RAS response to the BNSC consultation on the review of space exploration policy

The Royal Astronomical Society (RAS) encourages and promotes the study of astronomy, solar-system science, geophysics and closely related branches of science both in the UK and internationally. The Society therefore welcomes the opportunity to comment on the BNSC review of options for involvement in space exploration. This is an area of key concern to the fellowship of the RAS, many of whom are either actively involved in the field and / or depend on investment in space science to carry out their scientific research.

This response seeks to align the views put forward by the RAS with some of the questions put in the consultation Terms of Reference.

The Economy: To what extent can the Exploration programme drive growth in the Space industry, help pioneer novel and disruptive technologies and capitalise on these for commercial advantage?

The Society strongly supports the desire to maintain or increase the UK's market share in Space and related activities. RAS Fellows were involved in formulating the 'Case4Space', some are based in space-related industries in companies like EADS Astrium and many others are involved in related programmes.

In the area of exploration, many UK space scientists work on cutting-edge projects, usually within an international framework. For example, the ESA Aurora and UK-led MoonLITE programmes are of great scientific importance and help to attract and retain talented scientists and engineers. There is also much innovative smaller scale work like the 'magnetic space shields' recently developed and demonstrated by scientists at the STFC Rutherford Appleton Laboratory. Researchers are also working on micro-thruster technology, essential for missions like the gravitational wave observatory LISA, the X-ray observatory IXO and the planet finding mission Darwin, where multiple spacecraft have to fly in formation, on ion drives, power technology (e.g. solar cell development) and novel Radioisotope Thermoelectric Generators (as the world is running out of the plutonium required for these systems).

Future UK involvement and active participation in the ESA Horizon and Cosmic Visions programmes (including for example whichever of the Titan Saturn System Mission or Europa Jupiter System Mission is selected) will undoubtedly drive further innovation like the examples cited above.

The Society also believes that commercial development of space exploration should be encouraged by the RCUK, the BNSC partnership (or a future space agency), DIUS and DBERR. Along with the direct stimulation of a high-value industry this offers the opportunity to reduce expenditure in the long term. It should lead to lower-cost launches and will likely expand opportunities to access space, for example by commercial operators carrying sub-orbital research payloads along with their passengers.

Science: How can the UK maintain its world-leading position in areas of fundamental science like the history and formation of the Moon and the development of life?

The principal scientific importance of the Moon arises from the fact that its ancient surface preserves a record of the early geological evolution of a terrestrial planet, and of the space environment in the inner Solar System billions of years ago. Through our involvement with the Indian Chandrayaan-1 lunar orbiter (the UK provided the C1XS instrument), the US Lunar Reconnaissance Orbiter (the UK is involved in the DIVINER instrument), and the proposed UK-led MoonLITE mission, the UK is playing an active role in lunar exploration. These developments are helping to building up a community of UK lunar scientists who will be well-placed to make major contributions to lunar science in the context of future exploration programmes. In order to maintain this momentum it is important that the UK is actively engaged with international lunar programmes, as envisaged by the Global Exploration Strategy.

Alongside a suite of US missions, ESA's Mars Express orbiter has successfully detected some of the ingredients that hint at the possibility of extinct or continuing life on Mars, such as methane and water ice. Beginning with the ExoMARS orbiter and rover, the Aurora programme will continue this work over the next two decades with significant scientific and industrial involvement from the UK. Beyond 2020, the proposed ESA mission to Jupiter and Europa (or Saturn and Titan) should investigate another candidate location for extraterrestrial life in the Solar System.

The GES (and this consultation) specifically refer to exploration by both robots and astronauts. In this vein, a report commissioned by the RAS in 2005 concluded that there were specific scientific goals that could only be met by Human Space Exploration (HSE - see **http://www.ras.org.uk/index.php?option=com_content&task=view&id=846&Itemid=2** for the full report).

However, the Society remains concerned that involvement in HSE could be at the expense of scientific research and / or education elsewhere and that a decision to participate requires investment additional to the core science, research and education budgets. In an electronic poll of RAS Fellows in early 2007, more than 96% of the 460 respondents supported this position. With this caveat, the RAS therefore broadly supports UK participation in HSE.

There is also the issue of investment in fundamental research. UK scientists are increasingly running into problems with the level of funding for ESA programmes. If we are not able to put sufficient resources into providing instruments for the missions ESA is supporting, and for which we are paying through the subscription, we lose leadership opportunities on the key instrumentation and science activities. There is therefore a risk that our scientists will no longer be able to obtain leadership roles in these ventures, reducing the effectiveness of the UK space programme.

How can the UK capture the wider scientific benefits stimulated by the inherently cross-disciplinary nature of the exploration programme (e.g. in medicine, energy and autonomous systems)?

There are significant benefits that have already resulted from the spin-off of space technology into ground-based applications. Examples include detectors originally designed to study the

wider Universe that are now deployed to diagnose and improve the treatment of cancer. Miniaturised instruments on planetary landers have been turned into hand-held devices for field geology and a hand-held gamma camera for use during surgery. Similar developments can only continue to be realised if the science base remains in good health.

Skills: How should the UK invest in order to develop the next cadre of experts in spacecraft and instrument development?

Currently, it is very difficult to provide adequate hands-on training for the next generation of experts. In universities in particular, the costs of access to space and the timescale of space programmes have made it almost impossible to give students exposure to real space systems. However, there are new opportunities, with appropriate low level funding, that could be exploited to provide this experience. The Research Councils and HEFCE should be encouraged in their funding models to provide support for these projects and to act as brokers (in the case of STFC) for launch opportunities.

For example, the UK could actively engage with the small rocket programmes operating out of EU sites such as Andoya and Kiruna or the Cubesat projects, where a satellite costs of the order of £20k.

It is also necessary to continue adequate support of the fundamental and inspirational exploration programmes that draw in the talent required.

Inspiration: How should the UK position itself to use of the exploration of the Solar System to attract the next generation of young scientists and engineers?

The RAS welcomes and supports any move to use space exploration to attract young people to work in science and engineering and strongly supports this strategy. The Society believes it should be broad-based, involve relevant learned societies, universities, industry, science centres and museums and draw on the techniques successfully adopted by DIUS in the current 'Science – so what? So everything' campaign.

With a large number of space scientists in the RAS fellowship, the Society would be happy to support this work, both in the development of the strategy and in the delivery of the resulting public engagement programme. Our Education Committee (EdComm) contains practicing teachers, researchers, outreach and engagement specialists and a representative from OFSTED, all of whom consider how best to use astronomy and space science to engender interest in the physical sciences. EdComm would therefore be well placed to assist in setting the direction of this strategy. One early suggestion from Fellows is that projects like Cubesat could be extended into school level education - evidence from the Scottish Space School and National Space Centre indicate that direct participation of this kind can be very inspiring.

Leadership of space exploration in the UK

It is the belief of the RAS that the current structure (with BNSC as a partnership of a number of organisations) has served neither the space community nor the needs of the country effectively, a view echoed recently by the Royal Society (see for example

http://royalsociety.org/document.asp?tip=0&id=5915). The proposal for an enhanced Space Exploration programme demands increased funding and input from different stakeholders across society and the RAS remains concerned that BNSC lacks the strength to lead this work.

The Society believes that progress in space science and exploration would be facilitated by reforming BNSC into a new, independently funded, technically aware organisation for coordinating space exploration activities in the UK, which could take the form of an independent UK Space Agency.