THE EDUCATION AND SKILLS CASE FOR SPACE

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Executive Summary

Our survey found that space has a direct, positive effect on educational and career decisions and on participation and achievement in physical sciences at GCSE, A-level and in Higher Education. It also improves motivation and behaviour. Substantial anecdotal evidence and limited but persuasive quantified evidence (some newly presented in this report) support these assertions.

Respondents feel that space appeals to boys and girls across ages, abilities and cultures; it connects to unanswered questions, large scale resources and innovative technologies. Beyond science, it has global, environmental, ethical, humanitarian and enterprise dimensions. No other theme is suggested with as much opportunity to interest, motivate and influence young people.

National space activity is considered important. Awareness of the UK space industry is low, but Universities most closely connected to it attract students into physics against the national trend, affecting career choices and the UK's skill and knowledge base.

Teachers want resources directly linked to curriculum outcomes and easy to locate and use, and the NASA website is the main resource for most. With changed national priorities, new GCSE syllabuses, specialist diplomas and out-of hours learning there is demand for new resource. Many feel that UK space-related material is ideally placed to meet this demand.

Science is universally seen as essential for technological and economic success but fewer young people enter scientific studies and careers. Across the world space is used to attract them into STEM areas and to achieve broader educational objectives. In the UK, Scotland has space most embedded in the curriculum. Northern Ireland has a new Space Office and space will feature more in the curriculum there.

There is global agreement about why space is used in the curriculum; it contributes to SCIENCE, to ENTERPRISE and to ENVIRONMENTAL outcomes. Science motives range from narrow, for future space industry and STEM professionals, to broad, for career awareness or informed citizenship. Space is felt to offer a contemporary and exciting context for science learning. Enterprise and Environmental motives for using space include global, political, cultural and personal themes.

Claims are universally made that space attracts young people into STEM subjects and careers, though few countries can offer quantitative evidence for this. Evidence from Space Camp shows a very positive impact. From 2007 NASA education programmes must include self-evaluation, student feedback and longitudinal data.

The Space Industry has one of the highest skill and productivity levels of any UK industry. It has an ageing workforce and faces potential loss of much experience and knowledge. Careers information, advice and guidance are found inadequate. The industry needs specialist knowledge and broader skills such as project management and team-working. The industry has skills gaps (within the existing workforce), skills shortages (recruitment problems), and there is concern about the skill levels of new recruits.

INTRODUCTION AND BACKGROUND

0.1 This study was commissioned as one component of the broad Case for Space that is being made by UK space industries through UKISC (the United Kingdom Industrial Space Committee) as the Government's investment in space is examined within the 2007 Comprehensive Spending Review.

0.2 The study is based on the premise that alongside industrial, economic and other arguments, there are important education and skills dimensions to the case for retaining and developing a healthy UK space industry. It seeks to draw out - and where possible quantify - the educational benefits of space activity within the UK and to establish the extent to which these benefits have been identified elsewhere.

A new UK Space Strategy is due in 2007

0.3 Current UK space activity falls within the three objectives described in the *UK Space Strategy 2003-2006 and beyond*. [1] These can be summarised as:

- SPACE FOR SCIENCE - enhancing the UK's standing in astronomy, planetary and environmental sciences;
- SPACE FOR ENTERPRISE - stimulating increased productivity by promoting the use of space in government, science and commerce; and
- SPACE FOR THE ENVIRONMENT - developing innovative space technologies and systems, to deliver sustainable improvement in the quality of life.

0.4 These three objectives relate directly to important underlying purposes of education itself, and epitomise the reasons for including space in curricular and extra-curricular activity.

0.5 It should be stated at the outset that this study is not about space education for its own sake, nor is it about the education and skills needed by the space industry of the future; it is about the potential benefit that national and international space activity can bring to education and skills as a whole. It does not seek to make a case for space education, but rather to make an educational case for space.

0.6 Given the particular connection between space and the STEM subjects (Science, Technology, Engineering and Mathematics) another vital context is that these subjects have just been restated as priorities by the Government. Following the 2006 Budget a key paper [2] has spelled out ambitions to:

- achieve year on year increases in the number of young people taking A-levels in physics, chemistry and mathematics;
- continually improve the number of pupils getting at least level 6 at the end of Key Stage 3 (11-14 year olds);
- continually improve the number of pupils achieving A*-B and A*-C grades in two science GCSEs; and
- step up recruitment, retraining and retention of physics, chemistry and mathematics specialist teachers.

0.7 To meet these goals, the Government has announced a package of measures to improve the skills of science teachers, the quality of science lessons and increase progression to A-level sciences, including new commitments to:

- make science a priority in schools by including science in the School Accountability Framework;
- an entitlement from 2008 for all pupils achieving at least level 6 at Key Stage 3 to study three separate science GCSEs, to increase progression to, and attainment at, A level science;
- continue the drive to recruit science graduates into teaching via Employment Based Routes with new incentives to providers of £1,000 per recruit to attract more physics and chemistry teachers; and
- develop and pilot a Continuing Professional Development (CPD) programme, leading to an accredited diploma, to give existing science teachers without a physics and chemistry specialism the deep subject knowledge and pedagogy they need to teach these subjects effectively.

0.8 The above measures present a significant opportunity for increased use of space in the science curriculum.

Study Objectives

0.9 The objectives of the present study are expressed as six key questions, and in the following chapters we look at each in turn.

KEY QUESTIONS

1. **What is the evidence that engagement with space makes a difference to the education and career choices of young people?**
2. **How does space compare with other themes in engaging young people on Science / Engineering / Technology?**
3. **What is the evidence that engagement with national space activities makes an added difference to the education and career choices of young people, compared with engagement with space activities where there is no UK involvement?**
4. **What evidence is there that space is recognised by authorities around the world as a key educational tool?**
5. **What assessments have been made elsewhere as to the reason for using space in education, and the subsequent benefits from following this strategy?**
6. **How does the skills base of the UK Space Industry compare with other industries?**

Study Methodology

0.10 The study was carried out during April and May 2006. Bookwork methodologies included surveying UK and international data and referring to related studies, including cross-reference to the wider Case for Space study activity.

0.11 A questionnaire was devised (see Appendix 1), mainly for use with personal or telephone interviews, but in a few cases used by email or postal returns. The questionnaire formed the basis for interviewing key agencies, for establishing views and attitudes and for developing case studies. Three slight variants were produced to allow for the perspectives of:

- education providers and agencies;
- industry; and
- students

0.12 46 completed questionnaires were received, backed up in many cases by extensive personal and telephone interviews. The British Rocket Oral History Project (BROHP) annual gathering at Charterhouse School in April 2006 was a concentrated gathering of many parties concerned with space in education, and was of significant benefit to the study.

0.13 At an early stage in the study, on offer was received from the Institute of Mechanical Engineers (IMechE) to survey their membership electronically. This was gratefully accepted, and a modified survey instrument was devised (see Appendix 2) to fit the parameters and methodologies of such surveys. The survey was sent to 3000 members of IMechE (between 25 and 55 years old) on 18 April 2006. 498 responses (16.6%) had been received by 11 May 2006.

Acknowledge-ments

0.14 We are grateful to all respondents to our surveys and interviews, and specifically to the following for their direct contribution to the study (any errors or omissions are of course entirely our responsibility):

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KEY QUESTION 1

What is the evidence that engagement with space makes a difference to the education and career choices of young people?

Space in the English National Curriculum

1.1 Schools use space activity at all key stages (KS), from KS1 (age 5-7) to Post-16. There is greater emphasis on space activity at KS2 (7-11) and KS3 (11-14) and increasingly at KS4 (14-16). To a degree this is encouraged by the requirements of the National Curriculum and by provision of GCSE options related to space activity and astronomy.

A typical KS2 attainment target: use simple models to explain effects that are caused by the movement of the earth, e.g. the length of a day or year.

1.2 In KS2 the knowledge, skills and understanding requirements include The Earth and Beyond.

1.3 Building on this, at KS3 The Earth and Beyond programme of study requires pupils to be taught:

- how the movement of the earth causes the apparent daily and annual movement of the Sun and other stars;
- the relative positions of the Earth, Sun and planets in the solar system;
- about the movements of planets around the sun and to relate these to gravitational forces;
- that the Sun and other stars are light sources and that the planets and other bodies are seen by reflected light; and
- about the use of artificial satellites and probes to observe the earth and explore the solar system.

The KS4 PoS states that the following should be covered: 'The solar system is part of the universe, which has changed since its origin and continues to show long term changes.'

1.4 From 2006 a new programme of study (PoS) for Science at KS4 gives greater emphasis to space activity and related themes. At the same time a new GCSE in Applied Science becomes available to fulfil these new National Curriculum requirements.

1.5 All GCSE Physics syllabuses cover 'The Earth and beyond.' In addition, the Edexcel Examining Board offers a GCSE in Astronomy.

1.6 Post-16, space themes are used in many A-level Physics courses to demonstrate key principles such as forces and gravity.

Space across the curriculum

1.7 It is evident that beyond the space-specific National Curriculum requirements, many schools use the space theme across STEM and a number of other subject areas at all key stages. Examples from the survey include:

- Design & Technology: ratios (weight to power etc), control of vehicles, robots.
- Geography: remote sensing as basis for data mapping, land-use; where best to launch rockets; generalising landscaping and atmospheric effects, exploring their impact on earth compared to Mars.

"We include as many examples of the space industry in our science teaching as we can. Newton's 3rd Law of motion is far more interesting to pupils when you tell them that, 'if you break wind in space you move forward!'" (Barbara George, Dyffryn HS)

- Biology: environmental lessons, earth science
- Chemistry: hydrocarbons on Titan
- English: creative writing, drama. role-play, communications
- Creative: (Music, Art, Design)
- ICT: space offers an exciting context

1.8 The use of the space theme as an extra-curricular activity appears to be widespread. Most typically these are astronomy or rocketry / rocket building clubs and are found in both Primary and Secondary schools. They are invariably the result of on an individual teacher's interest. Other activities include space themed activity days and talks by visiting astronauts from both NASA and Star City (Moscow).

Space in Extra-Curricular Activity

1.9 Although taking place out of school hours, many of the activities have direct links to the curriculum. Some of these activities have involved large numbers of schools and pupils and clearly demonstrate the interest aroused by the space theme. The use of space in extra-curricular activity is explored further in Key Question 2.

1.10 Some Primary Schools hold a Space Week during which the whole curriculum is covered using space themes. A recent example is Oakworth Primary School in Keighley, West Yorkshire. A number of survey respondents also mentioned the value of space as a link programme between Primary and Secondary schools (e.g. St Peter & St Paul's, Halton).

The Impact of Space on Learning

1.11 All the survey respondents were enthusiastic about the use of the space theme on young people's learning, including its effect on behaviour, motivation and achievement. There is much anecdotal and little quantifiable evidence, but the cumulative and consistent messages become powerful.

"Space activity is inspirational" (Secondary Science teacher)

"Space exploration creates a sense of wonder" (Primary teacher)

"The College of St Mark and St John (Plymouth) offers an Exeter University validated MA to teachers which includes a 'space in the classroom' module. Teacher reports show an almost universal pupil improvement in behaviour, motivation and achievement. Small scale action research projects indicate that positive outcomes are shown on motivation and student achievement measured over the six month period of the project."

Steve Lloyd, College of St Mark and St John

"Space is one of the two most popular themes (the other is dinosaurs) among children of Primary age. Teachers report huge interest and motivation when using the space theme."

Steve Smyth, London SETNET

"I have no quantifiable evidence that I could refer to, but I certainly fill in less behavioural report forms than when doing other topics."

Barbara George, Head of Physics, Dyffryn High School

The Impact of Space on Educational Outcomes and Choices

1.12 Key Question 1 concerns the long-term impact of space through its effect on educational and career choices. Mean and Wilsdon [3] conclude that "children are … excited by space, as shown by the popularity of the space exhibits at the Science Museum and the National Space Centre at Leicester, but this enthusiasm is rarely converted into longer-term engagement with space." They attribute this to the nature of UK space: "For space to work as public space, openness and accessibility are key. Currently, the UK space community fails this test. It is dominated by two groups – industry experts and amateur enthusiasts – whose average profile is white, male and middle-aged."

1.13 In 2000, Jarvis and Pell [4] monitored 650 children's attitudes toward the Challenger space simulation experience in Leicester. They investigated 10 and 11 year-old boys' and girls' general attitudes toward science and space during the mission and 5 months after their visit by examining their responses to five different attitude scales. Immediately after the Challenger experience 24% of boys and girls became more positive about wanting to follow a scientific career in the future. This change of attitude was maintained to a certain extent for several months.

1.14 One of their most striking findings was that girls were more likely to be inspired by Challenger to want become scientists than were the boys. These girls also improved their appreciation of the value of science to society; this remained relatively stable over the five months.

1.15 Jarvis and Pell's second study [5] covered general school visits to the National Space Centre. Additional variables such as teacher preparation and patterns of group and leader behaviour caused them to conclude that "there is no evidence of a long-term effect on enthusiasm for science due to the visit for the whole sample." There were positive outcomes for some, however: "It is a common trend that pupils' enthusiasm for science declines in Year 5 and 6 of primary school. It appears that the visit made an important impact on 18% of boys and 20% of girls that halted, and for the 5-month period reversed, the decline."

1.16 Our survey responses included examples of sustained intervention which have resulted in quantifiable positive educational outcomes. Over a ten year period Anu Ojha, an Advanced Skills Teacher of Physics at Perry Barr High School, Birmingham, has systematically recorded the impact of space-related ideas on pupils' educational outcomes for use during annual Performance Management reviews or as evidence for threshold and Advanced Skills Teacher assessment. He has amassed data from classes in which space was used extensively as a context for learning within different Key Stages and different ability groups in state schools in Coventry and Norfolk.

1.17 His data shows that the space context has had significant measurable impact on achievement, often on whole classes. Students have regularly achieved better than predicted grades at GCSE and A-level, and increased numbers have progressed on to physics and related courses at University.

The Scottish Space School

1.18 Careers Scotland (CS) have the responsibility for matching the skill needs of the Scottish economy against learning and training provision in order to meet the needs of employers, as well as the aspirations of individual learners. As elsewhere in the UK, Scotland has a serious shortage of young people wanting to go into careers in science and engineering. In order to address this problem CS made the decision to use space activity as a major motivating 'tool' to promote learning and career opportunities in these areas. They therefore introduced the Scottish Space School, targeted at the full age range, 5-18.

Space School also offers CPD opportunities for science teachers from every LEA up to a max of 100. To date 20 teachers have attended Space Camp in Houston or summer school at Strathclyde.

1.19 The aim of the Space School is to "promote understanding and enthusiasm for science as a career and ensure that enough people study science to a standard which will enable the future needs of the country to be met." The objectives are to:

- Provide inspiration, increase motivation and raise aspirations of young people in STEM subjects;
- Encourage more students to study science related courses at Standard Grade (SG), Higher Grade (HG) and University;
- Promote the wide range of career opportunities in science and technology; and
- Increase self-confidence through the development of high quality communication and team-building and problem solving skills

Blast off to science links in with the 5-14 curriculum 'Earth and Space' topic and is backed up by support materials for teachers and pupils on the Scottish Science & Technology Network web site (SSTN). It is expected that 25,000 pupils (over 22,000 in 2004) will attend a session of Blast Off

1.20 There are two principal activities:

- **Residential Programme**

  Each LEA is invited to participate. For students from the S4 cohort (equivalent to Y11) preparing for SG Science. 3000 take part, 50 of whom are selected to attend Space Camp at Houston Space Centre and a further 120 attend a summer school supported by NASA Astronauts and scientists at the University of Strathclyde.

- **Blast-off to Science**

  This is a NASA visit programme. In June each year NASA astronauts and scientists visit Scotland to support CS's *Festival of Science and Enterprise*. Each LEA is offered the opportunity to host an astronaut for a day to work with SI (Year 8) pupils and encourage them to select two sciences for study at Standard Grade.

1.21 The Space School provides teachers with a context for the application of classroom based knowledge and skills. E.g. NASA modules complement Unit 7 of SG Physics, in particular the topics on Rockets, Interplanetary Flight, Gravity and Weightlessness, Artificial Satellites, Projectiles and Re-entry. There are also links from NASA's web-based educational material to the SG and HG Curricula on the Space School website.

1.22 Both the Space School and Blast off to Science are designed to

increase the popularity of, and therefore influence choices towards, the STEM subjects. Space School has already shown a noticeable impact, but Blast Off impact data will take longer.

1.23 Subject choices at Higher Grade in S5 (Year 12), S6 (Year 13) and at university are the measure used, and at Standard Grade more students choosing two sciences is the prime objective.

1.24 A tracking system is in place and there is already evidence of the impact of the programmes. In particular, significant growth in the numbers of young people attending for interview at Scotland's four main engineering universities who have cited Space School as a major influence. The table shows this influence for the 53 students who attended either the Houston or Strathclyde space school programmes in 2004 and then chose to apply for University courses. They were asked whether the Space School experience influenced their course or career decisions.

"Space School may turn out to be the defining moment in the careers of many of our young people; it has certainly inspired me to motivate my pupils towards science." (Teacher)

Influence of Space School on Course / Career Choice	**Nos.**
Directly influenced the decision to follow Science / Engineering Course or Career	25
Already wanted to do a STEM related course / career but space school reinforced this choice	12
Didn't influence choice but helped in other ways	12
No influence and may actually have turned off choice of science / engineering course / career	4
Total number of students	53

1.25 Students indicated a number of other benefits of their Space School experience including:

- Increased confidence
- Enhanced team building / problem solving capabilities
- Reduced concern about moving away from home
- Influence on choice of University
- New insights into the type of courses / careers that are possible

Information on the Scottish Space School was provided by Gordon McVie (Careers Scotland)

1.26 Dyffryn High School has seen a dramatic increase in the numbers of pupils opting to do triple science at GCSE through the use of space activity. Barbara George reports that in

Dyffryn High School is an 11-16 High School in Port Talbot

2004 – 2006 the school had one group of 27 pupils doing triple science out of a year group of 170. In 2005 – 2007, following space experience at KS3, there are two groups of 25 and 26 pupils doing triple science in a same size year group. There has also been an effect on the numbers choosing to do A-level Physics. *"We currently have more pupils taking A-level Physics when they leave our school. In the present group 12 are expressing a real intention to study A- level Physics."* She adds that the use of space activity has had a positive impact on pupil behaviour.

1.27 Andrea Fesmer from St Peter and St Paul's High School, Widnes introduced a space module in 2001. From her top Science set of 30 pupils each year, the number opting for AS level Physics rose from 4 in 2000 to 17 in 2001.

1.28 Mike Grocott, Director of the Callington Space Centre near Launceston responded that *"Through running a selection procedure for Y12 and 13 students to win the opportunity to travel to either America or to the Russian Space Olympics in Moscow, students have gone on to choose STEM related degree courses. The use of the Space Centre has also ensured that post-16 choices for Physics and mathematics are healthy in the present climate."*

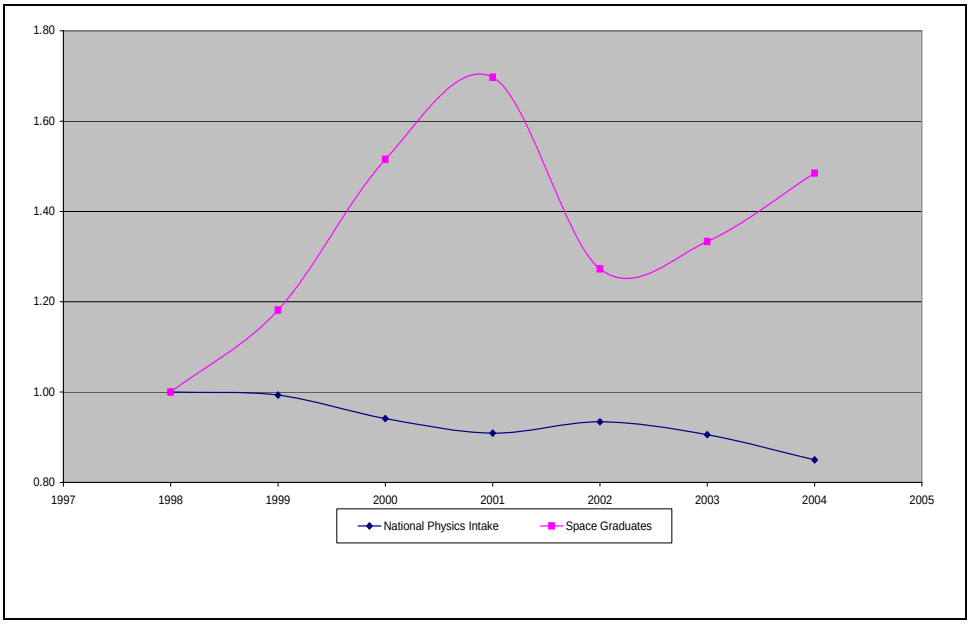
The Impact of Space on Higher Education Choices

1.29 Another important effect of the Scottish Space Camp experience is the impact on the choice of Universities by individual students. Of the 53 students involved 32 (60%) chose to go to the two universities directly involved in the Space School programme rather than to others in Scotland or elsewhere in the UK.

1.30 There is also evidence that a 'space' option can increase the popularity of Physics degree courses. As part of the Institute of Physics Survey of Graduate and Undergraduate Views in March 2001 [6] students were asked to choose the most important factors motivating their recruitment to physics at university. Fascination with astronomy / space / science fiction came out highest among 24+ yr old undergraduates, 2nd highest among under 23 yr olds undergraduates and 3rd highest among graduates recruiting to postgraduate study.

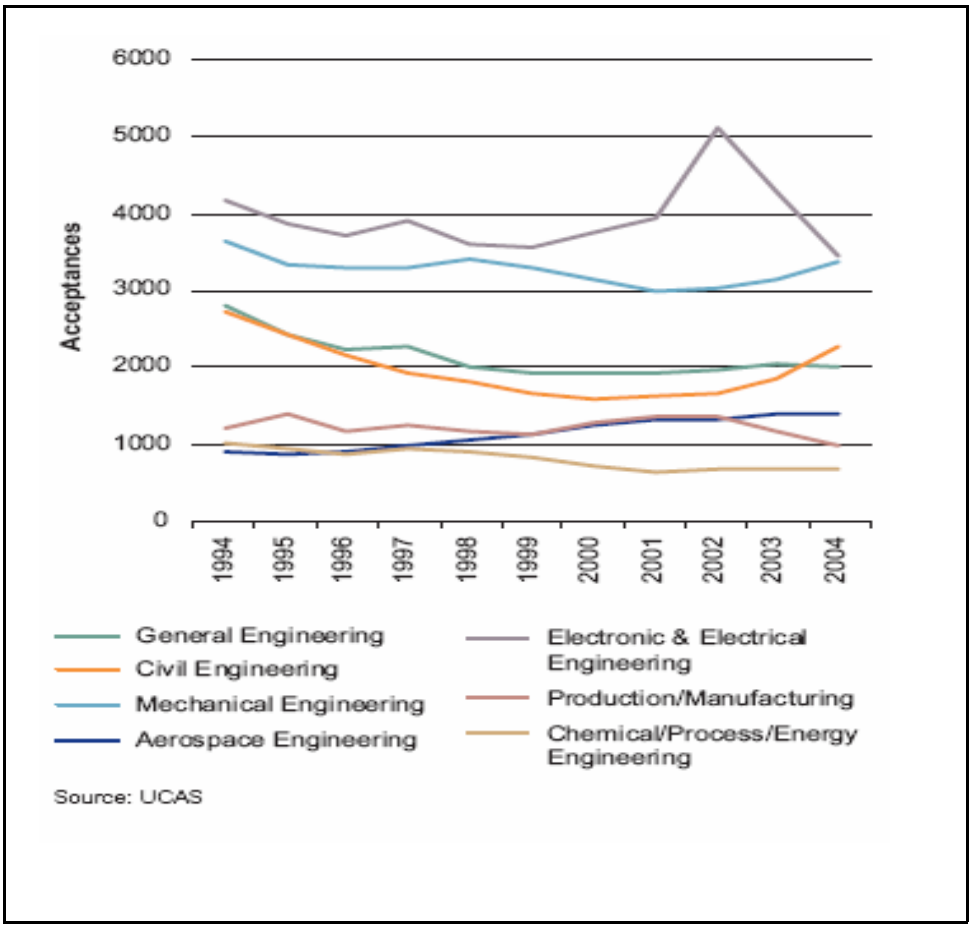
1.31 Salford University reports considerably larger numbers opting for the Physics with Space Technology programme than for more traditional Physics courses.

1.32 Similarly Professor Alan Wells of the University of Leicester and the National Space Centre reports that while the national trend in Physics recruitment shows a decline, the intake at Leicester is bucking that trend, which he attributes to the involvement with space activity:



National A-Level Pass Rates since 1998, compared with Space Science and Astrophysics Graduate Rates from Leicester (normalised on 1998 figures).

1.33 Further evidence of the positive impact of space activity is that of all acceptances on to engineering first degrees, only those for Aerospace Engineering have shown a consistent growth over the last ten years:



Home Acceptances on to Engineering First Degree Courses (data from UCAS, presented in Engineering UK 2005 [7])

The Impact of Space on Career Choices

1.34 Most of the evidence for the influence of space activity in school on career choice is retrospective - derived from people who have come through the education system and are now working, or preparing for working, in space-related industry. It is very difficult to track the progress of young people from the point of the 'space experience.'

1.35 Many people who choose a career in space-related industries point to the influence of an early interest in space exploration often following a school based experience.

"I should say that I was always interested in rockets and space. The activities at school that most energised me were when we studied space and astronomy in Physics. Our teacher had a telescope and would sometimes go out on the playing fields in the evening to help teach us astronomy."

James Habershon, Systems Engineer, BAE

"I was a greatly influenced by experiences at school. I found Mathematics difficult although I was good in Physics, Chemistry and Biology. Space gave some concrete problems to solve where Maths is a tool and not an end."

Elie Allouis, PhD Planetary Exploration, Surrey University

"It was during my time at university that I became particularly interested in space and the aerospace industry. There were two main factors, one was I was at Salford University where the Starchaser project was a key part of the physics department and this was something I was partly involved with through the department. The other was that my third year (out of 4) at university was an industrial placement year where I spent 12 months at BAE Systems. I did placements in various departments and found it interesting. It was the summer of this third year that I worked at MBDA before completing my studies at university."

Helen Horridge, formerly with MBDA; now re-training as a secondary school Physics teacher

"I was going to take a degree in Music Technology, but saw a picture of a rocket in the Leicester prospectus, and decided to take Physics with Space Science and Technology instead. This sounds far-fetched, but it is actually true! I have always been interested in Physics and space from a young age due to my father - I realised that the only way to pursue a career in this kind of environment would be with a degree in a physics-related subject."

Keith Sprake, BAE Systems

"I took part in the Careers Scotland Space School in January 2002. This involved a trip to the Johnston Space Centre in Houston. Having a chance to meet the engineers and receive first hand advice on how to get into the space industry directly affected my choice of university course."

Matthew Kay, Aeronautical Engineering student, Bristol

1.36 It is at this point that we introduce the findings of the survey of IMechE members referred to in the study methodology. The survey results add significant weight to the argument that space influences education and career choices.

1.37 Of the almost 500 respondents, 10% were in jobs 'very strongly connected' to the aerospace industry, a further 27% were 'strongly connected' and another 16% 'moderately connected'.

1.38 When asked how significant space was as a factor in influencing their own education and career decisions:

- 38% said that space was a significant factor in influencing their subject choices at school;
- 35% said that space was a significant factor in influencing their further and higher education choices; and
- 27% said that space was a significant factor in influencing their career choices.

1.39 When the engineers were asked whether they thought space influenced young people at school (moderate influence or higher):

- 80% thought that space influenced the motivation of young people;
- 25% thought that space influenced the examination achievement of young people; and
- 78% thought space influenced young people towards Science, Engineering and Technology subjects.

The Impact of Space Activity on Different Groups

1.40 The question arises about whether interest in space and the effects noted in preceding sections are universal, or whether the impact on certain groups is greater or less than on others.

1.41 Among the survey respondents there was full agreement that the space theme at KS 1 and 2 was equally successful with both boys and girls and, if pitched appropriately, with all ability levels. *"Every ability range seems to find its own level and loves it."* (Andrea Fesmer, St Peter and St Paul's HS, Widnes)

1.42 Although some respondents felt that this was also the case at KS 3 and KS4, more felt that boys were more interested and responsive to the theme than girls. Some also thought that there tended to be an identification of the theme with 'nerdy' or 'geeky' boys. *"At Primary schools it is of equal interest to both genders and all abilities. At Secondary schools it tends to be seen as a boys' subject, and a rather 'nerdy' one at that."* (Steve Smyth – London SETNET)

The Bradford and District Children's University uses space as the context for learning with the particular aim of challenging gender segregation in STEM employment areas. Using the

resources of Keighley College STAR centre, 'Bees in Space' clubs and a Space Summer Camp they set out to raise aspiration through the use of space. Director Mark Curtis says *"The challenge for all of us is to ensure that space is not the Final Frontier for girls and women – that space and the space industries are equal opportunities employers"*

1.43 Comment was also made about the success of the theme with the two extremes of the ability range. The theme was as popular with those classified as 'gifted and talented' as it was among those with learning difficulties: "*Space activities work best at the extremities of the ability range*." (Mike Cripps, Neatherd HS, Norfolk)

1.44 Commenting on age range one respondent noted *that "Lifelong Learners are often attracted to astronomy – there are a large number of part-time and distance learning courses in astronomy available across the UK, as well as a network of amateur astronomy societies. It is probably the only branch of science where this is the case."* (Andy Newsam, Liverpool JMU Astro-Physics Department)

1.45 One of the significant recommendations in the recent Barstow Report was that "Space should be adopted nationally as a flagship topic to enhance science teaching in general". (Barstow p19)

1.46 We leave the last word to Professor Stephen Donnelly, Dean of the Faculty of Computing, Science and Engineering, Salford University: *"My career choice was greatly influenced by following the coverage of the moon landings in the 1960's.* ***I am absolutely convinced that by giving space activity in the school science curriculum a higher profile it is possible to influence young people today into making educational and career choices that will significantly boost the numbers taking up science and engineering related options****."*

Conclusions on Key Question 1

1.47 Space has an overall positive and direct effect on educational and career decisions, and has a generally beneficial impact on motivation, behaviour and achievement. In the context of a general decline in interest and uptake of the physical sciences, an emphasis on space-related areas appears to oppose the trend at GCSE, A-level and in Higher Education.

1.48 In support of these assertions there is a substantial body of anecdotal evidence and a limited but persuasive body of quantified evidence, some of which is quite substantial, and all of which points in the same direction. New quantified evidence presented within this report reinforces the assertions.

KEY QUESTION 2

How does space compare with other themes in engaging young people on Science / Engineering / Technology?

2.1 Osborne and Collins [8] researched pupils' and parents' views of the schools science curriculum, and in doing so made some interesting comparisons across topics and subjects which make up the science curriculum. All pupils and parents saw science as important and prestigious, but there were marked variations of attitude across different components.

2.2 Among the aspects found interesting, biology was well-received, particularly by girls. Some parts of chemistry were enjoyed but that subject "attracted the most antipathy" because it was seen as "abstruse and irrelevant to contemporary needs … **The one topic that generated universal enthusiasm was any study of astronomy and space.**" (Osborne and Collins P5 - emphasis mine)

2.3 In the section on *Aspects of physics found interesting*, having looked at gender differences in interest levels across various topics, the authors add: *Despite these differences, an interest in 'space' was the one aspect of physics that united all continuing science and non-science groups. Even those pupils who claimed to have no interest in physics entered into lively discussions on this aspect of science* (Osborne and Collins p35)

2.4 The reasoning they ascribe to the special place of space is that it offers "a focus on fundamental, cosmological questions of who we are, what we are and where we are. Such knowledge helps us to construct versions of self, identity and our role within any cosmic order". They conclude that "**the universal success of this topic, which is still regarded with antipathy by many secondary school teachers, should not be underestimated as a valuable point of engagement with science**". (Osborne and Collins p36)

2.5 In her study of values and beliefs in relation to science and technology amongst 11-21 year olds, Haste [9] looks at gender differences in attitude towards different aspects of science and concludes that "for boys, science and technology are more likely to seem fused, and separate from ethics. For girls, science is markedly distinct from technology, and the ethical dimensions of science are highly salient and interwoven with it. There are considerable implications of this for education as well as for public dialogue." (Haste p2)

Girls who are interested in a job related to science provide the most surprise: they are least interested in space issues and science fiction (Haste p14)

2.6 Space themes more than most within the science curriculum are strong in both of these dimensions, and hence offer potentially universal appeal – but only if handled properly, as Haste concludes: "The educational implications of this picture are surely that the science curriculum must first, not be unduly laden with the 'space + hardware' appeal that draws boys." (Haste p3)

(Information From Barry Meatyard, Director, Achievement and Progression, National Academy for Gifted and Talented Youth, University of Warwick)

2.7 An interesting example of a free choice of topic occurred during the establishment of the National Academy for Gifted and Talented Youth. In the first phase of the Academy's recruitment process, in which students were asked to pose questions on topics that interested them, questions relating to astronomy formed the biggest single category of all questions.

2.8 Osborne and Collins (p112) cite an observation on the changed nature of science from the Times commentator, Simon Jenkins (1998), who says 'the new science is science appreciated, not practised. It is science history, science ethics, science argument and controversy, even scientific method, the science of wonder in micro and macro-dimensions'. If this is so, then of all topics space offers an abundance of opportunity.

2.9 The decline in uptake of science at GCSE and A-level is well documented, notably in the landmark Roberts Review, *SET for Success*. [10] One recent figure of interest is the year-on-year growth in entries for GCSE Astronomy, introduced in 2003, albeit from a very low base: 2003 (501); 2004 (587); 2005 (734).

2.10 Higher Education may be beyond the scope of Key Question 2, as the students are already engaged in Science, Engineering or Technology. However it is salient to mention that among other potential factors attracting people into higher education, space again compares very favourably. We have referred already to engineering enrolments and the way Aerospace Engineering enrolments have risen when all other engineering disciplines are at lower levels than 10 years ago.

OTHER TOPICS:
Matter
The Nucles, Nuclear Energy
Generation of energy
Optics
Atoms, Molecules and Chemical Physics
Electronics
Computing
Medical and Biological Physics
Other

(PPARC 1995)

2.11 The PPARC 1995 Survey of new Physics Undergraduates [11] showed that of the topics that had influenced their choice of physics, the four highest were:

- Relativity and Gravitation (65% of respondents)
- Astronomy, Astrophysics, Cosmology and Space Research (55% of respondents)
- Quantum Theory and other Theoretical Physics (43%)
- Elementary Particles (34%)

All other topics had much lower scores (between 5 and 18%)

2.12 Key Question 2 was included on our survey, and an interesting general response emerged. Respondents felt that space compared very favourably with other themes, and very few 'competitor' themes were mentioned. At the youngest ages, dinosaurs were considered very captivating, but interest tails off early. A few generic themes such as construction, sport, environmental / 'green' issues and enterprise activity were mentioned.

2.13 *"Space activity provides an ample supply of 'action' options – rockets, space probes, robots etc – which are the most effective with pupils of all ages and abilities."* (Trevor Sproston, Pilbeam Laboratories)

"'It ain't what you do, it's the way that you do it!'"

(David Ross, SETPOINT West Yorkshire)

2.14 Many respondents felt that the approach was as important as the theme, and in particular that a 'hands-on' experience in which the pupils are actively involved is crucial. In addition a real life context and 'fun' in doing the activity were also seen as important. *"By and large it is not the theme that matters but the types of activities that it allows. Students are excited by the idea of space but turned off when they find that the activities involved in learning National Curriculum space are not as exciting as they thought."* (Mike Cripps, Neatherd HS, Norfolk)

2.15 In making an earlier 'case for space' to the European Space Agency Anne Brumfitt [12] indicates how space can stand out among other themes in an age when technology is generally assumed: "New and wonderful science continues but not necessarily in ways that communicate immediate relevance or excitement for the ordinary person in their daily life. Our youth take for granted the technological world they live in – it becomes increasingly difficult to impress them." (Brumfitt p4)

"Space is exciting to students and valued by teachers" (Professor Alan Wells, University of Leicester/ National Space Centre)

2.16 Newly released data for 2005 from the National Space Centre reveals the extent of the attraction of the space theme to the compulsory education sectors. The broader roles of space in inspiring young people, in science and maths education and in workforce development were presented by Professor Alan Wells at the first Appleton Space Conference in December 2005 [13].

Summary of School Visits, Teacher Training Visits and Outreach Activity Numbers for 2005 (National Space Centre, May 2006, unpublished)

	Schools	Students				Teachers	Teaching Assistants/ PGCE students
		KS1	KS2/3	KS4	Total		
Challenger Missions	150	-	8590		8590	520	-
General visits	1100	4000	42500	2000	48500	2000	3000
Teacher Training	-	-	-	-	-	200	250
Outreach / Video conf	258	8000	21400	-	30700	1300	-
TOTAL CONTACTS	1508	12000	72490	2000	87790	4020	3250

2.17 Another indicator of the popularity of space compared to other themes comes from PPARC. Each year PPARC receives many bids for funding for projects to add excitement to science in schools. In the most recent round PPARC Small Awards, 18 out of a total of 38 applications were for Space-related projects.

Information from Andrew Morrison Schools Officer, PPARC

IMechE survey

2.18 When the approx. 500 mechanical engineers in the IMechE survey asked if they could think of another topic as effective as space in interesting young people in science, engineering and technology, 45 named 'transportation' and 23 named 'buildings and structures'. No other topic had significant mention.

Conclusions on Key Question 2

2.19 Space scores over most other themes on several counts. It is a multi-faceted topic with sufficient aspects of inherent interest to offer appeal to different ages and abilities and to boys and girls; there is a band of very enthusiastic teachers; there are exciting large scale resources; it relates to many unanswered questions, it offers opportunities to push forward technological barriers.

2.20 In addition to its scientific basis, space has humanitarian, global, environmental and enterprise dimensions, it crosses one spectrum from aero-space to astro-space, and another from ethical across to technological issues. No other theme presents such a range of opportunities to interest, motivate, and influence young people.

KEY QUESTION 3

What is the evidence that engagement with national space activities makes an added difference to the education and career choices of young people, compared with engagement with space activities where there is no UK involvement?

3.1 During the development of the current UK Space Strategy the Demos ThinkTank along with key Government and industrial partners undertook a major research project called UK Space: Black Sky Thinking. One conclusion was that "Space, which should be visible as a leading creative industry in the UK, is largely invisible" and that "Space is an important yet neglected part of the public realm." (Mean and Wilsdon p13)

3.2 The UK approach to Space hinges on the economic and technological benefits, with a principal focus on satellite and communication applications. The Demos project concluded that "The unintended effect of this cumulative message was to portray space as 'worthy but dull'". (Mean and Wilsdon p11)

3.3 The Demos report continues: "Officially, the UK does have a vision for space. It runs as follows: '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.' None of this is wrong; it all makes perfect sense. But the danger is of it being so sensible that it fails to ignite any new public or political enthusiasm for space." (Mean and Wilsdon p21)

"Britain needs a distinctive account of why space matters" (Mean and Wilsdon p15)

3.4 Virtually all respondents to our survey indicated that awareness of the UK space industry was very limited and certainly superficial:

"Overall awareness is low. People generally, and young people in particular, relate to the US or Russian space industry for historic reasons and rarely to that of the UK, possible because we do not have a Cape Canaveral type setting."

Tom O'Connor, Norfolk SETPOINT

"We have not carried out any research but I suspect that student knowledge is at best very limited and in most cases non-existent."

Richard Healey, Sheldon Heath, City Learning Centre

"Most people have no concept of what the UK is involved in, and how space impacts on everyday life."

Keith Sprake, BAE Systems

"I think most pupils I have dealt with are unaware of the UK space industry and do not see the UK having a space industry."

Helen Horridge, Trainee Physics teacher previously employed in the Aerospace industry.

"Most UK students are unaware of UK space activities. They are also very aware of the US and its space activities."

Steve Bennett, Starchaser Industries Ltd

Visitor numbers at the National Space Centre increased by 15% at the time of Beagle, and there was a significant effect for three months (Professor Alan Wells, National Space Centre)

3.5 It was pointed out by some respondents that the UK media did not portray the UK Space industry in a positive light: *"There is a widespread perception that space is something other countries do and that to express an interest in the possibility of British activities is ridiculous. Beagle 2 confirmed this for the media, but hopefully Venus Express will help to change these perceptions."* (Robin Hague, Bolton TIC).

3.6 On a more positive note a number of respondents commented on the increased awareness and corresponding interest of young people following visits e.g. to EADS Astrium and the National Space Centre in Leicester. There was also greater awareness of the UK industry around the time of big events.

"The space centre and its associated college has successfully linked four Cornish / Devon schools with schools in Azerbaijan as an extra-curricular activity." (Mike Grocott, Callington Space Centre)

3.7 The general picture of a low profile UK Space industry stands in spectacular contrast to the number and range of Space-based resources giving hands-on, interactive experiences to UK young people. Some work at a local or regional level but many are operating at the national level. They can be either industry based with an interest in linking with educational establishments or educationally based with a specific interest in space and astronomy.

3.8 Industry based organisations include: Surrey Satellites (Guildford), Starchaser (Greater Manchester), EADS Astrium (Stevenage) and many others. Their main priority is production (e.g. satellite technology) but they have an interest in working with education both to raise their own profile, but also out of concern for the shortage of scientists and engineers coming through the education system.

3.9 Education focused initiatives are often closely associated with Higher Education Institutions. Examples include the National Space Centre (University of Leicester), the National Schools Observatory (Liverpool John Moores University), Jodrell Bank (University of Manchester) and the Bradford Robotic Telescope (University of Bradford).

In 2005 over 1000 schools (4000 students) from across the UK entered Edge into Space *with 24 teams reaching the finals (ISSET).*

3.10 In addition there is a whole range of private companies focussing on space as an educational resource, e.g. *ISSET, Out of this World Learning, Space Signpost, Astra, Pilbeam Laboratories* and many more. These companies appear to be the 'brainchild' of individuals who have a specific interest in space exploration and whose own interest and subsequent career were stimulated by experiences at school.

3.11 Schools also use the interest and resources of local astronomy and rocketry clubs.

3.12 This whole industry of visitor attractions, hands-on experiences and visiting resources offers schools and children something they generally value very highly. As an example, Meric-Stanley *(Starchaser Industries Ltd)* provide a range of *in-situ* educational programmes for schools. Evaluation of their 2005 Primary school visits by teachers (17) showed the following:

Question – How would you describe your visit from the Starchaser Educational Outreach team?

	Definitely Not	Not Entirely	Sometimes	Yes	Yes Definitely
Inspirational		6%		35%	59%
Exciting			6%	18%	76%
Informative			6%	12%	82%
Entertaining			12%	6%	82%

3.13 In addition to this abundance of space-themed resource we can add numerous websites, some of which (such as NASA and the Hubble Telescope sites) contain immense amounts of information and material. There is little wonder that one of the recommendations of the recent Barstow Report [14] was for "a 'one-stop-shop' website … to coordinate and showcase space education resources". (Barstow p20)

3.14 Even yet the picture is not complete. There is a wide range of agencies, organisations and initiatives such as Education Business Partnerships, SETPOINTs, Careers Scotland and Careers Wales, National and Regional Science Learning Centres, the Children's University, Aim Higher and local Innovation / Technology Centres that use space activity to support teachers or learners in innovation, enterprise, entrepreneurship or in promoting STEM subjects.

3.15 Relating all this to the Key Question itself, the connection between the UK Space industry and the wealth of resource, experience and expertise available to UK learners of all ages is not always easy to find. The vast majority of resources emanate ultimately from NASA, which is in a league of its own.

The ESA connection

3.16 It might be argued that since UK Space industries operate very much in the context of ESA, it is ESA that should have the profile rather than UK itself. Unfortunately this is not borne out by evidence, whether published or through our survey.

3.17 Brumfitt reports that "a major pan-European survey initiated by ESA Science and conducted in all member states in June-July 1998 revealed 12% of the general public were aware of ESA and 35% were aware of NASA, yet 42% were positively interested in space. Only 8% of those positively interested in space were spontaneously aware of ESA. When questioned, 92% revealed spontaneous/aided awareness of NASA and a total of 35% revealed spontaneous/aided awareness of ESA." (Brumfitt p6)

3.18 Brumfitt also shares our observation about the origin of most resource material: "There are several alternative bodies that offer "space" to education stakeholders and to the general

public. These gestures range from national… to media, publishing houses, toy manufacturers, science museums, observatories, planetaria and space activity/ theme centres. **However most of these providers rely upon the same initial and non-European source for material and support – NASA.**" (Brumfitt, p9) (emphasis mine)

In the absence of any known alternative provider, NASA has become the accepted 'authority' on all space matters. Each provider regenerates and re-circulates the same material. (Brumfitt, p10)

3.19 National space activity is seen as important by the public, but the Demos study showed the mismatch between the perception and the reality of the nature of UK Space: "our MORI poll found that 47 per cent of respondents believe the UK is currently involved in human space, and 55 per cent believe it should become more involved." (Mean and Wilsdon p70)

"The greater impact seems to be through excitement and interest in manned space flight rather than unmanned activities." Stephen Lloyd, College of St Mark and St John, Plymouth – based on evaluation reports from MEd students)

3.20 Within the survey we asked about the level of awareness about employment opportunities within the UK Space industry. The level of such awareness was non-existent or very limited. Honourable exceptions to this are the Universities who have close connection with space industries: *"My University (Leicester) was excellent in the field of space research, so I was always made aware of the employment opportunities." (Keith Sprake, BAE Systems)*

3.21 A number of respondents commented on the lack of careers materials available in schools and the poor quality of advice from both school and careers advisers.

"A message too for the UK space industry (is) to increase its promotion to youngsters in schools – sponsorship opportunities, including research placements for 14 to 19 year olds and undergraduates. They do it in the States, not to mention hosting and training our teachers for very little cost." (Tom O'Connor – Norfolk SETPOINT)

3.22 A majority of those surveyed felt that a UK context for space activities in schools could influence attitudes to the UK industry. However, many also believe that, to date, the UK government has made very little attempt to encourage this, whilst ESA's efforts were seen as largely ineffectual and less professional than those of the USA.

3.23 It was suggested, however, that for such an approach to be effective it would need:

- considerable resource;
- detailed evaluation of the benefits of space activity on education and career choice;
- co-ordinated and coherent re-organisation of available materials and activities;
- clear links with the National Curriculum, particularly for STEM subjects;
- awareness raising and training for science teachers on the effectiveness of using the space theme to promote the STEM group of subjects;
- general awareness raising on the value of the space industry to everyone's' daily lives.

"It is important that 'off the shelf,' proven activities are made available and funded to reduce teacher time." (John Douglas, St. George of England – Litherland)

3.24 At higher education level, we have already observed in Key Question 1 that space activity has a very positive and direct impact on recruitment to physics and related degree courses. The contribution of national space activity should not be overlooked here. Those Universities with direct connection to the UK space industry through research activity and industry connections appear to be the ones showing increased recruitment on to physics and related courses, against a national picture of decline. This increased recruitment then has knock-on effects into career choices, including (but not limited to) careers in the space industry itself. Such universities are making substantial contributions to a science-trained workforce.

Conclusions on Key Question 3

3.25 Engagement with national space activity is seen as important. Many of our respondents would like to use UK-based resources if they were there, but the nature of the UK space industry, and its association with the utilitarian end of space (satellites and communication) make it an industry invisible to the majority. The overwhelming quantity, quality and availability of information and resource from NASA make their website the first port of call for most. Teachers looking for resources need them to be easy to locate and use, and need them directly linked to National Curriculum outcomes.

Space should be enshrined in the teaching specifications (Barstow, p21)

3.26 Evidence shows that there is a direct connection between UK space activity and recruitment on to physics and related courses within higher education; the universities most closely connected to the space industry appear to be attracting students when overall numbers are declining. This has positive effects on subsequent career choices and on the skill and knowledge base of the UK workforce.

3.27 It is a time of opportunity for the UK space industry to make a mark; a combination of coincident factors such as unprecedented emphasis on the STEM subjects, changes in the GCSE syllabuses across the UK, the introduction of specialist vocational diplomas and the promotion of out-of hours learning through the Extended Schools initiative will create demand for new resource which space-related material is ideally placed to fill.

KEY QUESTION 4

What evidence is there that space is recognised by authorities across the world as a key educational tool?

4.1 Given the widespread use and impact of space activity within the UK curriculum at all levels from primary to higher education it would be surprising if other countries did not make similar extensive use of space. The terms of the question however are not simply about the extent to which space is used on a voluntary or informal basis by practicing teachers, but more about the official recognition of its value by national or state education departments, curriculum agencies, awarding bodies, research councils and the like. We shall also take it to include an implied reciprocal question, i.e. the extent to which space agencies around the world recognise the importance of the educational dimensions of space activity. In other words, do education agencies recognise the importance of space, and do space agencies recognise the importance of education?

4.2 What follows does not set out to be an exhaustive list of all space-related activity in every country. Rather it seeks to illustrate the point that space is widely regarded as a key educational tool.

USA

"This country must sustain world leadership in science, mathematics, and engineering if we are to meet the challenges of today. . . and of tomorrow."

(President William J. Clinton, November 23, 1993)

4.3 Since we have stated earlier that NASA is the source of most space-related educational resource, it makes sense to start with the USA. In 1994 the first major presidential speech 15 on science policy since 1979 was made by President Clinton, committing his Administration to fundamental science, and setting five main goals for US science policy:

- Maintain leadership across the frontiers of scientific knowledge;
- Enhance connections between fundamental research and national goals;
- Stimulate partnerships that promote investments in fundamental science and engineering and effective use of physical, human, and financial resources;
- Produce the finest scientists and engineers for the twenty-first century; and
- Raise the scientific and technological literacy of all Americans.

"We choose to explore space because doing so improves our lives, and lifts our national spirit. So let us continue the journey." (President George W Bush January 14, 2004)

4.4 Space is clearly seen in the USA as a major contributor to these long-term goals, as confirmed by the announcement by President Bush of a 'New Vision for Space Exploration' in January 2004 16 including a moon landing by 2020.

4.5 It is difficult to exaggerate the profile of education within NASA. It is a fundamental operating principle embedded in every NASA activity.[17] For the financial year 2007 there is a budget request of $153.3M, 35% of which is for higher education, 31% for elementary and secondary education, 26%

for Minority University research and education, 6% for e-education and 2% for informal education. [18]

The Office of Education strives to reach youth...to excite, and inspire the next generation of scientists, inventors, technicians, and explorers. (NASA)

4.6 The education budget request starts with the statement that "Achieving NASA's mission depends upon educated, motivated people with the ingenuity to invent new tools, the passion to solve problems, and the courage to ask the difficult questions. It is not enough to depend on the excitement generated by NASA images. NASA must use its discoveries and achievements to engage students and the education community."

4.7 The manifestation of this commitment is in a website that is the origin of most of the space-based resource across the world, and a host of activity such as the Space School at the Johnson Space Centre in Houston and Space Camp.

4.8 In addition, most NASA science missions support Education Ambassadors whose role is to use outreach and educational material developed by the project to support classroom teaching and learning programmes in the districts where the Ambassadors reside.

Russia

4.9 In Russia, Space education is considered an integral part of the whole system of education. In addition to specific STEM promotion, it is believed to give global understanding of the human place in the environment, in the development of civilization and in decision making. Within the specific STEM objectives, an annual "Space Olympics" competition is held in Korolev, Moscow, with regional and national heats.

Australia

4.10 In Australia, the Victorian Space Science Education Centre opened in September 2005 with the aims of increasing participation in science education and promoting careers in science and technology. The vision is to provide science education using scenario-based programs that foster problem-solving and teamwork skills.

Canada

4.11 The Canadian Space Agency (CSA) is very active in education, with a range of K-12 (Kindergarten – Grade 12) material but a principal focus on high school age children and on STEM subjects. CD and on-line resources are provided free of charge, and there is a particular emphasis on CPD for teachers (including distance learning activity). The CSA also offers distance learning workshops for students, hosted by scientists and engineers from CSA, to complement the school curriculum. Provincial Governments lead on the development and delivery of the curriculum, based on a Pan-Canadian Protocol.

Information on CSA supplied by Jason Clements in videoconference with Space Connections, 3 April 2006

Space Camps

4.12 Across the world there are five Space Camps. The original Space Camp is in the US Space and Rocket Center in Hunstville, Alabama, and the other four operate under a licensing agreement with Huntsville. These are in:

- The Laval Cosmodome in Quebec, Canada;
- The Euro Space Center in Transinne, Belgium;

- Space World, Kitakyushu City, Fukuoka, Japan;
- Space Camp Turkey in Izmir, Aegean Free Zone, Turkey.

"… The Space Camp program helps further children's study of mathematics and sciences and teaches children two things. The first is teamwork, and nothing can be done without teamwork. And, more important, the program teaches children about themselves. Hopefully, it teaches the kids that space is not just an adventure for the United States and Russia, space is an adventure for all mankind."

(Scott Carpenter, former astronaut, on the occasion of the opening of Space Camp Turkey.)

4.13 In addition to Space Camps, a number of other international initiatives are in place, some specifically targeted at developing countries. ESA and UNESCO have a number of such cross-country initiatives. An example from the USA is *Permission to Dream*.

Permission to Dream (PTD) *is an international science education NGO founded in 2001 that seeks to inspire and motivate children through astronomy and space. Based in Los Angeles, PTD began by donating telescopes to developing or underprivileged communities and then developed a new initiative focused on community planetariums.*

To date, PTD has sent telescopes to 33 schools or groups distributed across 15 countries and 6 continents, along with other materials such as star charts and astronomy software. PTD has also created a curriculum that guides students through an exploration of the night sky, including teachers' guides and assignments, for learners from late primary school to early university.

The countries involved are: Algeria, Australia, Brazil, Chile, China, Croatia, Iran, Israel, Nepal, Pakistan, Russia, Sri Lanka, South Africa, United States and Zambia.

Asia Pacific

In 2003 China launched more missions than Europe

4.14 Space Technology is now well developed in India and China, and the educational spin-off benefits are not lost on those nations. Using a perverse interpretation of the Key Question, it is interesting to note also that India has recently launched the world's only satellite dedicated to education. *Edusat* aims to beam lessons through the 'school in the sky' project to 37 million schoolchildren over seven years.

UK

4.15 The variation across the UK countries should not be overlooked in this section. We have already referred extensively to the Careers Scotland Space School, which "seeks to inspire young Scots to pursue science related courses of study, and consider careers in science and technology." [19]

4.16 The Scottish Space School is strongly supported by the Scottish Executive, and operates within the latter's overall Science Strategy, which aims to:

- promote science education in schools;
- develop an understanding of and enthusiasm for science as a career; and
- ensure the supply of well-qualified scientists to meet Scotland's future needs.

4.17 There are four municipal observatories in the UK, all in Scotland. Airdrie Public Observatory (North Lanarkshire) has received National Lottery funding to give presentations to all age groups. The first school visit took place in April 2006, linked to 'The Earth and Space' course units, and within the first month 20 school visits have been arranged.

Information supplied by Duncan Lunan

4.18 In Northern Ireland a Space Office (NISO) has been set up with a number of key educational objectives, and the Armagh Planetarium runs extensive programmes of learning on- and off- site, meeting primary, post-primary and special needs provision. Over the next year, the Council for the Curriculum, Examinations and Assessment is revising current specifications and designing new qualifications. The revision of GCE specifications has already commenced and GCSE is to follow. Included in the commitments are two with particular relevance to the use of space in the curriculum:

The Armagh Planetarium has had over 1.7m visitors in 20 years – this is more than the entire population of Northern Ireland (Rob Hill)

- developing contemporary specification content that is interesting, challenging, and up-to-date; and
- developing applied GCE and GCSE qualifications that are new, stimulating and refreshing.

Objectives of the Northern Ireland Space Office

- *To show best practice in utilising exciting ICT projects related to Astronomy and Space in the classroom;*
- *To create innovative curricular material developing key skills in numeracy and literacy;*
- *To demonstrate the use of Space-related activities and themes in the classroom to develop pupil-teacher confidence in using new resources available to schools;*
- *To generate teacher enthusiasm in using Astronomy and Space-related resources through teacher training;*
- *To engage with local industry and curriculum development partners to create a curriculum addressing the needs of modern industry and society;*
- *To be a repository of Astronomy and Space-relater resources; and*
- *To encourage development of similar Space Offices globally.*

4.19 The Welsh Assembly Government has just established a Department for Education Lifelong Learning and Skills (DELLS) and is currently reviewing its progress towards the 10-year goals set out in 2001 in The Learning Country. There is a current consultation process, through The Learning Country 2: Delivering the Promise 20 which presents an opportunity to promote the education case for space.

4.20 Because it is such a vital current context, we make no apology for returning to the opportunities of the Budget Paper referred to in the introduction. The Government has just stated unequivocally the importance of STEM subjects, and has established stretching targets for increased participation and achievement in these subjects coupled with measures to improve teacher supply and development.

4.21 Taken together, these developments across the UK give unprecedented opportunity for the contribution of space to education to be heralded and recognised.

Conclusions on Key Question 4

4.22 Across the world, authorities recognise the vital importance of science for their technological and economic futures. At the same time they face a shortage of young people wishing to pursue scientific studies and careers. Space activity is widely regarded as a significant way of engaging young people in science, of attracting them into STEM related courses and subsequently into STEM related careers. Beyond that many countries see space as a major means of achieving broader educational objectives (explored more fully in Key Question 5).

4.23 Within the UK, space activity is most consistently embedded in the curriculum experience in Scotland, through the activities of the Scottish Space School. The Northern Ireland Space Office has recently opened to act as a focal point for the educational uses of space. Proposed curriculum and assessment revisions in England, Wales and Northern Ireland offer enormous opportunity for engagement with space activity to increase and develop.

KEY QUESTION 5

What assessments have been made elsewhere as to the reason for using space in education, and the subsequent benefits from following this strategy?

5.1 Alongside the extent of space usage within education covered in Key Question 4 sits another point - the purpose for which it is used. We began this report with reference to the three components of the 2003 – 2006 UK Space Strategy, namely that space was important for SCIENCE, for ENTERPRISE and for the ENVIRONMENT. As well as setting the rationale for national investment in space, these three elements usefully categorise the purposes for which space features in the learning experience of young people.

5.2 The most frequently stated motive for using space in the curriculum is to encourage uptake of Science / STEM related subjects, either in general or among underrepresented groups. Within this overall motive there is a spectrum ranging from specialist to general. At the specialist extreme comes replenishing the particular skill and knowledge needs of the space industry itself. That is followed by the need for specialists within broader STEM-related occupations, then by the need for STEM trained individuals across the wider workforce. After that comes awareness of career opportunities and finally the need for an informed populace.

5.3 Beyond that, space may be used as a context for enterprise activity, including creativity, economics, project planning, team working, business awareness, productivity and the like.

5.4 The third major motive for including space in the curriculum arises from global and environmental issues, which may range across political, humanistic and cultural themes including such diverse aspects as sustainability, pollution and international relations.

NASA

"The greatest mission this Agency has ever accepted is helping to open the mind of a child to unimagined possibilities." (Sean O'Keef, former NASA Administrator)

5.5 In 'A Message from the Office of Education' dated 7 April 2006 [21] four primary goals of the NASA Education Programme are set out:

- to motivate students to pursue careers in science, math(s) and engineering;
- provide educators with unique teaching tools and compelling teaching experiences;
- to improve our Nation's scientific literacy; and
- to engage the public in shaping and sharing the experience of exploration and discovery.

5.6 In view of the budget of over $150M p.a. there is surprisingly little formal assessment of the impact of NASA's education programme. There is an evaluation system (known as NEEIS, available on https://neeis.gsfc.nasa.gov/) which is strong on participation data and on factors such as ethnicity/diversity,

underrepresented groups, student, teacher and family participation and which sets targets for some of these areas but which is silent on impact data.

5.7 Personal communications from key NASA personnel have confirmed that there is little such data: “I am unaware of any quantitative assessments of the efficacy of including of space science in educational curricula at any level, K-12 or otherwise. Anecdotal stories abound, of course…” (Dr. Heidi B. Hammel, Senior Research Scientist, Space Science Institute, NASA (2003)). Recent personal discussion (2006) with Hugh Harris, former head of NASA Education agreed with this view.

5.8 NASA seem to be wakening up to this issue, and in the 2007 budget request there are following funding lines:

- “to complete a retrospective longitudinal study of student participants to determine the degree to which participants maintain affiliation with NASA through the pipeline”; and
- “to collect, analyze, and report longitudinal data on student participants to determine the degree to which participants enter the NASA workforce or other NASA-related career fields.”

5.9 The US Office of Management and Budget analysed the NASA Education Programme using the Performance Assessment Rating Tool (PART) and rated it "Adequate" in 2004. As a consequence, all future NASA-funded programmes will be required among other thing to:

- “perform self-evaluations including, as appropriate, solicitation of student feedback and collections of longitudinal data on student career paths;
- develop appropriate performance measures, baselines, and targets; and
- fill the Agency’s workforce needs by making a stronger effort to consider eligible Education program participants for and facilitate their entry into jobs at NASA.” (FY2007 Budget Request, NASA [22])

Space Camp

5.10 Space Camp however is clear about its impact, and quotes the following impressive figures[23]:

- After attending SPACE CAMP, almost 93% took more science courses, particularly physics and chemistry;
- Almost 91% reported that SPACE CAMP inspired them to take more math(s), particularly calculus;
- 74% said they learned about careers at SPACE CAMP; and
- nearly half said their SPACE CAMP experience influenced their college major and 45% said it affected their career choice.

ESA

5.11 ESA's objectives for education are very straightforward: "Our aim is to help young Europeans, aged from 6 to 28, to gain and maintain an interest in science and technology by organising or informing them about various activities designed for their specific age group." (http://www.esa.int/esaED/)

5.12 ESA is establishing Education Resource Offices (ESEROs) in member states, the first being opened in Amsterdam in April 2006, with others to follow in Madrid and Belgium. Agreement has just been reached between ESA and Space Connections / Yorkshire Forward (Regional Development Agency) to establish a pattern of ESERO representation across the nations of the UK. In personal discussion (2006), Hugo Marée (Head of Education at ESA) indicated that there was currently no impact data for ESA's education activity, but that he was expecting the emerging ESERO offices to be in a position to secure such data for their own country.

Scottish Space School

5.13 We have already cited in Key Question 1 data from the Scottish Space School on the benefits arising from their activity. It is worth noting at this point the objectives they have identified:

SCOTTISH SPACE SCHOOL

Objectives

- *to inspire, motivate and raise the aspirations of young people in Science, Technology, Engineering and Maths (STEM);*
- *to encourage more students to study science related courses at school, college and university;*
- *to increase awareness of career opportunities in science and technology; and*
- *to increase participants' self-confidence by developing their communication, team-building and problem solving skills.*

5.14 Within science education, space is a topic relevant to students in the 21st Century. Osborne and Collins talk of the importance of science being set in a contemporary social context, and of the desire among students for a science curriculum that presents a more contemporary face to its pupils. They observe that "*for too many, it would seem, the changes in modern society have simply passed the science curriculum by*" and suggest applications from medical science, astronomy and space travel could make school science more relevant. (Osborne and Collins pp 57-58)

5.15 Although the STEM objectives predominate, the other benefits of space activity should not be overlooked. *Global Friendship Through Space Education* for example takes students from different countries to Space Camp Turkey to share their cultures and develop friendships through a common interest in space. Whilst still focusing on STEM, they also cover common

global space issues such as sharing space among nations and keeping space clean and safe. Funding comes exclusively from private sector sources. (See http://www.gftse.org/)

5.16 Turning to the Enterprise and Environmental educational values of space activity, Careers Scotland again provide an excellent example. They link space to science, enterprise and the environment through an annual Festival of Science and Enterprise. A feature of the programme is the Global Enterprise Challenge:

SCOTTISH SPACE SCHOOL

Global Enterprise Challenge 2005

"500 students from 10 countries took part in this year's event, which was launched by NASA Astronaut Leroy Chiao in a live web stream from Glasgow Science Centre. Students in Glasgow and the other locations, (Spain, Japan, New Zealand, Australia, South Africa and Singapore), watched and waited with bated breath as Leroy read out the Challenge:

'Global warming and climate change are now at the top of the geopolitical agenda, and it is universally accepted that our reliance on fossil fuels has to decrease, either by conserving our current energy use or using cleaner renewable alternatives. If each of us reduces our energy consumption by a small amount the difference it makes globally can be vast.

Your challenge is to produce a working model of an innovative product for use in the home that will make a contribution at the local level to help avert this major crisis facing Planet Earth in the 21st century.'"

Gordon McVie, Careers Scotland

"One of the most significant contributions that space has made is in triggering a new environmental consciousness" (Mean and Wilsdon p78).

Conclusions on Key Question 5

5.17 There is global agreement about the principal reasons for using space in the curriculum experience of young people. Broadly these can be categorised as its value to SCIENCE education, to ENTERPRISE education and to ENVIRONMENTAL education.

5.18 Science-related motives are most commonly quoted; they range from narrow ones such as developing future space industry and STEM professionals to broader ones such as raising career awareness or producing scientifically informed citizens. Space also offers a contemporary and relevant context for science learning.

5.19 Enterprise and Environmental motives for including space embrace diverse global, political, cultural and personal themes.

5.20 Across the world, ambitious claims are made for the impact of space within education, especially in attracting young people towards STEM subjects and careers. There is abundant anecdotal evidence and some quantitative evidence that the claims are valid. Evidence from Space Camp and the data quoted in Key Question 1 combine to give a very positive picture of the many benefits of using space in education. From 2007 all NASA education programmes will be required to perform self-evaluations including, as appropriate, solicitation of student feedback and collections of longitudinal data on student career paths.

KEY QUESTION 6

How does the skills base of the UK Space Industry compare with other industries?

The Nature of the UK Space Industry

6.1 The UK space industry had a total turnover of £4.8 billion in 2004/2005. The total value of ESA contracts awarded to it through *juste retour* in 2005 was £~100 million. The UK's public sector expenditure on civil space activities is around £200m per year, of which 65-70% goes to the European Space Agency (ESA)[24].

'Upstream' refers to the provision of technology, 'downstream' to the exploitation of technology

6.2 Recent BNSC data [25] shows that total employment in the UK space sector stood at approx 16,200 in 2004-5, with 5,600 employed in upstream companies and 10,600 by downstream companies. 90% of the upstream jobs in the South East and Eastern regions, and 82% of the downstream jobs are in London. There are smaller clusters of employment in the South West and Yorkshire & the Humber regions (p10).

6.3 Value added turnover per employee (a measure of productivity) rose from £116k in 2002/3 to £137k in 2004/5. (BNSC, p10). In a parallel study to this one (not yet published), Oxford Economic Forecasting estimate that the UK space industry with its supply chain supports 70,000 jobs and contributing £7bn pa to GDP. This gives the industry one of the highest productivities of any UK industrial sector, running at 2 to 3 times the average for the UK economy as a whole.

6.4 Overall in the space industry itself some 57% of employees had at least a first degree (BNSC, p10). In summary, the UK space industry has possibly the highest skill level and one of the highest value-added contributions of any UK industry.

A Skills Gap is one within the existing workforce

A Skills Shortage refers to difficulty in recruiting

6.5 In spite of the distinctive nature of UK space, its skills base has features in common with those of the wider aerospace industry and with other branches of engineering. Four such features, which we shall consider in turn, are:

- An ageing workforce;
- Skills gaps;
- Skills shortages; and
- Concern about the quality of new recruits.

Ageing Workforce

6.6 The average age of Boeing employees is now 49. According to the Demos Report, some 30 per cent of those working in UK space industries are due to retire by 2015, and the average age of space scientists and industrialists is increasing by a year every year. (Mean and Wilsdon, p85) This represents the imminent potential loss of 'institutional memory' along with vast experience and significant intellectual capital.

Skills Gaps

SBAC is the Society of British Aerospace Companies, one of the sponsors of UKISC, the UK Industrial Space Committee.

6.7 That the space industry needs highly qualified specialists goes without saying. But, in common with parts of the wider aerospace, specialism is not enough; the development of skills such as communications, team working, systems awareness and leadership is vital. In a recent newspaper feature on Aerospace [26], Rhiannon Chapman (SBAC Advisor on People and Skills) says "the aerospace sector needs not just specialist mechanical engineers, materials scientists, physicists, mathematicians and information technologists, but also manufacturing engineering and management, supply chain management, programme and project management, finance, human resources management, logistics and marketing."

6.8 The National Employers Skills Survey (NESS)[27], published annually by the Learning and Skills Council (LSC), gives a breakdown of skills gaps by Sector Skills Council. The most commonly reported skills gap (i.e. within the existing workforce) across SEMTA was Technical and Practical Skills (63% of all skills gaps), but second came Team Working Skills (52%).

6.9 The BNSC Executive Summary *Size and Health of the UK Space Industry 2006* (p11) states that "almost half of the companies surveyed reported a shortage of specific skills. The main shortages identified were in a range of engineering disciplines, and physics. The demand for RF/microwave engineers and mechanical engineers has increased during the last two years"

Skills Shortages

6.10 NESS also reports on skills shortages (i.e. recruitment difficulties). The 2004 figures across SEMTA (the Science, Engineering and Mathematics Skills Alliance) showed the second highest level of Skills Shortages of any sector. 30% of all employers in the sector reported vacancies - only the care sector had a higher level (33%).

6.11 SEMTA is also one of three sectors (along with construction and health) suffering the greatest skill challenge in recruitment (NESS p37). Across the whole SEMTA sector, skills shortages vacancies were among skilled trades (42% of vacancies) and operatives (21%) rather than among professionals (5%) or associate professionals (8%) (NESS p38).

6.12 *SET for Success* (the Roberts Review) reported that "in the R&D-intensive aerospace industry, one survey established that the main reasons for recruitment problems were "not enough suitably skilled people, people lacking practical skills and a lack of people interested in the type of work", suggesting that both quality and quantity issues may be at the root of the problem." (Roberts p30)

6.13 In her article referred to above Rhiannon Chapman says, "On the supply side, the main problem is that engineering is not generally perceived as glamorous, while the aerospace sector just doesn't appear on many young people's radar when it comes to career options." (Chapman, 2006)

Quality of New Recruits

6.14 Not only is there concern about the number of recruits, there is also genuine concern about their overall quality, and this is not unique to the UK. For those in the industry, our survey contained specific questions about skills issues. Responses to the question on the skills issues facing young recruits included:

- Declining GCSE and A-level standards;
- Poor mathematical skills;
- Little experience of team working;
- Lack of commercial awareness;
- Lack of fundamental work ethic;
- Low awareness of how things work.

Six months after completing their degrees, 33.1% of Aerospace Engineering graduates are working in professional engineering

(this compares to Civil engineering 68.2%

Mechanical engineering 48.8%

Chemical engineering 46.6%) HESA 2004

In my experience the British Aerospace Engineers are among the best in the World. The Americans are all experts in a particular field. You cannot ask them anything they do not know in that field but if you ask them anything in another field you have to find another expert. While I was working in the USA I found that all the key players in almost all the USA companies I visited were Brits because they have a very broad range of experiences and can therefore easily adapt to almost any need of the projects.

The UK Space and Aerospace Engineers have a great deal of skill and knowledge which sets them apart from most other industries in the UK. They can easily adapt to working in the car industry or in the Atomic Power industry and you only need to look at the diversity of many of our aerospace companies to see just how wide the skill base is. Whereas those in the car and other industries usually need some retraining before they can start to input due to the regulations and certification issues which they will encounter.

Ivan Dean, Chairman, IMechE Aerospace North West

*An 'application' culture has developed where it is only necessary to know how to **use** the application, rather than to understand **how it works**. While this is a very good principle for most consumers, engineers are still required who do know 'how it works' and can develop new products.*

Maths skills are particularly important. I understand that many engineering courses are removing all maths from the syllabus. I can't understand how this is possible, or how graduates will possess any skills which will be useful to employers if this is the case.

Ian Jones, Managing Director, Orbit Research Ltd, Bradford

Careers Information Advice and Guidance

6.15 We have already discussed in Key Question 3 the low level of overall awareness of the UK space industry. Whether as a cause or as a result, there is little careers material or awareness among the Careers Information, Advice and Guidance community to inform potential recruits to the industry. Primary school children generally know of only one space-related career; being an astronaut. Secondary school children generally believe that to work in the space industry you would have to go to America.

6.16 It is difficult to capture an overall image of the UK space industry given its low to non-existent profile. Looking for example at the satellite gallery in the National Science Museum with its roomful of display posters firmly stuck in the late 1980s, proudly looking forward to the time when Hubble will be launched (!) and speculating as to what might be launched in the early 1990s, one gets an image of an industry which moved directly from the future to the past without impacting on the present at all. What are young people who are excited by space or who might be interested in a career in the space industry to make of such a woeful image? In spite of this, to those 'in the know' the image is often prestigious.

Ambassadors

6.17 SETNET operates the Science and Engineering Ambassadors (SEA) scheme, which aims to promote STEM subjects and careers. It does this by providing enthusiastic, vetted volunteers to work with young people and teachers in schools. SEAs have backgrounds in any aspect of STEM and seek to inspire and excite children and young people about the possibilities these subjects and their related careers. Larger companies in the space industry are involved in the scheme. Some are calling for specific 'space ambassadors' who can achieve these objectives while making the space industry more visible.

Conclusions on Key Question 6

6.18 The Space Industry has possibly the highest skill level of any UK industry and is among the highest for productivity. In common with the wider aerospace industry and engineering in general, it suffers from an ageing workforce and the consequent loss of accumulated experience and knowledge.

6.19 The nature of the space industry is such that it needs people not only with specialist scientific and technological knowledge and skills, but with a wider range of skills such as project management and team-working.

6.20 The space industry has both skills gaps (within its existing workforce) and skills shortages (recruitment problems), and there is general concern about the skill levels of new recruits.

6.21 Careers information, advice and guidance are inadequate, and the overall image of the industry is good only to those who already have some awareness of it.

Next Steps: Consultants' Suggestions

1 **Government should note that investment in space brings about significant educational advantage**, especially in contributing to the *Science and Innovation Framework* targets for participation and achievement in science.

2 **The UK Space community should initiate the development of new UK-based curriculum material directly related to existing and emerging new curriculum requirements.** Such material should be inclusive, appealing across gender, age and ethnic differences. Revision of the curriculum in England, Wales and Northern Ireland provide an important and timely opportunity.

3 **Detailed evaluation of the benefits of using space in education should be carried out.** The impact of space activity on participation, achievement, retention, progression should be unequivocally established, along with impact on such aspects as motivation and behaviour. At higher education level, the effect of space-related courses on recruitment into physics should be systematically established. Future activity should include impact assessment. This aligns with the STEM Mapping review activity.

4 **Teachers should be made aware of, and offered CPD in, the benefits of space education.** This relates to the *Science and Innovation Framework* targets, and includes the use of space within and beyond STEM subjects and in enterprise and environmental activity.

5 **Space-themed material should be developed for use in the new 14-19 specialist vocational diplomas and in Out of School Hours activity.** New developments such as vocational diplomas and Extended Schools present an ideal opportunity for raising the profile and awareness of UK space.

6 **England and Wales should note the lessons to be learned from developments in Scotland and Northern Ireland.** Space is now well embedded in the Scottish curriculum largely through the work of the Scottish Space School, and the Northern Ireland Space Office is now established. The applicability of these models to England and Wales should be assessed.

7 **UK (and ESA) Space programmes and activities should have educational objectives built in and identified from the start.** NASA is clear that all its programmes should have an educational component; in the UK and ESA these are not directly evident. Educational objectives should feature strongly in the new UK Space Strategy.

8 **UK Space industries, working with their Sector Skills Council (SEMTA) should produce careers material giving accurate information about the UK space industry.** Current levels of awareness of the nature of, and employment prospects in, the UK space industry are lamentably low. Up-to-date careers material is urgently needed.

APPENDIX 1: SURVEY QUESTIONS

1. Do Space-related activities make a difference to education and career choices?

In what ways does your organisation use space activities in the school curriculum? (include key stages and subject areas)

Which subject / curriculum areas do you think are particularly enhanced by using space as a context?

What other organisations do you work with in the delivery of space activity?

Do you use space themes as a context for other areas of the curriculum, e.g. enterprise education or environmental education?

Do you believe, and have you ant evidence, that space activity influences young people's post-16 educational choices (e.g. towards Mathematics, Science, Engineering or Technology subjects)?

Do you believe, and have you any evidence, that space activity influences young people's career choices (e.g. specific space industry careers or related science and engineering careers)?

2. Do UK Space-related activities add specific value to education and career choices?

How would you rate the level of awareness of the nature and extent of the UK space industry among the young people you deal with?

How would you rate the level of awareness of the employment opportunities within the UK space industry among the young people you deal with?

Do activities that are specifically related to the UK space industry have any influence on the interest and motivation of young people?

What Space-related resources / organisations / websites have you found to be particularly effective in motivating young people? (Please group by origin)

[UK / Europe / USA / Other]

3. How does Space compare with other themes in engaging young people with Science, Engineering and Technology?

What evidence do you have of the positive impact of space activity on the motivation and achievement of young people?

Are there other themes that you have found more effective in engaging the interest of young people than space? If so, please specify

When young people have a choice of themes (e.g. in project activity), how popular is the space theme compared to other potential themes?

Do you think the space theme is more or less effective with particular groups of young people e.g. according to age, gender or ability?

APPENDIX 2

IMechE SURVEY: THE CASE FOR SPACE

- Sent to 300 mechanical engineers (UK only)
- Between ages of 25-55 years
- Emailed to members on 18 April 2006;
- Results compiled on 11 May 2006
- 498 responses (16.6% of sample)
- Results are 90% +/- 1% accurate from sample

Question 1 **Is your own work connected with the aerospace industry?**

Part of the Industry / Very strongly connected	52	10%
Strongly connected	136	27%
Moderately connected	78	16%
Very little / not connected	232	47%
Total	498	100%

Question 2. **How significant was space as a factor in influencing your own subject choices at school?**

Very significant	74	15%
Quite significant	97	19%
Of little significance	193	39%
No significance	134	27%
Total	498	100%

Question 3. **How significant was space as a factor in influencing your own further or higher education choices?**

Very significant	76	15%
Quite significant	105	22%
Of little significance	211	42%
No significance	106	21%
Total	498	100%

Question 4. **How significant was space as a factor in determining your career?**

Very significant	54	11%
Quite significant	78	16%
Of little significance	273	55%
No significance	93	18%
Total	498	100%

Question 5. **Do you think space as a topic influences the motivation of young people at school?**

Very strong influence	48	10%
Strong influence	63	12%
Moderate influence	289	58%
Little or no influence	98	20%
Total	498	100%

Question 6. **Do you think space as a topic influences the examination achievement of young people at school?**

Very strong influence	25	5%
Strong influence	33	7%
Moderate influence	65	13%
Little or no influence	375	75%
Total	498	100%

Question 7**. Do you think space as a topic influences young people towards science, engineering and technology subjects?**

Very strong influence	51	10%
Strong influence	74	15%
Moderate influence	265	53%
Little or no influence	108	22%
Total	498	100%

Question 8. **Can you think of another topic or theme that you think could be as effective as Space in interesting young people in Science, Engineering and Technology?**

Building and structures	23
Transportation (sport cars, rail, planes, cars etc.)	45
Medical	4

Question 9. **What do you observe to be the ONE main skills issue in young people currently entering engineering industries?**

Lack of maths / English (essential skills)	12
Detail of degree with practical application	9
None but salary expectations are incorrect	5
None but expectations of engineering are incorrect	2

Question 10. **Could more use of space-related themes in the school curriculum be useful in addressing this skills issue?**

Yes	143	29%
Perhaps	238	48%
Probably not	96	19%
No	21	4%
Total	498	100%

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