off

217. Space technologies cover a variety of areas including materials, automation, robotics, electronic, sensors, optics, communications, power and energy devices. In order to cope with the harsh environment of space, the components used need to be light, strong, durable, temperature-resistant, and radiation-resistant. Consequently there are opportunities for space technologies to be used in a number of other sectors including defence, aerospace, transport, power, and healthcare. John Rootes from JRA Technologies told us that “A lot of the space, X-ray, [and] gamma-ray detectors have application in life sciences and medical engineering and PPARC and BNSC occasionally have put the money in, if not in a coordinated programme, over the last few years to help this along”.

218. ESA has taken responsibility for technology transfer to other sectors. In 1990, it set up the ESA Technology Transfer Programme (TTP) facilitated by a network of technology transfer practitioners in 23 countries. JRA Technology is the UK broker for ESA’s TTP. It assists with marketing, business planning, partner searches, promotional events, and access...
to ESA experts. ESA has recently also set up a European Space Applications Fund, which is being managed by E-Synergy Ltd in the UK. The investment focus for this fund will be start-up companies within ESA’s Member States using space-related technologies in non-space applications.

219. ESA’s TTP has stimulated over 200 successful space-non-space technology transfers and generated nearly one billion euros in business turnover since its inception. ESA has found that the non-space commercialisation of space technology is not widespread in the UK. JRA Technologies told us that “In 2001 a survey of 187 UK space companies/research groups identified 26 that had admitted to pursuing non-space commercialisation of their research.” There have, however, been several notable successes such as Anson Medical and Thruvision Limited (see Box 7).

**Box 7 Technology transfer from space to other sectors**

**Anson Medical**
In the 1990s researchers at Brunel University’s Institute of Bioengineering experimented with shape memory alloys (SMAs) for use in the European space programme. If heated to a certain temperature these alloys return to a particular shape and are thus able to carry out repetitive tasks such as clutching. In 1994 one of the researchers, Tony Anson, supported by ESA created a spin-out company, Anson Medical Ltd to develop SMAs for applications in healthcare such as an orthodontic spring to control the displacement of teeth. In 1995 the company received funding from DTI and ESA’s EURECA programme. In 1997 private equity placement through corporate assets management raised further funds for the company. In 2001, Anson Medical was sold to Lombard Medical for £27 million.

**Thruvision**
Thruvision has adapted space technology for the defence and security sector. Thruvision Ltd is a high-technology spin-out from the Rutherford Appleton Laboratory’s space programme. It is developing terahertz technology for the security market enabling the detection of weapons and explosives. The technology was originally funded as a £100k grant from PPARC and NERC for the remote studies of planetary atmospheres. In 2004 Thruvision won the RCUK business plan competition and was presented with a £25000 prize. It then secured £0.75 million in seed funding and is now a multi-million pound, 35-person SME.

220. The secondary use of space technologies promoted by JRA Technologies is closely related to the knowledge transfer activities undertaken by Qi3. BNSC, PPARC and JRA Technologies have worked together on conferences such as “Bio-Imaging, Can Space Help?” but there is room for further collaboration. ESA reassured us that in the future the activities undertaken by JRA Technologies and Qi3 on knowledge and technology transfer in the space sector and beyond will be “integrated to achieve maximum cooperation and […] to avoid duplication of money and effort.”

221. We recognise that there are mechanisms for knowledge transfer within the space sector. Given that the space sector is characterised by its remit across numerous Government departments as well as the STFC, NERC, and EPSRC, we recommend that the BNSC establish a broad space knowledge transfer network for academics and industrialists from the upstream and downstream space industry and related sectors to complement existing activities. We recommend that BNSC and ESA continue to
emphasise the importance of knowledge transfer between the space field and other sectors.
Earth observation

Overview

222. Research in the field of Earth observation provides a large-scale view of the Earth and enables scientists to monitor how the planet changes over time. Earth observation can be undertaken from space by satellites, by aircraft and by ground-based instrumentation. There are numerous uses of Earth observation by satellites such as disaster monitoring, environmental monitoring, and weather forecasting. Examples of disaster monitoring include the use of the Disaster Monitoring Constellation to assess the damage left by Hurricane Katrina in August 2005, the use of Ikonos satellite imagery to assess the impact of the earthquake in Pakistan in October 2005, and the ongoing use of the ESA satellite Envisat to monitor floods in China. Several projects use satellites for environmental monitoring. The Cryosat 2 satellite will investigate the state of the Earth’s ice cover, the Jason-1 satellite has provided information about the topography of the oceans, and the Advanced Along-Track Scanning Radiometer (AATSR) on Envisat is recording sea surface temperatures. Satellites are also being used increasingly in weather prediction and monitoring. High-resolution satellite imagery allows short range forecasting, so-called “Nowcasting”, which can give early warning about dust storms, mountain waves or severe storms. Beyond the civil space sphere, satellites can also be used for imaging for military purposes.

223. Earth observations from space have limitations and must be used in conjunction with other forms of observation. Professor Duncan Wingham from University College London explained to us that:

   Satellites have strengths: they can cover the whole globe; they do can do it regularly; they can give you continuous data. They have significant weaknesses: you can see through the atmosphere but you cannot see through the ocean; you cannot see through solid earth, you can only look at the superficial surface; and they are limited in resolution.

Matthew Stuttard from BARSC used the specific example of oil slick monitoring, explaining that satellites can monitor oil slicks but only in certain sea conditions and only when the satellites provide sufficient coverage. However, Earth observations from space have the potential to make a significant contribution to the monitoring and understanding of climate change. They can be used to provide long-term data sets including ice cover, coastal erosion, habitat loss, ozone depletion, flooding, and sea level change. Measurements from Envisat, for example, are used to monitor greenhouse gas concentrations. The evidence collected from Earth observation has also underpinned recent reports such as the Stern Review: The Economics of Climate Change or the Intergovernmental Panel on

---

400 Ev 293
401 Q 366
402 Q 363
403 BNSC, Space Activities 2006, p 29
Climate Change’s report, *Climate Change 2007*. It is crucial that researchers and policymakers have access to international data sets in this area and that there is secure funding for the maintenance of long-term data sets that could provide such vital information.

### Introduction to Earth observation programmes

224. The field of Earth observation is characterised by international collaboration and cooperation. The UK is involved in work on Earth observation through several organisations: the Committee on Earth Observation Satellites (CEOS); the Group on Earth Observations (GEO); the European Organisation for the Exploitation of Meteorological Satellites (EUMETSAT), and ESA (see Box 8).

**Box 8 International Earth observation organisations**

#### CEOS
CEOS is an international body charged with co-ordinating international civil space-borne missions designed to observe and study the Earth. It was created in 1984 and now has 25 members including the BNSC and ESA. The main goal of CEOS is to ensure that critical scientific questions relating to Earth observation and global change are covered and that satellite missions do not unnecessarily overlap.

#### GEO
GEO is a larger international partnership comprising 65 member countries, the European Commission and 43 participating organisations. GEO has adopted a 10 year implementation plan for an integrated Global Earth Observation System of Systems (GEOSS). GEOSS is an ambitious programme of information intended for monitoring and understanding climate change, the impact of global warming and deforestation, the extent of disasters due to human activities. Europe is contributing to GEOSS with the creation of the GMES programme.

#### EUMETSAT
EUMETSAT was established in 1986 and has 18 European Member States. It is an intergovernmental body, mandated to establish and maintain Europe’s system of meteorological satellites providing operational Earth observations. EUMETSAT maintains a close relationship with ESA, who are responsible for the development of the first meteorological satellite in each system. EUMETSAT operates a fleet of meteorological satellites and their related ground systems to deliver reliable data and images. The satellites are used for a variety of purposes. The Meteosat-5 satellite is being used for disaster monitoring within a tsunami warning system and MetOp-A provide information about the polar regions.

#### ESA
ESA’s work on Earth observation is focused on two main programmes: GMES (see below), and the Earth Observation Envelope Programme (EOEP). The scientific objectives of EOEP identified in ESA’s strategy for Earth observation were: developing our knowledge of the Earth, preserving the Earth and its environment, and managing life on Earth in a more efficient way. The EOEP meets these objectives by funding environmental science satellite missions called Earth Explorers. The Earth explorer missions are divided into two categories—Core and Opportunity. Core missions respond directly to specific areas of long-term public concern. Opportunity missions are smaller, low-cost satellites that are relatively quick to implement so that they are able to address areas of immediate environmental concern. To date, there have been three Core missions and three Opportunity missions. Two missions, an Opportunity mission, CryoSat, and a Core mission, EarthCARE, have been led by researchers from the UK. Six proposals for Core Earth Explorer ideas are currently being assessed. Two of these proposals, BIOMASS and PREMIER, are led by researchers from the UK. BIOMASS is focused upon taking global measurements of forest biomass and PREMIER is a project concentrating upon the processes that link trace gases, radiation, chemistry and climate in the atmosphere.

---


406 Ev 281

225. As well as participating in international programmes, the UK through NERC runs a national Earth observation programme. NERC’s work in relation to Earth observation is governed by its *Earth Observation Strategy 2004-2009*. The strategy focuses upon three areas: the exploitation of current satellite observations, support for new satellite observations through subscription to European Space Agency programmes, definition and support for longer-term technology for future satellite observations.\(^{408}\) Several long-term objectives are outlined in the strategy, such as developing partnerships with other space users to support common developments in instrumentation and technology, encouraging the development of lower-cost missions, and increasing long-term support for technology and instrument systems.

226. NERC funds seven Earth observation Centres of Excellence.\(^{409}\) In August 2006, following a review of this sector, NERC announced that it would establish a National Centre for Earth Observation by February 2008 to integrate the expertise developed in the other centres.\(^{410}\) NERC and DIUS are also establishing a Centre for Earth Observation Instrumentation.\(^{411}\) This centre will support knowledge transfer and skills development in Earth observation. The first programme will focus on the development of technologies on key environmental issues relating to climate change and air quality.

227. The UK is internationally recognised as a leader in Earth observation science.\(^{412}\) Jean-Jacques Dordain, Director General of ESA identified Earth observation as one of the UK’s strengths.\(^{413}\) Professor Shaun Quegan from the University of Sheffield added that “The investment by NERC in Earth Observation Centres of Excellence has allowed the UK to produce world-leading science inside a flexible framework that allows NERC to respond to changed priorities.”\(^{414}\) We are impressed by the UK’s commitment to Earth observation internationally and nationally. We welcome the establishment of the NERC National Centre for Earth Observation and the Centre for Earth Observation Instrumentation. It is essential that these bodies develop relationships with other organisations such as the STFC, Defra and the Met Office. Earth observation is especially important to the study of climate change. It is crucial that the UK work internationally to ensure provision, availability and maintenance of long-term, sustained data sets in this area.

**Funding**

228. Funding for Earth observation primarily comes from NERC, the Met Office and Defra. NERC funds Earth observation activities internationally and nationally. It pays the

---


\(^{409}\) Centre for Air-Sea Interactions and Fluxes (CASIX), Climate and Land-Surface Interaction Centre (CLASSIC), Centre for Polar Observation and Modelling (CPOM), Centre for Terrestrial Carbon Dynamics (CTCD), Centre for the Observation and Modelling of Earthquakes and Tectonics (COMET), Data Assimilation Research Centre (DARC), Environmental Systems Science Centre (ESSC).

\(^{410}\) “Providing a health check on Planet Earth—the UK’s first national centre for Earth observation”, NERC Press Release, 1 August 2006

\(^{411}\) “Industry and science join forces to strengthen the UK’s capability in monitoring the environment from space”, BNSC Press Release, 1 May 2007

\(^{412}\) Ev 231

\(^{413}\) Q 533

\(^{414}\) Ev 298
UK subscription of £27 million per annum to EOEP. 55% of this subscription covers Earth explorer missions and 45% covers development and exploitation, Earth observation preparatory activities, instrument pre-development, EarthWatch definition activities, mission exploitation, and market development. NERC invests approximately £10 million on Earth observation at a national level, including direct EO Programme spend, responsive-mode grants, and facilities.415

229. The Met Office funds the UK’s subscription to EUMETSAT (see table 14).

Table 14: UK Payments to EUMETSAT

<table>
<thead>
<tr>
<th>Year</th>
<th>General administration and preparatory activities for new programmes €000s</th>
<th>Geostationary satellites €000s</th>
<th>Polar Orbiting Satellites €000s</th>
<th>Ocean Altimetry €000s</th>
<th>Total €000s</th>
<th>Approx. Sterling value £000s</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>2,285</td>
<td>13,577</td>
<td>22,535</td>
<td>38,258</td>
<td>26,385</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>1,909</td>
<td>11,206</td>
<td>23,117</td>
<td>36,064</td>
<td>23,726</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>1,658</td>
<td>11,691</td>
<td>19,919</td>
<td>33,100</td>
<td>20,559</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>2,329</td>
<td>13,084</td>
<td>22,196</td>
<td>300</td>
<td>24,806</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>2,480</td>
<td>22,614</td>
<td>20,151</td>
<td>303</td>
<td>31,490</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>2,541</td>
<td>21,226</td>
<td>19,536</td>
<td>367</td>
<td>30,186</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>3,808</td>
<td>16,062</td>
<td>16,860</td>
<td>380</td>
<td>25,449</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>4,251</td>
<td>11,061</td>
<td>15,825</td>
<td>395</td>
<td>22,059</td>
<td></td>
</tr>
</tbody>
</table>

Source: Met Office Ev 398

The major satellites (polar and geostationary) are funded through programmes with a total life of 20-25 years. This leads to a cycle of expenditure with significant peaks and troughs. The contributions are currently in trough and contributions will increase over the next few years. The Met Office says that it is content that the long-term average payment of £33 million a year is “adequate to meet existing capabilities.”416

230. Defra provides funding for various technology and application programmes in climate, marine, agricultural and land management and environment protection. Defra has taken responsibility from NERC for funding AATSR in order to ensure a long-term data record for global sea surface temperature and it pays a subscription for Jason 2, which will provide high quality radar altimetry data. Defra uses satellite data to check subsidy claims made to the Rural Payments Agency and is funding the UK Land Cover map as part of the
Countryside Survey, which will integrate satellite information with the Ordnance Survey’s MasterMap to produce the first parcel-based land cover map.417

**Use of Earth observation data**

231. We are concerned that there is a lack of connection between Earth observation researchers and policymakers. We were told by Professor Shaun Quegan that the take-up of Earth observation outputs by Government departments is “patchy”: “The links between academia and government agencies as regards use of space data are generally not well developed, largely through the failure to identify mutually attractive aims.”418 He explained that this lack of connection was due to several factors such as a cultural difference between Government departments or agencies and academia, the difficulty of translating academic research into an operational mode, and the inevitable focus of policymakers on specific regional concerns that affect the UK. Professor Duncan Wingham emphasised that it was important that there was understanding within Government about how Earth observation data could be used. He explained that “it is really a question of broadening to the largest extent possible the understanding of the potential uses of these data by all aspects of government which is likely to make the pick-up the largest […] it is obvious that some parts of government are rather focused on their day-to-day regulatory functions”.419 He said that there was “insufficient understanding in the Department for Transport, the Department for the Environment and so on”.420

232. Professor Alan Thorpe, Chief Executive of NERC noted that there had been an expansion in the observations that could be made from space and there was an opportunity for an increasing number of Departments and agencies to use Earth observation data.421 He subsequently told us that “Raising the awareness of Government departments to the potential uses that they might make of such data is clearly important if Earth observations are to be exploited effectively in the policy arena.”422

233. Although the Met Office and Defra both defended themselves against claims that they had not used data, BNSC partners have taken some action in order to increase awareness of Earth observation across Government.423 The DTI established the GIFTSS scheme to fund pilot projects using information from satellites. Defra has helped to create a cross-Government Earth Observation Forum, which includes representatives from Defra, Scottish Executive, Welsh Assembly Government, Forestry Commission, Environment Agency, Natural England, Joint Nature Conservation Committee, Countryside Council for Wales, Scottish Natural Heritage, English Heritage, Highways Agency, British National Space Centre, the Centre for Environment, Fisheries and Aquaculture Science, and Lancaster County Council.424 Membership is open to any public body. Defra explained that

---

417 Ev 282
418 Ev 297
419 Q 367
420 Q 377
421 Q 345
422 Ev 396
423 Q 345
424 Ev 397
“The Forum is discussing where common interest in EO lies and what activities should be undertaken to make the availability and use of EO more efficient for all.”

234. The BNSC has undertaken several initiatives in order to increase awareness across Government of Earth observation. However, we believe that understanding of the variety and potential uses of Earth observation data could be increased. We recommend that the BNSC develop a strategy to improve understanding of Earth observation across Government. The new Centre for Earth Observation and Centre for Earth Observation Instrumentation should be hubs for knowledge transfer from academia to user Government departments and agencies.

**Co-ordination of Earth observation activities in the UK**

235. The co-ordination of Earth observation policy in the UK is monitored by the BNSC’s Earth Observation Programme Board (EOPB), which meets four times a year. The Board produced a strategy for Earth observation from 2003 to 2006, which stated that the “diversity of uses of EO demands joined-up thinking in government and effective communications with industry and the scientific community.” It also noted that, given the complexity of interfaces between the different partners and interested bodies, “there is a serious danger of fragmentation and duplication of effort.” There are several strategies in the field of Earth observation which underlines the need for co-ordination. As well as BNSC’s overarching *EOPB Strategy—2003 to 2006*, NERC has its *Earth Observation Strategy 2004-2009* and Defra is developing an Earth observation strategy.

236. It has been suggested that there continues to be insufficient co-ordination in Earth observation. The National Physical Laboratory claimed that “whilst there is some coordination between government agencies and departments this is very weak and leads to inefficiency and fragmentation. It leads to duplication of effort in studies and expertise.” Professor Alan Thorpe, Chief Executive of NERC, accepted that “I am not saying that co-ordination could not be improved”. Professor Quegan told us that “The name of the game is actually putting the mechanisms in place and lining up what the different organisations might want to do individually and what they can do mutually to make sure they are consistent and focused to deliver things for everybody. I do not think we have done that particularly well.” We have concerns that neither the EOPB or the BNSC is able to meet the challenge of co-ordinating activities. Professor Shaun Quegan told us that “My perception of the working of the EO Programme Board of the BNSC (on which I served from 2001-03) was that it provided little deep analysis of how to maximise the

---

425  Ev 283
426  Representatives from Assimila Ltd, EADS Astrium, QinetiQ, Plymouth Marine Laboratory, Infoterra-Global, Infoterra Limited, SciSys, Defra, RAL, DTI, MoD, NERC, Met Office and an independent consultant.
428  As above, p 4
429  Ev 283
430  Ev 231
431  Q 340
432  Q 361
return from space, as vested interests hindered hard discussion of weaknesses.” Defra have also raised concerns regarding the EOPB, saying that it suffers from two things: “There is no Earth Observation ‘programme’” and “It does tend to get dominated by industry lobby to DTI/BNSC”. Professor Howard Dalton, the Departmental Chief Scientific Adviser at Defra, added that “How well organised and how well structured that is open to question. More work clearly needs to be done.”

The need for co-ordination in the Earth observation sector is demonstrated by the UK’s approach to two international collaborations: GMES and GEO. GMES involves four BNSC partners and requires a co-ordinated approach across Government. We will consider this programme in more detail in the following section. Two BNSC partners, Defra and the Met Office, have an interest in GEO. Defra provides the HMG policy lead and the Met Office provides the UK GEO Principal, who acts as lead delegate at non-Ministerial meetings and the national GEO co-ordination role. In relation to GEO, Alan Douglas, Head of Assurance at the Met Office, told us that “There is more that we can do within the UK still to co-ordinate and make the arrangements across the UK more effective.” Defra also told us that GEO suffers problems because it is a cross-cutting project and related interests are in academia, government and industry. Defra is currently considering development of a UK GEO strategy.

The BNSC lacks a clear and co-ordinated Earth observation programme. We recommend that the BNSC review the co-ordination of its work in this sector, including the role of the Earth Observation Programme Board, and apply the lessons learned. We recommend that BNSC Headquarters lead on the creation of a GEO strategy, working closely with Defra and other interested parties.

GMES

The GMES programme seeks to bring together the needs of society associated with the issue of environment and security with the advanced technical and operational capability offered by terrestrial, airborne and space-born observation systems. It is a direct response to the growing concerns amongst policymakers to ensure access to information on the environment at global, regional and local level. GMES will be based on observation data received from Earth Observation satellites and ground-based information. This will be analysed and prepared for end-users. The services that will be provided by GMES can be classified into three categories: mapping including topography, land use and forestry monitoring; support for emergency management in relation to natural hazards; and forecasting in areas such as air quality and crop yields. The programme is a joint ESA/EC initiative and is expected to be operational from 2008 onwards. Jean-Jacques Dordain, Director General of ESA, emphasised that “GMES is not a space programme. It is a
programme for delivering services. Space is just one of the complementary sources which provides data to these services.\textsuperscript{438}

**Funding**

240. There are two sources of funding for the space element of GMES: subscriptions to ESA and the EU Framework Programme 7.\textsuperscript{439} The ESA GMES Space Component Programme aims to provide the satellite infrastructure to support the GMES services. The original ESA estimate was that this would cost €2.3 billion from 2006-2013. It is planned that this will be funded 50% by ESA member state subscription and 50% from the EU. Two problems arise from the joint funding of the ESA Space Component Programme. First, EU funding for GMES comes through the FP7 space programme. Of the €1.2 billion allocated to GMES through FP7, the EU is planning to invest just €780 million in the ESA Space Component programme.\textsuperscript{440} This is €370 million short of the €1.15 billion ESA expected the EU to contribute. Secondly, the rules for industrial return (\textit{juste retour}) differ for ESA and EU programmes. The UK will be entitled to industrial return from its subscription through the ESA but not for money invested through EU at a level of 13.1%.

241. The UK contributes to the EU funding for ESA’s Space Component Programme through its net contribution to the overall budget of the EU:

*Table 15: European Commission Proposal for FP7 funding of the ESA Space Component Programme*

<table>
<thead>
<tr>
<th>Year</th>
<th>Third Party Data/ € million</th>
<th>Space Infrastructure/ € million</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>48</td>
<td>-</td>
</tr>
<tr>
<td>2008</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2009</td>
<td>-</td>
<td>85</td>
</tr>
<tr>
<td>2010</td>
<td>50</td>
<td>120</td>
</tr>
<tr>
<td>2011</td>
<td>-</td>
<td>125</td>
</tr>
<tr>
<td>2012</td>
<td>-</td>
<td>160</td>
</tr>
<tr>
<td>2013</td>
<td>32</td>
<td>160</td>
</tr>
<tr>
<td>Total</td>
<td>130</td>
<td>650</td>
</tr>
</tbody>
</table>

Source: BNSC, Ev 363

\textsuperscript{438} Q 544

\textsuperscript{439} Ev 362

\textsuperscript{440} The remaining money will be used to help establish pre-operational GMES environmental and civil security monitoring and information services.
242. The overall UK contribution to the programme through ESA is as follows:

<table>
<thead>
<tr>
<th>Segement/Phase</th>
<th>Timing</th>
<th>Member State Subscription/ € million</th>
<th>UK Subscription/ € million</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1</td>
<td>2006-2009</td>
<td>250</td>
<td>11.04</td>
</tr>
<tr>
<td>1/2</td>
<td>2008-2012</td>
<td>Decision mid 2007</td>
<td>Decision mid 2007</td>
</tr>
</tbody>
</table>

Source: BNSC, Ev 363

243. The UK’s subscription of €11.04 million (£7.23 million) to the optional ESA programme is split between several BNSC partners (Table 17). Defra is the policy lead on GMES because it is deemed to be likely to be the primary user of information produced by the programme.

<table>
<thead>
<tr>
<th>BNSC Partner</th>
<th>Contribution over 3 years (2006-2009)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defra</td>
<td>£2.5 million</td>
</tr>
<tr>
<td>NERC</td>
<td>£2.2 million</td>
</tr>
<tr>
<td>DIUS (previously DTI)</td>
<td>£1.53 million</td>
</tr>
<tr>
<td>MoD</td>
<td>£1.5 million</td>
</tr>
</tbody>
</table>

Source: Defra, Ev 281

244. It has been asserted that the UK’s subscription to the ESA programme is unacceptably low. UK funding amounts to a 5% share approximately of the ESA programme compared to a 30% share for Italy and a 31% share for Germany. Mr Dordain, Director General of ESA told us that “I would like much more UK support in the applications of earth observation, for global monitoring and environmental security.” UK Space argues that “GMES remains 75% under-funded by the UK, seriously prejudicing the UK’s role in EU exploitation of Earth Observation.” We note that both of these comments come from parties with vested interests: ESA is running the programme and the UK space industry receives contracts in proportion to the UK’s subscription due to the principle of *juste retour*. Defra explained that “The UK contribution has been heavily criticised by industry as the geographic return rules of ESA mean that UK companies are unable to secure major contracts in this programme.”

245. There is concern within the BNSC that the GMES programme does not meet user objectives and policy requirements and therefore does not warrant additional funding. Dr
David Williams, Director General of BNSC, told us that “the reason why the UK has not gone into the higher level is because at the moment the programme is not deemed to meet the policy requirements of government.” He explained further that it “is not seen to be delivering what policy departments want to do their work […] it would be wrong to put money into a programme that will not deliver at day one what we perceive is necessary to meet the policy objectives.” Defra is concerned that the proposals, especially those relating to the ESA GMES Space Component Programme, will not provide an operational system that guarantees continuity of data. As it is currently designed, GMES is not going to be an operational service but rather a series of one-off satellites. Defra will not change its mind about GMES unless a guarantee of continuity can be given. The Met Office “supports the user-driven approach towards GMES adopted by DEFRA”.

246. The situation has been exacerbated because Defra believes that GMES is driven by short-term industrial needs rather than long-term user driven goals. Defra told us that it was enlightening to see how European counterparts competed to increase their commitment to the GMES programme. This was driven largely by commitment to their respective national space industry and demonstrated the difficulties of a user-driven approach in an environment that is not driven by the common constraints and objectives.

Dr Williams, Director General of BNSC, agreed that GMES was “driven too much by short-term industrial goals and not enough by looking at what the actual application user really needs to have the confidence to move over to using the system. Until we solve that problem, I think it would be wrong to move from the position we are in”.

247. The BNSC has been working with the Commission and ESA in order to alter ideas about the structure of the programme. However, the BNSC acknowledged that “Persuading our European colleagues to agree that GMES should have better data continuity guarantees is proving to be difficult.” The main difficulty is that ESA measures “continuity in the context of work flow in the establishments and industry and not in the output data sets.” ESA acknowledged that it is partly to blame for Defra’s lack of confidence in the project. David Southwood told us that “it is also a failure on our part and also particularly on the Commission’s part to persuade Defra that really what we are talking about is what they want […] I see a confidence deficit on the part of Defra, but you have to recognise that if somebody does not have any confidence in you there is a deficit on the other side […] there has been a failure of communication or a failure to understand...

---

445 Q 668
446 As above.
447 Ev 357
448 Q 624
449 Ev 296
450 Ev 284
451 Q 164
452 Ev 357
453 As above.
what we believe is the long term commitment here." We sense that there may be a compromise in the near future since the BNSC has recently drawn up an agreement with Defra on the importance of operational observations for climate change. If the BNSC is able to convince Defra that GMES will provide such operational observations, Defra may increase funding for the programme in future.

248. The UK’s relatively low investment in the GMES programme will have an impact upon UK space industry. Whereas the German industry can expect contracts in the region of £45 million due to juste retour, the UK industry only expects contracts in the region of £7 million. These contracts would not only benefit UK industry but would bring benefits to the UK economy by providing jobs and potentially developing technologies that could be exploited even further. The space industry has looked to Defra to increase its investment because it is policy lead for the programme. Defra, however, has resisted increasing its investment because of its concerns about the programme and because it believes that as a user it does not have a responsibility to industry. Professor Dalton, Departmental Chief Scientific Adviser at Defra, explained that “Defra’s business is not essentially trying to stimulate the industry to be able to produce their machines in the first place.” As for NERC, the other funding partner, when we questioned Professor Alan Thorpe about the purpose of NERC’s investment in GMES he emphasised that their investment “is not focused purely on industry. It is focused on making sure that we stimulate the basic science and understanding that we need of the climate system.” Professor Wingham from UCL, Director of the NERC Centre for Polar Observation and Modelling, supported NERC’s approach, stating that “My view has been that NERC’s approach to this question, particularly to what extent should it fund GMES, just to be practical, has been, in my view, sensible and appropriate for that agency.”

249. Defra and NERC have made it clear that they do not intend to increase their investment in the programme. Professor Dalton told us that “It was quite difficult for us to be able to come up with the sort of money that we did in order to be able to make our contributions to GMES.” He explained further that “In our view, we have done as much as we possibly can under the circumstances.” Professor Thorpe told us that regarding financing GMES “I do not think NERC would have or should have taken a larger role in that.” Both suggest that additional funding should come from another source. Professor Thorpe, for example, told us that “Clearly DTI have a role in technology development and industrial stimulation. It would be natural to ask the question whether the issue should lie there.” Given the machinery of Government changes, it is still unclear as to whether
DIUS or the Department for Business, Enterprise and Regulatory Reform is responsible for the DTI’s ESA subscriptions.

250. We asked ESA whether it would be possible for the UK to change its subscription level to GMES. The Director General, Jean-Jacques Dordain told us that “When a participating state wants to change its contribution and increase it—it is forbidden to decrease it—it can do that any time providing the other participating states agree.”\textsuperscript{463} He identified two particular opportunities: summer 2007 when states have to confirm or change their contribution to the first part of GMES, and the Ministerial Council at the end of 2008 when states will consider segment two of GMES.\textsuperscript{464}

251. We understand the reasons for Defra’s cautious approach to funding GMES and recommend that it continue to work with the BNSC and the ESA regarding its concerns about the programme. If these concerns are addressed, given that extra funding to GMES would benefit UK industry through the ESA’s policy of \textit{juste retour}, we recommend that the Government consult industry regarding the level of subscription it deems necessary to stimulate activity and then consider providing additional funding to GMES.

\textbf{The lead BNSC partner}

252. The BNSC has nominated Defra as the lead department on GMES. The lead was originally held by the DTI and it has been transferred to Defra in recognition of the importance of GMES in developing environmental policy. However, the information produced by GMES could be used by a number of Government departments, including DFID, DIUS, MoD, NERC and the Met Office.\textsuperscript{465}

253. Defra has raised some concerns about its role as lead on this programme. Professor Sir Howard Dalton, Chief Scientific Adviser at the Department of Environment, Food and Rural Affairs told us that “We are principally a user of the information. We are not, in a sense, there to fund and organise and set it all up in the first instance.”\textsuperscript{466} Professor Dalton explained further that “we are doing it because we are a user and we need this activity to take place. Who should do it? That is a good question. I will leave that up to other government departments to sit down and think about it.”\textsuperscript{467}

254. Several other submissions highlighted a problem with the lead on GMES. ESA told us that Defra does not seem to have the confidence to act with authority.\textsuperscript{468} Colin Paynter from Astrium said “We need a stronger co-ordination at the centre of government […] so that appropriate decisions can be made early on”.\textsuperscript{469} Professor Shaun Quegan told us that

\textsuperscript{463} Q 546  
\textsuperscript{464} As above.  
\textsuperscript{465} Ev 280  
\textsuperscript{466} Q 310  
\textsuperscript{467} Q 324  
\textsuperscript{468} Ev 338  
\textsuperscript{469} Q 39
“Clearly there is not one organisation which can necessarily take a lead on this. BNSC clearly should have a role in this because it is an overarching issue.”

255. Defra has set up mechanisms that will help it to lead on this programme. For example, it has appointed a full time GMES Co-ordinator to handle the workload and Defra participates in the GMES Programme Board, which is the core group of departments responsible for UK policy on GMES. Defra states that this group has been “hampered by differences over objectives and funding responsibility” but that things are improving. Defra also works with a number of government departments on GMES through a GMES Whitehall Group chaired by Defra’s Environment Strategy Director. The group is underpinned by a team with membership from Defra, the then DTI, NERC, MoD and Met Office. Defra told us that this group “has not met for a while as GMES PB discuss the next stages of GMES programme and implications for UK.”

256. As we have previously observed (paragraph 45), it is difficult for one department without substantial experience of space projects to provide the policy lead for a programme such as GMES that has multiple future applications and possible policy directions, even if they are likely to be the main user of the material produced by the programme. Defra’s lead on GMES is proving problematic. We recommend that the BNSC Headquarters provide the lead and work closely with Defra as primary user. GMES is a programme where a strengthened BNSC Headquarters could provide leadership, drive and ambition.

Applications

257. Numerous applications will be supported by the GMES programme. There are plans to create applications centres focusing on environmental monitoring, vegetation monitoring, crisis management and humanitarian aid, and the development of a European spatial data infrastructure. Intellect explained that the location of Applications Centres will be decided during the ESA phase of the programme and will be influenced by the subscriptions that Member States have made to ESA’s GMES programme. BARSC has highlighted its concerns that the UK has not yet claimed any area as a priority. It suggested that the UK could focus upon atmospheric monitoring aspects of GMES.

258. We are concerned lest the BNSC allow the discussions between its partners regarding subscriptions to the ESA programme to distract it from considering how the UK will make best use of GMES services and how it can best exploit the programme downstream. Professor Duncan Wingham from UCL told us that “our experience has been that if you pay for satellites you must invest 40% of your budget in the downstream application of the data if you wish to be successful. It is not altogether clear to me that we are doing that with

---

470 Q 372
471 Ev 284
472 Ev 281
473 Ev 285
475 Ev 213
476 Q 382
GMES.”\textsuperscript{477} Intellect emphasised to us that “Long term wealth creation under GMES will be facilitated by having the most appropriate Applications Centre(s) in the UK.”\textsuperscript{478} Furthermore, Matthew Stuttard warned us that if it does not take action “the UK will get in a situation where it has no option but to buy services by proxy through the EC from non-UK companies.”\textsuperscript{479} The BARSC is concerned that the UK has not yet claimed any service area as a priority.\textsuperscript{480} It has said that the UK could focus upon the atmospheric monitoring aspects of GMES.\textsuperscript{481}

259. The Government needs to work out how it will support applications arising from GMES. We recommend that the BNSC commission a study similar to the ABOTTS report looking at the opportunities and challenges created for the UK Earth observation sector by the GMES programme. The UK’s approach to the GMES programme including applications should be outlined in the space strategy.
Satellite navigation and telecommunications

Satellite navigation

260. Satellite navigation systems allow people to locate their position anywhere on the planet. These systems have opened up a whole range of possibilities for business and consumers. Ships, cars and pedestrians can use satellite navigation to check their position and get directions. Companies can use satellite navigation to track the location of goods and plan their operations much more efficiently. Satellite navigation devices, which can be smaller than a mobile telephone, receive radio signals from a network of satellites in orbit around the Earth. By measuring how long it takes to receive these signals from the satellites, the device calculates how far it is from different satellites and therefore where it is. Depending on the system used, satellite navigation can tell someone their position to within a few metres. The most commonly used satellite navigation systems are the Global Positioning System (GPS), which was developed by the US Department of Defence, and a Russian system called GLONASS. Both are available for civilian use. In the short term, the reliability of GPS is being improved by the European Geo-Stationary Navigation Overlay System (EGNOS). EGNOS is expected to be certified for safety-critical applications in March 2008. In 2004, the DfT agreed to £5.4 million to support the certification. Additional funding is now required and the ESA has proposed that the UK contributes €6 million. The Commission and the ESA are also developing a new system, Galileo, which is intended to be more accurate and reliable than GPS or GLONASS.

Galileo

261. According to the Department for Transport (DfT), “Galileo will provide a highly accurate, guaranteed, global positioning service, under civil control.”482 30 Galileo satellites will be in circular orbits 23,222km above the Earth, and ground stations spread about the globe will monitor the satellites’ positions and accuracies. Galileo will provide five services: an open, free service like GPS; a commercial service; a safety of life service for transport applications; a search and rescue service, and an encrypted public regulated service.483 Until the exact details of the signals are finalised, the range of specific applications is unknown.484 There are, however, numerous potential applications for Galileo, ranging from the management of traffic and transport systems to the navigation of emergency services to the co-ordination of works on the public highway to reduce congestion. The Commission has estimated that the potential market for GNSS products and services (Galileo and GPS combined) could reach €400 billion in the next decade, of which UK industry can expect to capture perhaps as much as €24 billion.485 Following a recommendation by the House of Commons Transport Select Committee, the DTI and DfT became more proactive in

482 Ev 287
483 As above.
484 Q 387
485 Ev 288
identifying public sector uses for Galileo. The DfT, for example, is sponsoring research into possible applications, including a road user charging project. The department has allocated £10 million to time, distance, and place charging demonstration projects. The DTI has set up and is funding a Location and Knowledge Transfer Network in order to foster efforts to develop new applications for services offered by Galileo. We welcome the work that DTI and DfT have undertaken to identify new applications and services that will be enabled by Galileo. We recommend that the Government report on progress in this area in the annual BNSC report.

262. Galileo has the potential to be a dual-use system serving civil and military purposes. The possibility that Galileo could be used as a military programme was raised by the Transport Select Committee in November 2004. The Committee was concerned that Galileo might be used for military applications, such as missile guidance systems, as well as for military uses, such as tracking groups of men. Whilst there would be no bar to using Galileo for military use, it is not intended for military applications. The Government responded that Galileo “will be a civil service, under civilian control […] Any proposals to alter the civilian status of the PRS must be unanimously agreed by Member States.” We are concerned, however, that there may be increasing pressure in Europe to exploit the military potential of Galileo for military applications. In July 2005, the European Scrutiny Committee noted that the draft European space policy did not make a clear distinction between the use of space for defence and security. The European Space Policy published on 26 April 2007 states that “Many civilian programmes have a multiple-use capacity and planned systems such as GALILEO and GMES may have military users.” This comment does not clarify whether those military users could use Galileo for military applications or not. A recent communication from the Commission regarding Galileo noted that “Whilst maintaining the system as a civil system significant revenues could also come from military users.” Dr David Williams told us that “other countries have been saying, ‘We want to use this programme for military requirements’, but […] the UK has a very strong, loud voice in Europe, saying, ‘We must maintain this and we cannot allow it to drift across to the military side’.” In response to recent Parliamentary questions, the then Minister for Transport, Dr Stephen Ladyman MP, reiterated that Galileo remained a civil programme under civil control. He noted however that Galileo’s open service could be accessed by all and could be used by military forces. We seek assurance from the Government that it will continue working at a European level to ensure that Galileo remains a civil system under civil control. The Government must clarify the ways in which military forces

486 Transport Committee, Eighteenth Report of Session 2003–04, Galileo, HC 1210, para 56; Ev 116
487 Ev 372
488 HC [2003–04]1210, para 51
489 As above, para 47
491 European Scrutiny Committee, First Report of Session 2005–06, HC 34–i, para 22.11
492 EC, European Space Policy, SEC(2007)504, p 7
494 Q 112
495 HC Deb, 24 May 2007, col 1460 WS; HC Deb, 11 June 2007, col 725 WS
would be allowed to use Galileo and whether Galileo could be used for military applications.

263. Within the UK, the Department for Transport is the lead department on the Galileo programme and it works closely with BNSC.496 Dr Williams told us that “it is quite correct that if you are going to have a system that is designed for traffic management the department responsible, Transport, should be involved at policy level, saying what they are doing in the future.”497 The DfT co-ordinates the UK position through the Galileo Co-ordination Group, which brings together representatives from interested departments across Government. Given that the focus of Galileo has been primarily upon its use in transportation, the programme does not seem to have suffered the same difficulties as GMES with regard to its lead department. We note, however, that has been a significant imbalance in funding between DTI and DfT. We recognise the role taken by DfT to co-ordinate work on the Galileo programme. We recommend that DfT be known as primary user for this programme, DIUS as primary funder and BNSC Headquarters be identified as the lead with the appropriate transfer of staff accordingly.

264. There was agreement between witnesses that there are currently problems in the Galileo programme. Dr Williams told us that “There is going to be a lot of hard management going into Galileo with some very significant challenges coming up.”498 Malcolm Wicks MP said that “I think Galileo has certainly run into some difficulties.”499 Elizabeth Duthie, Divisional Manager of the Galileo Programme Division in DfT, told us that “There are a great many challenges in the Galileo programme.”500

265. The intention was that Galileo would be implemented through a Public Private Partnership (PPP). The programme was organised so that ESA would be responsible for putting four satellites in orbit to demonstrate to private investors that the system can work. A private concessionaire was then going to be responsible for launching the next 26 satellites and for delivering the services. A concessionaire, a consortium of eight companies, was appointed but it was unable to agree on a common negotiating position.

266. On 16 May 2007, a communication from the Commission to the European Parliament and the Council stated that “the concession negotiation which should have led to the deployment and exploitation of Galileo has stalled.” In this communication, the Commission invited the Council and European Parliament to take note of the failure of the current concession negotiation and to conclude that the current PPP negotiations should be ended.501 The Council adopted a resolution concluding that current concession negotiations have failed and should be ended, supporting the deployment of Galileo and recognising that the implementation of a deployment of Galileo would need additional

496 Q 163
497 Q 164
498 Q 163
499 Q 584
500 Q 423
public funding.\textsuperscript{502} The Council requested that the Commission submit detailed alternative proposals for funding Galileo by September 2007.

267. The Commission has recommended that the European Union and its Members States run a public procurement of the first constellation of eighteen satellites and then establish a PPP to procure the remaining satellites. This scenario would require the European Union and its Member States to find an additional €3.4 billion for the period 2007 to 2013.\textsuperscript{503} On 13 June 2007, the Minister of State for Transport, Dr Stephen Ladyman MP, explained that the UK was committed to the PPP principle and was concerned about the potential increased costs of public procurement.\textsuperscript{504} The Government welcomed the Presidency’s acceptance that the project could be ended if acceptable answers could not be found.

268. The proposed additional costs for a public procurement are set against a history of rising costs within the programme. The programme has four phases: definition, development and validation, deployment, and commercial operating. The costs of the first two phases have exceeded original estimates. The total cost of the initial definition phase increased from €80 to €130 million. The total cost of the second phase, the development programme, is estimated to be €1.5 billion, an increase of €400 million on the original estimate. The UK has invested £96.6 million in the programme so far, with £24.1 million contributed by DfT and £72.5 million contributed by DTI.\textsuperscript{505} If the Commission proposal for funding the deployment is accepted, the UK will be expected to pay its share of the further costs. There have been cost/benefit studies undertaken on Galileo at UK and European levels. We are however concerned that, given the changes to this programme, these studies are now out of date.\textsuperscript{506}

269. \textbf{We are concerned that the failure of the concessionaire and subsequent alternative funding proposals for the Galileo programme are likely to result in rising costs to the UK. We recommend that, before the next Transport Council meeting, the Government publish a new analysis of the costs and benefits of the Galileo programme to the UK. We recommend that the Government report to Parliament on a regular basis on its intentions in relation to Galileo.}

\section*{Telecommunications}

270. Telecommunications satellites are used frequently in our everyday lives. Satellites are used for distributing radio signals, for transmitting television signals, for distributing text, audio, and video by news agencies, for providing access to the internet, for providing mobile communications, and increasingly for enabling tele-education and tele-medicine. There is now a belt of over 100 satellites surrounding the Earth, providing radio, television and telephone communications.

\begin{footnotesize}
\begin{itemize}
  \item \textsuperscript{502} Council of the European Union, Council resolution on Galileo, 6-8 June 2007
  \item \textsuperscript{504} HC Deb, 13 June 2007, col 55 WS
  \item \textsuperscript{505} Ev 287
  \item \textsuperscript{506} Q 587. Price Waterhouse Cooper, \textit{Inception study to support the development of a business plan for the Galileo programme} (20 November 2001).
\end{itemize}
\end{footnotesize}
271. Telecommunications and broadcasting is the dominant sector within the UK space industry. Satellite broadcast services and satellite communications services accounted for 85% of downstream industry turnover in 2004-06 (approximately £3496 million). Colin Paynter from EADS Astrium told us that “The facts in the UK are that 80% of the industry and perhaps more of the wealth-creation is locked into telecoms research and development leading to wealth-creation”. ESA indicated that the market for satellite communications has been expanding at a sustained rate of more than 15% a year. The DTI forecast that “With the increase in Internet traffic and development of broadband, multimedia, mobile and digital broadcasting technologies, the satellite communications industry is set to experience significant growth in the coming years.”

272. The UK has maintained a strong position in the development of the telecommunications sector. Intellect claimed that “Over the past 40 years, the UK has been quite good at keeping up with, in some cases even leading, world trends in telecommunications and broadcasting”. The DTI told us that “UK companies have played a key role in the next generation of advanced civilian communications satellites for Inmarsat and are currently working to deliver advanced broadband and high definition TV services in Europe.” The Inmarsat-4 F2 satellite for example was launched on 8 November 2005 and now supplies users with broadband internet and 3G phone services. The UK is also involved in ESA’s AlphasBus project, which will create a platform able to accommodate up to 200 radio-frequency transponders. AlphasBus will facilitate a wide range of commercial missions ranging from TV broadcasting to multimedia applications, and including Internet access, mobile or fixed services in the widest sense.

273. It is important that the UK Government continues to support the space industry in this sector. We have mentioned earlier the importance of programmes such as ARTES and Alphasat in supporting work in this area (paragraphs 144 and 149). The BNSC acknowledged that “Much of the economic activity is currently in broadcasting and telecommunications and reflects past investments, with a significant downstream service industry based on the use of satellite systems. Future developments in this area will look at broadband links, digital communications and broadcasting.” The telecommunications sector is still growing. It is important that the Government continues to fund initiatives in this area such as ARTES and Alphasat, which provide vital seedcorn funding for high-risk, early stage R&D.

274. There are various regulations governing the orbit and frequency at which telecommunications satellites can operate. Satellites orbit the Earth at various levels and to maintain a particular orbit a satellite must travel at a specific orbital velocity. When a satellite is in geo-synchronous orbit, it orbits the earth once in 24 hours and is at approximately 36,000km above the Earth. The equatorial GEO orbit is popular for...
communications and weather satellites because the satellites remain stationary over the same point on the Earth’s surface. There is room for only about 180 active satellites in this orbit so demand for orbital slots and the frequencies at which they can communicate is high.514

275. Before a satellite is launched, it is necessary for the national regulatory body or administration to register and seek agreement for the proposed orbit and operating frequency spectrum of the communications satellite with the International Telecommunications Union Radiocommunications Bureau. UK registration takes place through Ofcom, which is responsible for co-ordinating applications for access to radio spectrums for communications and access to specific orbits. It notifies the International Telecommunications Union and then applicants join the queue for a frequency. Applicants also require a licence from the Government under the Outer Space Act (paragraph 169).

276. We have heard that UK satellite operators are facing challenges created by the inconsistent application of regulations internationally and the UK-centric focus of Ofcom.515 David Williams from Avanti told us that

some regulators will interpret ITU guidelines and rules in a way which is very flexible and gives a distinct competitive advantage to other satellite operators. So there are satellite operators in Europe, for example, for whom the same standard of rigour in interpretation of rules and guidelines that apply to me does not apply, and that gives me a competitive disadvantage.516

Intellect wrote that “Ofcom’s management of UK spectrum use is becoming very UK-centric in that the wider policy implications and international dimensions of existing and new satellite services do not appear to be taken into adequate account when planning future spectrum usage.”517 It provided several different examples such as Ofcom’s plans to allow new terrestrial services to use the receive “C-band transmission band”, which could jeopardise links to other countries such as Africa.518

277. There is potential for change in this area at national and European levels. Ofcom is currently reviewing its practices and has consulted interested parties regarding plans for new terrestrial services.519 The European Space Policy states that “Pan-European licensing of services, spectrum and content is needed, as well as a more flexible, market-based regime for allocating radio spectrum.”520 We recommend that the Government work at a European level to ensure that there is a consistent standard of regulation across Europe. When reviewing its practices, Ofcom should take the views of satellite operators regarding the international impact of its activities into account.

514 Military Uses of Space, POSTnote 273, Parliamentary Office of Science and Technology, December 2006, p 3
515 Ev 212
516 Q 47
517 Ev 212
518 As above.
519 Ev 408
520 EC. European Space Policy, SEC(2007)504, p 10
108 2007: A Space Policy

10 Exploration and launchers

Exploration

278. Exploration is crucial to improve knowledge and understanding of space. Beyond this, space exploration is driven by a need to discover and investigate. The then Minister Malcolm Wicks told us that exploration is “the great adventure and I think we will see great strides during the rest of this century and further into the millennium.”\(^521\) The then Minister’s enthusiasm was echoed by Professor Keith Mason, Chief Executive of STFC, who said that exploration opens up “huge scientific, technical—but also commercial—opportunities.”\(^522\) The UK’s current space strategy supports the use of robotic, telerobotics or semi-autonomous systems in exploration, but not human exploration.\(^523\)

279. 2007 marks the fiftieth anniversary of spaceflight. In 1957 the Soviet Union launched Sputnik, the first artificial satellite. Four years later Yuri Gagarin became the first man to orbit the Earth and by 1969 the US had put a man on the Moon. Some missions such as Apollo 11 and the Voyager series have been acknowledged as successes and others such as Beagle 2 and space shuttle Columbia tragic disasters. Our predecessor Committee considered the fate of Beagle 2 in a report in 2004. It commended the Government on its enthusiasm for Beagle 2 and said that the Government should continue to support participation in future planetary exploration missions on a well-defined multinational basis.\(^524\) Since 2004, there has been increasing global interest in space exploration demonstrated by NASA’s Vision for Space Exploration, ESA’s Aurora programme, and robotic lunar missions by India, China, Russia and Japan.

ESA’s Aurora programme

280. ESA’s Aurora programme was conceived in 2000, following a mandate by European Ministers to prepare for the next steps in human exploration. The primary objective of the Aurora Programme is to create, and then implement, a European plan for the robotic and human exploration of the solar system. It is a long-term programme, leading towards a human mission to Mars in 2033. One of the initial projects will be Exo-Mars, due to be launched in 2009, featuring an orbiter and a large rover.

281. In 2001 and 2004, the UK invested in the first two preparatory stages of Aurora. In 2001, the UK contributed £1 million to participate in the project definition phase. In September 2004, PPARC invested £5 million from its existing budget in the second preparatory phase.\(^525\) In December 2005, Lord Sainsbury announced that the Government would invest €108.1 million (approx. £74.4 million) in the next stage of Aurora from 2005-

\(^{521}\) Q 571
\(^{522}\) Q 179
\(^{525}\) “UK joins next stage of European preparatory space exploration programme- Aurora”, PPARC Press Release, 30 September 2004
2009, making the UK the second largest contributor after Italy.\textsuperscript{526} The UK is subscribing to the parts of the Aurora programme focused on the science-driven robotic exploration of Mars. The UK is not committed to funding the manned phase of Aurora and Dr Williams told us that “We very specifically blocked a change that would involve the UK being automatically committed beyond the robotic phase.”\textsuperscript{527}

282. The UK is acknowledged to be strong in many of the science areas included in the Aurora programme, several of which were developed by the Beagle 2 project. Professor Keith Mason has been reported as saying that “Beagle has been extremely successful in developing a capability that will allow us to be strong players in Aurora”.\textsuperscript{528} The Beagle consortium developed instruments and systems such as miniaturised integrated electronics, robotic arms and parachute designs that could be used in Aurora missions. PPARC also commissioned a report to identify the technology capabilities that could be developed through participation in Aurora.\textsuperscript{529} This report found that the UK was in a good position to provide the technologies required by Aurora “as a result of the strong existing space industry sector and knowledge base.”\textsuperscript{530} We welcome the UK’s involvement in the Aurora programme and recommend that the STFC ensure that the UK maintains its strong role in this programme.

\textbf{NASA’s Lunar Programme}

283. NASA’s lunar exploration programme is part of the US’s long-term space exploration programme announced by President Bush in January 2004.\textsuperscript{531} The lunar programme will begin with robotic exploration and aims to return humans to the Moon by 2020. On 4 December 2006, NASA released its lunar architecture plans. The main reasons given by NASA for a return to the Moon are: to use the Moon to prepare for future human and robotic missions to Mars and other destinations; to increase scientific knowledge; to extend human presence to the Moon; to expand the Earth’s economic sphere; to strengthen existing international partnerships, and to engage and inspire the public.\textsuperscript{532} The cost of the lunar programme is expected to be very large, perhaps many hundreds of billions of US$. There are many scientists who are sceptical about the quality, cost effectiveness and even the realism of many of the science objectives, while not doubting the economic, technical and public engagement benefits that would derive from such a programme.

284. There is an opportunity for the UK to be a partner in this programme. In April 2007 the BNSC and NASA signed a Joint Statement of Intent, which states that “NASA and BNSC confirm their mutual desire for detailed discussions on specific areas of potential collaboration involving lunar science and exploration. These cooperative efforts may range from the exchange of information related to research and development to actual hardware

\textsuperscript{526} “The UK supports major advances in space”, DTI Press Release, 6 December 2005
\textsuperscript{527} Q 652
\textsuperscript{528} ‘Transparency: the promise of a man who tried for absolute zero’, Research Fortnight, 12 October 2005
\textsuperscript{529} BNSC, Q/3, Abotts Knowledge Transfer from Space Exploration: Prospects and Challenges for the UK, April 2005
\textsuperscript{530} As above, p 3
\textsuperscript{532} “NASA unveils Global Exploration Strategy and Lunar Architecture”, NASA Press Relesase, 4 December 2006
contributions for particular missions.”533 NASA has confirmed that the UK’s stance on human spaceflight will not bar it from collaboration and that it “has very ambitious goals for exploration that integrate human and robotic activities over a wide range of disciplines. It is not necessary for our partners to share the same broad goals with respect to human space flight in order to benefit from bilateral cooperation in space.”534

285. In 2006, PPARC (now STFC) funded a pre-phase A study of two potential lunar missions: MoonLITE and MoonRaker. MoonLITE (Moon Lightweight Interior and Telecommunications Experiment) would comprise a small orbiter and four un-braked penetrators carrying miniature instruments to impact the Moon at high speed. The mission would investigate the unknown interior structure of the Moon by deploying a network of seismometers and heat-flow sensors. It would also discover whether high rate data communications were possible between the Moon’s surface, lunar orbit and the Earth.535 MoonRaker would be a small soft lander. It would test a novel technique of dating the age of rocks on the lunar surface.536 The STFC told us that it has discussed the study results with NASA who have recognised that they are aligned with the goals of the lunar exploration programme. Over the next 6 to 12 months, a joint study team from NASA and BNSC will define a common set of objectives and design solutions. The UK has also recently submitted the proposals for MoonLITE and MoonRaker into a recent open call for new mission concepts in the Aurora programme (paragraph 280).537

286. SSTL, which has been involved in the study, told us that “Such an initiative would enable the UK to develop and enhance its expertise in robotic space exploration and allow the UK to ‘punch above its weight’ in support of international exploration projects by providing essential infrastructure elements and addressing key scientific or technological issues.”538 The STFC said that the missions would extend the UK lead in small satellite technology and would test new technologies such as penetrators and robotic age dating equipment. We welcome the recent Joint Statement of Intent signed by BNSC and NASA and hope that this signals the beginning of fruitful collaboration on the MoonLITE and MoonRaker missions. We congratulate the STFC on its timely funding of preparatory work in this area.

The Global Space Exploration Strategy

287. In April 2006 NASA hosted a space exploration conference in Washington. Fourteen organisations, including the ESA and the BNSC, involved in the conference created an informal Global Space Exploration Strategy team.539 The team has worked to elaborate common themes and objectives covering robotic and human exploration of the Moon,
Mars and near-Earth asteroids. In December 2006, NASA released plans for the strategy outlining why it is necessary to return to the Moon and plans for lunar exploration. In May 2007, following discussions between the fourteen space agencies involved, The Global Exploration Strategy: The Framework for Coordination was published. The primary goal of the strategy is sustainable space exploration focused at first on the Moon and then Mars. The framework proposes that there should not be a single programme but rather a voluntary, non-binding forum where nations can share their plans. The BNSC says that “the UK is fully engaged, in order to understand the developing international context. The goal is to increase the coordination between future international exploration activities rather than to create a single programme.”

The then Minister Malcolm Wicks MP told us that exploration needs to be an “international endeavour, an international expedition, and I think we are very committed to internationalism in terms of space science and space exploration.”

288. The BNSC told us that BNSC partners are actively considering whether BNSC can contribute to the robotic aspects, and that “The UK […] is looking at what novel science can do and what technology can bring into it, so we have seen robotics and communications in going to the Moon as something where we have a skill and a skill which will contribute to whole”. The then Minister Malcolm Wicks MP believed that this exploration would involve Britain to a very full extent.

289. The BNSC has set up a Space Exploration Working Group composed of 22 scientists, technologists, entrepreneurs, officials and independents to assess the developing scene. It has four sub-groups focusing on science, technology, commerce and society. It is expected to publish its report by the summer, although Dr Williams told us on 18 April 2007 that the exploration group had only met once or twice.

290. ESA is also working out how to respond to the Global Space Exploration Strategy. The European Space Policy states that “By 2008, ESA will produce proposals for the involvement of Europe in the international exploration endeavour presenting options in planetary exploration and in cooperative development of human transport capabilities.” The BNSC notes that “ESA has been involved in discussions and are looking at how this initiative sits alongside its existing programmes.” There could be difficulties in reconciling ESA’s objectives and NASA objectives, given that ESA had chosen to focus on Mars in the Aurora programme and NASA has chosen to concentrate initially on the Moon. Jean-Jacques Dordain told us that ESA Member States would have to decide at the

541 Ev 358
542 Q 602
543 Ev 373; Q 119
544 Q 649
545 Ev 373; Qq 654–655
546 EC, European Space Policy, SEC(2007)504, p 14
547 BNSC, A Consultation on the UK Civil Space Strategy 2007-2010, p 13
next Ministerial whether to pursue the Aurora programme beyond Exo-Mars and whether
to contribute to a manned mission to the Moon driven by the US. 548

291. We welcome the BNSC’s active involvement in the Global Space Exploration
Strategy. We recommend that the findings of the BNSC Space Exploration Working
Group be published and subsequently incorporated appropriately into the forthcoming
space strategy. The Space Strategy 2007-2010 should outline how the UK intends to
respond to the different international exploration projects.

Manned spaceflight

292. On 29 November 2006, we met the NASA astronaut Piers Sellers who has had to
change his nationality in order to pursue a career as an astronaut because the UK does not
fund manned spaceflight. He argued persuasively that the UK should change its policy and
provide funding for manned spaceflight. The UK’s current policy in relation to manned
spaceflight is an emotive topic for many and we have heard strong arguments supporting
and opposing it. Many other countries including the US, Canada, Japan, Russia, China,
France, Germany and Italy support manned spaceflight, primarily (it could be argued) for
prestige reasons. The UK Government, under its user-driven approach to its civil space
activities, does not believe that “the potential benefits justify the costs involved” in manned
programmes. 549 The then Minister Malcolm Wicks MP told us that “What the best
evidence and what the science tells us, at the moment, is that man’s/woman’s exploration
of space should not be a priority for the United Kingdom.” 550

Arguments around manned spaceflight

293. The thought that there are humans currently orbiting the Earth in the International
Space Station is quite incredible, and this inspirational aspect of manned spaceflight is
emphasised by its supporters. One submission stated, for example, that “Human
spaceflight has always been looked at with awe and wonder.” 551 Several submissions
suggested that young people can be inspired by manned spaceflight to study science
subjects. Nicholas Spall, Fellow of the British Interplanetary Society told us that “human
spaceflight is a very good ‘inspirational’ aspect of science and technology and the efforts to
halt the decline in science courses in the UK could be firmly assisted by a national interest
in manned spaceflight.” 552 The Centre for Aviation, Space and Extreme Environment
Medicine stated that “Human space flight is a first class vehicle for science education and
the communication of scientific ideas to students at all educational levels.” 553 The then
Minister Malcolm Wicks MP agreed that manned spaceflight would be “a way of engaging
young people in the importance of space and the importance of science.” 554 It is difficult to

548 Q 567
549 BNSC, A Consultation on the UK Civil Space Strategy 2007-2010, p 9
550 Q 649
551 Ev 257
552 Ev 127
553 Ev 242
554 Q 649
substantiate these claims with evidence beyond the anecdotal but policymakers sometimes refer to the “Apollo effect”, which describes the rise in numbers of students studying STEM subjects in the early 1970s thought to be caused by NASA’s manned Apollo lunar missions between 1963 and 1972.  

294. On the other hand, the inspirational impact of space can be argued to apply beyond manned spaceflight to robotics. Dr Robin Clegg from the STFC told us that “While manned space flight is inspirational […] robotics has a very strong inspiration value too”. Paul Spencer, an Evaluator and Consultant for Space Connections told us that “The value of space to education is not just about humans in space, that is the tip of the iceberg.” Several submissions highlighted the public interest in Beagle 2. The Royal Aeronautical Society argued that “Human spaceflight captures the public imagination, but Britain’s Beagle 2 probe to Mars has shown that robotic exploration can too.” Professor Colin Pillinger, the project leader on Beagle 2 told us that “We have been told there were plenty of children, who got up before 6.00am Christmas morning 2003, to ask not ‘Where are my presents?’ but ‘What happened to Beagle 2?’.”

295. Furthermore, the link between manned spaceflight and interest in science apparently demonstrated by the Apollo effect is complicated by more recent statistics from the United States where there has been an ongoing manned programme and yet the number of students studying STEM subjects has not remained constant. The Science and Engineering Indicators 2006 from the US National Science Board found that the number of doctorates awarded in the sciences declined from 1998 to 2002 and has only recently begun to increase. A report from the National Academy of Sciences in 2006 said that the US faces limited undergraduate interest in science and engineering majors.

296. Another argument in favour of manned space activities is that such investment would benefit UK industry, particularly if investment was made through the ESA because of the system of juste retour. The Knowledge Transfer from Space Exploration: Prospects and Challenges for the UK report notes that “The decision by the UK not to participate in the human exploration aspects of Aurora will mean that UK capabilities in this area are not generally further advanced or adopted by the programme. There may however be opportunities for transfer of such technologies developed in the Aurora programme to the benefit of the UK.” Leonard Fisk, Chair of the Space Studies Board at the National Academy of Science has said that the Vision for Space Exploration will need 50,000 to 75,000 scientists and engineers. When we discussed the UK’s stance on manned

555 Ev 198
556 Q 250
557 Q 253
558 Ev 150
559 Ev 225
560 National Science Board, Science and Engineering Indicators 2006, February 2006, overview
561 National Academy of Sciences, Rising above the Gathering Storm, February 2006, pp 3-24
562 Ev 137
563 Qi3 & BNSC, Abotts Knowledge Transfer from Space Exploration: Prospects and Challenges for the UK, April 2005, p 38
564 House of Representatives Committee on Science, Hearing on ‘Perspectives on the President’s Vision for Space Exploration, 10 March 2004, p 219
spaceflight with industrialists, they emphasised the UK’s strengths in areas such as robotics and communication services. Sir Martin Sweeting from SSTL said that engagement in an exploration programme would have to be undertaken “in an appropriate way, exploiting our robotic and communications expertise in the UK.”

297. A recent report from the Royal Astronomical Society stated that there were some science programmes such as deep drilling on Mars that would require on-site humans and automation. It concluded that “there is science of profound interest to humankind that can only be pursued on the Moon and Mars by the direct involvement of humans”. Dr Ian Crawford, Lecturer in Planetary Science at Birkbeck College, University of London told us that astronauts “bring agility, versatility and intelligence to exploration in a way that robots cannot.” Professor Keith Mason, Chief Executive of STFC agreed that “There are places where robots will do a better job, there are places where humans might do a better job.”

298. We have also heard wholly opposing views. Professor Len Culhane from the UK Space Academic Network told us that manned spaceflight “would be very difficult to justify on purely scientific functionality grounds”. The Royal Aeronautical Society told us that “We consider that most if not all scientific exploration of the Moon can be done via robotic probes under remote control from Earth”. It commented further that “the oil and gas exploration industry is beginning to apply digital technology to drilling” and suggested that a prize could be offered for the development of digital drilling technology. During oral evidence, Professor Rowan-Robinson, President of the Royal Astronomical Society, clarified the Society’s position, stating that “The report says that there are some science goals that require human space flight which is a different thing from saying that the UK should now double its budget and go into human space programmes.”

Costs

299. The key issue in relation to manned spaceflight is its cost. Dr Robin Clegg, the then Head of Science and Society at PPARC, told us that “PPARC would not be in favour of investing in this manned work if it harmed what I will call the UK space science programme, the robotics and so on. PPARC would be very concerned about that. The human programme would come at an extra cost.” Lord Rees of Ludlow from the Royal Society explained that “we have got to bear in mind that, if we paid anywhere near the full

565 Qq 54, 56–57
566 Q 54
568 As above, p 23
569 Ev 137
570 Q 183
571 Q 437
572 Ev 150
573 As above.
574 Q 442
575 Q 251
economic cost, it would overwhelm all we could do on unmanned.” The Centre for Aviation, Space and Extreme Environment Medicine notes that “Entry to the ESA astronaut programme would require an annual subscription of 150 million Euro, a sum which is clearly prohibitive at this stage.” In February 2007, the Royal Astronomical Society polled its members and 96.1% agreed with the statement that “the prime drive in selection of scientific space missions, within an inevitably limited budget, should be the quality of the science. The Royal Astronomical Society recognizes that there may be some scientific goals that can only be achieved within a human spaceflight programme […] these goals are likely to be feasible only within a greatly expanded scientific space programme.”

300. There are several options for UK participation in manned spaceflight and the level at which the UK became involved in any programmes would inevitably influence the cost. Professor Keith Mason explained to us that “It is more of a graded scale than, perhaps, people realise, and provided one works in partnership with, for example, our European partners in ESA or within a bilateral relationship with NASA the costs need not be unaffordable. Certainly the budget will need to go up from what it is now, by perhaps a factor of two, not factors of ten.” The British Interplanetary Society agreed that “Cost is certainly not a reason to exclude UK science researchers from programmes such as the International Space Station.” The BNSC admitted that “Estimating the costs of a UK manned space activity is not a precise science, and varies depending upon whether the costs of the associated activities are included.” During this inquiry we have seen several different proposals for UK involvement in manned spaceflight programmes in the near future as outlined in Box 9.

Box 9: Possible options for UK involvement in manned spaceflight programmes

<table>
<thead>
<tr>
<th>Programmes</th>
<th>Potential Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESA’s Human Space Flight Programme (UK people could apply to be European astronauts)</td>
<td>£60 million a year + additional costs for related science</td>
</tr>
<tr>
<td>NASA shuttle programme (including training)</td>
<td>$50 million per mission per astronaut</td>
</tr>
<tr>
<td>Taxi to ISS (travel only, requires additional resources for experiments)</td>
<td>$20 million per person</td>
</tr>
<tr>
<td>BIS 2 missions to International Space Station (1 astronaut with experiments on 2 journeys)</td>
<td>£47.4 million</td>
</tr>
<tr>
<td>RAS proposal—UK has 15% share of ESA programme to establish lunar base (includes national experimentation costs)</td>
<td>£150 million a year for 15 years</td>
</tr>
</tbody>
</table>

Sources: Ev 358, 371

576 Q 436
577 Ev 242
579 Q 184
580 Ev 248
581 Ev 358
301. These cost estimates demonstrate that there is a wide variation in the levels at which the UK could participate and the resultant cost. Given the UK’s user-driven approach to space, any activity that the UK chose to fund would have to be driven by a clearly-defined user need, rather than be a prestige project.

**Future options**

302. There are therefore several options facing policymakers and it is important that they assess the merit of each one. In the current environment the UK has to be flexible about its plans. The manned aspect of the Aurora programme may not be pursued and the Global Exploration Strategy could expand, providing new avenues for UK involvement beyond the robotic. In relation to manned spaceflight, Jean-Jacques Dordain told us that “Today the question is not so much UK in or out, it is more ESA Member States in or out”.

303. Several submissions have raised concern that UK will miss the boat and lose the opportunity to be involved in manned spaceflight. The UK Space Biomedicine Group has told us for example that “If the UK follows its current course it is highly likely that, after a further period of non-participation, the current window of opportunity will have closed, and the UK will not have the critical mass of expertise required to influence the direction or progress of well-established international human space research programmes.” This contrasts with the message we have received from the BNSC that the UK could change its mind at any time. In relation to subscribing to the manned aspect of Aurora, Dr Williams told us that “I do not see a need to make a decision on that certainly in the next 10 years and then we could probably consider it at any point in time”. He explained further that “If, in 40 years’ time, things change or in 20 years’ time the system changes and there is a global astronaut corps, then it could be looked at at that time”.

304. Given the long lead times in the space sector, it is important that the UK plans strategically and leaves the option open for manned spaceflight in the future, even if it focuses upon robotics now. Professor Keith Mason from the STFC said that “If in 20 years’ time there is a reliable and sustainable infrastructure on the Moon, for example, then in order to be doing the sort of science that the UK is currently strong in we would probably want to be involved in that. We have to at least examine that question with an open mind and plan our future accordingly.” The then Minister Malcolm Wicks MP told us that if technological contribution now to the Global Exploration Programme “enabled British men and women to explore space (and I think we are talking about quite a long-term future) that would be wholly appropriate.”

305. In deciding its current policy and future plans regarding engaging in manned spaceflight, the BNSC needs to outline clearly what factors are important in judging whether or not to fund programmes in this area. Under the user-driven approach, it is

---

582 Q 567
583 Ev 236
584 Q 151
585 Q 120
586 Q 183
587 Q 649
306. **It appears that the Government currently objects to manned spaceflight on principle and we believe that this stance is unjustifiable.** Manned spaceflight proposals, like other proposals in other areas of space, should be judged according to a cost-benefit analysis. We recommend that whilst the BNSC emphasise the UK’s interest in robotic missions at this stage, it also keep the option of scientific manned spaceflight missions open for the future. The Government’s stance should be flexible enough to ensure that the best science can be funded, whether that be undertaken by manned or robotic exploration.

**Space medicine**

**Overview**

307. The UK’s approach to manned spaceflight has had repercussions for the field of space medicine and we have received many submissions requesting that the Government re-evaluate its policy in this area. Space medicine combines many medical specialities to examine the effects of spaceflight on humans and prevent problems associated with living in the unique, isolated, and extreme environment of space. Research undertaken in space could have terrestrial relevance, and technology developed for use in space often has terrestrial applications.

308. According to Dr Philip J Scarpa, Manager of Medical Operations at the Kennedy Space Center, space medicine topics include “astronaut bone loss, muscle loss, radiation exposure, heart and blood vessel deconditioning, anaemia, decreased immune system, kidney stones, mental health, toxic exposures, decompression sickness, occupational injuries, and trauma.” As well as treating astronauts, there are several possible terrestrial benefits of space medicine. Professor Kennard, Chair of the Neurosciences and Mental Health Board at MRC, told us that the study of loss of muscle bulk and stresses on the bone in microgravity environments could be a model for ageing and osteoporosis. Research in space could also provide information that was useful in the study of heart failure and the body’s vestibular or balance system that enables us to orientate ourselves in space.

309. The technologies that are used in space medicine can be transferred to terrestrial medicine. Marchbanks Measurement Systems, for example, has developed medical

---

588 HC [2005-06] 808-l, 18 January 2006, Q 14
589 Memoranda 3,11,13,17,19,23,24,26,27,28,37,40,47,51,54,55,59,60,61,64,72, and 74.
590 Ev 165
591 Q 463
equipment for human space exploration that can measure intercranial pressure without the need for surgery.\textsuperscript{592} The Osmosis Unit told us that its work on fluid balance shifts in astronauts could have terrestrial impact in the development of medical devices for the diagnosis and monitoring of conditions such as hypertension and shock.\textsuperscript{593} The question therefore arises of whether the UK should be supporting research into space medicine.

**History of the debate**

310. ESA runs a microgravity research programme that encompasses work on space medicine. The UK subscribed to ESA’s microgravity research programme, EMIR-2X, for several years at a low level. In 2002, the Government had to decide whether to participate in EMIR-2X’s successor, ELIPS (European Life and Physical Sciences) which was going to use the International Space Station (ISS). The Government set up an independent panel to review the potential benefits of work on microgravity. This panel recommended that funding be provided from the Office of Science and Technology for research topics such as signalling in cells, bone growth, materials and fluid behaviour. In May 2004, Lord Sainsbury announced, however, that having failed to find a source of funding within Government for the programme, the UK would not be subscribing to the ESA’s microgravity research programme. The following box outlines the main events leading to the Government’s decision:

**Box 10: Timeline of events**

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989</td>
<td>Publication of report by Professor Sir Brian Pippard, <em>Prospects for British participation in microgravity research</em></td>
</tr>
<tr>
<td>1999</td>
<td>Conference on ‘Futures in UK Space Biomedical Research’ held at UCL with support of BNSC</td>
</tr>
<tr>
<td></td>
<td>Formation of UK Space Biomedical Advisory Committee</td>
</tr>
<tr>
<td>2000-2003</td>
<td>UK participates in ESA microgravity programme EMIR-2X</td>
</tr>
<tr>
<td>2002</td>
<td>UK has to decide whether to subscribe to EMIR-2X’s successor ELIPS. Subscription costs approx. £3.4 million per year</td>
</tr>
<tr>
<td>August 2002</td>
<td>MRC &amp; BNSC hold workshop ‘Space for health, or health for Space?’ Government launches review of potential benefits of microgravity research chaired by Professor William Wakeham</td>
</tr>
<tr>
<td>January 2003</td>
<td>Report from Wakeham review recommends that Government participates in the ESA ELIPS programme at the minimum level</td>
</tr>
<tr>
<td>February 2003</td>
<td>RCUK considers recommendations and case for funding</td>
</tr>
<tr>
<td>September 2003</td>
<td>RCUK rejects recommendations and case for funding</td>
</tr>
<tr>
<td>May 2004</td>
<td>Lord Sainsbury announces that ‘having been unable to fund a source of funds’, the UK Government will not subscribe to the ESA ELIPS programme or fund a national programme of microgravity research</td>
</tr>
</tbody>
</table>

\textsuperscript{592} Ev 183

\textsuperscript{593} Ev 139
311. Despite the Government’s decision to not join the ESA’s programme, the UK’s space medicine community has continued to grow and become increasingly well-organised. There are several groups for people interested in this topic such as the UK Space Medicine Association, the UK Space Biomedicine Group and the UK Space Biomedical Advisory Committee. At UCL, a space medicine and extreme environment course has been established as part of the physiology undergraduate course and a research group, the Centre for Aviation, Space and Extreme environment medicine, has been created. Evidence from the medical profession argued that “the UK has already built a rapidly growing skills base of health professional and researchers with an interest in space medicine” and that “The UK has a strong health research base”.

**Potential for widespread benefit**

312. There is a debate about the benefits that funding space medicine would bring. The MRC notes that space medicine is usually focused on human spaceflight programmes and the health of astronauts who are usually extremely fit, young and able. The MRC says that “The study population in space research is atypical, since astronauts are a highly selected group of fit and intelligent individuals.” It adds that “The main benefit of such research is to the health of astronauts, rather than to the health of the terrestrial population.”

313. Space medicine experts disagree. Dr Alyson Calder wrote that “For every medical problem encountered in microgravity, an analogous condition occurs on Earth.” The examples she quoted are post-flight orthostatic intolerance and orthostatic intolerance experienced after bed rest and in conditions such as multiple sclerosis, diabetes and autonomic dysfunction; space motion sickness and inner ear disturbances such as Menières disease; muscle atrophy experienced by astronauts and muscle wasting following bed rest and sarcopenia of old age; and loss of bone mineral density in astronauts and disuse osteoporosis in hospital patients on bed rest or with immobilised limbs in plaster casts. The UK Space Biomedicine Group argued that research areas such as these are “relevant to healthcare and economic prosperity on Earth, as improved understanding of these areas will provide novel therapeutic approaches and diagnostic techniques for a variety of terrestrial medical problems.”

314. The MRC is unconvinced that there is substantial evidence to support broad claims about the impact of space medicine. Professor Chris Kennard noted that terrestrial benefits of space medicine were “potentially of relevance” rather than saying that they were proven to be relevant. He told us that “You can get information about how normal man works from microgravity. From the pathophysiology, when you actually have disease that is influencing the normal physiology, then that is where it is very questionable as to whether

---

594 Ev 210, 253  
595 Ev 192  
596 As above.  
597 Ev 180  
598 Ev 180–181  
599 Ev 235  
600 Q 463
there is any benefit from microgravity.” The MRC believes that regarding investigations into loss of bone and muscle mass, it “has yet to be established whether this is a useful model in terms of understanding the processes of ageing.” Furthermore “space studies do not provide a good model for heart failure and other cardiovascular disease processes.” The MRC concluded that “Current studies are generally descriptive, and the knowledge base at present is insufficient to ask the critical questions that microgravity might be able to uniquely answer.”

315. There is also the question as to whether research into these areas can only be undertaken in space or as to whether if the same amount of funding was put into research on Earth, solutions could be found. Professor Kennard explained that in 2002 “After bringing all the experts together, there was a general view that there were not any specific areas that […] could be seen to really definitely offer benefits that could not be obtained by work in laboratories around the world rather than having to go up into space.” The MRC asserted that “the majority of important questions being posed could be tackled on earth by careful design.” Dr Kevin Fong from CASE accepted that simulated environments can be used for research. He noted, however, that access to such facilities were “generally part of a wider human space flight programme with other agencies.”

The information report by the Microgravity Review Panel noted that approximately 60% of ESA microgravity activities are ground-based.

Funding

316. We have been told that, due to the Government’s decision in 2004 and its lack of support for manned spaceflight, it is difficult for space medicine researchers to find funding for their work. Dr Vishal Nangalia wrote that “The current structure of funding space related projects is broken and haphazard […] No organisation wishes to support a new field of discovery such as space medicine or human spaceflight”, while another doctor suggested that “the UK’s expertise in this area is at risk of collapse due to lack of support.” Researchers either tend to self-fund their work or undertake research in collaboration with international space institutes that work in this field, such as the Yuri Gagarin Cosmonaut Training Centre (Russia), the NASA Johnson Space Center (Texas), the NASA Kennedy Space Center (Florida), the Vanderbilt Centre for Space Physiology and Medicine (Tennessee) and the Microgravity Laboratory (Brazil).
The current funding strategy, explained to researchers at the MRC Workshop in 2002, is response-mode application to the MRC. Professor Kennard from MRC told us that:

the MRC does not just exclude and say we are not going to have anything to do with space flight […] we do consider applications that come on response mode so there are a number of individuals who link up with space programmes elsewhere who want to do experiments and come to the MRC and they are judged along with all the other applications that come through.612

When we asked Professor Kennard whether the MRC would strategically set money aside for space medicine, he told us that “we cannot see any real benefit, even long-term, from identifying a small amount of money to put into this that would generate a real benefit.”613 The space medicine community itself accepts this and is not seeking strategic funding from MRC but rather UK involvement in a manned spaceflight programme that would also provide access to microgravity research funding. Dr Kevin Fong explained that

With the line that MRC take, that they should not top slice their own budget to fund this, I think that is correct. They have agreed that funding in responsive mode is good and I think that is right. We need to have a different funding source for medical science because it is part of the human space flight programme.614

The space medicine community has not taken advantage of the MRC’s response-mode funding since there was only one application in this area in over the past five years.615 This application was unsuccessful.

318. The current funding mechanisms for space medicine projects have an impact upon the funding for spin-out products from this research. In relation to a device developed to take blood in space, Dr Evetts told us that “because of the virtual absence of support in Britain we are currently in negotiations with an American company concerning the continuation of the work through clinical trials and the subsequent commercial exploitation of this initiative.”616 In relation to technology to measure intercranial pressure, Dr Robert Marchbanks explained that “for a modest investment, NASA is a stakeholder in cutting-edge health technology and has created a ‘win-win’ opportunity for Space and Earth-based medicine.”617

319. We have not seen enough evidence to be convinced that a special stream of funding should be given to space medicine. Funding should continue to be available from MRC through peer-reviewed response-mode funding. The MRC should monitor developments in the field and liaise appropriately with BNSC. Given the current climate in global exploration, the BNSC should explore routes for non-financial co-operation with organisations such as NASA and ESA in this area.
Space tourism

Overview

320. Enthusiasts have been discussing the idea of commercial space travel since the 1950s. In the last six years, several key events have marked the development of a space tourism industry. In 2001, Dennis Tito was the first tourist to pay for a flight into space. He paid $20 million for an eight day holiday on the International Space Station. The following year another tourist Mark Shuttleworth followed suit. The company that offered the holiday, Space Adventures, is now offering reserved places on sub-orbital flights, sixteen day trips to the ISS and spacewalks. There has also been increasing interest in the development of spacecraft appropriate for space tourism, sparked by the promise by Dr Peter Diamandis of an award of $10 million, the 'X-Prize', for the first non-government organisation to launch a reusable manned spacecraft into space twice within two weeks. On 4 October 2004, Burt Rutan and Paul Allen won the X-Prize for their spacecraft, SpaceShipOne.

321. The potential of SpaceShipOne was quickly understood by Virgin Galactic who announced in September 2004 that it would create a commercial spacecraft based on the design of SpaceShipOne. The spacecraft is an eight-seat (2 pilots, 6 passengers) version of SpaceShipOne. The flight will have the same basic characteristics as SpaceShipOne flights: after being dropped from the carrier aircraft, a rocket motor will propel SpaceShipTwo into suborbital space, after which the spacecraft will glide back to a runway landing. SpaceShipTwo will have a peak altitude between 360,000 and 400,000 feet (110,000 and 122,000m), giving passengers a few minutes of weightlessness. The cost for early flights on Virgin Galactic is $200,000 and 200 people have paid a deposit. Will Whitehorn, the President of Virgin Galactic, said that within five years costs would be down to $75,000 and after nine years flights would cost $50,000. Virgin Galactic (VG) stated that "By the end of this decade VG intends to provide sub-orbital space tourism services to the general public, initially operating from the US."

322. There are also several other projects underway for low cost space travel. The founder of Amazon, Jeff Bezos, has developed a company called Blue Origin and the founder of PayPal, Elon Musk, has created SpaceX. In the UK, hope is focused on companies such as Bristol Spaceplanes and Reaction Engines. Dr Patrick Collins from Space Future Consulting told us that Bristol Spaceplanes “could make suborbital flights at a cost of £3000 a head.” Bristol Spaceplanes Limited proposes developing an orbital spaceplane, which it states would cost ten times as much to develop as a sub-orbital spaceplane. Reaction Engines told us that the development of a reusable launcher “could reduce the cost of access to low Earth orbit by a factor of 50.”

618 Q 499
619 Q 502
620 Ev 307
621 Q 505; Ev 387
622 Ev 148
623 Ev 128
We have heard claims that the space tourism industry has great potential and will expand beyond sub-orbital space. Space Future Consulting claimed that that “The most promising market for space activities is passenger travel.” Stephen Ashworth, Fellow of the British Interplanetary Society, told us that “Space tourism is about to become a major new industry, but requires an economic method of access to orbit.” Virgin Galactic wrote that “In the next few decades, VG forecasts that the industry will progress beyond sub-orbital space tourism to high-speed civil transportation outside the atmosphere and private orbital facilities.”

Environmental impact

There has been some scepticism about the environmental impact of space tourism. Howard Cambridge at the University of York has been quoted as saying that more work needs to be done to ensure that Virgin Galactic does not exacerbate the impact of aviation on the global climate. He said that “when you look at the number of passengers who will benefit from space travel, the environmental impact per passenger will be quite high.” Richard Dyer from Friends of the Earth has said that “Virgin Galactic will be the ultimate in irresponsible elitist travel. There’s a strange irony in tourists looking back at our damaged earth as they are helping to warm it up.”

Virgin Galactic defended its position, claiming that it can “get six people into space for an environmental effect less than a single business class ticket to New York.” It was argued that Virgin Galactic’s air-launch system was not comparable to the traditional ground-based launch systems: “by using an air launch system, by carrying our spacecraft above the atmosphere to 60,000 feet and launching it there, we can avoid almost all the environmental impact of the current space launch systems.” Dr Patrick Collins from Space Future Consulting told us that “the emissions from even several hundred sub-orbital space flights/day will be very small compared to the emissions from either aviation or motor vehicles, mainly because the rocket engines are used for only about one minute during each flight.” Jeff Gazzard from the Aviation Environment Federation agreed that “the impact of these launch systems, as they are currently proposed, is pretty minimal.”

Virgin Galactic plans to reduce the potential environmental impact of SpaceShipTwo by developing a new fuel, Butanol, which freezes at a lower temperature than ethanol and can be produced from biomass. Will Whitehorn said that “If we could develop that new fuel we could even lower the environmental impact of this system even more”
also set up a new company, Virgin fuels, which will invest $400 million in renewable energy initiatives over the next three years.

327. The then Minister Malcolm Wicks MP retained some concern about the potential environment impact of space tourism, saying that “the environmental impact in terms of carbon emissions might be something that should be looked at most carefully in judging whether this is a societal priority.”

**Government support & regulation**

328. We have heard several arguments that the Government should be supporting this fledging industry by providing seed-corn funding for the development of new spacecraft, by providing support for the establishment of space ports and by creating a favourable regulatory environment. Dr Patrick Collins from Space Future Consulting argued that the DTI should have provided seed-corn funding for developments in this area. He emphasised that “Suborbital flight is a very straight forward low cost investment” and said that “If the DTI is sincere in saying they wish to encourage the maximum commercial development of space, which is what it is, they should invest in this”. Virgin Galactic told us that “The UK should encourage private sector investment in space activities through commercial incentives, possibly through monetary and fiscal policy”. It also suggested that the Government “invest in Public-Private-Partnership type arrangements for basic infrastructures, such as space ports, that can be shared with the private sector for commercial activities”. The state of New Mexico provided assistance for the development of a space port in the Mojave desert and Will Whitehorn suggested that there was potential for creating space ports in the UK at Lossiemouth or St Mawgan if there was a suitable financial and regulatory climate.

329. The development of a robust regulatory framework is essential for the space tourism industry. Gates and Partners said that “a number of technological, operational and legal hurdles need to be addressed to support this nascent industry.” Will Whitehorn, President of Virgin Galactic, told us that “The role for government in our project is quite simple. We need to have a legislative background in the UK which would allow this type of commercial flight to take place here or we will lose a massive opportunity.” He explained further that Virgin Galactic would like to operate in the UK but there is no regulation governing this area or a responsible regulatory body. He further told us that “we need to look at some enabling legislation through Parliament to make sure that we can do what we do, otherwise we will have to do it under military licence through the MoD in some way”. Dr Collins from Space Future Consulting agreed that we need new legislation.

---

634 Q 662
635 Qq 508, 518
636 Ev 307
637 As above.
638 Q 516
639 Ev 398
640 Q 516
641 Q 519
330. The Outer Space Act 1986 does not define the start of outer space and does not distinguish between orbital and sub-orbital space. There has recently been legislation in the United States to enable Virgin Galactic to operate in the Mojave desert. On 23 December 2004, the Commercial Space Launch Amendments Act (CSLAA) 2004 was passed. The Act facilitates the

‘development of the emerging commercial human space flight industry’ by expressly authorising the licensing of manual re-usable launch vehicles, extending the liability indemnification regime for commercial human space flight and establishing a new system for experimental re-usable suborbital rockets.643

The Act created an Office of Commercial Space Transportation under the auspices of the US Federal Aviation Administration that is responsible for regulating the industry. Even though the US is leading the world in this area, it is unclear whether its new legislation will be sufficient. Gates and Partners told us that “Neither the international nor UK domestic existing legislation provides an adequate framework for dealing with space tourism and, even in the US, where legislation has been enacted in response to the developing industry many issues are not yet fully developed or resolved.”644

331. It is worth noting that the beneficial regulatory regime is not the only reason that Virgin Galactic is concentrating upon operating in the US. The technology used in SpaceShipTwo is US-based and therefore governed by export control regulations, specifically the International Traffic in Arms Regulations. In order to provide a favourable environment for Virgin Galactic to operate in the UK, the Government would also need to work with the US to ensure a workable export control regime. Virgin Galactic asserts that “export control regulations must not present an unnecessary and/or insurmountable barrier to commercial progress in the space sector.”645

332. The DTI pursued a policy of non-financial support for the space tourism industry. It stated that:

Commercial led new markets are emerging in which the role of the DTI is to facilitate through legislation and standards, rather than intervene directly. Space Tourism is potentially a highly visible example and the UK is well placed to become a major player. BNSC, through DTI will need to contribute with other interested bodies, to the development of an appropriate regulatory framework.646

333. The DTI’s consultation on regulation was expected to cover the space tourism sector (paragraph 171). The BNSC has aided the creation of networks in this area by supporting a conference on space tourism in 2006 and a symposium in 2005. Despite the BNSC’s enthusiasm at such events, we note that there is no explicit mention of space tourism in the consultation on the forthcoming space strategy. This omission was reflected in the then Minister’s view. He told us that "I think our role, in terms of BNSC and as Government, is

642 Q 518
643 Ev 401
644 Ev 402
645 Ev 309
646 Ev 115
334. We are excited by the potential afforded by sub-orbital travel and the rise of the space tourism industry. We do not believe that it is the responsibility of Government to fund this work but developments in this area should be encouraged through appropriate regulation. The BNSC should use its consultation on regulation to discuss the establishment of a regulatory framework and responsible body with the relevant authorities. We recommend that the Government continues its policy of non-financial support to the space tourism industry and that it outline the developing nature of that support in the forthcoming space strategy.

Launchers

335. A launcher is a vehicle used to carry satellite, space probes and/or elements of space stations into space. Launchers also protect payloads during lift off and during the critical stage of leaving the Earth’s atmosphere. In the 1950s, the UK was involved in developing several launchers such as the Blue Streak and Black Knight, initially for military purposes. Black Knight delivered a satellite to low orbit and Blue Streak became the first stage of the European ELDO launcher. With a French second stage and a German third stage the project never achieved real political stability. Although the UK first stage always worked, the ELDO launcher itself was never successful in delivering payload to orbit and was eventually cancelled. The European focus then moved to the Ariane programme and, after this disappointing period of rocket development, the UK took a decision not to participate, leaving the initial development to others and waiting for a launcher market to develop. More recently, in the late 1980s, new technologies were proposed for lower cost launcher systems but the UK Government again decided not to fund launchers to a significant degree.

336. The Trade and Industry Committee considered the Government’s approach to launchers in its report on civil space policy in 2000. It concluded that “The general perception among all those involved is that the Government and BNSC are following a policy of no involvement in launchers. It is our strong impression that in BNSC there is a less than open mind on the case for Government assistance to launcher development.” The Government response stated that “Ministers continue to have an open mind on this issue […] For the moment, however, it is the Government’s view that current proposals for the development of new launchers are heavily dependent on public money and could not be contained within realistic resources in the UK.”

337. The Government currently maintains a small subscription to the ESA’s launcher programme, Ariane, which has been running since 1974. The DTI was responsible for the

---

647 Q 662
648 Q 663
649 Trade and Industry Committee, Tenth Report of Session 1999-2000, UK Space Policy, HC 335, para 67
“token” subscription to the Ariane programme that benefited UK industry due to *juste retour*. The Director General of ESA, Jean-Jacques Dordain told us that “In my view, on Ariane 5 you are getting more than you are investing. This is one of the examples where you are over-returned on Ariane because we need some pieces from the UK which do not exist anywhere else in Europe”.

338. There is still keen interest in launchers in the UK. We have been told that the UK should have built upon its strengths in developing launchers and maintained its industrial capability in this area. Dr David Tsiklauri from the University of Salford argued that “The absence of space vehicle launching capability and necessary technology in UK’s space programme significantly reduced our country’s competitiveness in the global market.” There is also an argument that access to space is going to become increasingly important and the UK will be dependent upon other nations as usage in this area expands. Andrew Weston from the University of Warwick predicted that “Re-establishing a national launch capacity in some form is […] likely to provide economic gain and to provide a legacy of capabilities in an area that is only set to increase in usage in the future.”

339. It seems unlikely that the Government will change its position on launchers. The consultation on the forthcoming space strategy states that the “UK believes there is an adequate market capable of ensuring access to space for the UK and hence support for launchers is minimal.” Views have not been specifically sought on this statement in the consultation and Dr David Williams, Director General of BNSC, told us that “It is difficult at this stage to say that there will be a dramatic change and that we will go back into launches”. The then Minister Malcolm Wicks MP said that “If the situation changed then there may be a public policy case, there might be a commercial market, for developing launcher facilities but we do not see that as priority at the moment.”

340. The Government’s current position relies upon a healthy market for launchers and we explored this idea further in oral evidence. Dr David Williams told us that:

> I think the market for launches has opened up enormously since the UK decided not to go major into launches […] we now have the Russian market opening up, the Chinese launchers, the Japanese, Indian launchers and the American launchers as well as the European, so the launcher market has a large market available. At the present time, I would say we can buy off the market rather than go back into development.

Professor Mason agreed, saying that “In the very near future we will find a very healthy market for our needs”. The then Minister also supported these views, saying that “we
have found no problems in Britain in actually launching satellites into space; either through the Americans or the Europeans or using Russian launchers; there seems to be quite a healthy market, as I understand it, in launchers.\textsuperscript{660} Jean-Jacques Dordain, Director General of ESA, however, advised caution, saying that “I am not too sure that we can find a launcher anywhere any time on the market.”\textsuperscript{661} He said that US, Japanese and Chinese launchers were not currently on the market and that US export controls could cause problems because many satellites and launchers relied on US components. Dr Williams acknowledged that “there is a short-term problem […] a certain sea launcher has failed, as a result future orders have switched to other launchers and, as a result, the launcher market is sold out […] the market is currently saturated.”\textsuperscript{662}

341. The MoD indicated that it is willing to explore the idea of an indigenous UK launch capability, and this highlights the difference between civil and military drivers for investment in space. The MoD appears concerned that the UK should have guaranteed access to a launcher, particularly if it is likely to be reliant upon small satellites in the future. It “would welcome the opportunity to contribute to debates on the need for an indigenous UK space launch capability.”\textsuperscript{663} Air Vice-Marshal Chris Moran, Assistant Chief of the Air Staff, explained that “we do not have a firm plan to be involved in a launcher but we would very much like to explore a dialogue with industry, and others, to see how we could develop a low-cost launcher system… We do see the benefits of a potential, low-cost launcher to help support a low-cost small satellite.”\textsuperscript{664} Dr Stuart Eves, an industry expert, believed that it is necessary for the UK to consider the issue of access to space because “if the UK is to participate effectively in the ‘Responsive Space’ future which the US envisages, an indigenous launch capability would make a huge difference.”\textsuperscript{665}

342. We share the BNSC’s belief that in the development of launchers the “market” will provide. But there should be no “in principle” block on funding the development of launchers in the future. We recommend that the MoD and DIUS discuss whether a seed-corn funding exercise or prize might be developed in the future to provide an incentive for the development of a low cost small satellite launcher.
11 Education & outreach

Impact of space

343. We have heard from many sources throughout this inquiry that the study of space can be used within education to increase interest in science, encouraging young people to study STEM subjects and ultimately undertake scientific careers. For example, Space Connections stated that “We believe that space motivates young people and attracts them towards science and technology.”666 The Arts Catalyst told us that ”It is clear, from our experience of organising space-related education projects in schools over the last seven years, that the theme of space, particularly human spaceflight, acts as a real incentive to children and young people to study science and technology.”667 The Science Museum wrote that space “captures young imaginations and steers them, subtly, towards scientific and technological careers.”668 Professor Alan Wells from the University of Leicester also told us that “space education inspires interest and contributes to scientific skills among the young where other branches of education fail to motivate.”669 Finally, the Royal Society stated that “Space science and astronomy education in schools and college has a direct role in motivating and preparing young people to join the skills base in space-related research.”670

344. There has been some research undertaken that support this view. Space Connections, PPARC, EADS Astrium and the BNSC recently commissioned a study, The Education and Skills Case for Space, to gather evidence about the impact on students of studying space.671 It found that space science and astronomy have a direct, positive effect on educational and career decisions and on participation and achievement in physical science at GCSE, A Level and in Higher Education. Professor Wells from the University of Leicester told us that the National Space Centre had tracked the children that passed through its Endeavour Learning Centre in 2004-05 and measured the change in their attainment from Key Stage 2 to Key Stage 3. 91% had shown an increase in attainment of at least one level.672

345. If space were able to encourage students to study science, particularly physics, this would be important. As mentioned in paragraph 178, there are concerns regarding a reduction in the number of students studying physics at A level, the number of undergraduates studying space-related courses and the number of students pursuing careers in the space sector. The Government has focused upon the importance of science education in documents such as the Science and Innovation Investment Framework 2004-2014 and the Science and Innovation Investment Framework 2004-2014: Next Steps.673 It has

666 Ev 170
667 Ev 238
668 Ev 314
669 Ev 318
670 Ev 222
672 Q 231
set a target for increasing the take up of physics in particular: by 2014 it wants 35,000 entries to A Level Physics, up from 23,657 in 2006 and 24,094 in 2005.674

346. There are two main questions in this area. First, whether space has a unique ability to attract students to science subjects and second, whether space topics attract girls and boys equally. Two recent studies have considered the various drivers that encourage or discourage young people from science: the *Science in my Future* report by the Nestle Social Research Foundation, and the international Relevance of Science Education (ROSE) project.675 These studies have drawn contrasting conclusions. The *Science in my Future* report found that girls were not as excited by space exploration as boys, 27% of all those questioned would prefer that less was spent on space exploration, and more of the sample said that television programmes on space were boring rather than exciting.676 The report concluded that “the science curriculum must not be unduly laden with the ‘space + hardware’ appeal that draws boys.”677 The ROSE review also found that girls and boys tended to be interested in different aspects of science; girls were interested in topics related to self and boys in destructive technologies and events. The research found, however, that “boys and girls shared a common curiosity and excitement about the study of space (stars, planets, black holes, space travel, etc.), although boys showed a slightly higher level of interest in this than girls.”678

347. Ms Bramman from the DfES said that the findings of the ROSE review had convinced the DfES that space “is a motivating area of the curriculum.”679 The ROSE review, however, also found space is not the only subject that is able to motivate children in relation to science. The ROSE summary report stated that “When asked to choose a field of research they would pursue as a scientist, most students chose the treatment and cure of disease or aspects of space science.”680 Whilst an interest in space might encourage young people to engage with science, other drivers come into play when students choose their A levels. Evidence supplied by the DfES showed that factors such as attainment at GCSE are crucial when students are choosing topics to study at a higher level.681

348. Several witnesses agreed that it is necessary for there to be more research in this area. Ms Bramman from the DfES said that “there obviously is a call for more evidence than we currently have about space or any other element of the curriculum.”682 She further acknowledged that responsibility for undertaking such research could well lie with the DfES and said that if prioritised, it would be put out to tender as part of the department’s research programme.683 Space Connections conceded that “There is substantial anecdotal

---

674 Ev 324
676 Helen Haste, *Science in my Future, July 2004*, p 6, p 12, p 26
677 As above, p 3
678 Ev 325
679 Q 234
681 Q 264
682 Q 235
683 Qq 238–239
and limited quantitative evidence” available on the motivational impact of space. The British Rocket Oral History Programme told us that “there is a need for a rigorous statistical analysis to measure the impact of initiatives such as Spaceport, ISSET, NSSC, and the Scottish Space School on children’s aspirations, attitudes and in particular of the uptake of University places in STEM subjects.” Given the shift of responsibility for the curriculum to the newly-created Department for Children, Schools and Families, we believe that the previous responsibility of the DfES for undertaking research now lies with this new Department.

349. The evidence that we have seen regarding the unique ability of space to increase interest in science is inconclusive. The Department for Children, Schools and Families should work with BNSC and interested organisations to assess what research is required to assess first the impact of space upon interest in science and secondly how an interest in space might be harnessed in order to encourage students to pursue scientific study to GCSE, A level and degree level.

**Space in education**

**Current activities**

350. The promotion of space within education is undertaken by a number of bodies and organisations such as PPARC (now STFC), the National Space Centre in Leicester, the DfES and DTI. These organisations support a variety of activities ranging from workshops to virtual space missions to the provision of learning materials.

351. PPARC told us that it played two distinct roles in education: delivering excellent training in exciting scientific research through its postgraduate studentship schemes, and communicating the excitement and benefits of PPARC science to the general public especially the younger generation. PPARC’s educational work took place through its Science and Society programme, which ran several schemes for schools including a Moonrock loan scheme. PPARC aimed to include a science and society element in every major project that it funds, and we expect this focus on science and society to continue in the STFC. The scientists involved in the planned ExoMars mission, for example, will be encouraged to visit schools and the teachers will be given educational material related to the mission.

352. During this inquiry, we visited the National Space Centre (NSC) in Leicester. The NSC is the UK centre for space exploration, combining education, information and research on one site. The DfES and the DTI provided £345,000 to support the centre over a three year period from 2003 to 2006. The NSC has a number of on-site programmes such as the Challenger Learning Centre, the space theatre show, and exhibition trails. The NSC also runs outreach programmes such as Stardome (an inflatable planetarium), an e-mission, and loan activity boxes. The NSC has primarily concentrated on working with 8 to 14 years old but in 2006, in collaboration with PPARC and the East Midlands
Development Agency, NSC began to develop a new space-themed education programme for KS 4 (age 14-16) and a more advanced programme called “Careers Pathways and Workforce Development”. The NSC, PPARC and Science Learning Centre East Midlands have also designed a full-funded course for teachers to spend a day at the European Space Research and Technology centre in Noordwijk, Holland.

353. There are several other activities that have been supported by collaborations between BNSC partners. In 2004, the DfES and BNSC collaborated on the production of materials for schools relating to the Cassini-Huygens mission. More recently, the DfES and the DTI supported the Science and Engineering Ambassadors Programme that sends 12,000 role models to schools across the UK. Several hundred Ambassadors come from space, aerospace and military sector from academia and companies such as EADS Astrium.

Co-ordination

354. We have heard that, due to the number of organisations involved in space education and the variety of activities that they undertake, co-ordination in this area is weak. The Royal Astronomical Society stated that “the UK’s programme of space education is uncoordinated”. Professor Alan Wells claimed that “Coordination is hampered by the fact that the various activities are funded from many different sources, with each funding agency having differing priorities.” The lack of co-ordination is acknowledged by the BNSC. Ms Julie Bramman from the DfES also told us that “there is room for better co-ordination.” Dr Robin Clegg from PPARC said that there were a wealth of local and regional initiatives for schools and there was “a need to co-ordinate this better.”

355. As mentioned earlier, there was a lack of interaction between DfES and the BNSC partnership (paragraph 76). The DfES appeared unwilling to take responsibility for leading or co-ordinating action in the field of space education. Ms Julie Bramman from DfES told us that “the department always looks to work in partnership with others and not take everything on itself.” The lack of involvement from DfES in the field of space education, despite its role as a partner in BNSC, was disappointing. We hope that the Department for Children, Schools and Families will become involved in this field and will work closely with BNSC and the DIUS.

356. The void left by DfES had, luckily for the BNSC, been filled by the RDA for Yorkshire and the Humber, Yorkshire Forward. The structure of the RDAs means that each one has responsibility for a different field, and Yorkshire Forward is responsible for promoting science in schools. Yorkshire Forward has set up an organisation, Space Connections,

---

687 “Bringing space into the classroom: Department for Education and Skills joins the BNSC partnership”, BNSC Press Release, 16 December 2004

688 Ev 208

689 Ev 318

690 BNSC, A Consultation on the UK Civil Space Strategy 2007-2010, January 2007, p 20

691 Q 269

692 Q 257

693 Q 262

694 Q 697
“to bring coherence across the educational uses of space activity and to maximise the impact that space can have on the Science, Technology, Engineering and Maths (STEM) curriculum and on the wider curriculum.”695 Paul Spencer, an Evaluator and Consultant for Space Connections, told us that “BNSC and Yorkshire Forward are exchanging letters of agreement by which Space Connections will initiate the development of more effective coordination of space education activities in the United Kingdom.”696

**National Space Education Initiative**

357. The BNSC has taken action signalling its intention to improve the state of space education in the UK. In 2005, the BNSC developed a National Space Education Initiative (NSEI). The aims of the NSEI were: to inspire young people to study and achieve in STEM subject; to give teachers the skills, knowledge and resources to deliver exciting lessons and raise standards, especially in Key Stages 3 and 4; and to develop clear mechanisms for schools to benefit from local, national and European initiatives and resources. Professor Martin Barstow from Leicester University was appointed as a Project Manager/Consultant and a Steering Group was established with representatives from PPARC, DfES, CCLRC, BNSC and the Institute of Physics. Professor Barstow explained to us that “The National Space Education Initiative was a broad idea developed by the BNSC partners to try to raise the profile of Space as an important tool for stimulating schools student engagement with science.”697

358. Between April and September 2005, Professor Barstow undertook a consultation on space education and in October 2005 he produced a report with a number of recommendations. The report, *Bringing Space into School Science*, suggested a series of measures such as creating a single advisory body to co-ordinate space, launching a “one-stop-shop” website for space education resources and establishing a UK space education office as a central point of contact.698 Professor Barstow notes that following the report there was a lack of follow-up by DfES, which had provided £8,500 to PPARC to support the initiative. Professor Barstow wrote that “the re-arrangement of the department [DfES] created a significant discontinuity in the involvement of DfES in the project. Furthermore, expected financial support from DfES for carrying out the report’s recommendations evaporated.”699

359. The production of the Barstow report overlapped with a separate initiative by Yorkshire Forward to attract ESA to establish a European Space Education Office (ESERO) contact point in the UK, which we will consider in more detail below. The lack of coordination between these national and local initiatives is symptomatic of the space education sector. Dr Robin Clegg explained to us that the National Space Education Initiative was “overtaken by the arrival of the idea of the Space Education Office […] We believe that nearly all of the recommendations that Barstow made will be delivered by the

---

695 Ev 169
696 As above.
697 Ev 352
699 Ev 352
Space Education Office.” Professor Barstow acknowledges that “It is possible that some of the recommendations of my report may be delivered by a new initiative to establish a European Space Resource Office (ESERO) in the UK” but he notes that “so far substantive progress seems to be slow.” We are disappointed that, despite their initial investment, DfES did not actively follow up the Brining Space into School Science report. The fact that many of the recommendations made by this report could be met by Yorkshire Forward’s plans for a European Space Education Office in the UK seems to have resulted more from luck than judgement.

**ESA’s ESERO project**

360. ESA has been seeking to raise awareness of space within Member States through the establishment of European Space Education Resource Office (ESERO) contact points around Europe. These contact points, preferably located at an existing facility, would enable the ESA Education Department to support the specific educational needs of individual Member States and access existing national networks. ESA states that the ESERO project “is aiming at the development of close relations with national education stakeholders and the participation in education activities tailored to the specific situation in each Member State.”

361. Due to the diversity of education systems in Europe, ESA decided to take a Member State by Member State approach. Its intention was to support three trials in the Netherlands, Belgium and Spain. The contact point in the Netherlands is the National Centre for Science and Technology in Amsterdam, the contact point in Spain is La CosmoCaixa in Barcelona and the contact point in Belgium is the Planetarium in Brussels. Yorkshire Forward would like ESA to establish a similar contact point in the UK and negotiations have been underway since June 2005 as outlined in Box 11. It is unclear to us where the contact point would be located.

362. Two bodies have been created to oversee the further development of plans for the ESERO: a contract management group and an interim advisory group. The contract management group includes representatives from ESA, BNSC and Yorkshire Forward and has been established in order to ensure proper implementation, governance and quality of process. The interim advisory group has been created to advise on consultation among stakeholders about the infrastructure, to recommend in the light of the consultation of priorities for development of the UK space education/ESERO infrastructure and to inform BNSC, ESA and Yorkshire Forward on the strategy for space education. The BNSC has said that “BNSC partners working together (including DfES) will ensure that this initiative

700 Q 298
701 Ev 352
702 Ev 343
703 The interim advisory group includes representatives from the Armagh Planetarium, the Association for Science Education, BNSC, Careers Scotland, DfES, EADs Astrium, Ecsite-UK, ESA, the International Space School Educational Trust (ISSET), the National Academy for Gifted and Talented Youth, the National Science Learning Centre, STFC, SETNET, the Space Education Council, and Yorkshire Forward Space Connections.
is properly linked to the wider national science, technology, engineering and mathematics (STEM) initiatives by DiES and DTI.”

Box 11: Timeline of activities relating to a UK ESERO contact point

<table>
<thead>
<tr>
<th>Date</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 2005</td>
<td>First meeting between ESA and Yorkshire Forward</td>
</tr>
<tr>
<td>Summer 2005</td>
<td>ESA formally notified BNSC of negotiations</td>
</tr>
<tr>
<td>September 2005</td>
<td>Yorkshire Forward submit unsolicited proposal to ESA to manage and finance the ESERO pilot phase</td>
</tr>
<tr>
<td>October 2005</td>
<td>Publication of Barstow report, “Bringing space into school science”</td>
</tr>
<tr>
<td>November 2005</td>
<td>ESA and Yorkshire Forward meeting in Bradford</td>
</tr>
<tr>
<td></td>
<td>ESA and BNSC meeting in London</td>
</tr>
<tr>
<td>February 2006</td>
<td>BNSC Partnership and Yorkshire Forward met to discuss Barstow report and ESERO Project</td>
</tr>
<tr>
<td>March 2006</td>
<td>ESA, in agreement with BNSC, invite Yorkshire Forward to submit a proposal for the management of the ESERO pilot phase in the UK.</td>
</tr>
<tr>
<td>April 2006</td>
<td>Yorkshire Forward submit proposal for the management of the ESERO pilot</td>
</tr>
<tr>
<td>June 2006</td>
<td>ESA invited Yorkshire Forward to undertake a six month research and</td>
</tr>
<tr>
<td></td>
<td>consultative/study phase to provide a comprehensive financial forecast</td>
</tr>
<tr>
<td>November 2006</td>
<td>Wide stakeholder consultation</td>
</tr>
<tr>
<td>March 2007</td>
<td>Outcome of consultative/study phase</td>
</tr>
</tbody>
</table>

Source: ESA, Ev 339-340

363. We welcome the plans for the establishment of an European Space Education Resource Office contact point in the UK and we congratulate Yorkshire Forward on its ambition in taking this project forward. The plans for this project should be outlined in the space strategy. It is crucial that the UK and ESA agree on the aims, remit and activities that are encompassed by the project. We are concerned that the UK has higher expectations of this project than ESA since BNSC is presenting it as an all-encompassing solution to its problems in space education. As a result, the initiative may not deliver all that is required. We seek reassurance that this will be the start of a truly national education project and urge the BNSC to clarify in the space strategy which body will be responsible for education in this area.

Space education materials

364. One of the key outcomes of the creation of the ESERO contact point could be the consolidation of space education materials and information. Resources are currently provided separately by the STFC, the National Space Centre, ESA and the BNSC. It is important that these resources are linked to the curriculum and are easy for teachers to use. The report, Bringing Space into School Science, stated that the take-up of resources was patchy and it recommended the creation of a website where all the material could be found.
in one place. Dr Robin Clegg said that “I hope that the coming Space Education Office will be able to have a good one-stop shop website to give teachers the clearest information on what is available.” Several witnesses mentioned NASA’s education programme and its provision of material for teachers. Professor Wells from Leicester University noted, however, that NASA’s education programme is an “open-ended activity of pushing out material into schools […] the feedback from that is very minimal”. The ESERO contact point project should be used as a driver to create a one-stop website for space material. BNSC should work closely with STFC, the Department for Children, Schools and Families, and ESA to ensure that material fits into the curriculum. It is crucial that feedback is sought from teachers on the usefulness of such a website and the appropriateness of the material provided.

Outreach

365. Beyond space education in schools, the BNSC and STFC have a role in broader outreach activities. The BNSC notes that “It is a vital part of the BNSC’s role to raise the profile and to promote the achievements of UK space science and industry.” BNSC has worked to promote missions, to produce press materials, to exhibit at exhibitions and events, to provide resources, to produce the magazine Space:UK and its website. The Royal Astronomical Society notes that “In recent times BNSC has taken a much more active role in publicising UK space activities which has been welcomed. More would be good for the country.” The STFC runs a science and society programme which varies from lectures to open afternoons to workshops.

366. It is difficult to know to what extent the public is aware of the role that space plays in their everyday lives in communication, broadcasting, navigation, security and defence. The Institution of Mechanical Engineers told us that “There is still a perception that the UK isn’t involved in space to the degree that it actually is.” In August 2006, Demos’s report Black Sky Thinking concluded that “space in the UK, which should be seen as one of the most creative industries in the UK, is largely invisible”. We acknowledge the work that the BNSC especially the STFC has undertaken in outreach. We suspect that unfortunately the public is still unaware of the variety, breadth and importance that space activities play in their everyday lives. We encourage the BNSC in partnership with academics and industrialists to seek ways to increase understanding and knowledge in this area.

705 Martin Barstow, Bringing Space into School Science, October 2005, p 20
706 Q 218
707 Q 280
708 BNSC, Space Activities, p 47
709 Ev 208
710 Ev 215
711 Demos, Black Sky Thinking, August 2006, p 13
12 Conclusion

367. We have been impressed and often surprised during the course of this inquiry by the range of activities undertaken in the space sector in the UK. Although we have highlighted that there are weaknesses in the organisational structures, funding and co-ordination of space activities, we also acknowledge that the sector is characterised by an enthusiasm for discovery, research and experimentation. It is important for the Government to increase its funding for particular programmes in space now because of the long-lead times in space programmes. The space sector should not have to survive solely on the fruits of past investments in space. There are opportunities for the UK to lead developments in emerging areas such as exploration, satellite navigation and Earth observation. A strong political lead is essential for the UK research and industrial sectors. It is crucial that the Government uses its forthcoming strategy to declare its ambitions and to inspire people to develop new ideas. Space should be an arena in which today’s fantastic ideas are assessed seriously because they could be tomorrow’s reality.
Conclusions and recommendations

Does space matter?

1. We believe that space is a highly significant area of science policy. As other countries continue to exploit and explore space, it is crucial that the UK is also involved in this sector and it is necessary for the Government to take a more strategic approach to space. (Paragraph 14)

Current UK space policy

2. Despite recommendations by the National Audit Office, the BNSC has still not developed a robust performance management system. We are disappointed that the BNSC failed to take advantage of the opportunity to establish a performance management system offered by the implementation of the UK Space Strategy 2003-2006 and beyond. The new strategy should outline how the partnership will track its performance and BNSC Headquarters should ensure that performance monitoring is undertaken. (Paragraph 25)

Space Strategy 2007-2010

3. The new strategy is an opportunity for BNSC to outline clearly its vision and ambition for space. The strategy should inspire and motivate the UK space sector and emphasise the UK Government’s commitment to space. (Paragraph 34)

4. We are concerned that there is a lack of co-ordinated horizon scanning within the BNSC partnership. We recommend that BNSC Headquarters assume responsibility for horizon scanning and informing partners of emerging issues. The BNSC should liaise with the Foresight programme within the Department for Innovation, Universities and Skills on approaches to horizon scanning. (Paragraph 34)

5. We recommend that alongside the Strategy 2007-2010 the BNSC develop a long-term roadmap from 2010-2050. This roadmap should complement the short-term strategy by providing a flexible indication of where the space community is heading. The roadmap should be seen as an active document to be displayed on the BNSC website and updated at regular intervals incorporating policy changes or the results of horizon scanning activities. (Paragraph 34)

The partnership model

6. We support the UK’s user-driven approach to space but are concerned that user Departments might start leading programmes without sufficient expertise or skills. We recommend that in the early stages of programmes BNSC headquarters provide the skills and expertise to enable user departments to engage with space solutions and that BNSC headquarters be responsible for building up understanding of space within Departments. BNSC headquarters should be perceived as leading projects in conjunction with primary and secondary user partners. The BNSC should explain in
its forthcoming strategy how funding models in the future will work for projects involving many partners. (Paragraph 46)

7. If current levels of expenditure in space persist, the Government should not establish a space agency but should continue to pursue the partnership approach to space. If expenditure is substantially increased, the question of an agency should be reviewed. However, we believe that there are problems with the current partnership arrangement and that it should be strengthened appropriately. (Paragraph 53)

Strengthening the partnership

8. We recommend that the BNSC partners work towards strengthening the status and profile of BNSC Headquarters. As part of this, the BNSC should review the effectiveness of its brand internationally and nationally, including the possible impact of a change of name. Projects should be associated firstly with BNSC and secondly with the partner involved. The relationship between the BNSC partners and BNSC Headquarters should be clearly outlined in the forthcoming strategy. The recent machinery of Government changes provide BNSC with an ideal opportunity to establish a clear separation from DIUS. The BNSC should emphasise its independence from DIUS by splitting the costs of its administration between its partners or covering its own costs in order to become a clearly defined entity. (Paragraph 60)

9. We welcome the Government Information from the Space Sector (GIFTSS) initiative. We believe that there is further scope for BNSC Headquarters to provide leadership in the space sector and to promote the use of space within Government through initiatives such as GIFTSS. We believe that BNSC Headquarters would be well-placed to provide leadership for the space community, if empowered to do so. (Paragraph 62)

10. We recommend that the BNSC use the new strategy to set firm, specific goals agreed with the BNSC partners, as well as providing a general overview of aspirations in different areas. BNSC partners should prepare and publish an implementation plan for their part in delivering the strategy. (Paragraph 64)

11. We recommend that BNSC Headquarters produce an annual report and accounts, with a breakdown of funding by partners into national programme, subscription to individual ESA programmes and administration costs. BNSC Headquarters could then use this report to highlight positive or negative trends. The report should also report on performance linked to the space strategy. Such a report would give a clear focus to UK space activities and act as a branding exercise for BNSC. The report would also be a source of information for the space community and enhance scrutiny of UK space policy across the board. (Paragraph 66)

12. We are concerned that there is insufficient co-ordination across the BNSC partnership. We recommend that the BNSC include in the response to this Report the steps that they will take to address this shortcoming. (Paragraph 69)

13. We are concerned that BNSC Headquarters currently works under several constraints including limited resources and dependency upon its partners for funds.
We recommend that BNSC Headquarters be provided with a small budget of its own, following the necessary changes to its legal status. BNSC Headquarters should use this budget to cover its own overheads and to run the National Space Technology Programme. We recommend that BNSC Headquarters review its staffing and skills needs and that additional resources are provided where necessary. (Paragraph 74)

14. We were very concerned about the attitude of DfES towards the partnership and hope that the new Department for Children, Schools and Families engages positively with the BNSC partnership. We strongly recommend that the Department for Children, Schools and Families joins the BNSC partnership. (Paragraph 77)

15. We can see significant value in greater contact between BNSC and MoD at ministerial and official level. We recommend that the BNSC and MoD evaluate how dual use technologies might be of benefit across the BNSC partnership and include dual use technologies in the forthcoming BNSC strategy. (Paragraph 80)

16. We are disappointed by DFID’s lack of response to this inquiry. The use of space has clear relevance for DFID in the field of disaster monitoring and other environmental applications. We recommend that the BNSC strengthen links with DFID in relation to the use of space for environmental and disaster monitoring. (Paragraph 84)

17. We recommend that the BNSC continue to develop a close relationship with the National Offender Management Service, the Ministry of Justice and the Home Office Scientific Development Branch. These organisations should continue to monitor possible applications of satellite technology in offender management and security. (Paragraph 86)

18. More research is needed to understand how space applications might provide solutions for social problems. We recommend that BNSC work with ESRC and NHS Research to develop research funding calls, possibly in conjunction with STFC and with reference to the Foresight programme within DIUS, focused on the social and potential health applications of satellite technologies. (Paragraph 88)

19. We believe that it would unusual and inappropriate for industry to be a partner in the BNSC partnership. (Paragraph 89)

20. We recommend the creation of a Space Forum whose membership would include representatives appointed by the Secretary of State from industry, education, and academia. We suggest that this should be a dynamic small body with a maximum membership of fifteen, staffed by a small independent secretariat. The Forum should meet several times a year to scrutinise space policy and should report annually to the Secretary of State on the work of BNSC. (Paragraph 90)

European Space Agency

21. The UK’s involvement in ESA is worthwhile. It enables UK scientists and engineers to take part in programmes that would otherwise be beyond their reach. Given the UK’s level of investment in ESA, we urge the Minister with responsibility for space to sustain ongoing contact with the Director General of ESA. (Paragraph 95)
22. Although there are individual optional programmes where investment could be increased, we support the UK’s selective approach to ESA and we believe that the UK has maintained on average a reasonable level of investment in ESA programmes. (Paragraph 106)

23. We acknowledge that all involved have taken action in order to remedy the under return to the UK. We recommend that the BNSC develop a strategy with ESA over the next year in order to ensure that this situation does not recur. (Paragraph 112)

24. We recognise the work that BNSC has undertaken helping ESA with the reform of its processes and encourage the BNSC to continue working in this area. (Paragraph 114)

25. We believe that the establishment of an ESA centre in the UK would be beneficial and recommend that the BNSC pursue this aim as a priority. (Paragraph 117)

European Union and European Commission

26. We welcome the European Space Policy and the inclusion of space in Framework Programme 7. We recommend that BNSC Headquarters in partnership with DIUS or the STFC hold a series of workshops in order to inform the space community about recent developments. The BNSC should advertise opportunities for scientists and companies arising from FP7 and should provide advice on applications where necessary. (Paragraph 122)

Bilaterals

27. We acknowledge the BNSC’s work in encouraging collaboration with other countries such as China and welcome the recent joint statement of intent with NASA. However, the development of new opportunities must not be undertaken if there will be a reduction in scientific quality. We recommend that the BNSC outline its current activities and future intentions in international collaboration in the forthcoming strategy. (Paragraph 129)

The UK space industry

28. We are impressed by the range of activities undertaken by the UK space industry and by its ambition to remain world-leading. We welcome the work that BNSC has undertaken in this area in order to track the health of the industry and recommend that such studies continue. (Paragraph 139)

Government support for the space industry

29. The ARTES programme is important to the UK space industry because it provides vital seedcorn funding for high-risk, early stage R&D. Investment in this programme should produce high returns. We recommend that the Government review its subscription to the ARTES programme before the end of the year. (Paragraph 148)
30. We congratulate the BNSC on its innovative approach to finding funding for the Alphasat programme. We recommend that the BNSC involve RDAs in funding ESA missions in future when there is likely to be specific regional benefit. (Paragraph 151)

31. We are concerned by the impact upon the space industry of the shift of funds from the DTI national programme to the Technology Strategy Board. We welcome the attempts by the BNSC to address this problem through the National Space Technology Programme and hope that industry and academia make the most of this programme. (Paragraph 156)

32. We recommend that the DIUS and MoD initiate another programme as a successor to the MOSAIC programme within the next year. (Paragraph 159)

33. The investment of private finance in the space industry is crucial and Government co-investment at a seedcorn level would help to attract private finance and venture capital. We acknowledge that the BNSC is already working with industry in this area. We recommend that the BNSC seek ways in which to stimulate the increase of private finance and venture capital in the field of space in its forthcoming strategy. The BNSC should elect a co-ordinator who can work with the venture capital industry in order to help companies to explain their technologies. (Paragraph 164)

34. We note the importance of SMEs in the space industry and believe that it is crucial that they receive appropriate support. We are concerned that in the past SMEs in the space industry have lacked non-financial as well as financial support from the DTI. We recommend that SMEs be represented on the Space Forum and that the Government establish mechanisms to increase support for SMEs. (Paragraph 168)

35. We are concerned that the current licensing regime impedes enterprise. We welcome the review of licensing and look forward to the public consultation on BNSC’s proposals. We recommend that the BNSC pay particular attention to the needs of SMEs in this area. (Paragraph 171)

36. We welcome the BNSC’s funding for space surveillance. We recommend that future plans for this area, particularly in relation to a possible European project for space surveillance, be outlined in the new space strategy. (Paragraph 174)

Health of space science and technology in the UK

37. In the light of the contrasting views on the health of space science and technology in the UK, we recommend that the BNSC undertake research in this area and commission a study on the size and health of the space science and technology field. (Paragraph 179)

38. We are concerned that there is a skills shortage in the space industry. Potential space scientists and engineers may be moving into other sectors due to the low profile of the industry. Although the UK is currently able to attract and retain international scientists and engineers to fill the gap left by a lack of “home-grown” talent, we are concerned that this situation is not sustainable, particularly if the number of overseas students entering UK universities declines. We believe that a broad programme of incentives may be necessary to ensure a continued flow of people into the space
sector from UK universities and from abroad. We recommend that the BNSC work with DIUS, HEFCE, individual universities and industry in order to develop a 'people' strategy to address the skills shortage. (Paragraph 183)

Creation of the Science and Technology Facilities Council

39. We welcome the creation of the STFC and were pleased to hear assurances from the Chief Executive that the STFC will not favour funding for large facilities over basic science. We recommend that the STFC work with NERC and EPSRC to ensure that there are no gaps in funding for research in space science. (Paragraph 190)

Current levels of investment

40. We are concerned that investment in space science instrumentation has reduced over the last decade. We recommend that the STFC increase funding for space science instrumentation. (Paragraph 194)

Technology development

41. We welcome PPARC’s approach to the Aurora programme and recommend that the BNSC develop mechanisms to increase the co-ordination between industry and academia at early stages in technology development, if necessary on a mission by mission basis. (Paragraph 198)

42. We welcome the proposal for the National Space Technology Programme and urge the Government to provide appropriate funding for this initiative. Information about the detailed mechanisms of the programme and clarification regarding its performance management and anticipated interaction with other bodies should be published in the forthcoming strategy. We recommend that the BNSC lead and manage the operational aspects of this programme. Arrangements should be altered so that the Director General of BNSC can be the Accounting Officer without the need for delegation of responsibility from the STFC. (Paragraph 209)

Technology spin-off

43. We recognise that there are mechanisms for knowledge transfer within the space sector. Given that the space sector is characterised by its remit across numerous Government departments as well as the STFC, NERC, and EPSRC, we recommend that the BNSC establish a broad space knowledge transfer network for academics and industrialists from the upstream and downstream space industry and related sectors to complement existing activities. We recommend that BNSC and ESA continue to emphasise the importance of knowledge transfer between the space field and other sectors. (Paragraph 221)

Introduction to Earth observation programmes

44. We are impressed by the UK’s commitment to Earth observation internationally and nationally. We welcome the establishment of the NERC National Centre for Earth Observation and the Centre for Earth Observation Instrumentation. It is essential
that these bodies develop relationships with other organisations such as the STFC, Defra and the Met Office. Earth observation is especially important to the study of climate change. It is crucial that the UK work internationally to ensure provision, availability and maintenance of long-term, sustained data sets in this area. (Paragraph 227)

45. The BNSC has undertaken several initiatives in order to increase awareness across Government of Earth observation. However, we believe that understanding of the variety and potential uses of Earth observation data could be increased. We recommend that the BNSC develop a strategy to improve understanding of Earth observation across Government. The new Centre for Earth Observation and Centre for Earth Observation Instrumentation should be hubs for knowledge transfer from academia to user Government departments and agencies. (Paragraph 234)

46. The BNSC lacks a clear and co-ordinated Earth observation programme. We recommend that the BNSC review the co-ordination of its work in this sector, including the role of the Earth Observation Programme Board, and apply the lessons learned. We recommend that BNSC Headquarters lead on the creation of a GEO strategy, working closely with Defra and other interested parties. (Paragraph 238)

GMES

47. We understand the reasons for Defra’s cautious approach to funding GMES and recommend that it continue to work with the BNSC and the ESA regarding its concerns about the programme. If these concerns are addressed, given that extra funding to GMES would benefit UK industry through the ESA’s policy of juste retour, we recommend that the Government consult industry regarding the level of subscription it deems necessary to stimulate activity and then consider providing additional funding to GMES. (Paragraph 251)

48. Defra’s lead on GMES is proving problematic. We recommend that the BNSC Headquarters provide the lead and work closely with Defra as primary user. GMES is a programme where a strengthened BNSC Headquarters could provide leadership, drive and ambition. (Paragraph 256)

49. The Government needs to work out how it will support applications arising from GMES. We recommend that the BNSC commission a study similar to the ABOOTTS report looking at the opportunities and challenges created for the UK Earth observation sector by the GMES programme. The UK’s approach to the GMES programme including applications should be outlined in the space strategy. (Paragraph 259)

Satellite navigation

50. We welcome the work that DTI and DfT have undertaken to identify new applications and services that will be enabled by Galileo. We recommend that the Government report on progress in this area in the annual BNSC report. (Paragraph 261)
51. We seek assurance from the Government that it will continue working at a European level to ensure that Galileo remains a civil system under civil control. The Government must clarify the ways in which military forces would be allowed to use Galileo and whether Galileo could be used for military applications. (Paragraph 262)

52. We recognise the role taken by DfT to co-ordinate work on the Galileo programme. We recommend that DfT be known as primary user for this programme, DIUS as primary funder and BNSC Headquarters be identified as the lead with the appropriate transfer of staff accordingly. (Paragraph 263)

53. We are concerned that the failure of the concessionaire and subsequent alternative funding proposals for the Galileo programme are likely to result in rising costs to the UK. We recommend that, before the next Transport Council meeting, the Government publish a new analysis of the costs and benefits of the Galileo programme to the UK. We recommend that the Government report to Parliament on a regular basis on its intentions in relation to Galileo. (Paragraph 269)

Telecommunications

54. The telecommunications sector is still growing. It is important that the Government continues to fund initiatives in this area such as ARTES and Alphasat, which provide vital seedcorn funding for high-risk, early stage R&D. (Paragraph 273)

55. We recommend that the Government work at a European level to ensure that there is a consistent standard of regulation across Europe. When reviewing its practices, Ofcom should take the views of satellite operators regarding the international impact of its activities into account. (Paragraph 277)

Exploration

56. We welcome the UK’s involvement in the Aurora programme and recommend that the STFC ensure that the UK maintains its strong role in this programme. (Paragraph 282)

57. We welcome the recent Joint Statement of Intent signed by BNSC and NASA and hope that this signals the beginning of fruitful collaboration on the MoonLITE and MoonRaker missions. We congratulate the STFC on its timely funding of preparatory work in this area. (Paragraph 286)

58. We welcome the BNSC’s active involvement in the Global Space Exploration Strategy. We recommend that the findings of the BNSC Space Exploration Working Group be published and subsequently incorporated appropriately into the forthcoming space strategy. The Space Strategy 2007-2010 should outline how the UK intends to respond to the different international exploration projects. (Paragraph 291)

Manned spaceflight

59. It appears that the Government currently objects to manned spaceflight on principle and we believe that this stance is unjustifiable. Manned spaceflight proposals, like
other proposals in other areas of space, should be judged according to a cost-benefit analysis. We recommend that whilst the BNSC emphasise the UK’s interest in robotic missions at this stage, it also keep the option of scientific manned spaceflight missions open for the future. The Government’s stance should be flexible enough to ensure that the best science can be funded, whether that be undertaken by manned or robotic exploration. (Paragraph 306)

**Space medicine**

60. We have not seen enough evidence to be convinced that a special stream of funding should be given to space medicine. Funding should continue to be available from MRC through peer-reviewed response-mode funding. The MRC should monitor developments in the field and liaise appropriately with BNSC. Given the current climate in global exploration, the BNSC should explore routes for non-financial co-operation with organisations such as NASA and ESA in this area. (Paragraph 319)

**Space tourism**

61. We are excited by the potential afforded by sub-orbital travel and the rise of the space tourism industry. We do not believe that it is the responsibility of Government to fund this work but developments in this area should be encouraged through appropriate regulation. The BNSC should use its consultation on regulation to discuss the establishment of a regulatory framework and responsible body with the relevant authorities. We recommend that the Government continues its policy of non-financial support to the space tourism industry and that it outline the developing nature of that support in the forthcoming space strategy. (Paragraph 334)

**Launchers**

62. We share the BNSC’s belief that in the development of launchers the “market” will provide. But there should be no “in principle” block on funding the development of launchers in the future. We recommend that the MoD and DIUS discuss whether a seed-corn funding exercise or prize might be developed in the future to provide an incentive for the development of a low cost small satellite launcher. (Paragraph 342)

**Impact of space**

63. The evidence that we have seen regarding the unique ability of space to increase interest in science is inconclusive. The Department for Children, Schools and Families should work with BNSC and interested organisations to assess what research is required to assess first the impact of space upon interest in science and secondly how an interest in space might be harnessed in order to encourage students to pursue scientific study to GCSE, A level and degree level. (Paragraph 349)

**Space in education**

64. The lack of involvement from DfES in the field of space education, despite its role as a partner in BNSC, was disappointing. We hope that the Department for Children,
Schools and Families will become involved in this field and will work closely with BNSC and the DIUS. (Paragraph 355)

65. We are disappointed that, despite their initial investment, DfES did not actively follow up the Bringing Space into School Science report. The fact that many of the recommendations made by this report could be met by Yorkshire Forward’s plans for a European Space Education Office in the UK seems to have resulted more from luck than judgement. (Paragraph 359)

66. We welcome the plans for the establishment of an European Space Education Resource Office contact point in the UK and we congratulate Yorkshire Forward on its ambition in taking this project forward. The plans for this project should be outlined in the space strategy. It is crucial that the UK and ESA agree on the aims, remit and activities that are encompassed by the project. We are concerned that the UK has higher expectations of this project than ESA since BNSC is presenting it as an all-encompassing solution to its problems in space education. As a result, the initiative may not deliver all that is required. We seek reassurance that this will be the start of a truly national education project and urge the BNSC to clarify in the space strategy which body will be responsible for education in this area. (Paragraph 363)

67. The ESERO contact point project should be used as a driver to create a one-stop website for space material. BNSC should work closely with STFC, the Department for Children, Schools and Families, and ESA to ensure that material fits into the curriculum. It is crucial that feedback is sought from teachers on the usefulness of such a website and the appropriateness of the material provided. (Paragraph 364)

Outreach

68. We acknowledge the work that the BNSC especially the STFC has undertaken in outreach. We suspect that unfortunately the public is still unaware of the variety, breadth and importance that space activities play in their everyday lives. We encourage the BNSC in partnership with academics and industrialists to seek ways to increase understanding and knowledge in this area. (Paragraph 366)
### Abbreviations used in this report

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ARTES</td>
<td>Advanced Research into Telecommunications</td>
</tr>
<tr>
<td>BARSC</td>
<td>British Association of Remote Sensing Companies</td>
</tr>
<tr>
<td>BNSC</td>
<td>British National Space Centre</td>
</tr>
<tr>
<td>CASE</td>
<td>Collaborative Awards in Science and Engineering</td>
</tr>
<tr>
<td>CCLRC</td>
<td>Central Laboratory of the Research Councils</td>
</tr>
<tr>
<td>CEOS</td>
<td>Committee on Earth Observation Satellites</td>
</tr>
<tr>
<td>COSPAR</td>
<td>Committee on Space Research</td>
</tr>
<tr>
<td>CSR</td>
<td>Comprehensive Spending Review</td>
</tr>
<tr>
<td>Defra</td>
<td>Department for Environment, Food and Rural Affairs</td>
</tr>
<tr>
<td>DfES</td>
<td>Department for Education and Skills</td>
</tr>
<tr>
<td>DFID</td>
<td>Department for International Development</td>
</tr>
<tr>
<td>DfT</td>
<td>Department for Transport</td>
</tr>
<tr>
<td>DGSI</td>
<td>Director General of Science and Innovation</td>
</tr>
<tr>
<td>DIUS</td>
<td>Department for Innovation, Universities and Skills</td>
</tr>
<tr>
<td>DMC</td>
<td>Disaster Monitoring Constellation</td>
</tr>
<tr>
<td>DTI</td>
<td>Department of Trade and Industry</td>
</tr>
<tr>
<td>DSTL</td>
<td>Defence Science and Technology Laboratory</td>
</tr>
<tr>
<td>EC</td>
<td>European Commission</td>
</tr>
<tr>
<td>EEDA</td>
<td>East of England Development Agency</td>
</tr>
<tr>
<td>EGNOS</td>
<td>European Geostationary Navigation Overlay Service</td>
</tr>
<tr>
<td>ELIPS</td>
<td>European Programme for Life and Physical Sciences</td>
</tr>
<tr>
<td>EO</td>
<td>Earth Observation</td>
</tr>
<tr>
<td>EOEP</td>
<td>Earth Observation Envelope Programme</td>
</tr>
<tr>
<td>EOPB</td>
<td>Earth Observation Programme Board</td>
</tr>
<tr>
<td>ESA</td>
<td>European Space Agency</td>
</tr>
<tr>
<td>ESERO</td>
<td>European Space Education Resource Office</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>EUMETSAT</td>
<td>European Organisation for the Exploitation of Meteorological Satellites</td>
</tr>
<tr>
<td>FCO</td>
<td>Foreign and Commonwealth Office</td>
</tr>
<tr>
<td>FP7</td>
<td>Framework Programme 7</td>
</tr>
<tr>
<td>GEO</td>
<td>Group for Earth Observation</td>
</tr>
<tr>
<td>GEOSS</td>
<td>Global Earth Observation System of Systems</td>
</tr>
<tr>
<td>GJU</td>
<td>Galileo Joint Undertaking</td>
</tr>
<tr>
<td>GMES</td>
<td>Global Monitoring for Environment and Security</td>
</tr>
<tr>
<td>GNSS</td>
<td>Global Navigation Satellite System</td>
</tr>
<tr>
<td>GOC</td>
<td>Galileo Operating Company</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning Systems</td>
</tr>
<tr>
<td>GSA</td>
<td>Galileo Supervisory Authority</td>
</tr>
<tr>
<td>HEFCE</td>
<td>Higher Education Funding Council for England</td>
</tr>
<tr>
<td>ISS</td>
<td>International Space Station</td>
</tr>
<tr>
<td>ISSET</td>
<td>International Space School Educational Trust</td>
</tr>
<tr>
<td>KTP</td>
<td>Knowledge Transfer Partnerships</td>
</tr>
<tr>
<td>LDA</td>
<td>London Development Agency</td>
</tr>
<tr>
<td>MoD</td>
<td>Ministry of Defence</td>
</tr>
<tr>
<td>MoonLITE</td>
<td>Moon Lightweight Interior and Telecom Experiment</td>
</tr>
<tr>
<td>MRC</td>
<td>Medical Research Council</td>
</tr>
<tr>
<td>MOSAIC</td>
<td>Micro Satellite Applications in Collaboration</td>
</tr>
<tr>
<td>NAO</td>
<td>National Audit Office</td>
</tr>
<tr>
<td>NERC</td>
<td>Natural Environment Research Council</td>
</tr>
<tr>
<td>NPL</td>
<td>National Physical Laboratory</td>
</tr>
<tr>
<td>NSC</td>
<td>National Space Centre</td>
</tr>
<tr>
<td>NSTP</td>
<td>National Space Technology Programme</td>
</tr>
<tr>
<td>OSA</td>
<td>Outer Space Act</td>
</tr>
<tr>
<td>OSI</td>
<td>Office of Science and Innovation</td>
</tr>
<tr>
<td>PPARC</td>
<td>Particle Physics and Astronomy Research Council</td>
</tr>
</tbody>
</table>
RAS    Royal Astronomical Society
RDA    Regional Development Agency
ROSE   Relevance of Science Education
SEEDA  South East England Development Agency
SME    Small and Medium Enterprise
STFC   Science and Technology Facilities Council
TTP    Technology Transfer Programme
UCL    University College London
VG     Virgin Galactic
Formal minutes

Wednesday 4 July 2007

Members present:

Mr Phil Willis, in the Chair

Dr Evan Harris  Dr Bob Spink
Dr Brian Iddon  Dr Desmond Turner
Chris Mole

The Committee considered this matter.

Draft Report (2007: A Space Policy), proposed by the Chairman, brought up and read.

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

Paragraphs 1 to 367 read and agreed to.

Summary read and agreed to.

Abbreviations read and agreed to.

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

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

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

Several Memoranda were ordered to be reported to the House for printing with the Report, together with certain Memoranda reported and ordered to be published on 6 December 2006 and 30 January 2007.

[Adjourned till Wednesday 11 July at 9.00am]
Witnesses

Wednesday 6 December 2006

Mr Colin Paynter, Managing Director, EADS Astrium, Mr Stuart Martin, Business Director, Space and Satcoms, LogicaCMG, Mr David Williams, Chief Executive, Avanti, and Sir Martin Sweeting, Chief Executive, Surrey Satellite Technology Limited.

Dr Trevor Cross, Technology Director, e2v, Mr John Rootes, Managing Director, JRA Technology Ltd, UK and Mr Nathan Hill, Managing Director, Qi3.

Wednesday 10 January 2007

Dr David Williams, Director General, Miss Paula Freedman, Director, DTI Space, and Dr Arwyn Davies, Director, Earth Observation (at both BNSC and NERC), British National Space Centre.

Professor Keith Mason, Chief Executive, Particle Physics and Astronomy Research Council (PPARC), Professor Richard Holdaway, Head of Science Programmes, Council for the Central Laboratory of the Research Councils (CCLRC), and Air Vice-Marshal Chris Moran, Assistant Chief of the Air Staff, Ministry of Defence.

Wednesday 30 January 2007

Ms Julie Bramman, Divisional Manager for School Curriculum, Department for Education and Skills, Dr Robin Clegg, Head of Science and Society, Particle Physics and Astronomy Research Council (PPARC), Paul Spencer, Evaluator and Consultant, Space Connections, and Professor Alan Wells, Emeritus Professor and Leverhulme Emeritus Fellow, University of Leicester, and Non-Executive Director, National Space Centre.

Wednesday 7 February 2007

Professor Sir Howard Dalton, Chief Scientific Adviser, Department for Environment, Food and Rural Affairs, Professor Alan Thorpe, Chief Executive, Natural Environment Research Council (NERC), and Alan Douglas, Head of Assurance, Met Office.

Matthew Stuttard, Chairman, British Association of Remote Sensing Companies, Professor Shaun Quegan, Director, NERC Centre for Terrestrial Carbon Dynamics, and Professor Duncan Wingham, Head of the Department of Earth Sciences, University College London, and Director of the NERC Collaborative Centre for Polar Observation and Modelling.

Ms Elizabeth Duthie, Head of Galileo Programme Division, Department for Transport, Neil Ackroyd, Director of Data Collection and Management, Ordnance Survey, and Patrick McDougall, Vice President, Corporate Development and Director of Galileo Programme, Inmarsat.
Wednesday 21 February 2007

Professor Len Culhane, Chairman, UK Space Academic Network, and Emeritus Professor of Physics, University College London, Lord Rees of Ludlow, President, Royal Society and Professor of Cosmology and Astrophysics, University of Cambridge, and Professor Michael Rowan-Robinson, President, Royal Astronomical Society and Head of Astronomy and Astrophysics Department, Imperial College, London.

Dr Kevin Fong, Co-Director, Centre for Aviation, Space and Extreme Environment Medicine, Professor Chris Kennard, Chair, Neurosciences and Mental Health Board and MRC Council Member, Medical Research Council (MRC), and Michael Gourlay, Quality Control Consultant, Marchbanks Measurement Systems.

Will Whitehorn, President, Virgin Galactic, Jeff Gazzard, Board Member, Aviation Environment Federation, and Dr Patrick Collins, Director, Space Future Consulting.

Monday 19 March 2007

Jean-Jacques Dordain, Director General, and Professor David Southwood, Director of Science, European Space Agency.

Wednesday 18 April 2007

Malcolm Wicks MP, Minister for Science and Innovation, Department of Trade and Industry, and Dr David Williams, Director General, British National Space Centre (BNSC).
## List of written evidence

<table>
<thead>
<tr>
<th>Page</th>
<th>Name</th>
<th>Page(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Department of Trade and Industry</td>
<td>Ev 113</td>
</tr>
<tr>
<td>2</td>
<td>British National Space Centre</td>
<td>Ev 118, 353, 355, 362, 373, 375, 382, 387</td>
</tr>
<tr>
<td>3</td>
<td>Gihan Ganeshanantham</td>
<td>Ev 125</td>
</tr>
<tr>
<td>4</td>
<td>Nicholas Spall</td>
<td>Ev 127</td>
</tr>
<tr>
<td>5</td>
<td>Reaction Engines</td>
<td>Ev 128</td>
</tr>
<tr>
<td>6</td>
<td>UK Space</td>
<td>Ev 130, 363, 366, 368</td>
</tr>
<tr>
<td>7</td>
<td>Amicus</td>
<td>Ev 134</td>
</tr>
<tr>
<td>8</td>
<td>Dr I A Crawford</td>
<td>Ev 136</td>
</tr>
<tr>
<td>9</td>
<td>Osmosis Unit</td>
<td>Ev 138</td>
</tr>
<tr>
<td>10</td>
<td>Space Foundation</td>
<td>Ev 142</td>
</tr>
<tr>
<td>11</td>
<td>Dr Simon N Evetts</td>
<td>Ev 146</td>
</tr>
<tr>
<td>12</td>
<td>British Spaceplanes Limited</td>
<td>Ev 147</td>
</tr>
<tr>
<td>13</td>
<td>James Molony</td>
<td>Ev 149</td>
</tr>
<tr>
<td>14</td>
<td>Space Group Committee of the Royal Aeronautical Society</td>
<td>Ev 149</td>
</tr>
<tr>
<td>15</td>
<td>Space Future Consulting Ltd</td>
<td>Ev 151, 384, 387</td>
</tr>
<tr>
<td>16</td>
<td>University of Leicester</td>
<td>Ev 162, 352</td>
</tr>
<tr>
<td>17</td>
<td>Dr Philip J Scarpa</td>
<td>Ev 165</td>
</tr>
<tr>
<td>18</td>
<td>LogicaCMG</td>
<td>Ev 166</td>
</tr>
<tr>
<td>19</td>
<td>Miss Agniezska Skorko</td>
<td>Ev 169</td>
</tr>
<tr>
<td>20</td>
<td>Space Connections</td>
<td>Ev 169</td>
</tr>
<tr>
<td>21</td>
<td>Space Enterprise Partnerships Ltd</td>
<td>Ev 171</td>
</tr>
<tr>
<td>22</td>
<td>Royal Institution of Great Britain</td>
<td>Ev 172</td>
</tr>
<tr>
<td>23</td>
<td>Dr Richard J E Skipworth</td>
<td>Ev 173</td>
</tr>
<tr>
<td>24</td>
<td>Dr Tamara Banerjee</td>
<td>Ev 175</td>
</tr>
<tr>
<td>25</td>
<td>UK Space Academic Network</td>
<td>Ev 176</td>
</tr>
<tr>
<td>26</td>
<td>Dr Alyson Calder</td>
<td>Ev 180</td>
</tr>
<tr>
<td>27</td>
<td>Dr Jagtar Nijjar</td>
<td>Ev 181</td>
</tr>
<tr>
<td>28</td>
<td>Emma-Jane Smith</td>
<td>Ev 182</td>
</tr>
<tr>
<td>29</td>
<td>Dr Robert Marchbanks</td>
<td>Ev 183, 353</td>
</tr>
<tr>
<td>30</td>
<td>Astrium Limited</td>
<td>Ev 183, 370</td>
</tr>
<tr>
<td>31</td>
<td>Foreign and Commonwealth Office</td>
<td>Ev 189</td>
</tr>
<tr>
<td>32</td>
<td>Council for the Central Laboratory of the Research Council</td>
<td>Ev 189</td>
</tr>
<tr>
<td>33</td>
<td>Engineering and Physical Sciences Research Council</td>
<td>Ev 191</td>
</tr>
<tr>
<td>34</td>
<td>Medical Research Council</td>
<td>Ev 191, 395</td>
</tr>
<tr>
<td>35</td>
<td>Particle Physics and Astronomy Research Council</td>
<td>Ev 193</td>
</tr>
<tr>
<td>36</td>
<td>Natural Environment Research Council</td>
<td>Ev 198, 395</td>
</tr>
<tr>
<td>37</td>
<td>Anna Lamond</td>
<td>Ev 203</td>
</tr>
<tr>
<td>38</td>
<td>Klaus Becher</td>
<td>Ev 203</td>
</tr>
<tr>
<td>39</td>
<td>Royal Astronomical Society</td>
<td>Ev 206</td>
</tr>
<tr>
<td>40</td>
<td>Dr Benjamin Marriage</td>
<td>Ev 210</td>
</tr>
<tr>
<td>41</td>
<td>Intellect</td>
<td>Ev 210</td>
</tr>
<tr>
<td>Number</td>
<td>Institution/Entity</td>
<td>Event Page</td>
</tr>
<tr>
<td>--------</td>
<td>---------------------------------------------------------</td>
<td>------------</td>
</tr>
<tr>
<td>42</td>
<td>Institution of Mechanical Engineers</td>
<td>Ev 214</td>
</tr>
<tr>
<td>43</td>
<td>Ordnance Survey</td>
<td>Ev 216</td>
</tr>
<tr>
<td>44</td>
<td>BROHP (British Rocket Oral History Programme)</td>
<td>Ev 219</td>
</tr>
<tr>
<td>45</td>
<td>The Royal Society</td>
<td>Ev 220</td>
</tr>
<tr>
<td>46</td>
<td>Professor Colin Pillinger</td>
<td>Ev 223</td>
</tr>
<tr>
<td>47</td>
<td>Dr Peter Hodkinson</td>
<td>Ev 227</td>
</tr>
<tr>
<td>48</td>
<td>Group of interested scientists</td>
<td>Ev 228</td>
</tr>
<tr>
<td>49</td>
<td>National Physical Laboratory</td>
<td>Ev 229</td>
</tr>
<tr>
<td>50</td>
<td>Thaddeus R F Fulford-Jones</td>
<td>Ev 234</td>
</tr>
<tr>
<td>51</td>
<td>UK Space Biomedicine</td>
<td>Ev 234</td>
</tr>
<tr>
<td>52</td>
<td>Arts Catalyst</td>
<td>Ev 237</td>
</tr>
<tr>
<td>53</td>
<td>Jerry Stone</td>
<td>Ev 239</td>
</tr>
<tr>
<td>54</td>
<td>Centre for Aviation, Space and Extreme Environment Medicine</td>
<td>Ev 242</td>
</tr>
<tr>
<td>55</td>
<td>Dr Victoria Wykes</td>
<td>Ev 245</td>
</tr>
<tr>
<td>56</td>
<td>British Interplanetary Society</td>
<td>Ev 246, 371</td>
</tr>
<tr>
<td>57</td>
<td>British Association of Remote Sensing Companies</td>
<td>Ev 249, 396</td>
</tr>
<tr>
<td>58</td>
<td>East of England Development Agency</td>
<td>Ev 252</td>
</tr>
<tr>
<td>59</td>
<td>Dr Ben Douglas</td>
<td>Ev 252</td>
</tr>
<tr>
<td>60</td>
<td>Dr Patrick Magee</td>
<td>Ev 254</td>
</tr>
<tr>
<td>61</td>
<td>Dr Vishal Nangalia</td>
<td>Ev 255</td>
</tr>
<tr>
<td>62</td>
<td>Avanti Screenmedia</td>
<td>Ev 259</td>
</tr>
<tr>
<td>63</td>
<td>ABL Space Products</td>
<td>Ev 260</td>
</tr>
<tr>
<td>64</td>
<td>John Carroll, University College London</td>
<td>Ev 261</td>
</tr>
<tr>
<td>65</td>
<td>Nigel McNair Scott</td>
<td>Ev 262</td>
</tr>
<tr>
<td>66</td>
<td>QinetiQ</td>
<td>Ev 263</td>
</tr>
<tr>
<td>67</td>
<td>Hertfordshire Business Incubation Centre</td>
<td>Ev 265</td>
</tr>
<tr>
<td>68</td>
<td>Stephen Ashworth</td>
<td>Ev 267</td>
</tr>
<tr>
<td>69</td>
<td>Surrey Satellite Technology Limited (SSTL)</td>
<td>Ev 271</td>
</tr>
<tr>
<td>70</td>
<td>Andrew Weston, University of Warwick</td>
<td>Ev 273</td>
</tr>
<tr>
<td>71</td>
<td>Reginald Turnill</td>
<td>Ev 275</td>
</tr>
<tr>
<td>72</td>
<td>Simon Pearce</td>
<td>Ev 279</td>
</tr>
<tr>
<td>73</td>
<td>Department for Environment, Food and Rural Affairs</td>
<td>Ev 280, 397</td>
</tr>
<tr>
<td>74</td>
<td>Daniela Garelick</td>
<td>Ev 286</td>
</tr>
<tr>
<td>75</td>
<td>Department for Transport</td>
<td>Ev 286, 371</td>
</tr>
<tr>
<td>76</td>
<td>Ministry of Defence</td>
<td>Ev 291, 397</td>
</tr>
<tr>
<td>77</td>
<td>Dr Stuart Eves</td>
<td>Ev 296</td>
</tr>
<tr>
<td>78</td>
<td>Professor Shaun Quegan</td>
<td>Ev 297</td>
</tr>
<tr>
<td>79</td>
<td>Dr David Tsklauri</td>
<td>Ev 299</td>
</tr>
<tr>
<td>80</td>
<td>British Antarctic Survey</td>
<td>Ev 301</td>
</tr>
<tr>
<td>81</td>
<td>Inmarsat</td>
<td>Ev 303</td>
</tr>
<tr>
<td>82</td>
<td>Virgin Galactic</td>
<td>Ev 307</td>
</tr>
<tr>
<td>83</td>
<td>e2v</td>
<td>Ev 310</td>
</tr>
<tr>
<td>84</td>
<td>JRA Technology</td>
<td>Ev 311</td>
</tr>
<tr>
<td>85</td>
<td>Science Museum</td>
<td>Ev 314</td>
</tr>
<tr>
<td>86</td>
<td>Professor Alan Wells</td>
<td>Ev 315</td>
</tr>
<tr>
<td>87</td>
<td>Chas Bishop</td>
<td>Ev 319</td>
</tr>
<tr>
<td>88</td>
<td>Department for Education and Skills</td>
<td>Ev 324</td>
</tr>
<tr>
<td>89</td>
<td>Space Insight Limited</td>
<td>Ev 329</td>
</tr>
<tr>
<td>90</td>
<td>Aviation Environment Federation</td>
<td>Ev 332</td>
</tr>
<tr>
<td>91</td>
<td>Spacelink Learning Foundation</td>
<td>Ev 334</td>
</tr>
<tr>
<td>92</td>
<td>Professor Colin R McInnes</td>
<td>Ev 336</td>
</tr>
<tr>
<td>93</td>
<td>ESA</td>
<td>Ev 338</td>
</tr>
<tr>
<td>94</td>
<td>Gates and Partners</td>
<td>Ev 398</td>
</tr>
<tr>
<td>95</td>
<td>National Aeronautics and Space Administration</td>
<td>Ev 403</td>
</tr>
<tr>
<td>96</td>
<td>Satellite Observing Systems</td>
<td>Ev 404</td>
</tr>
<tr>
<td>97</td>
<td>British Telecommunications plc</td>
<td>Ev 405</td>
</tr>
<tr>
<td>98</td>
<td>Science and Technology Facilities Council</td>
<td>Ev 406</td>
</tr>
<tr>
<td>99</td>
<td>Ministry of Justice</td>
<td>Ev 407</td>
</tr>
<tr>
<td>100</td>
<td>Ofcom</td>
<td>Ev 407</td>
</tr>
</tbody>
</table>
List of Reports from the Committee during the current Parliament

The reference number of the Government’s response to each Report is printed in brackets after the HC printing number.

**Session 2006–07**

<table>
<thead>
<tr>
<th>First Report</th>
<th>Work of the Committee in 2005-06</th>
<th>HC 202</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second Report</td>
<td>Human Enhancement Technologies in Sport</td>
<td>HC 67 (Cm 7088)</td>
</tr>
<tr>
<td>Third Report</td>
<td>The Cooksey Review</td>
<td>HC 204</td>
</tr>
<tr>
<td>Fourth Report</td>
<td>Research Council Institutes</td>
<td>HC 68-l</td>
</tr>
<tr>
<td>Fifth Report</td>
<td>Government Proposals for the Regulation of Hybrid and Chimera Embryos</td>
<td>HC 272-l (Cm 7139)</td>
</tr>
<tr>
<td>First Special Report</td>
<td>Scientific Advice, Risk and Evidence Based Policy Making: Government Response to the Committee’s Seventh Report of Session 2005-06</td>
<td></td>
</tr>
</tbody>
</table>

**Session 2005–06**

<table>
<thead>
<tr>
<th>First Report</th>
<th>Meeting UK Energy and Climate Needs: The Role of Carbon Capture and Storage</th>
<th>HC 578-l (HC 1036)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second Report</td>
<td>Strategic Science Provision in English Universities: A Follow-up</td>
<td>HC 1011 (HC 1382)</td>
</tr>
<tr>
<td>Third Report</td>
<td>Research Council Support for Knowledge Transfer</td>
<td>HC 995-l (HC 1653)</td>
</tr>
<tr>
<td>Fifth Report</td>
<td>Drug classification: making a hash of it?</td>
<td>HC 1031</td>
</tr>
<tr>
<td>Sixth Report</td>
<td>Identity Card Technologies: Scientific Advice, Risk and</td>
<td>HC 1032</td>
</tr>
<tr>
<td>Seventh Report</td>
<td>Scientific Advice, Risk and Evidence Based Policy Making</td>
<td>HC 900-l</td>
</tr>
<tr>
<td>First Special Report</td>
<td>Forensic Science on Trial: Government Response to the Committee’s Seventh Report of Session 2004-05</td>
<td>HC 427</td>
</tr>
<tr>
<td>Second Special Report</td>
<td>Strategic Science Provision in English Universities: Government Response to the Committee’s Eighth Report of Session 2004-05</td>
<td>HC 428</td>
</tr>
</tbody>
</table>