



postnote

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UK CIVIL SPACE ACTIVITIES

This POSTnote provides an overview of the UK's civil space activities. It focuses on space exploration and Earth observation, discussing UK participation in international projects in the light of decisions made at a European Space Agency ministerial meeting in December 2005. Preparations for the 2007 comprehensive spending review are underway within government, giving rise to increased debate over the future of UK civil space activities. The note highlights key aspects of this debate such as the future of the UK space industry and the role space plays in drawing young people into science and technology careers.

Background

In October 1957, the first man-made satellite, Sputnik 1, was launched by the former Soviet Union. Fifty years on, many diverse activities now take place in space such as:

- astronomy and planetary exploration;
- observing the Earth from orbiting satellites;
- using satellites for telecommunications and navigation.

The UK's public sector spending on civil space activities is £~200 million per year. Almost 70% is spent on the first two areas above, which are the focus of this briefing. The UK is also involved in space-based navigation and telecommunications, major international projects such as Galileo (POSTnote 150) and defence-related activities, but these are beyond the scope of this briefing.

Astronomy and planetary exploration

The UK participates in a number of international projects in this area (Box 1). These include the Cassini-Huygens mission to Saturn, the Aurora Mars exploration programme and astronomical observation projects such as the Hubble space telescope. By sending probes to other planets and by placing telescopes in orbit around the Earth, researchers are addressing many questions:

- how the Earth and the Solar System formed;
- how life on Earth evolved and whether there is life elsewhere in the Universe;
- how the Universe evolved.

Box 1 Astronomy and planetary exploration Planetary exploration

The **Cassini-Huygens** mission to explore Saturn and its largest moon, Titan, was launched in 1997. It is a joint mission between ESA, NASA and the Italian space agency. ESA's Huygens probe landed on Titan's surface in January 2005 and has sent back pictures such as that below. Data from this probe show that Titan's atmosphere contains methane, a possible sign of biological activity.

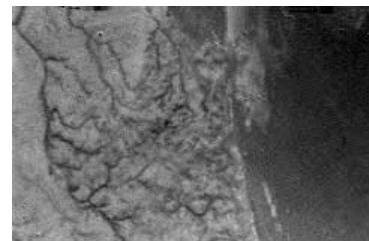


Figure 1. One of the first Images of Titan from the Huygens probe. Image:ESA.

Another mission currently being planned is **Aurora**, ESA's Mars exploration programme. Mars is the most Earth-like of all the planets in our solar system, and may once have supported life. The mission will take place in three stages:

- **2011-2013:** ExoMars, an €0.8bn mission consisting of an orbiter, a lander and a rover. The rover will travel several kilometres over the Martian surface, analysing soil samples for evidence of past or present life.
- **2020-2024:** Mars sample return (MSR), a robotic mission to return Martian soil back to Earth for more extensive laboratory analysis.
- **Beyond 2020:** Based on the results of the ExoMars and MSR missions, ESA will then decide whether to embark on a human mission to Mars.

Space is also an ideal setting for astronomical observations, as sensitive measurements can be made without disruption by the earth's atmosphere. One example is the Hubble telescope, which has been in orbit around the earth since its launch in 1990. Another is SWIFT, a joint UK, NASA and Italian mission to detect and accurately calculate the position of gamma ray bursts - the most powerful explosions observed in the universe.

Earth observation

As outlined in Box 2, Earth observation satellites allow data to be gathered over wide geographical areas for purposes such as:

- collecting data about climate change (for example monitoring hurricanes or the polar ice caps);
- predicting and monitoring the weather, now very dependant on satellite data;
- using images to coordinate aid for both natural and man-made disasters.

Box 2 Earth observation

Earth observation data from satellites contribute to environmental research, policy making and activities such as disaster management. Some examples are outlined below.

Environmental research

The Natural Environment Research Council (NERC) has seven Earth Observation Centres, hosted by NERC-funded institutes and university departments in the UK. They use satellite data to research issues in environmental science. The UK plays a leading role in the CRYOSAT-2 mission, an ESA satellite designed to gather data from parts of the polar ice caps not previously observed from space. CRYOSAT's first launch failed and it is being rebuilt (see page 3).

Policy making

Global Monitoring for Environment and Security (GMES) is a European Commission/ESA initiative to improve provision of environmental monitoring data to policy makers in Europe. It will integrate various data sources, including from satellites, to support decision-making on environmental and security issues (such as border control or disaster management).

Disaster Monitoring Constellation (DMC)

The Disaster Monitoring Constellation (DMC) is a network of four small, low cost, satellites (each around 90kg and under £10 million) developed by Surrey Satellite Technology Ltd. Data from the DMC network helped co-ordinate aid after the Asian Tsunami on Boxing Day 2004. Use of small, low cost, satellites (conventional satellites can weigh several tonnes and cost over \$200 million each) allows greater numbers to be deployed and data to be obtained more rapidly over a wider area, albeit at lower resolution.

UK civil space activities

Priorities and organisation

The UK's Space Strategy¹ identifies the three primary purposes for investment in space:

- academic research to expand knowledge in astronomy, planetary and environmental sciences;
- creation of opportunities for commercial exploitation of satellite systems;
- advancement of key public services.

This strategy is published by the British National Space Centre (BNSC), which acts as a focus for civil space activities in the UK and for the UK's relations with civil international bodies. It is a partnership across 11 government departments, Research Councils and agencies. The BNSC interacts regularly with UK space industry representatives. It also deals with policy matters such as licensing, insurance and space debris.

Expenditure²

The BNSC does not directly allocate funds to partners from a central budget; its role is to co-ordinate their civil

space spending. Space exploration and astronomy is funded and managed by the Particle Physics and Astronomy Research Council (PPARC). In 2004/2005 PPARC spent £~66 million on space. Earth observation research is funded and managed by the Natural Environment Research Council (NERC), which spent £~52 million on space in 2004/2005. Other spending is through government departments with an interest in space. For example UK funding for Galileo comes from the Department for Transport (DfT) and the Department for Trade and Industry. The DfT leads UK involvement because of Galileo's transport related applications.

The UK in the European Space Agency (ESA)

Because space-based activities are complex and expensive, projects are often carried out as international collaborations. About 65-70% of the UK's civil space expenditure goes to ESA (Box 3).² In 2004/2005 the UK's total ESA contribution was £~129 million. Non-ESA expenditure is spent on domestic projects, collaboration with international space agencies, and on EUMETSAT (European Organisation for the Exploitation of Meteorological Satellites). At the ESA ministerial meeting in December 2005, the UK government made several key financial commitments including:

- the Aurora Mars exploration programme (Box 1);
- several environmental science and monitoring missions;
- advanced research into telecommunications satellites;
- a 2.5% funding increase for ESA's 'mandatory' activities (Box 3).

The UK's investment in ESA has a direct impact on the number of contracts awarded to the UK space industry. This is because of ESA's '*juste retour*' policy whereby the proportion of industrial contracts awarded to a country is in proportion to its financial contribution (see below).

Funding issues

Overall level of funding

Total UK public sector expenditure on civil space is low relative to the US and some other European countries (Figure 2), although the UK makes a significant contribution to individual projects such as Aurora. This reflects the fact that space activities in the UK are 'user-driven': they are funded when they are considered to be the best way of fulfilling an existing objective. This differs from the approach of other space-faring nations, such as the US or China, which might fund space-based activities for their prestige value or to have independent access to space. While some argue that the UK should increase its overall spending on space significantly, the current debate mainly relates to funding of specific projects.

The UK Space Industry

The UK space industry had a total turnover of £4.8 billion in 2004/2005.³ The total value of ESA contracts awarded to it through *juste retour* in 2005 was £~100 million. Decisions made at the December 2005 ESA ministerial meeting, such as the 2.5% rise in the mandatory ESA budget, and the UK's commitment to Aurora and to Earth observation projects, are expected to

increase industrial returns to the UK. However, concerns have been raised about the adequacy of the UK contribution to other ESA projects, particularly GMES.⁴

Box 3 International activities

The European Space Agency (ESA)

ESA is a collaboration between 17 European countries and Canada. Its budget is €~3bn (£~2 bn) per year. In recent years ESA has sent probes to explore our solar system as well as running an Earth observation programme. ESA activities are split into *mandatory* and *optional*. Mandatory activities include missions such as Cassini-Huygens (Box 1) and accounted for about 25% of ESA activities in 2004. Each country must subscribe to the mandatory programme in proportion to its relative GDP but can contribute anything above 25% of this proportion to optional activities (e.g. GMES, Box 2). In 2004, the UK contribution accounted for 17% of mandatory and 5.7% of optional activities. Overall the UK contribution amounted to ~8%, fourth behind France (~26%), Germany (~20%) and Italy (~11%).⁵

National Aeronautics and Space Administration (NASA)

The USA's space agency, NASA, has a higher civil space budget than any space agency in the world, \$~16bn (£~9 bn) a year. The US president announced in 2004 that by the end of the next decade NASA would return astronauts to the Moon for the first time since 1972, and eventually send astronauts to Mars. However many commentators are concerned that NASA does not have the financial resources to meet these goals without compromising in other areas.

Russia

Russia has an active civil space programme although its budget has been reduced since the collapse of the Soviet Union; it was \$~0.5bn (£~0.28 bn) in 2004. The Russian space agency owns a number of low-cost launchers which are used by the international community, including ESA.

Civil space activities in the Wider World

As the technology needed for space-based activities become more widely available, more countries can afford to participate. China, India and Japan have rapidly expanding space programmes. In October 2005 China completed its second human space mission, while India is developing an indigenous launch capability.

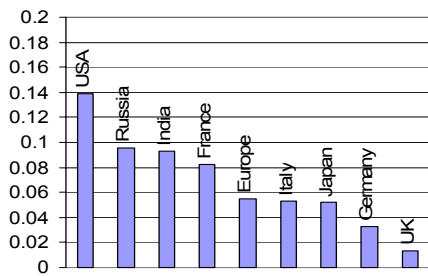


Figure 2. 2004 National civil space budgets as % of GDP in selected countries. Source: World Prospects for Government Space Markets, Euroconsult 2005. Data reproduced by kind permission of Euroconsult.

At the ministerial meeting, the UK committed to paying just over 4% (£6.5m) of the costs of the first €~250 million (£~170 million) phase of GMES. This is close to the minimum required to secure UK involvement. It reflects the UK government's concerns that GMES is not well enough tailored to user-needs. UK industry fear that because of this low contribution, it will be allocated very few contracts. The Department for Environment Food and Rural Affairs (DEFRA) takes the lead on UK policy on

GMES and is considering the UK's future approach in the lead up to the next ESA ministerial meeting in 2008.

Industry representatives say the value of contracts awarded to UK industry from ESA is not in proportion to the UK's ESA contribution. Until recently UK industry received well above its *juste retour* target. However for the last 3-4 years the amount received has been below this target. At the start of 2005, the UK was 'under-returned' by £~39 million. The BNSC has been taking measures to address this and reports that by the end of 2005 the deficit had reduced to £~28 million (a ~94% return on investment). Industry representatives say the UK is not investing enough in basic space technologies. They say one solution is to set up a basic technology programme within the BNSC. However, the Treasury points out that all sectors of industry may compete for R&D funding from the industry-led Technology Strategy Board, which allocates funds from the DTI.

Collaborative projects

Although it is agreed that UK scientists are successful within ESA, many academics say UK funding constraints and lack of strategic planning hamper scientific participation in specific projects. A widely cited example is ESA's BepiColombo mission to Mercury, due for launch in 2011-2012. This was planned with UK academics in a leading role, but involvement was halved due to budget constraints. Concerns are also expressed over the funds available for bilateral or multilateral collaborations. UK partnership is often sought by overseas agencies ranging from NASA to those in Canada, Japan, India and Korea. However, since 65-70% of the UK's budget is spent through ESA, such collaborations often have to be turned down. In 2004/2005, £55 million of PPARC's £66 million expenditure on space went to ESA.

Is space-based research value for money?

Risks

There is an ongoing debate over the 'value for money' of space-based research. Critics argue that it is a high risk activity, and cite examples of missions which have not gone according to plan. For example CRYOSAT (Box 2), crashed shortly after launch in October 2005. Another well publicised example is the UK's Beagle 2 project to develop a lander for ESA's Mars Express mission. Contact was never made with the Beagle 2 lander on the Martian surface. A report by the House of Commons Science and Technology Committee into government support of Beagle 2 pointed to a lack of oversight of the project both on the part of ESA and of the UK government, although it praised the government's enthusiasm for the project.⁶

Benefits

Proponents say that most missions do not encounter major technical problems: success rates above 90% have been achieved in the ESA programme over the past decade. They point out that expertise acquired during the Beagle 2 and the Cassini-Huygens missions will allow the UK to play a key role in Aurora (Box 1). Also, it is expected that CRYOSAT will be rebuilt in half the time taken to build the original craft, and will be launched by

2009. Proponents point to spin-offs from space missions: for example the miniaturised machines designed for Beagle 2 are being used in mobile medical laboratories.

There is evidence that space research has a positive impact on young people. Museum curators say space exhibits are among the most popular with children. Proponents say this could help draw young people into science and technology (S&T) careers, at a time when the numbers of S&T graduates in the UK is falling. During the manned Apollo missions to the Moon, the US saw numbers of S&T graduates rise by 30%. Public events during key points of the voyage of Beagle 2 to Mars and the Cassini-Huygens mission to Saturn (Box 1), both robotic missions, were also popular.

Structural issues

Partnership or Space Agency?

The UK's 'partnership' approach to space differs from the space agency structure found in countries such as the United States. NASA is an autonomous body with its own budget for space-based research (Box 3). In contrast, the BNSC co-ordinates partners with their own budgets. A 2004 National Audit Office (NAO) report praised the BNSC's partnership approach for its value for money.⁷ It is widely accepted within the UK space community⁸ that the existing structure is an efficient way of co-ordinating current levels of spending. Establishment of a UK space agency would meet with widespread support only if it were given a substantially increased budget.

Coherence of UK space strategy

The NAO report suggested that the large number of BNSC partners leads to lack of coherence in the UK's space strategy, an opinion echoed by those in academia and industry. As a result the BNSC has made changes to its governance: the smaller 'UK Space Board', with representatives from the five main funding partners, aims to provide more coherence and strategic direction; the 'Space and Advisory Council' with representatives from all 11 partners and the wider space community provides strategic advice to this board. The BNSC has also deployed more resources to focus on European issues. However, some concerns remain over a lack of 'joined-up thinking' across government and lack of appreciation of the benefits of space.⁴

Research priorities

Human Space Flight

The UK does not participate in human spaceflight missions as they are perceived as prestige projects of disproportionately low scientific value, given the demand they place on resources. In October 2005, a report commissioned by the Royal Astronomical Society (RAS) urged a review of this position.⁹ The report argues that planetary exploration is best done using the flexibility of humans along with robotic technology. The report points out that research is underway to overcome the technical challenges of sending humans to Mars.

Proponents argue that with adequate funds, the scientific, educational and industrial returns of manned

spaceflight would be high. However some academics are concerned that such projects run the risk of losing scientific focus through excessive bureaucracy and a lack of flexibility. Also, manned spaceflight would be very costly: the RAS report estimates the cost to the UK of participating in an international manned mission to Mars would be £~150m per year. This corresponds to about 5% of total spending by all the UK Research Councils.

Allocation of research funding

PPARC does not have a fixed budget for space-based research. It divides funding between planetary scientists, astronomers, particle physicists and astrophysicists. This can lead to disagreements between academics in different disciplines over allocation of funding. To address such concerns all projects are peer-reviewed and must be approved by a steering council.

Key points

- The UK's public sector expenditure on civil space activities is around £200 million per year; 65-70% goes to the European Space Agency (ESA).
- The UK is actively involved in preparation for the next stage of Aurora, ESA's manned mission to Mars, and in several earth observation missions.
- There are concerns over falling levels of industrial contracts awarded to the UK space industry from ESA.
- A 2004 National Audit Office report pointed to lack of coherence in the UK's space strategy and the British National Space Centre has taken measures to address this; however some concerns remain.
- Preparation for the government's comprehensive spending review 2007 is now underway and BNSC partners are developing proposals for space activities.

Endnotes

- 1 *UK Space Strategy, 2003-2006 and beyond*, British National Space Centre (BNSC), December 2003
- 2 *UK Space Activities*, BNSC, June 2005
- 3 *Size and Health of the UK Space Industry*, BNSC, 2006
- 4 *The Case for Space 2006*, Parliamentary Space Committee, March 2006
- 5 *ESA annual report 2004*, ESA, June 2004
- 6 House of Commons, 12th report of the Select Committee on Science and Technology, Session 2003-2004, *Government Support of Beagle 2*
- 7 *The United Kingdom's Civil Space Activities*, The National Audit Office, March 2004
- 8 'UK space community' refers to representatives from academia, industry, public sector and other bodies, with an interest in space-based activities.
- 9 Close F., Dudeney J., Pounds K., *Report for the Commission on the Scientific Case for Human Space Exploration*, Royal Astronomical Society, October 2005

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