STRENGTHENING THE EVIDENCE BASE FOR BUSINESS SUPPORT RELATED CIVIL SPACE ACTIVITY

Technical Report

Annex 3: Upstream Results

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1 Introduction

1.1 In this Annex we present the results and analysis from four different sets of fieldwork. They are as follows

- the twenty-two project specific interviews with firms whose project/contract was selected at random and based on the criteria outlined in Annex 1: Study Methodology
- interviews with six sub-contractors that were involved to varying degrees in one of the projects chosen at random
- the survey of nine main beneficiaries – this consisted of firms that had received large amounts of funding from the three BNSC national or two ESA programmes over a significant number of projects
- interviews with four non-participant firms that saw themselves as part of the UK Space industry but had not participated in any BNSC or ESA programmes.

2 Survey of Project Specific Interviews

2.1 This section is based on the findings of interviews carried out for 22 projects (undertaken by 18 firms) that were selected at random in order to attempt to identify spillovers of technology, processes or expertise from firms' civil space activities. Whilst 22 interviews were carried out these were not with 22 different firms due to the random selection process and criterion applied.

2.2 The relevant interviewees were identified by BNSC and most staff were at the senior manager level with significant experience and knowledge of the space industry. Most interviewees were aware of and able to outline the main role at least two of the five BNSC or ESA programmes. These individuals had a good understanding of the project, both its purpose and outputs, and in most cases they were comfortable with answering the wider questions concerning the impacts that civil space work has had on the business.

2.3 At the outset of the interview we asked whether it was most appropriate to gather information on the basis of:

- the whole firm
- a specific subsidiary, division or unit within the entity.

2.4 The answers were as follows:

Table 1: Interview focus in relation to size of entity

Firm	Information provided on[1] [2] [3]	Size of entity by employment in 2000/01	Overall Firm Size
1	Whole Firm	Medium	Medium
2	Whole Firm	Small	Small
3	Unit	Large	Large
4	Whole Firm	Small	Small
5	Whole Firm	Medium	Medium
6	Unit	Small	Medium
7	Whole Firm	Large	Large
8	Unit	Medium	Large
9	Unit	Large	Large
10	Whole Firm	Medium	Medium

[1] Except for the six questions in Section F of the project specific questionnaire

[2] The whole UK operations of Astrium were classified as one unit – it accounted for four of the 22 projects

[3] SSTL accounted for two of the 22 projects.

11	Whole Firm	Medium	Medium
12	Whole Firm	Medium	Medium
13	Whole Firm	Small	Small
14	Unit	Small	Large
15	Whole Firm	Small	Small
16	Whole Firm	Small	Small
17	Unit	Medium	Large
18	Whole Firm	Small	Small

Background on the Project Specific Firms

Size and level of involvement

2.5 Of the 18 units that were interviewed, three are large with 250 or more employees, seven are medium sized units (50-249 employees) and eight are small with fewer than 50 employees. Our sample can also be considered according to firms **(rather than units)** in terms of their level of participation in the five specific BNSC and ESA programmes:

- incumbents – high levels of financial support / major players: **five firms**
- involved but not embedded – regular participation through smaller value contracts: **eight firms**
- limited involvement: **five firms.**

2.6 The small size of the sample makes segmentation difficult. However, 60% of those with limited involvement (i.e. 3 firms) were small firms and one small firm was an incumbent. Eight firms had been involved in space projects for a long period of time, from 20 to 40 years. Four firms had no more than five years experience.

Civil and military Space work

2.7 Twelve firms were also involved in military space work but the importance of military projects was quite small for most; ranging between 1% and 25%. Three of these firms were small in size and five were incumbents. Where firms undertook military as well as civil space work, the civil work had preceded military in 83% (10) cases and 11 firms reported that civil was more important in technical terms. The relative contribution to the firms' profit margins was slightly more evenly split; seven firms felt civil was more important, three said military and two stated the two were of equal importance to their business.

2.8 Firms were asked about the relationship between their civil and military functions, and their responses are shown in Table 2 below. To summarise, the vast majority answered either 'nearly always' or 'usually' in terms of: synergies between military and civil space businesses; and the sharing of technology, processes, expertise and business functions.

Table 2: Firms' rating of the relationship between military and civil space work in their business	Nearly Always	Usually	Quite Often	Sometimes	Hardly ever	Don't Know
. . . there are opportunities for synergies between our military and civil space businesses	6	3	2	1	0	0
. . . our military and civil space programmes share technology	6	5	1	0	0	0
. . . our military and civil space programmes share processes	7	4	1	0	0	0
. . . our military and civil space programmes share expertise	7	4	1	0	0	0
. . . our military and civil space programmes share business functions such as marketing	7	2	2	0	1	0

Financial details

2.9 Turning again to consider units (which as Table 1 shows in 12 of the 18 cases was, in fact, also the whole firm), most were strongly focussed on civil space – only one unit stated that it did not have a long-term strategy for involvement in civil space work. The 17 units interviewed had an aggregate space turnover of some £438 million in 2000/01; this does not include one firm that was not founded until 2002/03 which has a space turnover of £400,000. The aggregate employment for the 17 units was 3709, ranging from 2100 to 3 employees; the unit founded in 2002/03 employs 5 staff.

2.10 For nine units R&D was not included in their accounts and as explained in the previous paragraph one unit (i.e. the firm) was not founded until 2002/03. Therefore eight units did include R&D in their accounts and the range of spend in 2000/01 was from £39,000 to £9 million. The space only R&D spend for these same eight units covered a similar range from £39,000 to £8 million. Table 3 shows that the contribution of space only R&D as a proportion of total R&D spend was between 76-100% for six units and five of these units said the figure was 100%.

Table 3: Total R&D spend and Space R&D spend by the unit (2000/01)	0-25 %	26-50 %	51-75 %	76-100 %
Total R&D / Turnover	5	0	0	3
Space R&D / Total R&D	2	0	0	6

2.11 In eight of the 17 units (one unit was unable to answer this question) turnover from civil space work was 70% or more. For six of these eight units the profit contribution to the business from civil space work was 70% or more. The profit contribution from civil space work was only greater than the contribution that space work made to turnover for three units, which

were all multi-sector firms. The profit and turnover contributions from space are the same for eight units and profit contribution is less than turnover contribution for six units.

Prior to participating in the project

2.12 We explored the position of the units prior to participating in the project and 13 units believed that their entity already had a strong reputation in space technology and research. Four of the five units which felt that they did not have a strong reputation were multi-sector firms. These same four units said that their products/services were not as technologically advanced as their competitors and also that they were not at the leading edge internationally. Ten units felt that they were at the leading edge internationally and these were a variety of sizes including five large firms, three medium sized firms and two small firms. Of the 12 units that cited their capability in space related technology as being their main competitive advantage six can be categorised as focusing on space markets only.

Table 4: Position of the unit before participating in the project

	Yes	No	Don't know
. . . your entity had a strong reputation in space technology & research	13	5	0
. . . your products/services were more technologically advanced than competitors	11 (1=On Par)	5	1
. . . your people were more technically skilled than those of the competitors	17	1	0
. . . you were at the leading edge internationally	10	8	0
. . . your capability in space related technology was your main competitive advantage	12	6	0

Information on the projects

Funding

2.13 In this study the twenty-two projects were selected from three BNSC and two ESA business support civil space related programmes – the random sampling meant that we looked at 17 BNSC funded projects and 5 from ESA. Table 5 shows that the total project value was £81.9 million with BNSC and ESA grants providing 41% of the finance for these projects. The overall value of the project work undertaken by the 'lead' firm and the value passed on to sub-contractors in the project was equally split, as also was the value of the BNSC/ESA grant retained by the 'lead' firm. The ESA grants included only one small firm, yet two of the firms were new entrants in terms of the number of previous ESA grants that they had received. This contrasted to the BNSC grants where four went to small firms, and five each to medium and large firms.

Table 5: Project value and funding for the sample of 22 projects

Programme	Total value of the projects (£)	Value of the BNSC / ESA grants (£)	Value of the work done by the 'lead' firm (£)	Value of the project work passed on to sub- contractors (£)
BNSC	45.1m	15.3m	15.1m	30m
ESA	36.7m	18.4m	25m	11.7m
Total	81.9m	33.7m	40.1m	41.7m

2.14 Despite the sample including more than three times more BNSC projects than ESA funded projects, the ESA grants accounted for around 55% of the public sector funding. This supports the view expressed by a number of firms that BNSC contracts provide seed corn funding which will enable them to compete for and win the larger ESA contracts on offer.

2.15 The Table also highlights a difference between BNSC and ESA projects in the value of work that is passed down the supply chain to sub-contractors – 67% of the value of BNSC projects was passed to sub-contractors compared to only 32% in ESA projects. Due to the capacity and capabilities of large firms it is perhaps not surprising that 75% of the BNSC and ESA grants (i.e. £25.3m) went to three large units – the total value of these specific projects was £49.1m and these large units undertook 62% of the value of this work themselves; two of these three units can also be described as incumbents. Seven medium sized units, **two of which were in large firms**, received around £6.4m worth of BNSC and ESA grants but only undertook 25% of the total value of the project work themselves – this resulted in £21.9m of contracts being passed down the supply chain to sub-contractors. The eight small units, **(two were in a medium sized firm and one was in a large firm)**, received £2m in grants from BNSC and ESA and behaved in a similar manner to the large units by undertaking 64% of the total value of the project (£2.3m out of £3.6m).

Reasons for participation

2.16 We questioned the units about their reasons for participating in the project and in 15 of projects the units hoped that participation would lead to a radical improvement in their competencies, products and services; seven of these projects involved a firm that can be categorised as an incumbent. Six projects involved the development of entirely new technologies altogether – four were undertaken by multi-sector firms and two by space only firms. Many projects were undertaken as means of both putting the unit at the leading technological edge internationally and also as a way of increasing their ability to develop products/services for other markets. Of the five projects where the intention was not to improve the unit's ability to develop products/services for other markets, three project involved space only firms.

Table 6: Units intended their participation in the project as . . .			
	Yes	No	Don't Know
. . . a radical improvement in your competencies, products, and services	15	7	0
. . . a development in technologies where you had limited or no experience	12	10	0
. . . involving the development of entirely new technologies all together	6	15	1
. . . putting you at the leading technological edge internationally	17	4	1
. . . an opportunity to make money	14	7	1
. . . a way of developing strategic alliances with other firms so as to bid for future work	14	7	1
. . . as a way of improving your ability to develop products/services for other markets	17	5	0
. . . technology transfer into your business from other organisations	15	7	0

2.17 Fourteen projects were seen as a way of developing strategic alliances with other firms so as to bid for future work and 12 of these 14 projects were seen as a means of transferring technology into the business from other organisations. This group included five small firms – three of which had had limited involvement previously in the BNSC/ESA programmes.

Project Structure

2.18 Table 7 shows that in the majority of projects the 'lead' unit was not focused on one particular role and instead involved in a variety of technological aspects.

Table 7: The technological aspect of the project or application(s) that the unit was involved in	
Role	Number of projects
R&D (new knowledge)	15
Development of products/ systems/ software	19
Testing	15
Overall project management	15
Managing sub-contracts for sub-systems / products	10
Supplying systems/ products/ components/ software	6

2.19 All of the projects established their own project team in-house and for the vast majority (91%) of firms the staff were drawn from a single division within the firm. At the time of the interviews only 13 of the 22 projects had already finished – of these projects 7 of the teams were disbanded at the end of the project with the staff returning to their divisions. In the six instances where the team has remained together this is due to further work being undertaken either for a new BNSC or ESA contract or as a result of anticipated sales from the project.

2.20 We asked how the sub-contractors were involved in the design and management of the project. The interviews found that ten projects involved what can be described as collaborative interaction between the 'lead' firm and sub-contractors – whereby the sub-contractors worked alongside the 'lead' as partners in the design and management of the project. One project was based on a mixed practice of activities with the sub-contractor (collaboration and work to set specifications). A further four projects had only limited interaction between the 'lead' firm and sub-contractors, meaning that the sub-contractors were simply given detailed specifications and the delivery schedule. Seven projects did not involve any sub-contractors.

2.21 Of the 15 projects that did involve sub-contractors five included the co-location of staff between the 'lead' firm and the sub-contractors. In three of these five projects the sub-contractors did gain new skills and/or technologies from the 'lead' firm. It is difficult to comment on whether these five projects were more likely to exploit the results of the project, however two of these five have already led to the sales of products/services; for the other three projects it was too early to discuss any sales. Two of the 15 projects involved the exchange of staff by the 'lead' unit with the sub-contractors. Separate, non-BNSC or ESA, IPR negotiations and agreements took place with sub-contractors in six projects.

Outputs and returns from participation in the project

Context

2.22 Any outputs and returns that have arisen to date from participation in the project must be considered in the context of when the project specific interviews took place, i.e. in Spring and Summer of 2003, against the state of project. By this we mean that only 13 of the projects had already finished – with 8 ongoing and one project having only just started due to various delays. Therefore, for a number of projects it was too early at this stage for the respondents to comment on the impact that participation in the project has had on their firm.

Meeting expectations

2.23 Twenty-one of the projects met all of their technical objectives for participation with one project stating that it was too early to respond due to the project having only just started at the time of the interview. Furthermore 20 projects stated that participation had met their strategic objectives for involvement and 17 projects had met the units' commercial objectives – for four it was too early to tell. One project had not met that unit's own commercial objectives principally because the potential customer for the product arising from this project is no longer interested.

2.24 Seven of the 17 BNSC projects claimed that the project involvement was important in winning subsequent contracts from ESA. The total value of these further contracts was approximately £32 million. In a further six of the BNSC projects the unit has not yet directly won any ESA contracts but the project has been used as an important piece of evidence to demonstrate their space experience when bidding for future work. Whilst the question was not directly asked during the project specific interviews a number of projects have resulted in further BNSC grants totalling £170,000.

Use of project results

2.25 In 16 projects the results of the project have been used commercially by the business – this included nine multi-sector firms and five space only firms **(two space only units were involved in more than one project)**. In seven of the projects the unit was focused on space only markets. The results from **six** projects (equally split between multi-sector and space only firms) have produced benefits for non-space work including:

- in **three** projects the products, services and expertise developed from the project have enabled the unit to enter a totally new market unrelated to space
- one project has resulted in sales to existing non-space customers **(not an additional project)**
- for two projects the results have been modified and embodied in products, services or expertise of non-space offerings **(one additional project)**
- four projects have led to improved techniques or processes which were used in non-space parts of the business **(one additional project)**
- five projects resulted in the development of new skills which were applied to the non-space part of the business **(one additional project).**

2.26 Where there have been sales of space related services to non-space customers this has involved:

- the transfer of space related expertise and techniques to the pharmaceutical industry and also to unmanned air and water exploration
- general improvements in capabilities in the areas of CAD, management and analysis.

2.27 In the two cases where the results have been modified and embodied in the products, services or expertise of other non-space product offerings this led to:

- one of these firms making a subsequent investment of around £1million in order to launch satellite based TV services and internet access via satellite

- a second firm, through minimal investment, pursuing opportunities in the multi-media education sector in Eastern Europe and also in the defence sector.

2.28 To the 'lead' units' knowledge there have been only being four instances where the sub-contractors in the project have used the results themselves. Three projects did mention the use of the project's results by non-participants i.e. commercial use by other firms outside the project. This included three firms that are listed in the UK Space directory and one firm that is a major ICT company.

Sales of products/services

2.29 Table 4 shows details from the eight projects identifying sales of products/services.

Table 4: Sales of products/services from the sample of 22 projects

Firm	Sales of products services (£)	Time profile of sales	Size of own investment by firm to get sales	Value added	Proportion of goods and services that are UK sourced	Uniqueness of product or service
1	First 1,000 units of the product ordered					
2	£5m	3 year operational agreements	£1m	30%	5%	Unique when started – now other competitors but are the market leader
3	£140k	See the benefits over the next 2-4 years	£120k-£180k	20%	100%	Unique
4	£450m	4 years – options remain for additional sales	£30m	33%	2%[6]	Unique – only one other supplier capable of doing comparable work
5	£1m					
6	£7.5m	Between 1999-2003 – number of orders has been steadily rising[7]	£450k plus time and effort required to raise profile of the business	Between 65-75%	95%	Unique when started – one other European competitor but they do not have the range of products. A couple of US suppliers but they have had little success
7	£30k	Summer 2003 –contract over a period of 3months	£2.4m[8]	Very difficult to judge	Don't know but likely to be less than 5%	Only supplier that can provide this service, which is also not a competitor to the manufacturer that the firm has won the contract from

[6] This is a best judgement estimate of the contract value for first tier suppliers only.

[7] Sales are expected to continue with a number of new contracts to be signed shortly.

[8] This mainly includes multiple investments from the foreign parent company which has resulted in the development of a substantial IP portfolio. This investment alongside the BNSC grant has led to the sales.

2.30 For 21 of the 22 projects the intellectual property conditions imposed by the project's contract did not restrict what the unit might have wanted to do in terms of further commercialisation. The one exception was where the interviewee was concerned about the IP being made available to the other partners in the project. This lack of control regarding the use of the information and who it would be disseminated to is problematic for a small firm, which cannot afford to get involved in litigation. None of the projects has resulted in a licence being issued.

2.31 We asked interviewees whether they were aware of any new firms that have been established based largely on technologies or processes or expertise arising from civil space projects, which are principally serving non-space firms. They were able to identify around 5 firms that met these criteria. We also asked if they could identify any such new firms serving military or civil space markets and they mentioned four firms – one of these four has spun out of an interviewee's business.

Additionality of the BNSC/ESA grant

2.32 The units were asked what would have happened to the project in the absence of the BNSC / ESA grant. The responses are summarised below:

- in 15 of the 22 projects a lack of funding would have meant no participation by the unit in the project – this included three projects undertaken by the three large firms
- three projects would have still continued but two would have been with a lower scale of involvement in the project and a further one would have been of a lower quality
- for the remaining four projects the units stated that their participation would have been negotiated over a longer period of time: one commented that it would have taken two years to make the same level of progress without the grant and in the meantime they would have missed out on a number of business opportunities; a second commented that the grant allowed the project to move forward at a much faster rate and not in piecemeal fashion
- eleven units claimed that without the grant they would have failed to win contract business that had been achieved.

Displacement of other projects

2.33 There were only two instances where a unit claimed that the BNSC/ESA project displaced other projects / activities that were under consideration at the time. For one unit the impact was negligible with the BNSC funding resulting in the project moving above other proposals that were under consideration at the time. In the case of the second unit as the grant was of a considerable size compared to the overall size of the firm the displacement meant that:

- the grant moved the project to the top of the priority list
- specialist staff were unavailable for other projects
- other projects were dropped as a result of the grant.

Involvement of sub-contractors

2.34 There were 15 projects, which in total involved 29 UK based sub-contractors. One project was only due to officially start in June 2002 and therefore could not comment on the sub-contractor relationship. So responses were limited to 14 projects.

Collaboration between the lead firm and the sub-contractors		
	Yes	No
. . . my firm gained new skills and/or technologies from the sub-contractors	8	6
. . . my firm gained new staff from the sub-contractors	0	14
. . . the sub-contractors gained new skills and/or technologies from my firm (or other sub-contractors)	10	4
. . . the sub-contractors gained new staff from my firm (or other sub-contractors)	4	10
. . . no change – there was no transfer of technology and skills across the project companies	2	12

2.35 In terms of the overall benefits of project collaboration a total of 11 projects involved the transfer of skills and/or technology between the 'lead' firm and the sub-contractor or vice versa – seven of the lead firms were multi-sector firms and four were space only firms. Of the 10 projects where the sub-contractors gained new skills and/or technologies, nine were based on collaborative interaction with the sub-contractors working alongside as partners in the design and management of the project and two of these nine projects involved the co-location of staff.

2.36 In three projects there was no change, i.e. no transfer of skills and/or technology took place, which in these cases was due to the sub-contracting relationship being a purely commercial, and not collaborative, arrangement to set specifications

2.37 The units were also asked about any other benefits from project collaboration – they highlighted such examples as:

- an improved working relationship and greater knowledge of each other's skills and business, which led to further collaboration and the forming of strategic relationships
- a better understanding of the academic community and its requirements
- exposure for SMEs to the technical depth and contacts of large space firms
- a stronger commercial presence in a competitive global market

- research into new technology areas that the firm would have been unable to do alone.

Impacts on the business entity from undertaking civil space work

2.38 So far the results and analysis have been based on a specific project that was discussed with the 'lead' unit. This section deals with the impacts of civil space work on the unit's business which are broader than the specific project related impact. Table 5 shows the responses from the 18 units regarding the impact that grant based civil space work has had on the unit.

Table 5: Participation in civil space work for which you have received a grant contribution towards the total cost has. . .

	Agree	Disagree	Don't Know
. . . met your strategic objectives for involvement	17	1	0
. . . strengthened your established lead over competition	16	2	0
. . . enabled you to catch up with the competition	8	10	0
. . . proved an unfortunate distraction from your core markets	0	18	0
. . . facilitated your entry into new product/service markets	13	5	0
. . . developed or retained key skills in your business	18	0	0
. . . kept you alert to technological developments	16	0	2

2.39 All but one unit stated that the civil space work has met their strategic objectives for involvement, as well as strengthening their established lead over the competition. The work has also enabled the all of these units to develop or retain key skills in their business and the majority of projects have kept the units alert to technological developments. Furthermore 13 units stated that the work has facilitated their entry into new product/service markets, which was not necessarily borne out in the project specific outputs where only a limited number of the projects has led on to entry into new product/service markets. Whilst civil space work has enabled eight units to catch up with the competition, the majority of units that disagreed with this statement and felt that they were already ahead of the competition.

2.40 All 18 units resoundingly disagreed with the statement that civil space work had proven to be an unfortunate distraction from the unit's core markets.

2.41 Table 6, in contrast to Table 5, seeks to understand the more specific business level impacts that participation in civil space work has had on the units in our sample. A majority of units stated that the contribution had been either 'high' or 'very high' in terms of both the development of new products and the development of new skills and working practices. The fact that seven units answered 'low' or 'very low' to the development of new markets not related to the civil space sector can be explained by four of these seven units being focused only on space markets. The contribution of civil space work to the development of alliances and long-term collaborations was rated highly by 15 units, which was also reflected in the units' responses to the reasons for participation in the specific projects.

Table 6: Contribution of unit's participation in civil space work to . . .

	Very high	High	Average	Low	Very low	Don't know
. . . development of new products	7	7	2	1	1	0
. . . development of new manufacturing processes	3	3	4	3	4	1
. . . development of new markets not related to the civil space sector	2	5	4	3	4	0
. . . development of new or better skills and working practices in the firm	5	8	3	1	0	1
. . . quality control and enhancement	2	6	3	4	3	0
. . . improved efficiency (less waste, better stock control etc.)	1	3	5	3	3	3
. . . development of alliances and long-term collaborations	5	10	1	1	1	0
. . . enhanced identification and adoption of technologies from other firms or industries	3	2	8	3	1	1

2.42 Table 7 focuses on the impact that grant funded civil space projects has had on the unit. For the majority of units this work has had a positive effect in terms of starting new R&D activities and developing new products/services, which were unlikely to have happened without this funding. All 18 units stated that this work has not resulted in the unit having to downscale or cancel other planned R&D or projects – this view is also supported by the lack of displacement for 20 of the 22 specific projects. Most units felt that grant funded civil space projects had led to increases in their market share at the expenses of foreign businesses rather than other UK businesses.

Table 7: Specifically because of *grant funded* civil space projects, we…..

	Yes	No	Too Early
. . . started new R&D activities that otherwise would not have been initiated	15	3	0
. . . developed new products/services that otherwise would have remained dormant	15	3	0
. . . increased our stock of R&D personnel to a scale that otherwise was not justified	9	9	0
. . . had to downscale or cancel other planned R&D or projects	0	18	0
. . . had to reallocate resources from other planned activities	3	15	0
. . . increased our market share at the expense of other UK businesses	4	10	4
. . . increased market share at the expense of foreign companies	10	4	4

2.43 In Table 8 the units rated the extent to which factors are important for the unit choosing to be involved in the civil space business.

Table 8: Factors that are important in the unit choosing to be involved in the civil space business

	Very high	High	Average	Low	Very low
. . . a profitable line of business – with good margins	4	7	5	1	1
. . . important for developing expertise that is applied elsewhere in the business	3	10	3	2	0
. . . important for developing research that is applied elsewhere in the business	2	11	1	2	2
. . . important for developing technology that is applied elsewhere in the business	2	11	1	3	1
. . . important for developing relationships that is applied elsewhere in the business	3	9	4	2	0
. . . important for your reputation with non-space UK customers	6	5	4	1	2
. . . important for your reputation with non-space customers overseas	5	6	4	1	2
. . . it's a natural market because of our involvement with military space business	1	5	2	3	1
. . . perceived future commercial potential	5	9	4	0	0

2.44 All 18 units viewed civil space work as beneficial to their staff, in some shape or form, and gave the following examples of learning benefits:

- knowledge improvement and advancement of certain techniques, systems, design processes
- sharing of knowledge and greater appreciation of other technological areas
- exposure to potential new customers, partners and the sub-contractors
- projects are not always so milestone driven, which means they can be approached in a less conservative manner – there is more freedom to develop and this allows the engineers to be better engineers. There is also more flexibility compared to purely commercial work, so staff can follow different avenues
- staff are trained to BNSC and ESA manufacturing standards – this means the firm is able to carry out high reliability type work to a higher quality and better specifications
- overall experience of working in an environment which is extremely technically challenging and commercially very competitive where resources are stretched to the limit.

2.45 In seven of the firms there currently is much movement of staff around the business and this is more prevalent in multi-sector firms than the space only firms (and not just the units). Over half of the units do consciously move staff around their business and again this practice is encouraged to a greater degree in the multi-sector firms (nine out of the 11). Nearly all firms also featured civil space programmes as a method for recruiting staff and felt that there was a certain kudos attached to staff that have participated in civil space programmes. In 11 cases these programmes are used explicitly to train staff but there was no pattern as to whether this was more commonplace depending on size of firm or familiarity with the space industry.

3 Sub-contractor Interviews

Background on the sub-contractors

3.1 This section reports on interviews with six sub-contractor firms which were involved in five of the projects discussed in Section 2. The sub-contractors were six different firms and each of them said at the outset of the interview that it would be appropriate to gather information on the basis of the whole firm (and not a unit within the firm).

3.2 One of the sub-contractors is a large firm with 250 or more employees, three are medium sized firms (50-249 employees) and two are small firms with fewer than 50 employees. The largest firm employed 350 staff and the smallest had only 4 employees in 2000/01. The turnover in 2000/01 ranged considerably for these six firms, from £30m to £300,000.

3.3 Four of the sub-contractors are multi-sector based firms and have previously had limited involvement in civil space programmes – of the two firms that are focused on space only markets, one has also had limited involvement and the other firm was an incumbent. Only one of the firms has been involved in civil space sub-contracts for more than ten years and two firms are relative new entrants with less than five years experience. Five of the six firms stated that they have a long-term strategy for involvement in civil space work. For the three firms that are also involved in military space sub-contracts, the civil side came first in two cases and the same two firms regarded civil as being more important to their business in technical terms. In relation to the profit margin, one firm felt that civil was more important, whereas the other two firms rated civil and military as being of equal importance to their business.

3.4 Table 9 shows how the sub-contractors rated the extent to which the following factors are important in their firm choosing to be involved in the civil space business.

Table 9: Factors that are important in the sub-contractor choosing to be involved in the civil space business

	Very high	High	Average	Low	Very Low
. . . a profitable line of business – with good margins	1	2	2	1	0
. . . important for developing expertise that is applied elsewhere in the business	2	2	2	0	0
. . . important for developing research that is applied elsewhere in the business	0	4	0	1	1
. . . important for developing technology that is applied elsewhere in the business	1	3	1	0	1
. . . important for developing relationships that is applied elsewhere in the business	2	2	1	0	1
. . . important for your reputation with non-space UK customers	2	3	0	0	1
. . . important for your reputation with non-space customers overseas	2	3	0	0	1
. . . it's a natural market because of our involvement with military space business	1	0	0	1	1
. . . perceived future commercial potential	1	3	2	0	0

3.5 The sub-contractors also described the position of the firm prior to participating in the sub-contract and four of the firms felt that they already had a strong reputation in space technology and research – three of these firms believed that their main competitive advantage was their capability in space related technology. Five firms said that both their products/services were more technologically advanced, and that their people were more technically skilled than their competitors. All six stated that they were at the leading edge internationally.

Information on the sub-contracts

3.6 The firms were questioned about their reasons for participating in the sub-contract and these responses are shown in Table 10. Four firms hoped participation would lead to a radical improvement in their competencies, products and services but for the same number of firms the sub-contract did not involve development in technologies where they had limited or no experience. The sub-contract was naturally seen as an opportunity to make money by five of the six firms – the sub-contractor that answered no to this question was a multi-sector firm which primarily saw the sub-contract as a way of developing strategic alliances with a space only firm so as it could bid for future space related work.

Table 10: Sub-contractors intended their participation in the sub-contract as		
	Yes	No
. . . a radical improvement in your competencies, products, and services	4	2
. . . a development in technologies where you had limited or no experience	2	4
. . . involving the development of entirely new technologies all together	1	5
. . . putting you at the leading technological edge internationally	3	3
. . . an opportunity to make money	5	1
. . . a way of developing strategic alliances with other firms so as to bid for future work	5	1
. . . as a way of improving your ability to develop products/services for other markets	5	1
. . . technology transfer into your business from other organisations	3	3

3.7 The total size of the sub-contracts passed on to these firms was £2.4m – however one sub-contract amounted to £1.7m (71% of the total). For four of the firms the size of the sub-contract warranted establishing a team in-house and the staff were all drawn from a single division within those firms; two of these teams have remained in place after the sub-contract finished due to the work being important to the firm's overall activities. For the two firms that did not establish a project team this was due to the small size of the sub-contract. Four firms described their level of involvement in the design and management of the overall project as being collaborative (i.e. the sub-contractor worked as a partner in the design and management of the project) and in two cases this involved their staff co-locating with the main contractor.

Outputs and returns from participation in the project

3.8 All six firms said that the sub-contract in which they participated had met all the technical objectives – five also stated that the sub-contract had met both the firm's commercial and strategic objectives for participation. For half of the firms the sub-contract was important in winning subsequent contracts/sub-contracts; the other three firms are using this project experience to try and win future space work.

3.9 In five firms the results of the sub-contract have been used commercially by the business and for three of these firms they hope that the products, services and expertise developed from the sub-contract will enable them to enter a totally new market unrelated to space. These applications include: working with an automotive manufacturer and also an aerospace firm; developing products for the terrestrial TV market; building a generic skill base which can be used in a number of applications.

3.10 Two of the sub-contractors were able to claim that the sub-contract has resulted in sales of products/services to other customers. One firm has sold equipment to the value of £400,000 and a second firm has achieved sales of £20,000 to date with the potential for much more. A

third firm said that through being a 'service' based company the concepts used in the sub-contract are broadly applicable to other work that it undertakes.

3.11 With regard to project collaboration, three of the sub-contractors said that they gained new skills and/or technologies from the lead firm, whereas five firms felt that the lead firm gained new skills and/or technologies from them. There was no exchange of staff, in either direction, between lead firm and sub-contractor(s) in any of the five projects. One sub-contractor stated that there had been no transfer of technology and skills across the project firms.

Impacts on the business entity from undertaking civil space work

3.12 As with the project specific interviews, the sub-contractors were asked about the broader impacts on their business of civil space work rather than just the specific sub-contract. Table 11 shows that for most firms the civil space sub-contracts do meet their strategic objectives for involvement and have strengthened their established lead over the competition. The sub-contracted work has not enabled these firms to catch up with the competition, which is not surprising as the firms are usually enlisted as sub-contractors in the first place because they already have the technology, skills or expertise internally. All six sub-contractors stated that civil space work has meant that the firm could develop or retain key skills in their business.

Table 11: Participation in civil space work for which you have received a sub-contract

	Agree	Disagree
. . . met your strategic objectives for involvement	5	1
. . . strengthened your established lead over competition	5	1
. . . enabled you to catch up with the competition	0	6
. . . proved an unfortunate distraction from your core markets	0	6
. . . facilitated your entry into new product/service markets	3	3
. . . developed or retained key skills in your business	6	0
. . . kept you alert to technological developments	4	2

3.13 Table 12 seeks to understand the more specific business level impacts that participation in civil space work has had on the six sub-contractors. The areas where this work has been having the most impact (i.e. 'very high' and 'high') for these six firms is the development of new or better skills and working practices in the firm, and the development of alliances and long-term collaborations.

Table 12: Contribution of firm's participation in civil space work to . . .

	Very high	High	Average	Low	Very low
. . . development of new products	1	2	1	1	1
. . . development of new manufacturing processes	0	3	0	2	1
. . . development of new markets not related to the civil space sector	0	2	0	3	1
. . . development of new or better skills and working practices in the firm	1	4	1	0	0
. . . quality control and enhancement	2	1	0	3	0
. . . improved efficiency (less waste, better stock control etc.)	0	2	0	3	1
. . . development of alliances and long-term collaborations	2	2	0	1	1
. . . enhanced identification and adoption of technologies from other firms or industries	0	2	1	2	1

3.14 The responses shown in Table 13 focus on the impact that grant funded civil space projects have had on the sub-contractor.

Table 13: Specifically because of *grant funded* civil space projects, we…..

	Yes	No
. . . started new R&D activities that otherwise would not have been initiated	3	3
. . . developed new products/services that otherwise would have remained dormant	3	3
. . . increased our stock of R&D personnel to a scale that otherwise was not justified	2	4
. . . had to downscale or cancel other planned R&D or sub-contracts	0	6
. . . had to reallocate resources from other planned activities	2	4
. . . increased our market share at the expense of other UK businesses	2	4
. . . increased market share at the expense of foreign companies	3	3

3.15 All six sub-contractors saw civil space work as being beneficial to their staff. Four firms feature civil space programmes as a way of recruiting staff and five felt that there is a certain kudos attached to staff who have participated in civil space programmes. The specific learning benefits mentioned by five of firms included:

- the discipline of undertaking ESA work – by ESA dictating the project reporting and timescales this forces the firm to carry out R&D in a particular, organised way
- the development of advanced skills and techniques
- the involvement of staff in a number of areas of product development such as integration and testing.

4 Findings from of the Main Beneficiaries

Background on the Main Beneficiaries

4.1 This section is based on the findings of research carried out with companies that had received large amounts of funding from BNSC national programmes or ESA projects over a significant number of years.

4.2 Interviews were held with nine organisations – mainly large firms but also including one public sector organisation and one small firm. Most of these had been involved in several of the five programme areas funded by BNSC or ESA. It is important to note that these discussions were held in relation to the organisation's overall experience with BNSC / ESA programmes and were not limited only to the five business support programmes

4.3 Five of the nine organisations interviewed had received more than 50% of their income from either BNSC or ESA either directly or indirectly through sub-contracts. One firm had an equal split between BNSC/ESA and other customers and three had the majority of their sales going to non-BNSC /ESA markets. There appeared to be no particular pattern distinguishing firms that were highly dependent on BNSC/ESA and those that were not, although firms that were mainly involved with software development normally had a fairly large non BNSC/ESA activity.

4.4 Most of the organisations had been involved in space for a long period of time, from 15 to 45 years, in most cases much longer than the respondent could recollect. In many cases, companies had undergone considerable reorganisation and/ or changes in ownership over recent years. Because of the complexity of some of the organisations interviewed, we asked respondents to define for themselves the most relevant division or locations that were involved in space activities and we then structured the discussion in relation to these divisions / locations.

4.5 Most of the organisations were strongly focussed on civil space. Six had over 70% of their turnover in civil space; one had 50% and one 35%. The importance of military space was quite small for most organisations ranging between zero and 25%. Where they undertook military as well as civil space work, the civil work had preceded military in most cases but companies reported significant cross-over benefits in relation to sharing of expertise and processes in both directions and that synergies were increasingly possible because both sectors were using more COTS (commercial off the shelf) products.

4.6 A few organisations were focussed on wider contract research markets, but the majority were primarily involved in the development of space and other systems. In general, companies had

a relatively modest expenditure on corporate R&D (defined as internally funded R&D rather than contract research) normally in the range 2-4% but in some cases up to 13%.

4.7 Grants and subsidies were seen as vital by most organisations and, in some cases, companies reported that would be unlikely to remain in business without them. For others, grants and subsidies enabled proof of concept trials to take place that would be too risky for the company to undertake alone, or that would have taken far longer without a grant. The importance of R&D funding was frequently related both to the inherent technical and market risks involved in space activities but also to the non-level playing field in world markets.

4.8 The additionality of BNSC /ESA funding was generally seen to be high with most organisations stating that would not have been able to participate in many R&D projects without funding or that they would have had to undertake projects over a longer period of time.

4.9 The organisations interviewed were involved in a variety of different segments of the space market including space, ground and value added services. Whilst they undertook some downstream activities, these were generally small although downstream value added activities were expected to become more important for the future.

4.10 Most activities were in the upstream areas such as building large and small satellites buses and payloads, sub – systems, control systems and instruments, components , ground stations, mission planning, ground control and modelling and simulation software. Many companies were involved in several of these areas.

4.11 In this study, the main source of views of companies involved in downstream activities such as telecommunications services or broadcasting has been through the 'Contextual interviews' section of the study which are reported elsewhere.

Benefits of participation in the space programmes including wider commercialisation of technology, skills and knowledge developed in the civil space sector

4.12 This section reports firms' views as to how the UK space sector benefits from civil space programmes. In considering the implications for public policy, it is important to bear in mind the extent to which firms are able to appropriate the benefits that flow from the projects. Whilst we were not able to gauge this from the discussions and there will, inevitably, be some variation from project to project, we have noted for each of the benefit categories, by means of a footnote to the section heading, our view as to the likelihood that benefits will be appropriable.

4.13 The benefits of participation in BNSC and ESA programmes were discussed with interviewees and a wide range of both specific and more generic benefits were reported. In most cases it was difficult to attribute either specific values or other quantification to these benefits. These benefits from space funding have been analysed into six main categories set out below:

- benefits from projects that helped the firm to gain other public sector grants or subsidies e.g. ESA contracts
- benefits from projects that helped the firm or other firms gain wider commercial or competitive contracts for the same / similar product e.g. from Inmarsat, Eutelsat or military contracts
- benefits from projects that helped the firm to develop technologies that could be applied in non space areas e.g. the use of space control software for the control of other applications such as water flow, or simulation space software that is transposed for simulating other systems
- benefits from projects that enhance the firm's capability or skills that can be used more widely
- benefits from enhancing the firm's credibility, for example by demonstrating their capability in managing complex projects requiring high reliability
- wider benefits outside the firm through the provision of services that are used by the public.

4.14 For some companies, the opportunities for wider benefits in some of these categories are limited. For example, some companies do not have any other business activities apart from space and have no mechanisms for space based technologies to spill over into other areas.

Benefits in gaining other publicly funded projects.[9]

4.15 The main area of benefit in this category was where firms utilised BNSC funding to position themselves to win larger ESA contracts. This was quite frequently mentioned by firms as being a benefit of having flexible BNSC funding. However, it was also pointed out that it cannot be assumed that the juste retour rules mean that UK firms would have obtained a similar funding anyway. The main benefit was seen to be in winning more technically advanced projects.

[9] The immediate benefit from securing other projects is appropriable by the firm, but there may be some non-appropriable benefits arising from the subsequent contract.

4.16 Many examples of specific BNSC projects that led on to wider ESA projects were provided. In particular, firms looked to BNSC funding to provide capability in new areas and proof of concept that would put them in a good position to bid for much larger ESA projects. Examples include funding under the BNSC Mosaic programme that provided technical capabilities used to win the Galileo System Test Bed project.

4.17 Key benefits were seen as providing demonstrations of new technology and reducing the risk of new technologies and markets.

Benefits in gaining wider space contracts including military/export[10]

4.18 Technologies used in BNSC/ESA civil space projects may form the basis for wider sales to commercial civil markets and sales of systems to other countries e.g. for telecommunications satellites as well as for military satellites for the UK or for foreign governments. In general, military space technology / markets were of lesser importance to respondents than civil technologies / markets. Civil programmes frequently lead in the introduction of technologies.

4.19 The benefits of gaining ESA contracts have been reported as having particular importance in establishing credibility in the wider market where the ESA 'stamp of approval' is important.

4.20 Examples of sales of the same or similar products to other space customers include:

- the development of fully digital communications satellites with phased array antenna which led to a contract for Inmarsat 4 large satellites
- sales of a constellation of small satellites to a variety of customers including the MOD and customers in different countries following the support given by BNSC under the Mosaic programme and subsequently under Artes programme
- the sale of star simulators and CCD test equipment to the Indian space industry
- ESA contracts enabled development of space craft and control systems which has resulted in contracts from Eutelsat, Eumetsat and MOD
- development of airborne earth stations using BNSC grants that enabled the development of a major share of the world market for airborne satellites links to aircraft manufacturers and airline operators
- enabling the organisation to maintain a critical mass of key specialist expertise that is needed for space projects and missions.

[10] We would expect these benefits to be appropriable, probably in full, by the firm.

Benefits in developing technologies that could be used outside the space sector[11]

4.21 Many examples of technology transfer were quoted in this area. These included both specific space product technologies and, also, production/process technologies Although attempts were made to put a value on the resulting sales; this was not a simple matter. In particular, although there were many examples most of the resulting benefits were relatively small. Specific examples of space product technologies used in other areas are discussed below:

- radiation hard cameras developed for space have been adapted for use in the nuclear industry. The value of sales has been in the order of £20,000
- hand held infra-red cameras developed using space sensors that are now used by the fire service in many parts of the world with sales in the region of £250,000
- development of low mass high stability structures for space which was beneficial in the development of laser vibrometry market where it has improved stability for products used in industrial applications enabling sales of some 50 per year
- developing a wide range of space technologies for applications in UAVs (unmanned air vehicles) where there is a major new market and where many space technologies that were constrained by lack of power in space can find an application in a UAV where more power is available
- development of special traffic light lenslets to provide spatial filtering and avoid sunlight reflections
- the development of a fast scan automatic inspection system for use in the manufacture of float glass that is now used throughout the world and which utilised space design capabilities and tools. Overall sales have been in the region £2-3m per annum
- the use of CCD detector equipment developed for space which have been incorporated into dentistry equipment to detect X rays for real time measurement of changes in the state of teeth
- development of SCADA (Supervisory control and data acquisition) software into simulated environments for battlefield information systems and simulation of the next generation of battlefield communications (Bowman)
- development of SCADA to allow utilities to control a wide range of sensors and control over a wide area e.g. for control of water and possibly for control of tight formations of UAVs. This has developed into a 100 person company with sales of some £1.5m per annum

[11] We would expect that these benefits would be partly, but not wholly appropriable by the firm.

- the use of specialist image extraction / enhancement software in other areas for which image enhancement is important
- the use of GPS for monitoring the position of trains
- the use of EO data for river height monitoring
- development of software for handling sea surface temperature data that could be used widely
- development of software for space applications that is also widely sold for the control of large ground based telescopes all over the world
- development of techniques and data to provide information for nautical almanacs
- use of GIS techniques which have been very relevant to applications in battlefield information systems
- increasing synergies between military and space applications as a result of both sectors making greater use of COTS (commercial off the shelf technology)
- development of smart optics developed for space for a wide variety of applications through the Smart Optics Faraday partnership
- the use of satellite terminal technologies to control gas flow for Transco
- potential to use the low mass data down link system developed for space as a down link for military aircraft
- the use of simulation software developed for space in other environments including the West Coast Main Line, air traffic control at Brussels airport and methods to enhance incident detection on controlled motorways
- use of simulation tools developed for space to simulate the response to stress of a new 3G mobile phone network and to develop the appropriate distribution architecture
- use of 'response to stress' software for defence systems
- the development of a broad band space communications system to provide distance learning systems for schools
- the development of specialist data distribution systems for retailers using addressable multi media satellite broadcasts.

4.22 Examples of process technologies used in space and transferred to other areas include :

- development of a specialised e.commerce portal that enables the prime contractor to manage complex project relationships with sub contractors in different companies, different countries and using different languages which is now being applied in the defence equipment sector and with potential for use in government departments and financial services
- development of improved manufacturing efficiency, quality and consistency in space related electronics manufacture with the same techniques being used successfully to manufacture other non-space products
- the possibility of using processes for polishing complex space mirrors to a high degree of accuracy for polishing prosthetic joints
- development of simulation software used for space applications for simulation of possible 3G telecom network capacity and operational performance
- development of new techniques and processes, including rigorous project management and quality control, that enable the firm to be more effective in other areas
- development of a new carbon fibre reinforced plastic joint with major opportunities in the aerospace sector.

4.23 Very few spin-out companies were mentioned during the interviews, apart from Infoterra.

4.24 The companies interviewed included those which were primarily focussed on space such as Astrium , SSTL and those which had wider commercial interests such as SIRA, Thales and Esys. These latter companies, unsurprisingly, had more opportunities to gain wider benefits from BNSC /ESA space projects. In the software area, the opportunities for transferring systems and solutions (such as simulation) from the space field to other fields seem to have been quite good

Benefits in developing capabilities and skills that could be used outside the space sector[12]

4.25 Benefits in this area include:

- improved management skills and a more critical understanding of how to set up projects including work package descriptions , plans and reviews

[12] We would expect these benefits to be mostly, but perhaps not fully, appropriable by the firm.

- project funding which had major benefits in providing development laboratories as well as in developing expertise
- the development of core capabilities from the civil space programmes in areas such as GIS which was first developed in the 1970s and 80s and which was too risky for industry to develop at the time
- the development of other core capabilities such as image processing, satellite communications delivery and project management
- experience in working in multi-disciplinary, cooperative international teams
- improvements in the organisation's capabilities in relation to optical devices as a result of space technologies
- utilising the skills involved in leading edge technologies to get into other markets such as non-space software
- major improvements in physical capabilities including 3D design, CMM and precision manufacturing
- improved capabilities in optical manufacture including new CAD and clean room facilities
- the disciplines of the space design process "improved the whole company".

Enhancing the firm's profile and credibility[13]

4.26 Several companies said that the indirect benefits to their credibility were enormously important, not only in marketing to organisations in the space sector, but also in wider markets. For example:

- software contracts gained from space programmes were used extensively in their non-space marketing where involvement in space demonstrated capabilities in mission critical and high reliability systems
- involvement in space enabled recruitment of high calibre people
- space is very motivational for staff wishing to be involved in leading edge space technology
- the demonstration of high reliability engineering improved credibility in other markets

[13] This is a benefit that will be appropriated fully by the firm.

- benefits through enhanced contacts in the UK and overseas market.

Wider benefits to society[14]

4.27 Examples of benefits in this area include:

- the development of phased array antenna which enable satellite operators to serve six times more customers from the same transponder
- monitoring crops by analysis of satellite EO data to determine whether farmers are utilising land according to their grant agreements within the CAP e.g. quota compliance
- monitoring space weather including variations in the activity of the sun which can have major disruptive effects on telecommunications, power distribution and space operations providing earlier warnings and ability to reduce impacts
- oil and gas industry for oil slick monitoring
- meteorology
- mapping GIS.

Potential benefits from future programmes

4.28 In addition to the actual benefits from existing and past programmes discussed above, a number of potential benefits are being evaluated and feasibility studies undertaken. These related to future programme areas such as Galileo and include:

- the possibility of using navigation satellite systems such as Galileo for a variety of applications including monitoring river heights in order to provide flood warning
- the potential use of colloidal thrusters developed to provide micro-thrusters in a silicon chip in order to develop specialist spraying of thin films of liquids.

[14] The firm may well have appropriated some of the benefits, but it is likely that there will be others that are not appropriated.

5 Non-Participants Interviews

Firm background

5.1 Whilst the nature of the four non-participants' involvements in the space industry varies considerably all four firms typically sit as value added suppliers in the value chain of space assets. The products or services supplied by these firms were, in their own words:

- applications side of the ground segment producing enabling technology for people who want to use earth observation data
- small aviation firm which builds and launches rockets
- geographic data and imaging – creation and supply of raw and value added imagery
- designer and manufacturer of consumer electronic accessories for the satellite industry.

5.2 All can be described as small firms with less than 50 employees – two were established in the 1990s, one in the 1980s and one in the 1960s. The three firms that included R&D in their accounts all said that their R&D as a share of turnover was less than 10%.

Receipt and knowledge of BNSC or ESA grants

5.3 Only one of the three firms had received any funding previously from BNSC or ESA. This same firm had also been involved in another BNSC contract in the mid 1990s. Again only this interviewee had heard of any of the three BNSC and two ESA programmes that were the focus of the study (the other firms had no real dialogue or relationship with BNSC or ESA). According to his understanding the purpose of the BNSC programmes was to: "*support technology development, encourage and facilitate SMEs and new entrants in the space industry, and initiative partnerships and collaborations"*. This same firm had previously applied to one of the BNSC programmes but the proposal failed on the grounds of being too technology led rather than articulating the market benefit of the work. To date the lack of BNSC funding has stopped the project going ahead despite the firm still being keen to continue with the work.

5.4 The three other firms gave the following reasons for not having applied to these programmes:

- firm is possibly not in the right market and no programmes match the firm's business – BNSC/ESA seen to be high level, research based work

- conscious of the amount of paper work that is required to understand the BNSC or ESA procedures and systems – significant amount of effort required to make the first step

- perception is that if the firm has not already received a BNSC or ESA grant then it is difficult to obtain one i.e. only established firms receive the funding

- the programmes are not fully funded – the firm does not have sufficient funding to invest in R&D spend as need to devote resources to product and market development

- firm is better off spending time and effort on genuine and realistic income avenues rather than speaking to BNSC/ESA and completing a proposal, which they have little chance of winning anyway.

Other Government funding

5.5 Two of the firms had made other applications to the UK Government for funding – both to non-space related schemes. These included the Small Firms Loan Guarantee Scheme (SFLGS) and the Smart award. For one firm the reasoning behind not applying for Government funding was due to the firm being well established and successful – not small and not large either.

Space industry

5.6 The firms were asked to comment on what they expected to be the most significant changes/trends in the civil space sector over the next 5 years:

- the usage of high resolution imagery and its integration into data warehouses and data management

- growing provision of two-way communication devices to commercial units and homes; particularly internet via satellite which will increase internet access in rural areas

- breakthrough in the value added or application market of geographic data and imagery

- due to the decline of the aerospace industry post 9/11 there is a need to find the next big industry i.e. space tourism – however the large aerospace manufacturers are not open to opportunities in this area.

5.7 The four non-participants mentioned a small number of relationships that they share with other firms or organisations in the space industry. The firms listed included QinetiQ, Invacom, ComSine, InfoTerra and Nigel Press Associates, and ASTOS, the Association of Specialist Technical Organisations for Space.

Appendix: The views of BNSC staff

Appendix: The view of BNSC staff

The views of BNSC staff

1. In addition to gaining views from beneficiary companies, we sought to gain views from BNSC programme managers on the areas where the UK gained benefits from the space programmes. The following key points were made.

2. The benefits might be considered against the classical arguments justifying public support i.e.:

   - **market failure** – where markets were highly risky in technological and market terms or where there was an unfair playing field.

   - **externalities** – where the benefits to society were likely to be much greater than individual firms might expect to appropriate for themselves and where additional public investment would yield external benefits.

3. Investments in space were thought to be justified on both grounds, given that the space market is highly risky with markets that are distorted by national policies and support and because a large part of space expenditure provides benefits to society that can not easily be appropriated by individual firms e.g. the benefits from effective monitoring of disasters or from better weather forecasts.

4. Some of the specific benefits claimed for UK support for space are summarised below.

The UK ability to influence wider policy

5. Having an active space programme and expertise in space markets and technologies allowed the UK to influence policy developments mainly at a European level (but also in other ways) in new areas of space activity; in particular the development of an independent European navigation systems and the possibility of reducing reliance in American systems such as GPS on which many other important systems such as mobile phones are reliant. Other benefits include the ability to influence standards in new application areas that are likely to be very significant markets for the future including vehicle telematics or tracking systems.

Ability to implement wider government policies

6. Government policies such as those to assist remote areas in gaining broadband access can be assisted by space programmes that allow much wider coverage. For example developments of projects have enabled new interactive services to be introduced such as addressable multi-cast services to allow farmers to participate in auctions remotely or the development of inter-

active learning materials that enable pupils across the UK to utilise the latest broad-band technology.

The use of space data and systems in government and the public sector

7. A wide range of space based data has its major use in public sector organisations, for example the use of EO for monitoring crop for compliance with agricultural policies, GIS systems, etc. In many cases these approaches need to be seen as complementary to existing systems rather than as a replacement.

Ability to gain the wider benefits to society

8. Many of the benefits from space technologies are not easily appropriable, but have important benefits to society. Examples include disaster monitoring, weather forecasting, monitoring the routes of vehicles, ships etc. with dangerous or illicit cargoes.

Assisting UK industry within an imperfect market

9. The UK support for space programmes is relatively small in relation to the US, France or Germany. Nevertheless, the UK has chosen specific strategic priorities in which there were thought to be major opportunities. UK funding through BNSC has therefore been undertaken to assist British industry in positioning itself to be competitive in larger programmes such as those of ESA, and for winning work from defence and civil space operating companies. Such funding has frequently been on the basis of calls for proposals in broad strategic areas with companies allowed considerable flexibility in project content.

10. The benefits of such assistance can be seen in areas such as:

- the support given to Astrium to develop the phased array digital antenna which positioned them to win major contracts from Inmarsat
- the support provided to Racal / Thales to develop airborne ground stations which have assisted them in becoming world market leaders
- the support provided to SSTL which assisted them in developing the Gemini small satellite on a modular basis which is now gaining sales in the small satellite market
- the assistance provided to ground control and satellite software companies which has enabled them to maintain a strong world – wide presence
- the development of ion engines that provide major benefits in terms of launch eight and long term operation in which support enable UK companies to gain a world lead and develop a growing business.

Wider benefits

11. The wider economic benefits from space programmes were seen to lie in areas such as:

- the potential for the transfer for simulation and modelling technologies developed for space into the modelling of 3G mobile phone network operations
- the use of space based technologies in the development of constellations of unmanned aircraft (UAVs) both in terms of control of formation flying and the use of instrumentation and control. In particular, many space technologies that were constrained by lack of power for space applications can be used with that constraint removed in the UAV field. Many space companies are working on the development of technologies for UAVs which are seen as a significant market
- the transfer of space technologies into completely different areas including technologies used to polish space mirrors in 3D being used to polish prosthetic joints, the use of space CCD sensors in dentistry to allow X –rays to be taken with major reductions in power
- the slow growth in EO markets which need to be developed, with a large part of the potential market coming from public sector sources. Many of these markets are likely to be concerned about continuity and are therefore unlikely to replace existing systems with space based systems. The slow developing market needs to be encouraged by demonstrating that space applications are a complementary product rather than a replacement product.