THE FUTURE OF HUMAN SPACEFLIGHT: A REVIEW OF UK NATIONAL STRATEGY

RAeS SPACE GROUP

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Front cover: Tim Peake during training for his mission to the International Space Station. NASA/Bill Stafford.

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SUMMARY

The UK National strategy for human spaceflight published in July 2015 is reviewed; a pertinent time with the imminent launch of British ESA astronaut Tim Peake to the International Space Station.

Three themes are selected for discussion: growth as an investment criterion, synergy between human and robotic spaceflight, and the vision for UK HSF. The overall response to the strategy is strongly positive because of the commitment to commercial benefits. A number of actions are identified for both government and industry to help ensure that the objectives laid down in the strategy document are achieved.

Responses to this paper would be welcomed to help refine the recommendations.

INTRODUCTION

1. Following almost three decades of a UK Government policy to not fund Human Space Flight (HSF) a government strategy document published in July 2015 by the UK Space Agency (UKSA) defined the logic for changing that policy. The change reflects, and provides a post-hoc rationalisation for, recent British funding of the European Space Agency (ESA) programme related to use of the facilities on the International Space Station (ISS). Tim Peake’s December 2015 to May 2016 mission to the ISS places the strategy firmly in the public and political spotlight.

2. The Royal Aeronautical Society published discussion papers related to UK HSF policy in 2005 and 2009, and considers the publication of the UK HSF strategy to be sufficiently important to warrant this new discussion paper.

3. This paper confines itself to the HSF aspects of the strategy document and omits discussion of ‘space environments’ – the term used in the strategy document for what is often referred to as ‘microgravity research’.

Structure of This Paper

4. After a detailed review of the strategy document, three topics have been selected under which to group the points for discussion. Each topic is covered in a separate section below and then some final concluding remarks are presented. The three topics are:

   - Growth and UK industry as Government HSF Investment Criteria
   - Synergy of Robotic Space Missions with HSF
   - UK’s Vision for HSF

5. Recommendations for action have been formulated to provoke discussion. The address to which to send comments is provided on page 2. The 1 December 2015 conference on human spaceflight provided an opportunity to comment on the paper.
8. ‘Growth’ is identified as the over-arching criterion for the HSF programme. We welcome this very strongly, since we consider that public sector investment in this domain cannot be justified in the current economic climate unless it generates economic growth. Commitment to a growth-led agenda will enhance the long-term sustainability of the programme.

9. The strategy strengthens the promise of growth by committing to “UK industrial capability and interests” being reflected in the specific programme plans to which the UK subscribes. A related goal is identified of “positioning UK for leadership of technologies for human exploration beyond LEO.” Furthermore, the Agency promises to work closely with industry and with international space agencies to ‘secure commercial opportunities for UK companies.” We strongly endorse these and encourage the UK Space Agency and the UK’s space trade association, UKspace, to set in place dialogue and governance arrangements to support them.

10. The strategy selects ESA’s ISS Utilisation programme because it offers “maximum return for UK investment” compared to investment in either of the other two approaches considered. On that basis, the selection is consistent with the objective of ensuring that “investment is well targeted.” Another justification for choosing this approach is that the UK Space Agency will have a seat at the table and thus help in determining the programme’s directions and priorities – although that would presumably also be true to some extent with bilateral or commercial programmes (the two alternatives). We welcome the commitment to gather evidence to measure the impact of the programme, which will help the Agency to monitor the return on investment and make future investment decisions.

11. The strategy aims to make the UK a place with the expertise and capacity to support HSF. The commitment to invest in the space segment infrastructure aspects of HSF is a significant change of policy from that of the past 30 years. The strategy mentions spaceflight infrastructure and “world leading capabilities in telecommunications and propulsion systems” as well as “developing capability in new areas where the UK can take the lead.” We would like the Agency to confirm that this list of “world-leading capabilities” is illustrative rather than exhaustive.

12. Not mentioned in the strategy is the fact that when last the UK’s technical strengths in HSF were competitively tested in European competition (in the Phases A and B of the ESA Columbus programme in the early to mid-1980s), software emerged as by far the most successful UK discipline. Note that the UK provided 15% of the Columbus pre-development phase funding, a third of which was to give the UK leadership in software, but withdrew from the development phase. NASA absorbed the UK from HSF in the late 1980s had no impact on the polar platform programme which morphed eventually into the Envisat satellite. The UK’s Columbus software leadership role was however immediately lost, being absorbed into the work of the prime and major subcontractors in the other participating countries. We would encourage the Agency to consider whether this new strategy is an opportunity to return the UK to its former role of European HSF software leadership.

13. We welcome the strategy’s endorsement of commercial HSF and its linkage to taking regulatory action and to supporting biomedical research. This is a forward looking perspective made even more interesting by its linkage to the establishment of a UK spaceport to support commercial spaceflight.

14. The strategy states that Tim Peake’s Principia mission provides an excellent opportunity to showcase leading UK science and technology. We agree, and we urge all UK space sector stakeholders to work with the UK Space Agency to take maximum advantage of this chance to advertise the UK’s strong track record in space to policy makers and to the general public.

SYNERGY OF ROBOTIC SPACE MISSIONS WITH HSF

15. The strategy calls for “expanding the synergies between human and robotic missions.” Previous RAeS discussion papers have encouraged this approach and have pointed out the relevance to HSF of many UK robotic space capabilities – we are pleased that the Agency listened to us, since we consider that our arguments are still valid.

16. In a December 2005 RAeS Discussion Paper, we noted that in the Earth-Moon system almost all activities could be undertaken via interactive control from Earth because the round-trip delay is less than three seconds. Hence human-in-the-loop can in principle be achieved without the need for human-in-space. Even in the depths of the lunar far-side, relay satellites in lunar orbit could provide human-in-the-loop, while close to the nearside, cable or microwave relay links to the nearside could do the same.

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16Humans in space – UK policy; The Aerospace Professional, December 2005, pp 14-16.
17. In a May 2008 RAeS Discussion Paper\(^1\) we argued that the development of systems for exploration of the lunar surface could be used as a driver for advanced robotics, including mechanisms, software and miniaturisation. We also suggested that the Internet has opened up new perspectives on space exploration. The example we gave was of a video feed from a rover traversing the Moon’s surface that could be made available to the public, with annotation and/or voice-over to identify features of interest. We speculated that if the rover had both wide-area and telescopic cameras, images from either could be selected by the viewer – similar to the options TV viewers are offered during Wimbledon tennis and Formula 1 racing. Real-time imagery from an orbiter could also be made available, annotated with information about the contents of the pictures.

18. Today’s technology strengthens the above arguments and suggests that ‘virtual astronautics’ involving robotic flight avatars has the potential to deliver many of the benefits of HSF, with less risk, and with the additional benefit of offering avenues for direct public engagement and for persistent presence in space. This type of initiative would build on the UK’s world-leading capabilities in computer gaming and related technologies as well as on our established strong track record in space software. It would also provide a natural follow on to many of the STEM youth outreach aspects of Tim Peake’s mission. We recommend therefore that the UK Space Agency promotes a lead role for UK industry in a virtual astronautics strand in ESA’s HSF programme.

19. The strategy rightly addresses the post-ISS era\(^1\). We consider that robotic missions have an important and cost-effective role to play in both direct and indirect support of any post-ISS programmes. Direct roles could consist of elements of infrastructure and/or support services required for HSF missions. Indirect roles could include undertaking research needed to optimise HSF programmes, for example (i) research in orbit into the biomedical effects on animals of various levels of artificial gravity, (ii) identification and detailed characterisation of potential HSF destinations. Given the UK heritage in robotic space systems we recommend that the UK Space Agency promotes a lead role for UK industry in a robotic systems strand of ESA’s post-ISS activities.

UK’S VISION FOR HSF

20. We welcome the attempt in the strategy to define a vision for the UK’s HSF activities. The high-level vision is defined\(^1\) as “the UK being a recognised and valued partner in HSF”. The strategy states\(^2\) that the long-term objective “ultimately leads to human missions on the surface of Mars or other solar systems planets, moons or asteroids.” This last ambition refers to the goals in the Global Exploration Roadmap\(^2\) (GER) but in fact it is a more ambitious version of those goals (GER limits itself to Mars as the ‘ultimate’ destination). We support the generalisation of this long-term goal away from Mars as the only identified destination.

21. The strategy rightly recognises\(^2\) that to be a ‘valued participant’ requires the UK to have “the expertise and capacity to support HSF”. In our view, such expertise or capacity needs to be cost-effective or world-leading if the UK is to be seen as a ‘valued’ partner. This would obviously reduce the number of areas where the UK could claim ‘valued partner’ status so we would welcome confirmation from the Agency that they share our view on this point.

22. Some short term aspects of the vision are mentioned\(^2\), viz “The path towards the achievement of the vision begins with space-analogue and orbital platforms...” and “The first steps focus on utilising the ISS, expanding the synergies between human and robotic missions, and pursuing discovery-driven missions in the lunar vicinity that help to develop capabilities and techniques needed to go further, as described in the GER.” It would be helpful to understand better what the vision is for the UK’s roles in these global initiatives. We recommend that the UK Space Agency undertakes an exercise to flesh out the short-term UK roles and communicates them to interested stakeholders.

23. Research priorities are addressed\(^2\) in the strategy making reference to research programmes in the Research Councils. With one or two obvious exceptions such as life and biomedical sciences, it is difficult to discern the link between these ‘highlighted areas’ (as the strategy calls them) and HSF. Establishing the research priorities for HSF is important to ensure that long term investments are optimised. We would therefore welcome further detailing and clarification by the Agency of the linkage between the highlighted research areas and HSF.

CONCLUDING REMARKS

24. The publication of a strategy that links Britain’s HSF activities to industrial growth is very welcome. The widespread enthusiasm that is likely to follow Tim Peake’s Principia mission will make it all the more important that the growth element of the HSF strategy gets underway immediately. Industry and government stakeholders need to engage rapidly to agree how to deliver on this.
SUMMARY OF RECOMMENDED ACTIONS

Growth and UK industry as Government HSF Investment Criteria
1. UKSA/UKspace to exploit opportunities in international programmes
2. UKSA to confirm list of world-leading capabilities is illustrative
3. UKSA to consider opportunity to return UK to European HSF software leadership

Synergy of Robotic Space Missions with HSF
4. UKSA to push for UK lead industrial role in virtual astronautics
5. UKSA to push for UK lead industrial role in post-ISS era robotic missions

UK’s Vision for HSF
6. UKSA to clarify criteria for ‘valued partner’
7. UKSA to flesh out short term UK roles
8. UKSA to clarify linkage between research priorities and HSF

We note with interest the various stakeholders identified by Government on the final page of the strategy document and we encourage UKSA to consider extending the list of Learned Societies to include the RAeS. On our side we stand ready to help UKSA to engage with the space community at home and abroad in pursuit of its HSF goals.