Research Report

Space Sector Skills Survey 2020

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Prepared for: UK Space Agency

Prepared by: Roger Sant, Chief Research Officer, Philip Roe, Research Associate, Emma Osborne, Associate Director, Lucy Hallam, Research Manager, Honor Sullivan-Drage, Research Executive, BMG Research

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Foreword by Co-Chairs of Space Sector Council

The space sector is not just an exciting place to work: it has become an essential part of our daily lives. The technology developed and operated by the UK's highly-skilled space sector underpin countless aspects of the UK's economy, and it's growing larger every day. We are delighted to support the publication of this important report, which will help us make sure we have the world-beating scientists and engineers to supercharge the UK's growth potential in space and across all regions of the UK.

This new evidence highlights that our space sector has an excellent foundation upon which to grow: more and more people every day are embarking on a career in space. We now have an opportunity to take steps to ensure they can grow and develop to make that career long and rewarding.

The UK Space Agency and its partners across the sector will now capitalise on this evidence to prioritise, support and target learning opportunities so that:

- the sector can continue to grow and attract the people that it needs,
- employers can develop their workforce wherever they may be based and retain skilled workers,
- individuals can ensure that they have the skills to work and thrive in a rapidly developing and exciting sector.
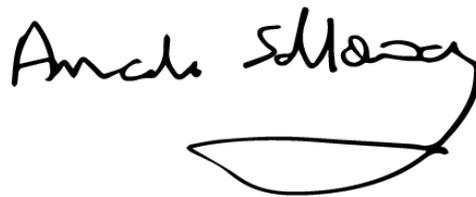
AMANDA SOLLOWAY MP

Parliamentary Under Secretary of State – Minister for Science, Research, and Innovation

WILL WHITEHORN

President, UKspace

1. Executive summary

Key findings

Overall, the Space industry has been revealed as dynamic in respect of recruitment, training and development, and wider opportunities for the development of high-level skills. Specifically:

- Recruitment for core industry skills – those at managerial, professional, and associate professional and technical level – is frequent.

- Industry businesses are heavily involved in training and staff development, including the frequent provision of opportunities for the development of under-graduates, graduates, post-graduates, and higher-level apprentices.

- There is support for a new Graduate or New Entrant Training Programme.

There is demand for a large number of technical skills in the industry but also a demand for soft skills, particularly with regard to skills in: collaborative working, commercial awareness, sales and marketing, proposal writing, mentoring and teaching junior staff, for an 'agile' and flexible workforce able to respond to innovation in technologies and materials, for particular skill combinations across the 'hard'/'soft' divide, and for middle and high-level managerial skills.

Shortfalls in supply, both in technical and non-technical areas, have been identified but also a number of factors to help mitigate this, including:

- Many young people perceive the industry as an exciting and attractive area in which to work.

- The industry is perceived to be culturally and ethnically diverse, welcoming many recruits from Europe and elsewhere in the world.

- Pay levels for entrants are competitive with those of most other sectors for comparable skill levels.

However, a number of challenges to solving skills supply issues were also identified:

- Recent growth in the industry has placed stress on skills supply – growth in the number of people with the required skills has not kept pace with growth in demand.

- The industry has very high expectations of recruits exemplified not only by the breadth and blends of skills expected but also by the industry's frequent expectations of skills, particularly technical ones, being supported by qualifications at post-graduate level and/or by experience in the industry.

- The industry suffers from an internal, inward-focused approach to recruitment, with preferences for 'network' recruitment of experienced and known recruits – extending to staff poaching on occasion. This preference for experienced people already in the industry decreases industry's total training effort and reduces the skilled labour pool.

In respect of recruitment, the following issues were identified:

- Whilst the industry recruits easily across cultures, ethnicities, and nationalities, the number of women employed in the industry is under-representative of the working age female population. Female recruitment suffers from the historically lower proportions of girls and young women studying STEM subjects in schools and

universities and, perhaps, from an image of the industry as a home for male 'nerdy' or 'boffin' types of people.

- Brexit has made it more difficult to recruit from Europe and has encouraged some European staff to return to their original countries.

- Whilst the industry offers good and competitive pay to its highly-qualified entrants, it may also struggle to increase pay at a point several years beyond recruitment – with consequent loss of high skills (particularly in software) to other sectors.

Limitations in the training infrastructure that have been identified include:

- Courses in universities, though space-oriented, lag behind industry developments

- The absence of conversion courses to allow people with relevant technical skills and qualifications to add a 'space' dimension to these

- Lack of resource in small space businesses to supply internal training (hence a frequent preference for recruitment of experienced staff from within the industry)

- The absence of a training-supported entry route for young people at the 'A' level point

The survey suggests that there is a mismatch between what skills the industry needs and what skills the UK Higher Education system produces. This is about both a simple shortfall in numbers as well as perceptions that HE courses lag behind rapidly advancing technologies or lack specificity to the space industry's particular needs.

It is evident from the survey that meeting industry skill needs is not a straightforward matter, with the key challenges faced including that:

- The lists of particular occupations suffering skill shortages and gaps and of under-supplied training courses are long and highly specialised.

- The industry has a strong focus on recruitment of people with high, often post-graduate, qualifications.

- The industry would ideally like recruits who have combined skills in more than one technical specialism and often including 'soft' business and team-working skills.

The survey

Both the global and UK space industries have grown strongly in recent years and both are forecast to grow further. However, the supply of relevant skills to support growth presents a challenge. This survey, commissioned by UKSA, provides an opportunity to investigate the scale and nature of the challenge and, hence, to inform possible ways in which the challenge may be met. The study as a whole comprised a *quantitative* survey of 96 structured interviews and a *qualitative* survey of 21 in-depth interviews. All interviews were undertaken with senior staff of 'core' space industry businesses. The interviews were undertaken in the autumn of 2020.

The sample profile

The samples for the survey were drawn largely from UKSA's database of businesses known to be wholly or strongly focussed on space-related activities and from organisations across the Space Growth Partnership. The samples were not intended to be formally representative of the UK space industry, which is not strictly defined.

However, the quantitative sample, particularly, might be assumed to broadly reflect some characteristics of the industry as a whole. Thus (as in virtually all UK sectors) a majority of

respondents were micro-businesses with fewer than 10 employees (39%) or small businesses with between 10 and 49 employees (31%). Just over a quarter (27%) were larger businesses with 50 or more employees. Employment was not established in a final 3% of cases.

Further, the geographic representation of the sample, with a focus on the South East and London (and some counties in the adjoining regions of the South West and East of England) and in Scotland, largely correspond with the known distribution of the wider industry.

UKSA's perspective of the industry, as one in which many core space businesses are engaged in multiple types of activity within the 'upstream' element of industry operation and not infrequently are engaged across the 'upstream'/'downstream' divide, was shown to be accurate.

Overall, therefore, it is likely that the quantitative survey sample, though limited in size, provides a sound base for the examination of various skills issues which constitute the remainder of this report.

Skills challenges

Skills specifically related to space industry operation and higher-level technical skills which are transferable into the industry were widely used across all 'activity' sub-groups. Recruitment levels for these skills were high when compared with typical levels of recruitment in other sectors of the UK economy.

A significant level of **recruitment difficulty** was also observed, with two-thirds or more of businesses which sought to recruit experiencing difficulty. Difficulty was more often experienced by larger businesses, which, by virtue of their size, recruit more frequently.

Much the larger part of recruitment difficulty concerned professional occupations or, to a lesser extent, technical jobs at the 'associate professional and technical occupations' level.

Further, **skill gaps** in the current workforce were identified by 51% of businesses, a much higher proportion than that for businesses across all UK sectors.

A large proportion of businesses with skill gaps (86%), located these in their scientific, engineering, or technical functions, whilst 43% located skill gaps in their managerial or entrepreneurial functions.

Scientific, engineering and technical skills gaps were widely distributed across a range of specialisms. Managerial and entrepreneurial skill gaps were more concentrated in one area, that of project management, having been identified by 67% of businesses with managerial or entrepreneurial gaps. Beyond that a wide range of different types of managerial or entrepreneurial skills gaps were each identified by between a quarter and a half of businesses with this type of gap.

The skills supply situation is worsened for approaching a quarter of businesses (23%) by **staff retention problems.** Essentially, with a limited supply of the required skills, individual staff are able to take advantage of opportunities to increase their pay or otherwise improve their situation by moving between employers.

Overall, two-thirds of businesses in the industry (67%), rising to 97% of businesses with 50 or more staff, experienced one or more of the three main skills issues which were investigated (recruitment difficulty, skill gaps, or staff retention problems)

A number of factors which helped mitigate the skills supply situation were identified:

- The industry is extremely attractive to those young people who have a passionate interest in space and are enthusiastic about entering the industry.

- The industry is culturally and ethnically diverse, welcoming many recruits from Europe and elsewhere in the world.

- Pay levels for entrants are competitive with those of most other sectors for comparable skill levels.

However, a lengthy list of issues precluding these factors from 'solving' the skills supply issues was also identified:

- Growth in the industry in recent years has placed stress on skills supply.

- The industry has very high expectations of recruits exemplified not only by the breadth and blends of skills expected but also by the industry's frequent expectations of skills, particularly technical ones, being supported by qualifications at post-graduate (often doctoral) level and/or by experience in the industry.

- Some respondents in the depth interviews also suggested that the industry's specialised and high-skill character was off-putting for some potentially employable individuals who perceived the industry as too rarified for their talents and qualifications.

- As a consequence of these constraints on external recruitment, the industry suffers from an internal, inward-focused approach to recruitment, with preferences for 'network' recruitment of experienced and known recruits – extending to staff poaching on occasion.

- There are limitations in the training infrastructure, with identification of:

  - Courses in universities, though space-oriented, lagging behind industry developments

  - Absence of conversion courses to allow people from other sectors with relevant technical skills and qualifications to add a 'space' dimension to these

  - Lack of resource in small space businesses to supply internal training

  - Concomitant with the industry' s focus on high qualifications, the absence of a training-supported entry route for young people at the 'A' level point

- Whilst the industry, as above, recruits easily across cultures, ethnicities, and nationalities, the number of women employed in the industry is low. Female recruitment suffers from the historically lower proportions of girls and young women studying STEM subjects in schools and universities and, perhaps, from an image of the industry as a home for male 'nerdy' or 'boffin' types of people.

- Brexit has made it more difficult to recruit from Europe and has encouraged some European staff to return to their original countries. The prospect of losing European collaborations and funding may reduce the innovation and 'excitement' factor which attracts people in to the industry and retains them in it.

- It was suggested that, whilst the industry offers good and competitive pay to its highly-qualified entrants, it may also struggle to increase pay at a point several years beyond recruitment – with consequent loss of high skills (particularly in software) to other sectors.

An immediate effect of such problems on businesses which experienced them was simply to increase workload on other staff or to outsource work to other businesses. However, a wide range of other more significant consequences were observed with some frequency, including

constraint on innovation, failure to exploit business opportunities or to win contracts, and reduced productivity.

Overall, more than half of businesses with these problems (55%) assessed their impact as 'moderate' but 9% (or 6% of all businesses in the sample) saw them as major. Only 2% reported that their skills issues had no impact on business performance or growth.

Responses to skills challenges

A high proportion of space businesses (80%) had responded to their skill challenges by training one or more of their staff within the 12 months prior to the survey.

This included both formal, off-the-job training, by 54% of businesses, and less formal but still intentional training, by 73% of businesses.

Training most frequently comprised the up-skilling of existing staff in space skills but work placement schemes for university students, graduates, and post-graduates and apprenticeships, including high-level apprenticeships, were also widely used.

Training was most often supplied by internal staff of the business (either specialist trainers or other staff) but private training companies were also used frequently (particularly by micro-businesses) as were universities and professional associations or sector-bodies.

Only a small proportion of businesses had not trained staff in the 12 months prior to the survey. Almost always these were micro-businesses which reported that their staff did not need training.

Four in ten of all businesses (40%) believed that some training or education was not available or was in short supply.

This missing or under-supplied training fell into three broad groups: space specialist training, generic technical training, and management and commercial training.

The missing or under-supplied training identified in the 'space specialist group' was very varied. What was less varied, however, was the expected level of training – most businesses would expect this training to be at least at under-graduate level and often at graduate or post-graduate level.

There was a general positive response to the concept of a new Graduate or New Entrant Training Programme for the space industry, though some of this response was conditional on the content, cost and other characteristics of the programme.

Looking to the future

There is an expectation of business growth over the next 3 years amongst the greater proportion of businesses in the sample (75%). An even larger majority, 85% of businesses, expect growth or replacement needs to require staff recruitment over the same period.

The great majority of recruits will be at professional or associate professional and technical levels spread across a wide variety of individual, mainly specialist, job types. Nearly all these job types are expected to be very or moderately difficult to recruit.

In this context, a number of more detailed perspectives on the industry's future in relation to its skills need were also identified, including:

- The prospect of limitation on productivity and growth because of skills shortages.
- Particularly, shortage of software, rather than hardware, skills potentially becoming a source of UK industry disadvantage.

- Growing demand for skills in Artificial Intelligence, Machine Learning, and associated software. With this demand being shared with several other sectors, there is likely to be a growing pool of people with these skills but also wider competition to recruit them – with the industry's inability to offer competitive salaries then coming even more strongly to the fore.

- It is likely that there will be a constant stream of 'agile' start-up businesses, driven by technological innovations and ideas – but, while these businesses will need commercial skills to move into successful growth stages, these skills are often in limited supply.

A future industry response to its skills challenges

Looking ahead, the wider skills environment may improve: Brexit finalisation and an end to uncertainty may allow supply of skilled European staff to stabilise and, perhaps, to increase again; national concern to widen and improve delivery of STEM subject education may strengthen the underlying basis of technological skills, and the slow increase of women interested and qualified in technical areas may continue. However, such changes may be marginal and incremental.

More immediately, the industry, including its associations and relevant agencies, may need to act.

The survey suggests that there is a mismatch between what skills the industry needs and what skills the UK Higher Education system produces. Contributing factors include a simple shortfall in numbers and perceptions that HE courses lag rapidly advancing technologies or are not precisely and well-matched to the space industry's particular needs.

However, it is also evident from the survey that meeting industry needs is not a straightforward matter. On the industry side:

- The lists of particular occupations suffering skill shortages and gaps and of under-supplied training courses are long and highly specialised.

- The industry has a strong focus on recruitment of people with high, often post-graduate, qualifications.

- The industry would ideally like recruits who have combined skills in more than one technical specialism, and often including 'soft' business and team-working skills.

One route towards improvement may simply comprise a greater commitment by the industry to its training efforts and budgets. Though the survey suggests that the industry may already be a relatively 'high training' sector, in view of its specialised demands, it may need to go further.

Additionally, the survey makes the point that industry collaborations with HE are mainly confined to knowledge transfer and technological development rather than including major collaboration on course development. Movement towards the latter instigated through the Space Growth Partnership may be beneficial.

An alternative, or perhaps complementary, approach may be for the industry to review its current focus on very highly skilled recruits. Respondents raised the idea of 'down-skilling' its entry requirements and, as above, increasing its support to training. This could be either internally or via external conversion courses to add specialist space emphasis to more generic technical or software skill sets, or to add the commercial or business skills which technological recruits are perceived as lacking.

The prospect of a UKSA-sponsored Graduate or New Entrant Training Programme was well-received. However, there were concerns about:

- How it could be structured to respond to the many and varied specialisms within the industry.

- How it could address the technical/commercial skills blend which is often sought.

- Whether it could be constituted as a 'new entrant' programme (rather than as a specifically 'graduate' programme) in order to allow entry to capable non-graduates and to candidates with experience in other sectors looking to convert into the space industry.

2. Introduction

Background

1   The UK Space Agency (UKSA) is an executive agency responsible for all strategic decisions on the UK civil space programme. It is sponsored by the Department for Business, Energy & Industrial Strategy (BEIS).

2   As part of its remit, UKSA oversees strategic action to build a strong space capability in the UK, which includes promoting scientific and industrial centres of excellence. It works to ensure that the necessary steps are taken to inspire and train a growing skilled workforce of space technologists and scientists within the UK.

3   In this last respect, ensuring that the space industry has access to appropriately skilled people underpins wider space sector objectives and priorities; and optimising the skills supply is key to the UK's success within the global space industry.

4   The Space Sector Skills Survey, commissioned in the summer of 2020 by UKSA, gathered information on the industry's recruitment and training practices and identified current and emerging skills needs in order to contribute to the industry consideration as to how skills supply can be maintained and improved.

Defining the sector

5   A first challenge to this enterprise is to accurately delineate the sector. This is not easily achieved by conventional means. The Standard Industry Classification (SIC) 2007, which is widely used to describe the UK's economic activity, is not, in this case, particularly effective in identifying all or even most of the businesses which actually have a role within the space industry.

6   A key aspect of this challenge is that the industry, as a sphere of UKSA's interest and operations, is complex. It has both 'upstream' and 'downstream' components. 'Upstream' refers to elements of space manufacturing, satellite operations, space applications, and ancillary support services segments. 'Downstream', to which revenue and employment is strongly weighted, refers to elements of satellite broadcasting and other satellite applications and the provision of associated services and equipment.

7   To some extent 'downstream' applications are the beneficiaries of 'upstream' activity while the requirements of 'downstream' applications often determine, and financially justify, 'upstream' manufacturing and space operations. However, to magnify the complexity of analysis of sub-groups within the industry, many individual businesses in the industry straddle the two groups, having business activities in both segments of the 'stream'.

8   A further issue challenging straightforward identification of whether a business is or is not part of the industry might be described as an 'intensity' one. On one hand there are businesses which are clearly 'space businesses' – being, for example, wholly concerned with satellite manufacture or launch systems or devoted to design of software for use in satellite control. On the other, there are, for example, businesses which make electronic products which have space applications but which are also widely used in other industries; or, on the downstream side, it might be considered that a small sub-contractor who installs domestic satellite dishes has a 'space industry' role but, even though the work is vital to service delivery, that role is clearly on the periphery of the industry.

9   While recognising these complexities, UKSA has worked to identify a practical universe of what can reasonably be considered as the UK space industry. Thus, the industry in the UK has been broadly estimated[1] as comprising 1,000+ organisations employing around 42,000 people across approximately 1,500 sites, and having an annual income (comprising commercial revenue, government contracts and grants from several UK and EU agencies) of c.15 billion pounds sterling. The industry's annual growth trajectory both in the UK and internationally has been upwards for at least two decades.

10   Beyond the space industry as such, a large and growing proportion of the UK and global economies is supported by satellite-based technologies – particularly Position, Navigation and Timing, meteorological, communications, and Earth observation technologies.

Survey purpose

11   UKSA undertakes research to investigate the dimensions, distribution, growth rate, and economic contribution of the UK's space industry (as exemplified by the research referenced above). This separate research reported here has a more limited focus. As noted above, a critical factor in the industry's competitiveness in global markets is the availability of the skills on which that competitiveness significantly depends. The main objectives of this survey are thus:

- To provide comprehensive information on industry skill needs and on current industry responses to those needs.

- To identify opportunities for the industry, in collaboration with external actors [including the UK government (for example through its apprenticeship programme), the UK Space Agency, and training providers (including FE Colleges, HEIs, and private providers)] to increase, and potentially optimise, skills supply.

12   In addressing these objectives, however, the survey has a further focus. The industry, of course, employs a range of staff who provide support functions in administration, financial management, office services, and so on. These staff are important, as in any sector, to business operation but are supplied by a general labour market which is usually not constrained.

13   What is more critical to the sector as a unique industry are the higher level technological skills on which space industry operations depend and the management skills required to deploy, direct, and develop technical capability effectively. The survey focuses mainly on these latter types of skill.

Methodology

14   The survey involved both quantitative and qualitative approaches to data collection:

- 96 structured interviews by telephone (38) and online (58)

- 21 semi-structured, depth interviews by telephone

15   These interviews were completed in September, October and November 2020. A detailed outline of the methodology is included in the Appendix.

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[1] Based on: *Size & Health of the UK Space Industry 2018, A Report to the UK Space Agency, summary report*, London Economics for UKSA, January 2019

Quantitative survey

16   In order that the survey should focus strongly on core space businesses, rather than include those which, as above, have a more peripheral part in the industry, the main source of contacts for the quantitative survey was a database of businesses developed by UKSA itself. These businesses are known to be wholly or strongly focussed on space operations either 'upstream', 'downstream' or both.

17   To ensure that respondent businesses were, as anticipated, significantly engaged in the industry, a 'filter' question checked that the business activity included any of the following:

- Manufacture of, or researching the manufacture of, equipment or components which are used in space operations;

- Development or researching the development of software for use in space operations;

- Research, management or other involvement in ground control, launch or satellite operations;

- Research or consultancy related to space activities or operations;

- Research or operations that are substantially or critically dependent on the capabilities or information supplied by satellites and related technologies;

- Another function in or related to the space sector, not covered in the above activities.

18   Further, respondents had to confirm that their organisation employed at least one person among their managers, scientists, engineers, technical staff or skilled operations that have:

- Specialist space-related knowledge and/or experience;

- Knowledge and/or experience that, although not specifically space-related, is relevant and could be transferred to the space sector.

19   It should be noted that the survey took place over a period in which Covid-19 concerns and constraints were significant. Intuitively this may have impacted on business activities such that, for example, forms of training normally involving off-site course attendance or visits by external training specialist may have been disrupted. To counteract this effect on survey findings, respondents were asked, where relevant, to 'normalise' their responses by answering as they would have answered in non-Covid-affected conditions.

20   At the end of the telephone interview respondents were further asked if they would be happy to take part in a depth interview exploring recruitment and skills issues within their organisation and across the Space industry in more detail. There were 68 positive responses to this request from which the 21 respondents in the qualitative interviews which contribute to this report were selected.

Qualitative survey

21   The qualitative discussions were guided, but not structured, thus allowing participants to give a more detailed account of the changing skill needs of the space sector and their interpretation of how these changing needs can be addressed. The discussion guide for these in-depth interviews is reproduced in the Appendix of this report.

22   The objectives and themes of the discussion guide are summarised below:

- To explore the skills that employers need within their businesses:

  - To include both upstream and downstream employers

- To include a variety of levels of seniority within the space sector (e.g. entry level to senior management)

- To understand how employers currently ensure these skills are met (e.g. through partnerships, collaborations, apprenticeships, funding, etc.)

- To discover the current concerns or difficulties employers experience in finding these skills in the current market (i.e. external recruitment difficulties and internal skills gaps) and understand why they believe these difficulties occur

- To compare these current concerns to any future concerns that employers may have

- To discuss how employers would recommend addressing skills shortages and gaps to include exploration of educational issues, collaborative skills development, and retention strategies

23   Some further objectives were also included in the qualitative discussions:

- To explore gender and ethnic diversity in the industry and its impact on the sector:

  - To include exploration of the issues regarding diversity

  - To include exploration of how diversity could be encouraged, and what impact this may have

  - To identify any perceptions of longer-term skills needs in the sector

  - To include an exploration of technological advances, future projects, and emerging industry priorities

  - To explore employers' perceptions of how education providers and businesses in the sector may need to respond to emerging skills needs

24   A total of 21 in-depth discussions with UK space industry professionals were held, with a balance between those operating in upstream and downstream areas, and those who took part in the conversations came from a range of different backgrounds, including academics teaching Space Science to students, HR and recruitment professionals working within large and established organisations, industry consultants, and industry start-up entrepreneurs.

Report contents

25   This report summarises the findings of the Space Sector Skills Survey 2020. The quantitative and qualitative elements of the survey are each discussed separately before findings from both elements are considered together to provide an overview of skills issues across the industry.

26   Charts and tables are used to illustrate the findings where appropriate.

27   The quantitative survey questionnaire and qualitative discussion guide are included in the Appendix.

3. Quantitative survey findings

Sample profile

28   This section describes the sample achieved in the quantitative survey and which constitutes the basis for subsequent analysis of survey findings.

29   A first analysis shows a breakdown of businesses in the sample by size (in terms of numbers of employees):

Figure 1: Proportions of businesses within employment size bands (all respondents)

Size band	Proportion
Under 10 employees	39% (37 cases)
10-49 employees	31% (30 cases)
50-99 employees	7% (7 cases)
100-249 employees	5% (5 cases)
250-999 employees	2% (2 cases)
1000+ employees	13% (12 cases)
Not known	3% (3 cases)
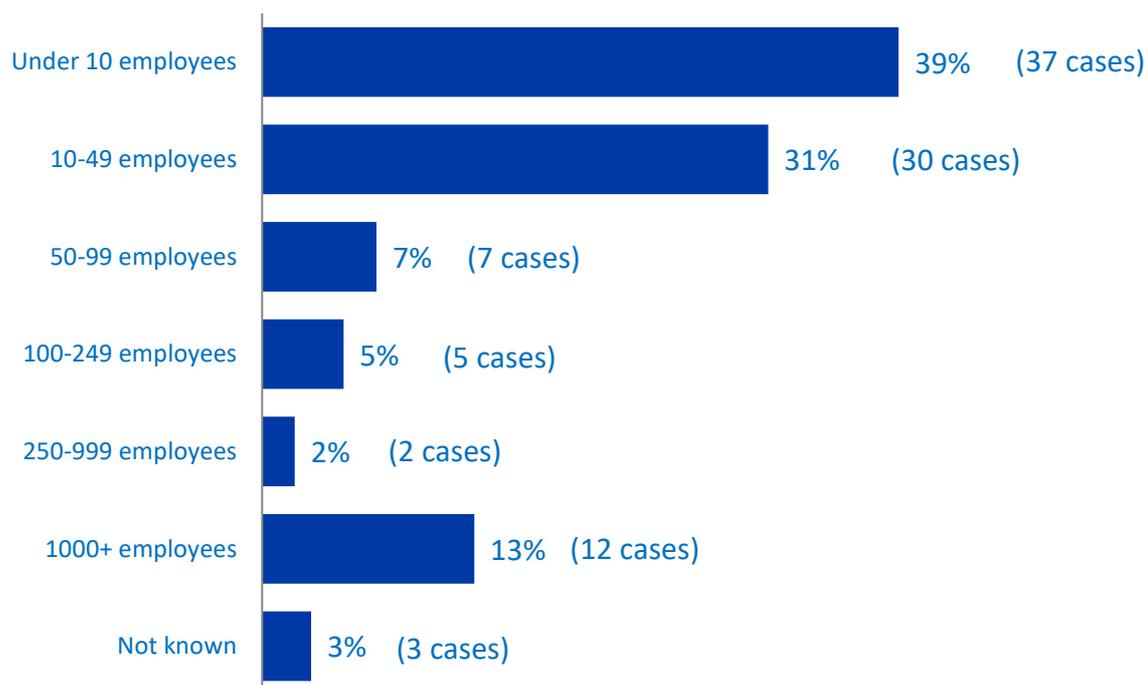
Sample base = 96 businesses

30   In the remainder of the report, 'size' analyses of different survey responses are placed into three groups – micro-businesses (less than 10 employees); small businesses (10-49 employees), and medium/large businesses (50+ employees) accounting for 39%, 31%, and 27% of businesses respectively.

31   A second figure (Figure 2) describes the profile of the businesses which took part in the survey in terms of the proportions of respondent businesses which undertake one or more activities of the different types which together constitute the broad repertoire of space industry activity as a whole.

32   Because of the difficulty of defining the sector by conventional Standard Industrial Classifications and because businesses included in the survey were deliberately selected for their status as 'core' industry businesses (rather than as a formally representative sample of a wider industry including businesses engaged in the industry but less definitively so) the statistics (as throughout the report) have not been weighted to reflect any notional structure for the industry as a whole.

33   Figure 2 shows that the activity of many businesses in the sector is not confined to a single category – hence percentages on the bars in the chart add up to very much more than 100%.

34   Overall, three-quarters (76%) of respondents are engaged in 'upstream' activities, and half (50%) in 'downstream' activities, with 34% (not shown in the figure) engaged in both categories. Over half of businesses (54%) report that they undertake space research or consultancy (a category which is not specifically assigned to the 'upstream' or 'downstream' categories as it could be undertaken with respect to any segment of the industry).

35   There is also an 'other' category in the chart. Closer examination of these responses shows that respondents chose to place a variety of their activities in this group – including involvement in military space applications, in cyber-security, in provision of industry-relevant training, and in space industry associations and membership groups.

Figure 2: Proportions of businesses engaged in different types of space activity (all respondents)
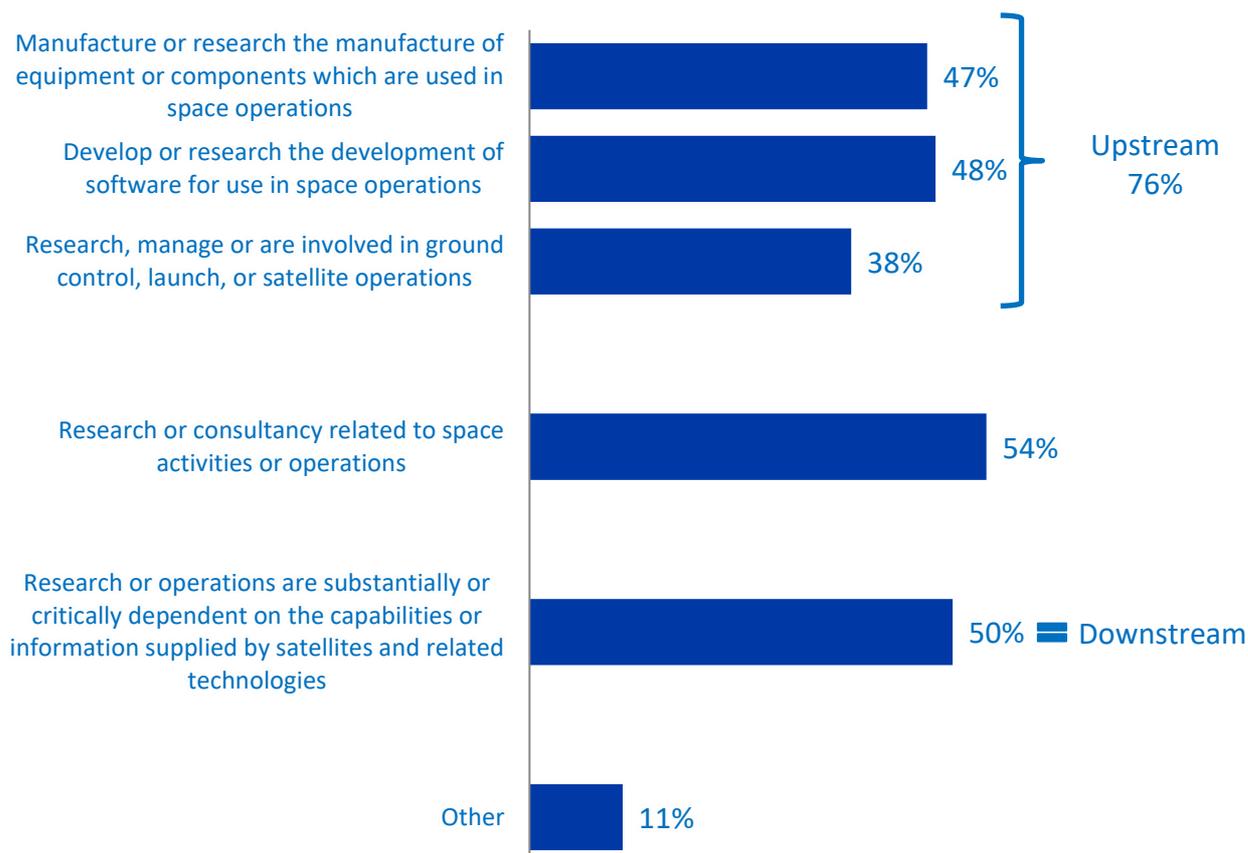
Sample base = 96 businesses

36   The next analysis (Table 1) looks at the question of industry integration in more detail. It shows again that businesses are largely not constrained in 'silos' such that they only manufacture equipment or write software or whatever. Rather they tend to be engaged in multiple aspects of industry activity as a whole (including as noted above, operation in both 'upstream' and 'downstream' segments in around a third of cases).

Table 1: Proportions of businesses engaged in different types of space activity engaged in other space activity - examining multi-activity (all respondents)

% of businesses operating within…	Equipment/ Components	Software	Satellite Ops.	Consultancy	Downstream
Upstream:					
Equipment/components: Manufacture or research the manufacture of equipment or components which are used in space operations	100%	54%	**61%**	50%	35%
Software: Develop or research the development of software for use in space operations	56%	100%	72%	54%	54%
Satellite Ops: Research, manage or are involved in ground control, launch, or satellite operations	**49%**	**57%**	100%	46%	40%
Downstream:					
Research or operations substantially or critically dependent on capabilities or information supplied by satellites and related technologies	38%	57%	53%	50%	100%
Neither upstream nor downstream:					
Consultancy: Research or consultancy related to space activities or operations	58%	61%	67%	100%	54%
Sample bases	*45*	*46*	*36*	*52*	*48*

Q1   **Bold font indicates statistically significantly higher than average to a 95% confidence level**

37   The somewhat complex data set out in Table 1 can be simplified by a third analysis of business engagement which divides businesses into those which are solely engaged in 'upstream' activity, those which are solely engaged in 'downstream' activity, those which are engaged in both of these, and those which are not clearly engaged in either. This analysis is set out in Figure 3 below:

Figure 3: Proportions of businesses engaged in different broad categories of space activity (all respondents)

Upstream only — 42%

Downstream only — 16%

Upstream and downstream — 34%

Not attributed/neither — 8%
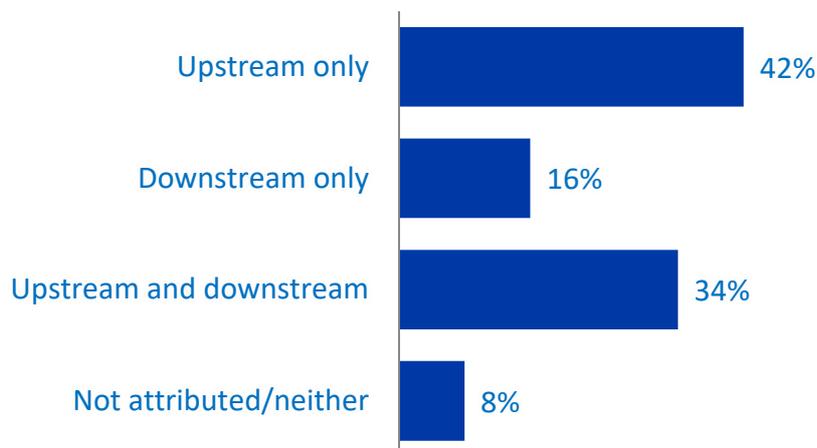
Sample base = 96 businesses

38   When engagement in different types of space activity is examined by the employment size of respondent businesses (see Figure 4 following) it can be seen that 'integration' - participation in more than one activity - is widely spread across all sizes of business, though, as would be expected, width of engagement for micro-businesses with fewer than 10 employees is lesser. The sum of percentages across the activity categories for these micro-businesses (a simple 'multi-engagement' measure) is 176%, compared with 323% for businesses with 10 to 49 employees and 314% for businesses with 50 or more employees.

39   Two other features of the data can be observed. First, the particularly high engagement, at 93%, of medium-sized (10-49 employees) businesses in upstream activities of one or more types is noted.

40   Second, the relatively moderate proportion (62%) of larger (50+ employees) businesses engaged in 'downstream' activities, reflects the particular nature of this sample. It does not (and is not designed) to capture what is otherwise known about the industry (from the London Economics study referenced earlier) – that the industry is highly concentrated, such that 7 large organisations, all having at least a partial role in 'downstream' activities (particularly direct-to-home broadcasting) generate around three-quarters of sector income and that 'downstream' activities as a whole account for 84% of total sector income and around 80% of total sector employment.

41   Essentially, an analysis of sample characteristics, as here, which is not weighted by the actual employment of businesses but reports only in terms of numbers of businesses, does not fully reveal the contribution of a small number of very large businesses to the totality of industry revenue and jobs.

Figure 4: Proportions of businesses within different employment size bands engaged in types of space activity (all respondents)

Legend: ■ Total (96) ■ Less than 10 employees (37) ■ 10-49 employees (30) ■ 50+ employees (29)

Manufacture equipment/components used in space operations
- 47%
- 38%
- 50%
- 55%

Develop software for use in space operations
- 48%
- 27%
- **63%**
- 59%

Research/manage ground control, launch, or satellite operations
- 38%
- 16%
- 47%
- 55%

upstream

76% total
59% of those with <10 employees
93% of those 10-49 employees
79% of those with 50+
.

Research/consultancy related to space activities
- 54%
- 49%
- 53%
- 62%

Other
- 11%
- 5%
- 10%
- 21%

Research/ops substantially dependent on capabilities/information supplied by satellites/related technologies
- 50%
- 41%
- 50%
- 62%

downstream

Bases (no. of businesses) in parentheses   **Bold font indicates statistically significantly higher than average to a 95% confidence level**

42   A further characteristic of the survey sample concerns the position of respondent businesses as either single-site businesses or as one establishment within an organisation which operates from two or more sites.

43   Overall, 58% of businesses, predominantly smaller ones operate from a single site. Forty-two per cent, including nearly nine out of ten of businesses with 50 or more employees, operate from more than one site (see Figure 5 following).

Figure 5: Proportions of businesses that are single site or multi-site, and proportions within different employment size bands (all respondents)

<10 employees	10-49 employees
11% 89% Single site Multi-site	37% 63% Single site Multi-site
50+ employees	**All businesses**
15% 85% Single site Multi-site	42% 58% Single site Multi-site

Sample bases = all businesses (96); <10 employees (37); 10-49 employees (30); 50+ employees (29)

Q2

44   Finally, the geographic distribution of businesses in the sample is described. Key clusters in the sample are located in Oxfordshire (strongly influenced by the Harwell site), Hampshire, London (a particular location for space consultancy), Scotland, Surrey, and Cornwall. Buckinghamshire, Devon, Hertfordshire, Northamptonshire and Berkshire had a lower level of representation, whilst 19 cases in the sample were distributed across a wider range of locations, with one or two cases in each of Bedfordshire, Yorkshire, Essex, Nottinghamshire, Dorset, West Sussex, Lancashire, Cambridgeshire, Bristol, Norfolk, Wiltshire, Cheshire, Cumbria, Northumbria, and Wales.

45   The sample, while noting that it is not intended to be formally representative of the whole of the UK's space sector, clearly reflects the known preponderance of industry businesses in Southern England, particularly the South East and London, and the significant level of activity in Scotland.

46   The geographic distribution of the sample is represented in the chart (Figure 6) that follows:

Figure 6: Numbers of businesses across the sample based in different geographic areas (all respondents)

Location	Number
Oxfordshire	17
Hampshire	15
London	12
Scotland	9
Cornwall	7
Surrey	6
Berkshire	3
Devon	3
Hertfordshire	3
Northamptonshire	3
Buckinghamshire	3
Other locations	19
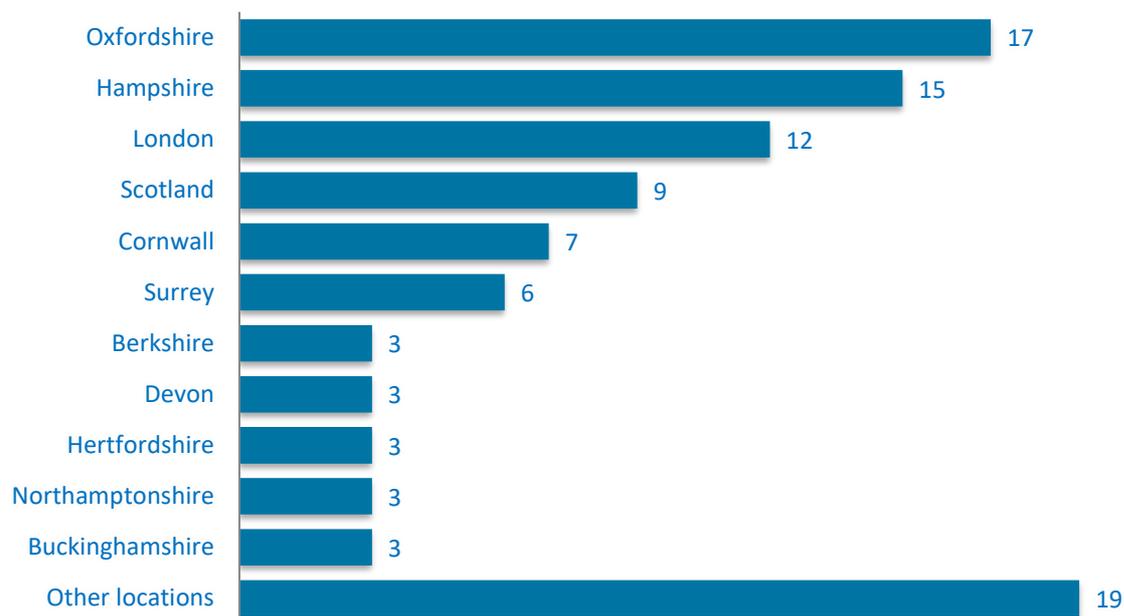
Sample base = 96 businesses

The sample profile: summary

47   A sample drawn largely from UKSA's database of businesses known to be wholly or strongly focussed on space-related activities was not intended to be formally representative of a UK space industry which is not able to be wholly defined using the UK Standard Industrial Classification (2007) system.

48   However, the sample might be assumed to broadly reflect some characteristics of the industry as a whole. Thus (as in virtually all UK sectors) a majority of respondents were micro-businesses with fewer than 10 employees (39%) or small businesses with between 10 and 49 employees (31%). Just over a quarter (27%) were larger businesses with 50 or more employees. Employment was not established in a final 3% of cases.

49   Further, the geographic representation of the sample, largely correspond with the known distribution of the wider industry, with a focus on the South East and London (and some counties in the adjoining regions of the South West and East of England) and in Scotland.

50   Finally, UKSA's perspective of the industry was shown to be accurate, with many core space businesses engaged in multiple types of activity within the 'upstream' element of industry operation and often engaged across the 'upstream'/'downstream' divide.

51   Overall, therefore, it is likely that the survey sample, though limited in size, provides a sound base for the examination of various skills issues which constitute the remainder of this report.

Skills challenges in the space industry

Skills in the workforce

53   Before considering a variety of challenges to the supply of skills in the space workforce, a simple picture of some underlying characteristics of industry skills was generated by the survey.

54   Figure 7 (below) shows the proportions of businesses engaged in different space activities which employ staff in each of three broad groups – people with specialist knowledge or experience of space technology or operations (space skills), people with knowledge or experience which can be readily used in the space-related functions but are not space-specific (transferable skills), and staff in support functions (generic skills). As noted earlier, it is the first two groups of skills which are particularly important to the industry and which are the focus of subsequent analyses.

55   It can be seen from Figure 7 that high proportions of businesses across all the activity strands employ people in each of the three groups.

Figure 7: Proportions of businesses engaged in different types of space activity employing each type of staff (all respondents)
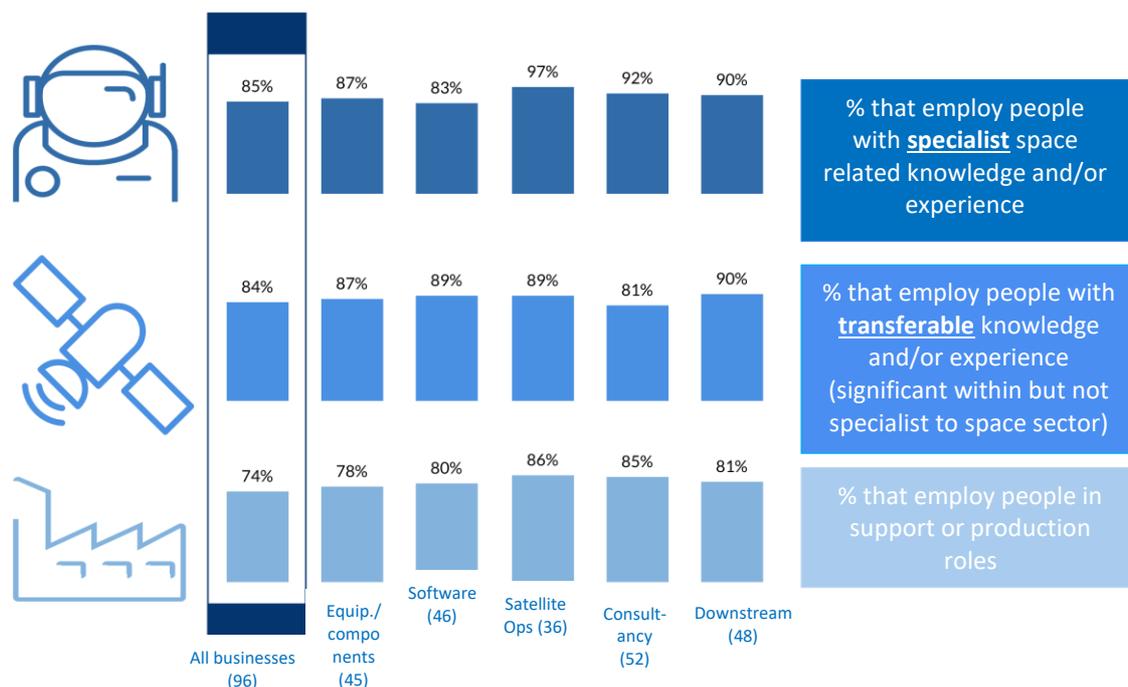

Bases (no. of businesses) in parentheses

Q7   *For example: 87% of businesses manufacturing equipment/components employ people with specialist space knowledge/experience*

56   Survey data (not shown in Figure 7) also shows that, as would be expected, the likelihood of employing staff in each of the three groups is higher in larger businesses than in smaller ones. One particularly notable 'size' difference is that only 43% of micro-businesses (1-9 employees) employ support staff, compared with 90% and 97% of small (10-49 employees) and larger (50+ employees) businesses respectively. This finding suggests that over half of micro-businesses are essentially comprised only of technical and managerial staff with business support operations presumably being undertaken by business managers or being outsourced to specialist contractors (in accounts, recruitment, and so on).

Recruitment activity

57   Focussing now on 'space skills' and 'transferable skills' (those which were adaptable to space activities) and excluding support skills, Figure 8 shows the proportions of businesses engaged in each type of activity which sought to recruit during 2019 or in the early, pre-Covid 19, months of 2020.

Figure 8: Proportions of businesses engaged in different types of space activity that sought to recruit staff with specialised space or transferable skills in 2019 and early 2020 (all respondents)
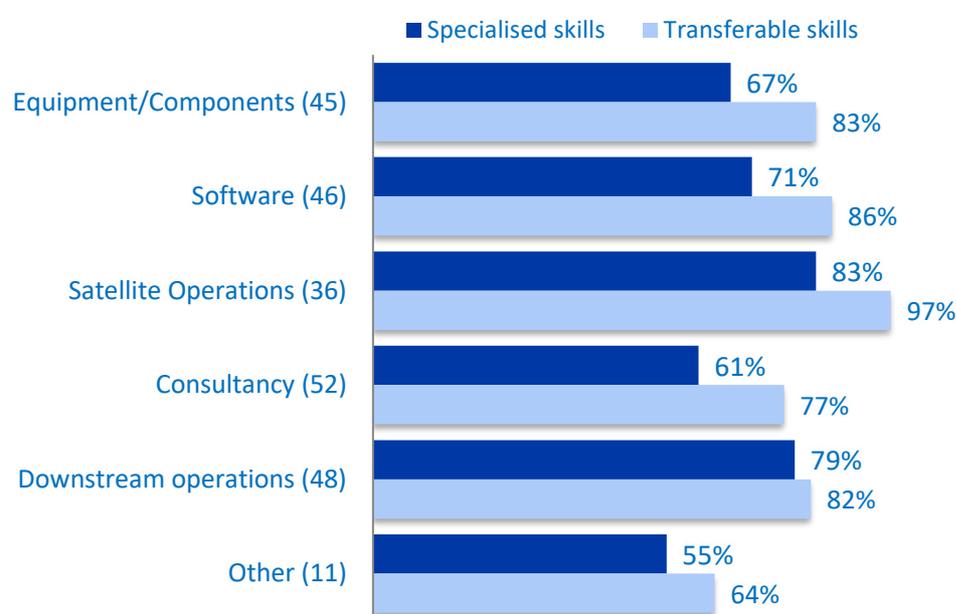
Sample bases in parentheses (no. of businesses) Q8   *For example: 67% of businesses manufacturing equipment/components tried to recruit people with specialist space knowledge/experience*

58   From Figure 8 it can be seen that recruitment levels were high[2] – with around two-thirds or more of businesses engaged in each type of activity reporting recruitment efforts in the period

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[2] In comparison, the report of the Department for Education's national skills survey of c.80,000 employers across all UK sectors in 2019 (*Employer Skills Survey 2019, Report,* DfE, October 2020) estimates that in the year prior to that survey, 46% of all employers had recruited. In two sectors most nearly corresponding to the space industry, manufacturing and ICT, the proportion of employers recruiting was 46% and 34% respectively. Because the national survey took place a year before the space survey reported here and because of difference in question wording, the comparison is not exact but the scale of difference in recruitment levels observed by the two surveys is sufficient to suggest that space industry recruitment levels can be reasonably described, as here, as ' high'.

- with a particularly high level of recruitment activity in businesses engaged in satellite operation.

59   To some extent, these distributions are affected by the average size of businesses engaged in each type of activity, since, of course, larger businesses with more staff are more likely to recruit. Thus, 54% of micro-businesses (1-9 employees) sought to recruit compared with 70% of small businesses with 10-49 employees and 80% of larger businesses with 50 or more employees.

60   A second factor is the growth ambitions of the business (a feature which will be discussed in more detail later in this report): 75% of businesses which aim to grow sought to recruit, but only 40% of businesses which expect to remain stable sought to recruit.

61   A third factor driving recruitment is, as might be expected, the existence of skills gaps in the firm's workforce. Thus, 71% of businesses reporting skill gaps in their workforce sought to recruit people with specialist space skills and 83% of those reporting skill gaps sought to recruit people with transferrable skills. The corresponding proportions for respondents not identifying skill gaps were significantly lower at 48% and 55% respectively.

62   Recruitment activity is, thus, a reflection of the basic size of the business (larger businesses having greater potential for normal staff replacement needs), of business objectives for growth or stability, and of the recognition of skill gaps in the workforce.

63   The number of recruits sought by businesses in the period varied, with 19% of businesses which sought to recruit specialist space skills seeking to recruit only one person, 25% seeking to recruit two or three people, and 56% seeking to recruit four or more people. Proportions in respect of staff with transferable skills were 22% (one person), 25% (two people), 31% (three to five people) and 22% (six or more people).

64   As with recruitment activity overall, the likelihood of recruiting larger numbers of staff was much higher for larger businesses. For example, 59% of all businesses in the sample with 50 or more people sought to recruit 4 or more people with specialist space skills, compared with 37% of small (10-49 employees) businesses and 3% of micro-businesses (1-9 employees).

Recruitment difficulty

65   However, in seeking to recruit, difficulty was frequently experienced – generally by two-thirds or more of the businesses which sought to recruit, as Figure 9 shows.

Figure 9: Proportion of businesses engaged in different types of space activity, and of different employment sizes, reporting recruitment difficulties (where sought to recruit)

Category	Percentage
Equipment/components (35)	63%
Software (37)	65%
Satellite operations (32)	78%
Consultancy (39)	67%
Downstream operations (38)	68%
Other (11)	55%
Less than 10 employees (22)	36%
10-49 employees (25)	56%
50+ employees (24)	79%
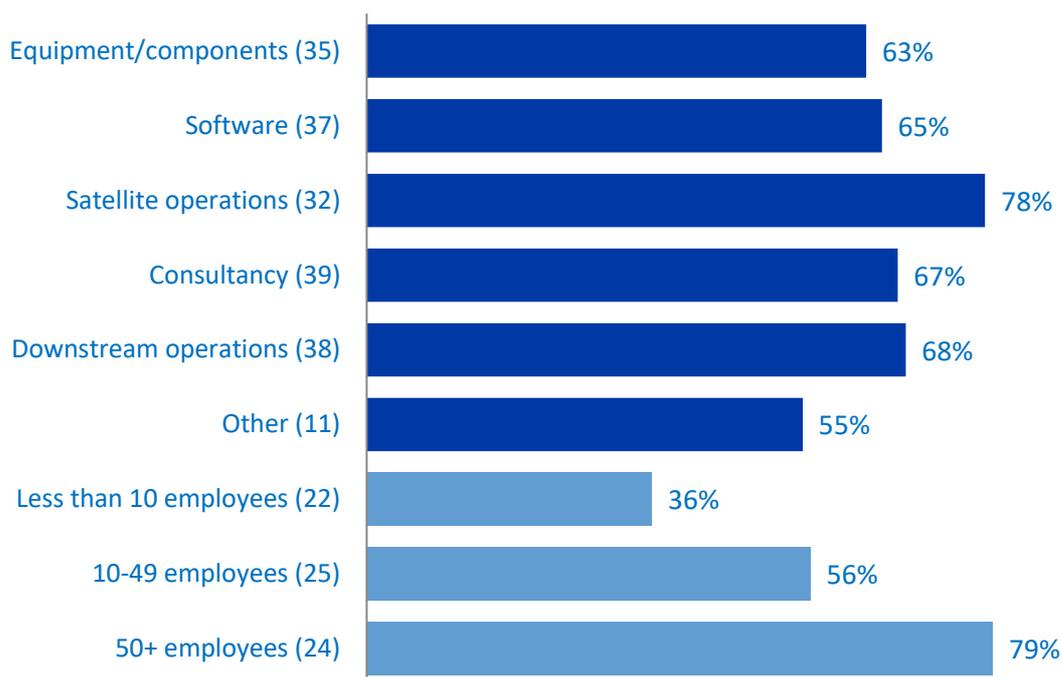
Sample bases in parentheses (no. of businesses) Q9 *For example: 63% of businesses manufacturing equipment/components reported difficulties in trying to recruit people*

66   Figure 10 (below) highlights the extent to which businesses in satellite and 'downstream' operations, which tend to be larger employers and therefore, are likely to recruit frequently and in larger volume, were more likely than average to report recruitment difficulty.

67   Except in manufacturing activity ('equipment/components' in Figure 10 below) where, perhaps, technology in space and other advanced manufacturing and technology sectors does not differ greatly and, therefore, does not require greatly different skill sets, recruitment difficulty in respect of transferable skills was a little more frequent than in respect of space skills.

68   In respect of all other types of space industry activity, the reverse was found, with space skills being more frequently difficult to recruit than the transferable skills which can draw on a significantly wider skills pool. As in other analyses, satellite operations report more frequent difficulty, in this case in respect of the recruitment of both transferable and, particularly, specialist space skills.

Figure 10: Proportions of businesses engaged in different types of space activity reporting recruitment difficulties in respect of recruiting specialist space and transferable skills (where sought to recruit)

Legend: ■ Specialised skills ■ Transferable skills

- Equipment/components (35): Specialised 57%, Transferable 60%
- Software (37): Specialised 62%, Transferable 57%
- Satellite operations (32): Specialised 75%, Transferable 66%
- Consultancy (39): Specialised 64%, Transferable 56%
- Downstream operations (38): Specialised 63%, Transferable 53%
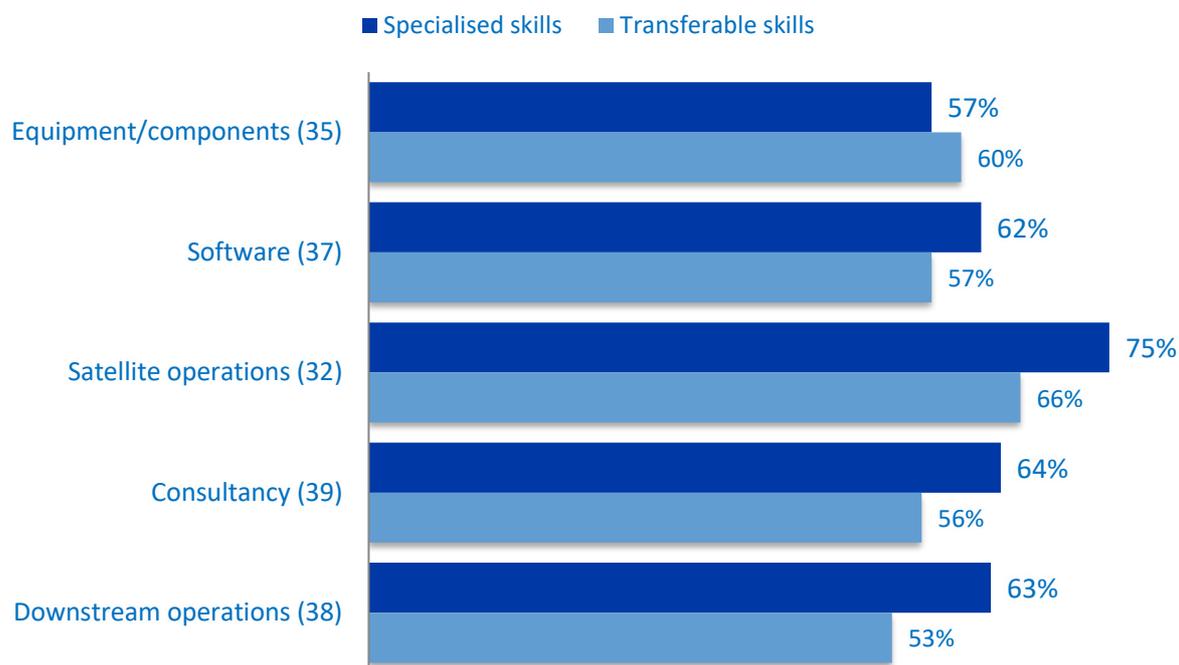
Sample bases in parentheses (no. of businesses)   Q9   *For example: 57% of businesses manufacturing equipment/components reported difficulties in trying to recruit people with specialised skills*

70   The London Economics report on the UK space industry which was referenced earlier, notes that 'the space industry workforce is exceptionally highly skilled, with 3 in 4 employees holding at least a primary degree. This is higher than any other sector covered by Census data for England and Wales.'

71   It is not surprising, therefore, that (see Figure 11) a very high proportion of businesses reporting recruitment difficulty reported that the difficulty concerned professional occupations with most concerns below this level relating to technical staff at the 'associate professional and technical'[3] level.

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[3] The Standard Occupational Classification 2003, includes the '**associate professional and technical'** (also International standard classification of occupations ISCO-08 major group 3). This group includes occupations whose main tasks require technical knowledge and experience in one or more fields of physical and life sciences, or social sciences and humanities.

Figure 11: Percentages of businesses reporting recruitment difficulties that cited recruitment difficulties in occupational groups (where experienced recruitment difficulties)
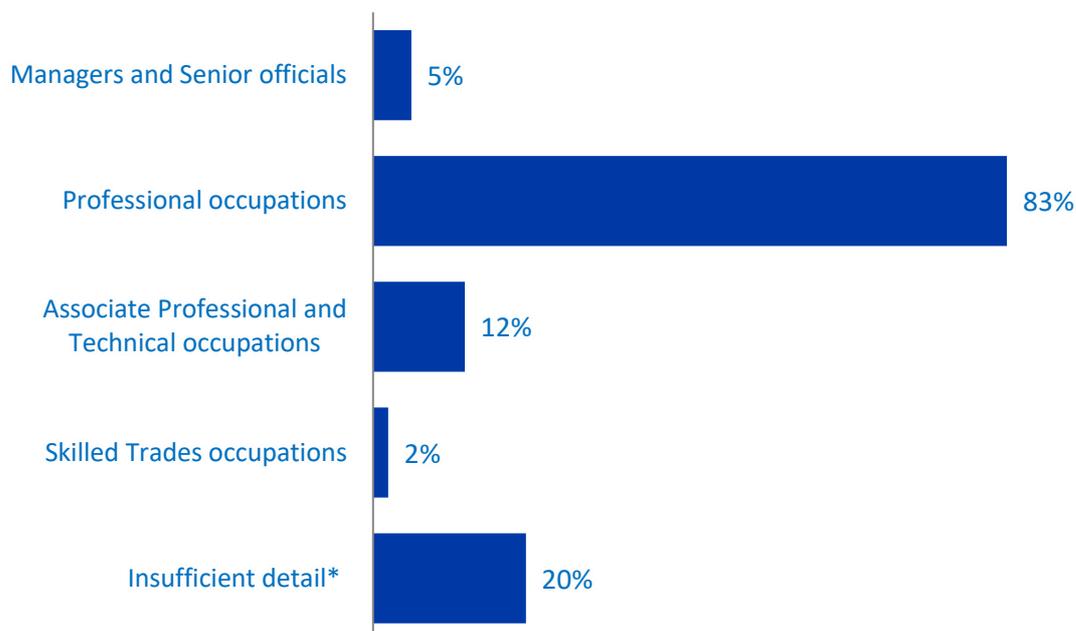
* respondents completing the online survey supplied insufficient information to classify responses
Sample base = 41 businesses   Q10   *For example: 5% of businesses that reported recruitment difficulties cited difficulty in recruiting managers and senior officials*

72   Within these overall statistics, there was little variation between businesses engaged in different types of activity; although at 77% for professional occupations and 19% for associate professional and technical occupations, 'downstream' activity was a little less affected at the higher level and a little more affected at the technical support level – presumably reflecting a greater proportion of employment in technical support functions in downstream activities.

73   The more detailed occupational groups identified as contributing to the 'professional' and 'associate professional' difficulties were heavily weighted to an 'engineering professional' designation, with the second most frequent category being 'Information Technology and Telecommunications professional'. Other occupational groups mentioned less frequently included 'Business and administration professionals', 'Production managers', 'Science professionals', 'R & D managers', and sales and marketing staff at associate professional level.

74   However, the aggregated data, summarised above at two levels of the Standard Occupational Classification system, conceals a greater variety of specialised occupations.   Just some examples cited by survey respondents are:

- Free space optical engineer
- Senior GPU software engineer
- Ground system engineer
- Flight system engineer
- Space situational awareness engineer
- Senior Principal engineer - Advanced payload architecture
- Attitude determination and control engineer
- Satellite software engineers

- Principal user terminal validation and type certification engineer
- Space mission project manager
- Ground segment engineer
- Thermal and mechanical space engineer
- Space craft controller

    ......and so on.

75   A first point here is that there is an obvious linkage between many of the occupations in so far as they clearly require a high level of technical and scientific expertise and the capability to deploy that expertise in space applications. However, beyond that, there is a high degree of specialisation within a more generic classification of 'space-related engineering' as a whole.

76   A second point, reflecting this observed diversity is, perhaps, that there is no obvious single focus for training and development at under-graduate level or above, such that a greater output from a single or small number of training programmes would address a substantial proportion of the recruitment difficulties identified here.

77   In respect of this observation, Figure 12 (below) considers the reasons which respondents perceived as being responsible for their recruitment difficulties.

Figure 12: Proportions of businesses that reported recruitment difficulties citing reasons for recruitment difficulties – prompted, multiple response (where have recruitment difficulties)

Reason	Percentage
Applicants lacked required experience	88%
Applicants lacked required specialist skills, knowledge, or qualifications	73%
Brexit reducing ability to attract people from Europe	61%
Competition from businesses in other sectors	51%
Competition from other businesses in space-related activities	49%
Difficult to attract people to move/travel to the location	49%
No or insufficient appropriate specialist training provided by UK educational institutions	44%
Pay or conditions able to offer was uncompetitive	39%
Shortfall of young people interested in technological/science/eng/maths education and training	34%
Applicants lacked required behaviours, attitude, motivation or personality	27%
Other	15%

Sample base = 41 businesses   Q11   *For example: 88% of businesses that reported recruitment difficulties cited applicants lacking experience as a cause*

78   The most frequent reasons – lack of experienced applicants and of applicants with the necessary skills, knowledge, or qualifications – clearly point to skill shortages across the external labour market relating to skills relevant to the space sector. Competition from other businesses, either in or outside the space sector, also reflects an underlying mismatch between supply and demand of high-level technological skills, both those specific to space applications and those transferable into the sector. This position reflects both a wider problem of higher-level skills shortage across UK technology sectors[4] and the focussed and highly specialised nature of the space industry's skill needs (as revealed here).

79   Brexit's discouragement of immigration of skilled staff from Europe, mentioned by 6 out of 10 respondents, has, in respondents' views, had a significant impact in limiting this alternative, wider, source of skills.

80   Given the location of much of the industry in some of the more attractive counties of the South East and adjoining regions, it is perhaps surprising that 'difficulty in attracting people to the location' is seen by half the sample as a further constraint on skills supply – but, hypothetically, a house price factor may be in play.

81   What may be of special interest, given the survey's rationale of informing UKSA interests in improving skills supply, is the observation by 44% of respondents, that there is insufficient appropriate specialist training supplied by UK educational institutions.

82   In view of the wide variety of specialist training needed to meet the diversity of recruitment needs it is important to consider how sufficient numbers of students per specialism can be attracted in order that provision is both financially viable for institutions and at a cost which employers would support.

Skill gaps

83   In addition to recruitment difficulties, businesses may be constrained by gaps in the skills of their current workforces. Of course, the two issues may be related. As in the previous section, skills gaps may be a stimulus for recruitment activity whilst, if recruitment difficulty is encountered, skills gaps may be generated or perpetuated.

84   As Figure 13 (below) shows, half (51%) of space businesses in the sample reported having current gaps or limitations in the skills of their workforces.

85   The Department for Education's national Employer Skills Survey 2019 (referenced earlier), based on around 80,000 interviews with UK employers also asked participant employers whether they had current skills gaps in their workforces. The comparison is not exact (for reasons noted in an earlier footnote. However, the contrast is stark. Compared with the space industry figure of 51%, the figures for all UK employers was 13%. For businesses in manufacturing and ICT, the two standard sectors which most closely approximate to the space industry, the skills gap proportions were 17% and 8% of employers respectively.

86   In more detail, Figure 13 again identifies satellite operations as having a noticeably higher figure; and, by virtue of their larger scope for skills gaps, larger businesses were more likely to report skills gaps than smaller ones.

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[4] For example, a report by the Institution of Engineering and Technology (*Skills and Demand in Industry, 2019 Survey*, IET, November 2019) suggested that there is an annual shortfall of 59,000 new engineering graduates and technicians in the UK, that 48% of employers in technology sectors experienced skill shortages, and that 60% of those employers see recruitment of skilled engineers and technicians as their biggest barrier to growth.

Figure 13: Proportions of businesses engaged in different types of space activity, and of different employment size, that reported current skills gaps or skills limitations (all respondents)
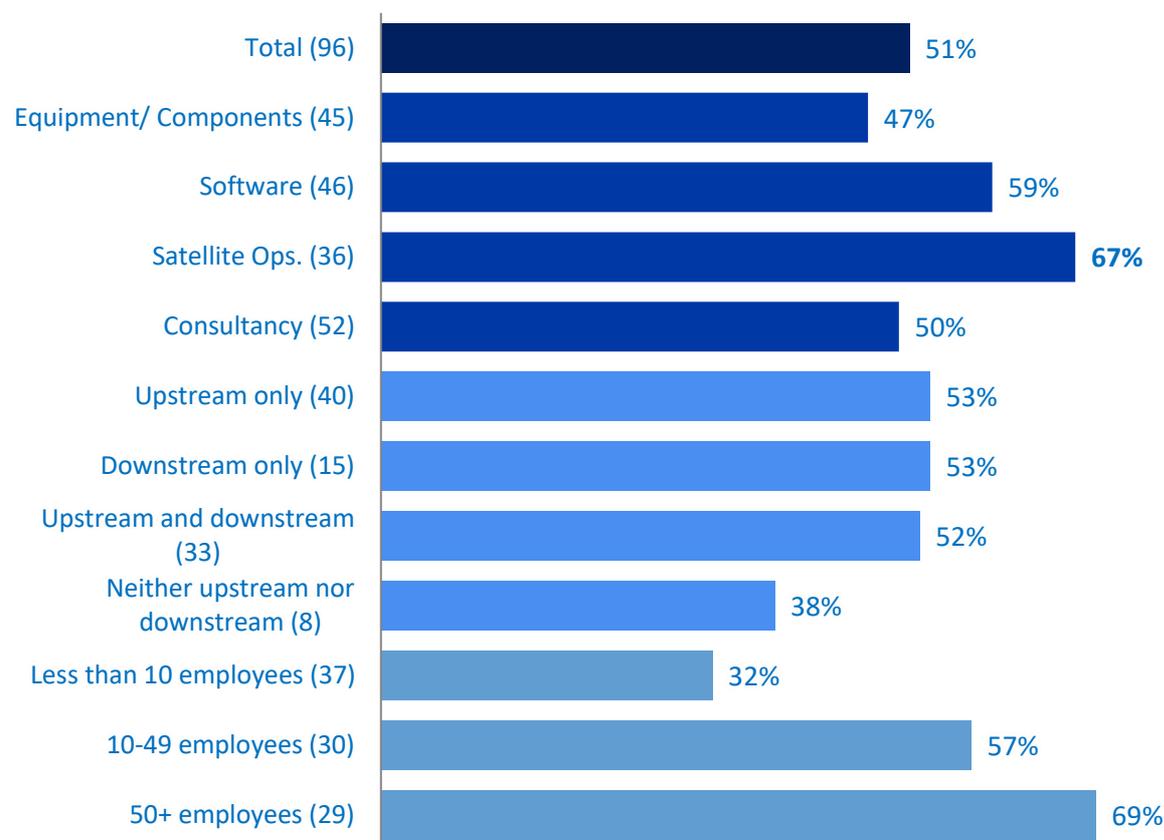
Bases (no. of businesses) in parentheses Q12 *For example: 47% of businesses that manufacture equipment/components reported having skill gaps/limitations*   **Bold font indicates statistically significantly higher than average to a 95% confidence level**

87   Of the 51% of businesses reporting skills gaps, 86% (or 44% of all businesses in the sample) reported that at least one of their gaps related to scientific, engineering, or technical functions, whilst 43% (or 22% of all businesses in the sample) reported that at least one of their gaps related to a managerial or entrepreneurial function.

88   Within scientific, engineering, and technical functions, type of skills gaps (see Figure 14 below) were headed, in order of frequency, by software, radio frequency, and systems engineering but, as with the variety of senior skilled occupations subject to recruitment difficulty, these technical skills are quite diverse and do not provide an obvious pointer to a single or simple skills development solution.

Figure 14: Proportions of businesses that reported having skill gaps or limitations among their workforce that cited each of a number of specific scientific, engineering or technical functions as lacking – prompted, multiple response (where have skill gaps or limitations within these functions)

Function	%
Software engineering	52%
Radio frequency engineering	48%
Systems engineering	45%
Engineering or electronics design	43%
Electronic engineering at professional level	43%
Artificial intelligence and Machine Learning	38%
Data analytics	26%
Calibration and testing	24%
Mechanical engineering at professional level	21%
Telecoms engineering	21%
Thermal effects and processes	19%
Radiation effects and processes	19%
Optical systems and opto-electronics	19%
Image processing and interpretation	14%
Robotics	14%
Operation of adv. prod. equip/mach. at technician/skilled level	10%
Procurement of equip/components/materials/techn. services	10%
Computer hardware operation and maintenance	5%
Other	7%

Sample base = 42 businesses   Q14   *For example: 52% of businesses that reported skills gaps cited a lack of software engineers*

89   Further analysis of the second group of skills gaps, those in managerial and entrepreneurial skills, reported by 43% of businesses with any skills gaps, shows a slightly more pronounced focus (see Figure 15 below).

90   Thus, 67% of businesses with managerial/entrepreneurial skills gaps reported having gaps in project management skills (indicating that around 15% or over 1 in 6 of all businesses in the sample) are affected by this particular shortfall in the organisation's skills.

91   Beyond this, however, a wide variety of managerial/entrepreneurial skill gaps were identified, each affecting from around 7% to 11% of all the space businesses which took part in the survey.

Figure 15: Proportions of businesses that reported having skill gaps or limitations among their workforce that cited each of a number of managerial or entrepreneurial functions as lacking – prompted, multiple response (where have skill gaps or limitations within these functions)

Skill gap	Percentage
Project management	67%
Team working and managing interpersonal relationships	48%
Leadership or motivational skills	43%
Business planning or foresight	43%
Client management skills	43%
Managing employee relationships and disputes	38%
People development training and career progression	38%
Financial control	38%
Personal time management and task prioritisation by senior staff	33%
Business marketing	33%
Optimising workplace organisation and work scheduling	24%
Obtaining external loan or capital finance	14%
Presentation skills at events and pitches	10%
Other	10%

Sample base = 21 businesses   Q16   *For example: 67% of businesses that reported skills gaps cited that staff lack project management skills*

92   Respondents further revealed (see Figure 16 below) that inability to recruit staff with the required skills was much the most frequent reason for their skills gaps. This reinforces the concept of an interactive relationship between skills gaps and recruitment difficulty such that skills gaps drive recruitment efforts whilst recruitment difficulties can be shown, as here, to generate or perpetuate skills gaps.

93   The second most frequent reason for skills gaps that newly recruited staff were not yet fully integrated into their roles may be less serious. Essentially, this is a transient problem likely to be resolved with the passage of time.

94   However, it may be noted that, in a national survey of the UK's employer population as a whole (the DFE's Employer Skills Survey 2019 referenced earlier), the 'new to the role' reason was the most frequent reason given, by 67% of employers with skill gaps, whilst recruitment difficulty as a reason was reported by only 32% (of employers with skill gaps)

95   This inversion of statistics (between space industry businesses and employers in an all-sectors UK sample) reinforces a proposition that the space industry suffers a particularly high level of shortage in the external labour market for the particular skills the industry needs.

Figure 16: Proportions of businesses that reported having skill gaps or limitations among their workforce that cited each of a number of possible causes of skill gaps or limitations as applicable to them – prompted, multiple response (where have skill gaps or limitations relating to these roles)
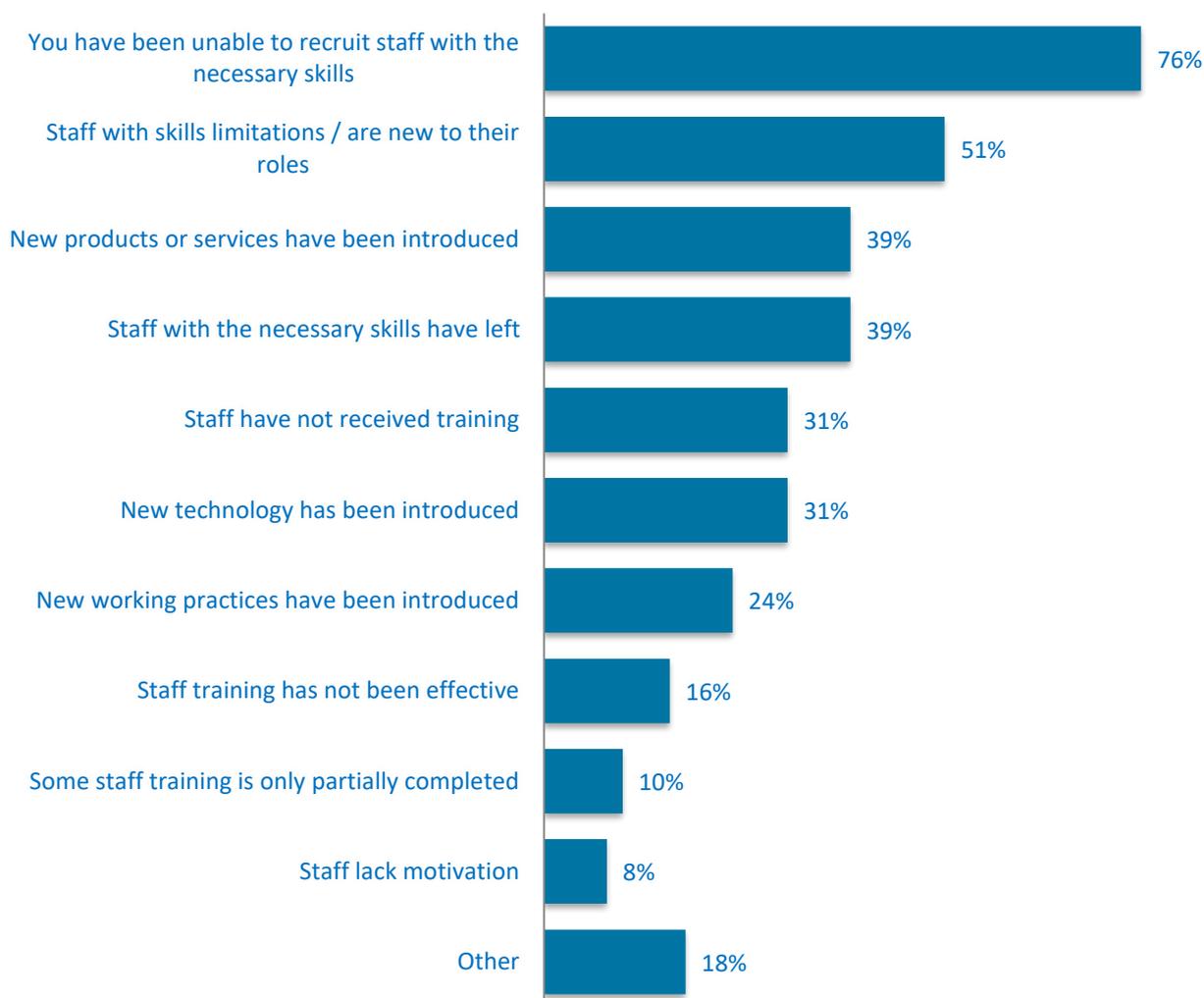

Sample base = 49 businesses   Q17   *For example: 76% of businesses that reported skills gaps cited being unable to recruit staff with the necessary skills as the cause*

Staff retention

96   A further factor in skills supply problem may be staff retention – people with important skills leaving the business to join other businesses in the space sector or other sectors, or to retire, or to pursue other life choices (including parenthood).

97   It was reported earlier (Figure 12) that competition, from other businesses in other sectors or from other businesses in the space industry, was a reason for recruitment difficulty perceived by 51% and 49% respectively of space businesses which experienced recruitment difficulty; and 39% of businesses with skill gaps reported staff with the necessary skills having left as a contributory factor in the presence of those gaps (Figure 16).

98   These statistics hint at a possible staff retention issue affecting space industry businesses.

99   When businesses were asked directly whether, in respect of their staff in scientific, engineering, or technical roles, they experienced difficulties retaining these staff, nearly a quarter (23%) of all businesses in the sample said that they had such difficulties – the proportion being much higher for larger businesses than for smaller ones (see Figure 17):

Figure 17: Proportions of businesses of different employment sizes that experienced difficulty retaining staff in scientific, engineering, or technical roles (all respondents)
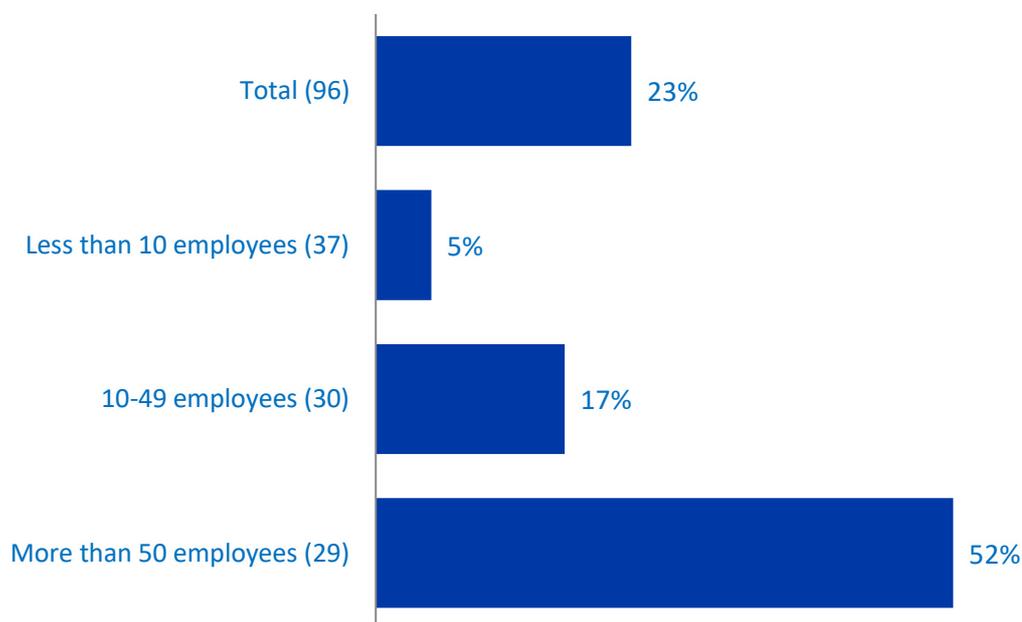
Sample bases in parentheses (no. of businesses)   *For example: 5% of businesses with less than 10 employees experienced difficulty in retaining staff*

100   The perceived reasons for retention difficulties were varied but the most frequent were uncompetitive pay and competition from other businesses in the space sector (see Figure 18 following):

Figure 18: Proportions of businesses that reported difficulties retaining staff giving each of a range of reasons for staff retention difficulties (where experienced retention difficulties)

Uncompetitive pay	41%
Competition from other space businesses	32%
Lack of career or skills development opportunities	27%
Brexit has led to staff moving out of the UK	27%
Uncompetitive conditions of employment	23%
Unfavourable location	23%
Competition from businesses in other sectors	9%
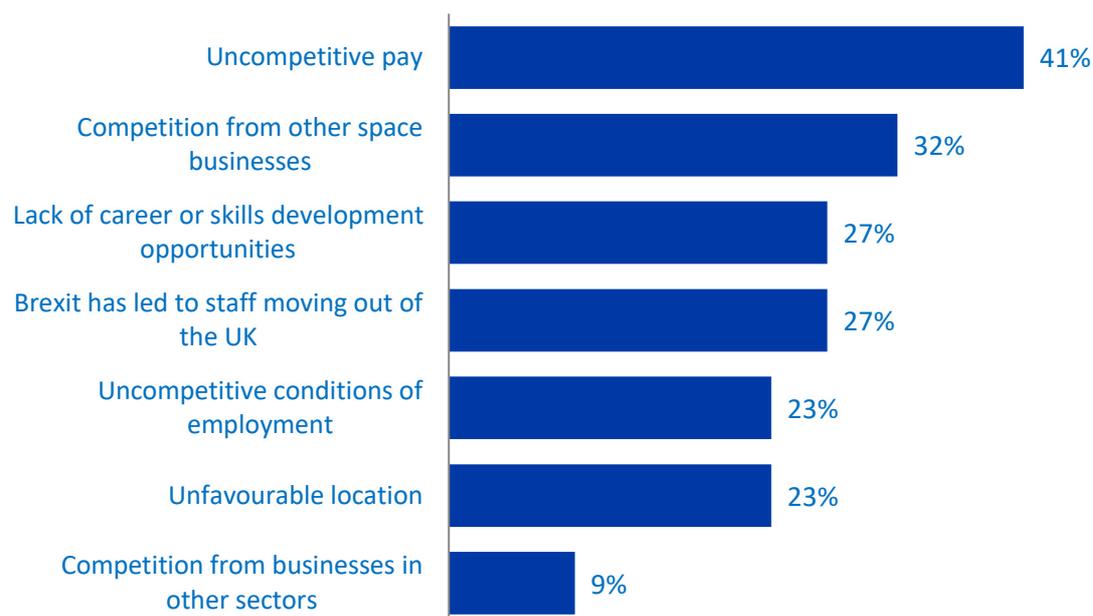
Sample base = 22 businesses *For example: 41% of businesses that reported retention difficulties reported uncompetitive pay as the reason*

Skills issues: Summary and effects

101 The three areas of potential skills problems – recruitment difficulties, skill gaps, and staff retention problems can be considered simultaneously:

Table 2: Proportions of space industry businesses engaged in different types of space activity, and of different employment sizes, reporting the range of possible skills issues (all respondents)

		Business activity type				Employment size		
	Total	Upstream only	Downstream only	Upstream and downstream	Neither	Less than 10 employees	10-49 employees	50+ employees
Recruitment difficulties	43%	33%	40%	61%	25%	22%	47%	66%
Skill gaps	51%	53%	53%	52%	38%	32%	57%	69%
Staff retention problems	23%	13%	40%	33%	0%	5%	17%	52%
Any of these issues	67%	63%	67%	79%	38%	41%	70%	97%
None of these issues	33%	37%	33%	21%	63%	59%	30%	3%
Sample bases (no. of businesses)	*96*	*40*	*15*	*33*	*8*	*37*	*30*	*29*

For example: 43% of all businesses; 33% of those in Upstream sectors only, reported recruitment difficulties

102   The data in Table 2 shows that, overall, two-thirds (67%) of businesses in the sector have one or more skills problems. These are most frequent in larger businesses, particularly those which have both 'upstream' and 'downstream' operations – to the extent that virtually all (97%) of larger businesses (with 50 or more employees) acknowledge one or more of the three problems.

103   The most frequent effect (see Figure 19 below) of having skills issues (of one or more of the three types) was the additional burden placed on workforces. Constraint on product development and innovation and increased use of outsourcing were the next most frequent impacts followed by a range of other negative business consequences – including failure to exploit business opportunities and to win contracts, reduced productivity, difficulty in introducing new working practices or technology, loss of business to competitors, higher operating costs, and others:

Figure 19: Proportions of businesses that have reported any skills issues that cite any of a number of possible impacts of those skills issues – prompted, multiple response (where have one or more of three types of skills issues)

Impact	%
Increased workload for other staff	70%
Delay in service or product development or reduced level of innovation	58%
Outsourcing or subcontracting of work which might have been done in-house	39%
Weakness in developing or exploring business opportunities	30%
Failure to win contracts which might otherwise have been won	30%
Reduced productivity	27%
Difficulty in introducing new working practices, processes or technology	27%
Loss of business to competitors	19%
Higher operating costs	19%
Weakness in responding to market changes	14%
Weakness in organisational or financial management and control	14%
Difficulty in meeting quality standards	6%
Other	8%
Don't know	3%

Sample base = 64 businesses   Q20/Q21   *For example: 70% of businesses that reported any skills issues cited the impact as an increased workload for staff*

104   Asked to summarise the impact of skills issues on the business, virtually all businesses (98%) which were affected by one or more of the three skills issues acknowledged that the issues had at least some impact on business performance and growth [representing two-thirds (66%) of all businesses in the sample].

105   The most frequent estimate of the severity of effect was 'moderate impact' but nearly 1 in 10 of affected businesses assessed the impact as 'major' (see Figure 20 below).

Figure 20: Proportions of businesses reporting different degrees of impact – major, moderate, minor, or none - on the business of skills issues (where have one or more of three types of skills issues)
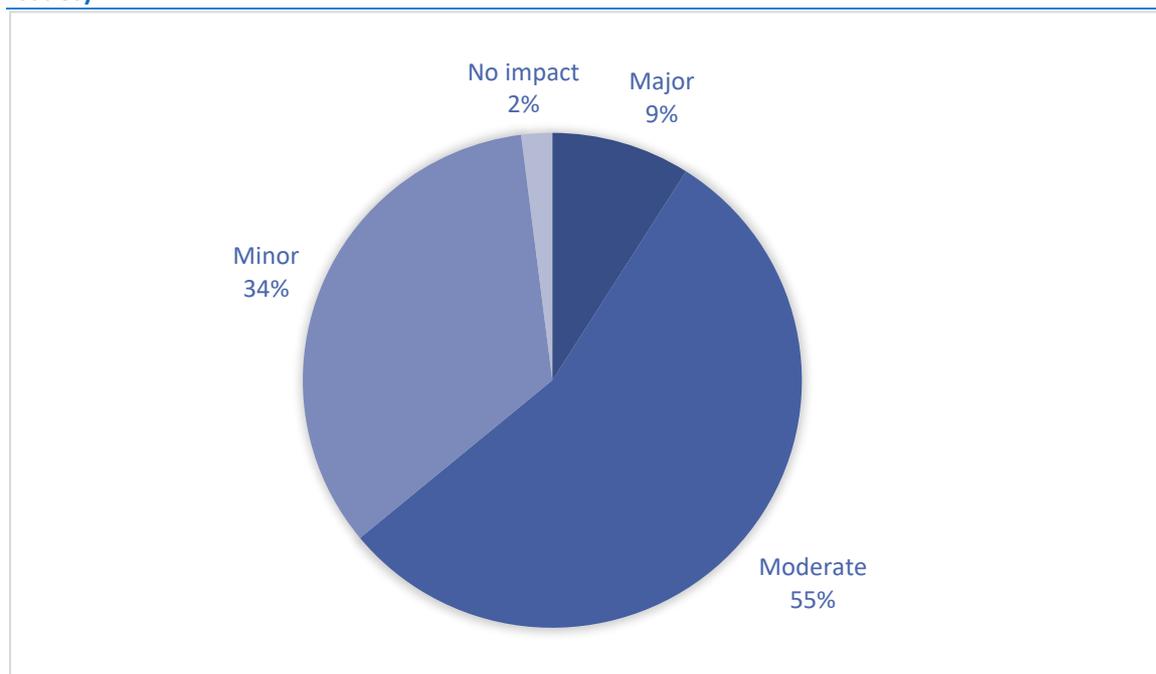
Sample base = 64 businesses   Q21   *For example: 9% of businesses with any skills issues reported a major impact as a result*

106   Within the overall picture of impact presented in Figure 20, micro-businesses (fewer than 10 employees) were most likely to report impacts as being 'major' – 20% did so, compared with 10% of small businesses (10-49 employees) and 4% of larger businesses (50+ employees). The latter, larger businesses, were most likely to describe impacts as 'moderate' – 57% did so compared with 52% of small businesses and 53% of micro-businesses.

Skills challenges: summary

107   Skills specifically related to space industry operation and higher-level technical skills which are transferable into the industry were widely used across all 'activity' sub-groups. Recruitment levels for these skills were also high when compared with typical levels of recruitment in other sectors of the UK economy.

108   A significant level of difficulty in this recruitment was also observed, with two-thirds of more of businesses which sought to recruit experiencing difficulty. Difficulty was more often experienced by larger businesses, which, by virtue of their size, recruit more frequently.

109   Much the larger part of recruitment difficulty concerned professional occupations or to a lesser extent, technical jobs at the 'associate professional and technical occupations' level.

110   A list of detailed job titles of identified hard-to-fill jobs were mainly of different engineering specialisms. The variety of these poses a challenge to the identification of a simple focused training solution which might widely ease industry recruitment difficulty.

111   Recruitment difficulty is largely due to a shortage of skills and/or experience in the labour pool from which space businesses seek to recruit. Brexit may also have narrowed this pool by discouraging in-migration of skills from Europe; and respondents frequently agreed that there is insufficient specialist training in UK educational institutions.

112   Skill gaps in industry businesses' current workforces were identified by 51% of businesses, a much higher proportion than that for businesses across all UK sectors.

113   A large proportion of businesses with skill gaps, 86%, located at least one of these in their scientific, engineering, or technical functions, whilst 43% located at least one of them in their managerial or entrepreneurial functions.

114   Scientific, engineering and technical skills gaps were widely distributed across a range of specialisms which, again, makes a simple, focused training solution less obvious. Managerial and entrepreneurial skill gaps had a slightly greater focus (gaps in project management skills being identified by 67% of businesses with managerial or entrepreneurial gaps) but, beyond that, a wide range of different types of managerial or entrepreneurial skills gaps were identified by between a quarter and a half of businesses with this type of gap.

115   The main reason for skill gaps was identified as skills shortage – recruitment difficulty when seeking skills in the external labour market. This emphasizes the reciprocal nature of the relationship between recruitment difficulty and internal skill gaps – businesses seek to recruit because of skill gaps while skill gaps occur or are perpetrated because recruitment difficulty is encountered.

116   The skills supply situation is worsened for approaching a quarter (23%) of businesses by staff retention problems – essentially, with a limited supply of the required skills, individual staff are able to take advantage of opportunities to increase their pay or otherwise improve their situation by moving between employers.

117   Overall, two-thirds (67%) of businesses in the industry, rising to 97% of businesses with 50 or more staff, experienced one or more of the three main skills issues which were investigated (recruitment difficulty, skill gaps, or staff retention problems)

118   An immediate effect of such problems on businesses which experienced them was simply to increase workload on other staff or to outsource work to other businesses. However, a wide range of other more significant consequences were observed with some frequency, including constraint on innovation, failure to exploit business opportunities or to win contracts, and reduced productivity.

119   Overall, more than half (55%) of businesses with these problems assessed their impact as 'moderate' but 9% (or 6% of all businesses in the sample) saw them as major. Only 2% reported that their skills issues had no impact on business performance or growth.

Responses to skills challenges

120 The most obvious response to skills supply problems, whether experienced when trying to recruit or evident in skills shortfalls within the internal workforce, is to train staff in the required skills.

121 Overall, 80% of businesses in the sample had provided training for their staff in the 12 months prior to the survey (See Figure 21 below). This includes 54% which had provided formal, off-the-job training and 73% which had provided less formal training (i.e. not necessarily off-the-job but still intentional and recognisable as training by the staff involved).

122 These are higher than the averages for all employers in the UK (using data from the UK Employer Skills Survey 2019 referenced earlier):

- Provided training: 61%

- Provided off-the-job training: 43%

- Provided on-the-job training: 49%

123 As in other analyses, larger employers in the space industry were more active than smaller ones:

Figure 21: Proportions of businesses of different employment sizes that have provided various types of training in the 12 months prior to the survey (all respondents)
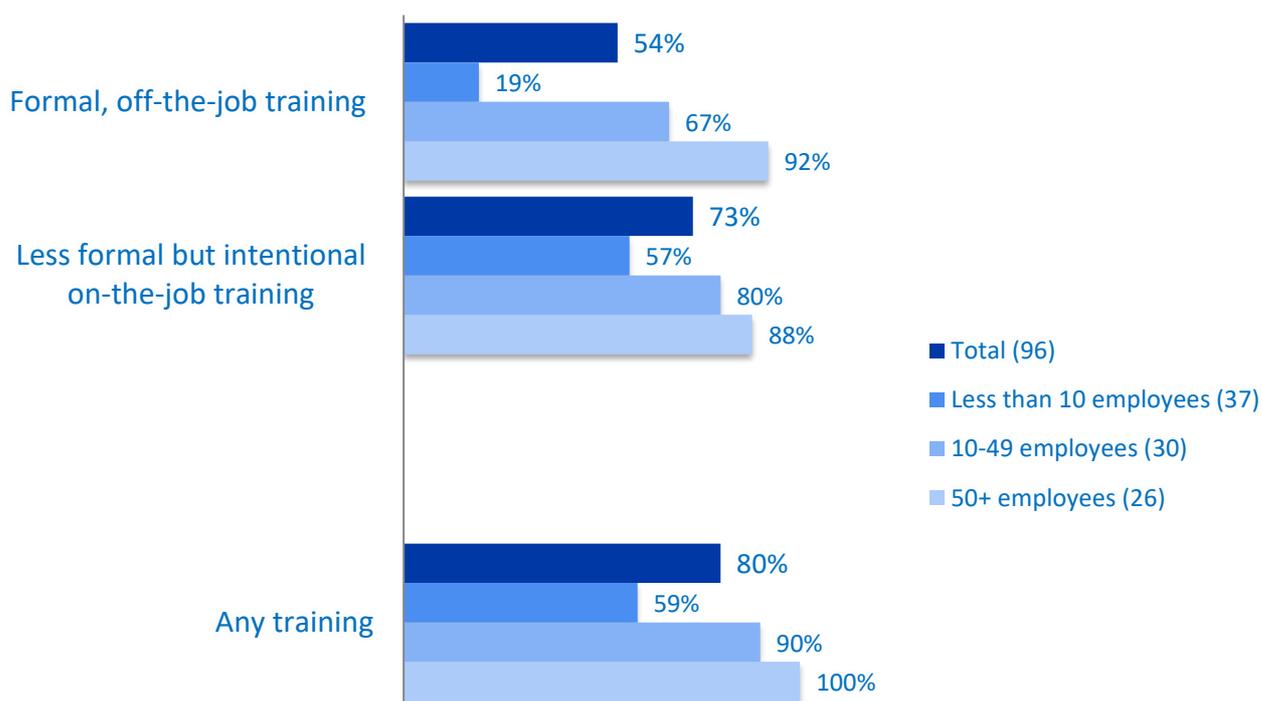
Bases (no. of businesses) in parentheses Q22   *For example: 19% of businesses with less than 10 employees had provided formal, off-the-job training in the last 12 months*

124 Businesses which had provided any form of training further revealed their use of some specific forms of training (see Table 3 below). Basic upskilling of staff in 'space skills' was most frequent but there was also substantial use of varied approaches to the development of graduate trainees.

125   Around a fifth of businesses (19%) had offered technical apprenticeships at level 4 and below and a similar proportion (21%) had offered higher level or degree apprenticeships in the 12 months prior to the survey. These figures compare with 9% of UK employers in all sectors which had offered apprenticeships (at any level) in the three years prior to the 2019 UK Employer Skills Survey (referenced earlier). As with training overall, higher proportions of larger businesses in the space sample than of smaller ones provided most of the specific forms of training:

Table 3: Proportions of businesses of different employment sizes that have provided specified types of skills development in the 12 months prior to the survey (all respondents)

		Employment size		
	Total	**Less than 10 employees**	**10-49 employees**	**50+ employees**
Upskilling of existing staff to develop specialist space-related skills which the business needs	73%	55%	81%	81%
A formal graduate or post-graduate traineeship	38%	18%	26%	65%
A substantial work experience placement of 3 months or more for an undergraduate undertaking a "sandwich" degree or its equivalent	47%	36%	48%	58%
A vacation work placement (for example: SPIN - Space Placements in Industry) of less than 3 months for an undergraduate or university student undertaking degree training	53%	45%	67%	50%
A degree or higher apprenticeship programme within the national government apprenticeship programme (level 5 and above)	21%	9%	7%	46%
A lower level technical apprenticeship within the national government apprenticeship programme (level 4 and below)	19%	5%	7%	46%
A formal company traineeship below graduate level outside the national apprenticeship programme	13%	5%	22%	12%
Summary: Any apprenticeship (degree or higher, lower level)	26%	9%	11%	58%
Summary: Any traineeship (i.e. graduate, post-graduate, under-graduate)	47%	23%	44%	69%
Sample bases (no. of businesses)	*77*	*22*	*27*	*26*

Q23   *For example: 55% of businesses with less than 10 employees have upskilled staff to develop specialist space skills in the last 12 months*

126   The most frequent source of training expertise (in respect of formal, off-the-job training) was other staff in the business. Private training companies were also frequently used as were universities and professional or industry bodies (see Figure 22 below):

Figure 22: Proportions of businesses that have provided off-the-job training in the 12 months prior to the survey that have used each of a range of possible external training provision – prompted, multiple response (where provided off-the job training)
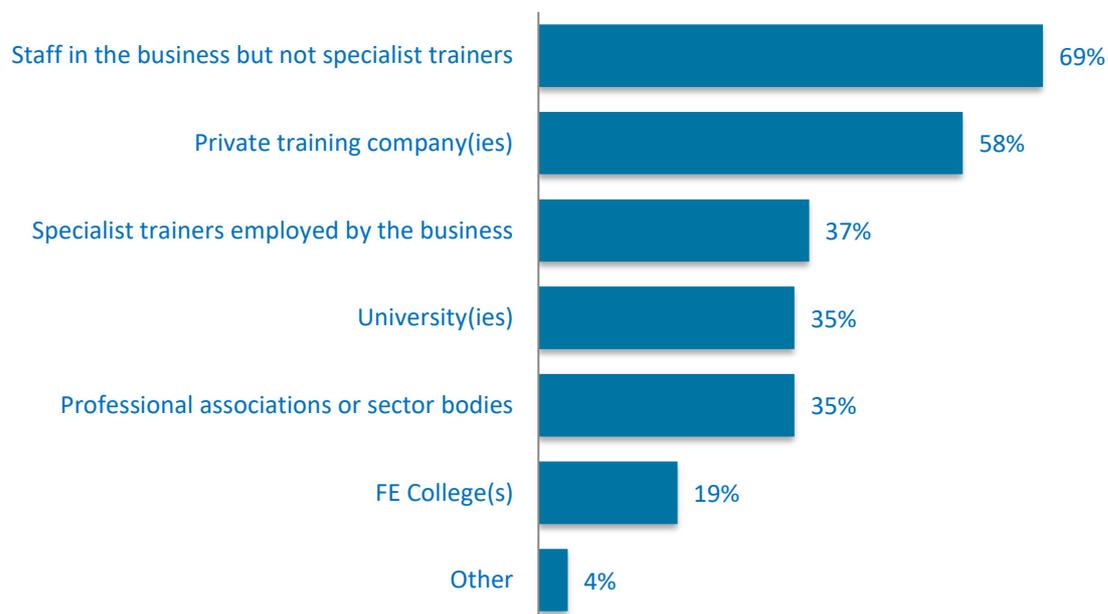
Sample base = 52 businesses   Q24   *For example: 69% of businesses that have provided off-the-job training have used staff in the business but not specialist trainers to deliver it*

127   There were differences in the sources of training used by businesses which trained off-the-job according to their size (see Table 4 following).

Table 4: Proportions of businesses of different employment sizes that have provided off-the-job training in the 12 months prior to the survey that have used each of range of possible external training provision (all respondents)

	Total	Employment size		
		Less than 10 employees	**10-49 employees**	**50+ employees**
Specialist trainers employed by the business	37%	14%	30%	48%
Staff in the business but not specialist trainers	69%	57%	55%	84%
Private training companies	58%	86%	50%	56%
Universities	35%	14%	35%	40%
FE colleges	19%	0%	10%	32%
Professional associations or sector bodies	35%	14%	20%	52%
Sample bases (no. of businesses)	*52*	*7*	*20*	*25*

Q24   *For example: 57% of businesses that have provided off-the-job training with less than 10 employees have used staff in the business but not specialist trainers to deliver it*

128   Caution is needed because of small numbers of cases, but the data supports a picture in which micro-businesses are more likely to rely on private training companies whereas larger ones are more able to supply internal training resource or to access public educational institutions (in respect, particularly, of the graduate work placements and apprenticeships observed earlier in Table 3).

129   A small number of businesses in the sample (15 cases) had **not** trained staff in the 12 months prior to the survey. These were overwhelmingly (12 cases) micro-businesses which, in 11 cases, said their staff did not need training. Only 2 businesses in the whole sample reported that they would have liked to supply training but couldn't do so. Overall, five reasons were given by these two cases ('can't afford time off-the-job', 1 case; 'training needs are specific and training courses are too generic', 2 cases; 'Don't have time or resources to identify training', 2 cases).

130   More generally, however, all businesses in the sample were asked if there were any type of training or education which they would like to be available but which is not available or is in short supply.

131   Four in ten businesses (40%) said that this was the case, with a somewhat higher percentage (48%) among larger (50+ employees) businesses.

132   When asked to identify the types of 'missing' or under-supplied training, as in some earlier analyses, there was a wide spectrum of responses. These were in three main groups:

133   Detailed space specialisms, for example…

- Geospatial data analytics
- Satellite imagery processing and interpretation/remote sensing
- GNSS
- Orbital mechanics
- Space warfare
- Space weather analysis training
- Launch operations
- EEE components
- Ground segment training
- Space system engineering
- Radiation effects

134   Generic technical training, for example…

- Data science
- AI techniques
- Software engineering
- Practical, hands-on electronics
- Cyber-security
- Technical sales skills
- Practical engineering

135   Generic management and commercial skills, for example…

- Commercial awareness

- Mid-level management training

- Enterprise skills

- Negotiation skills

- Leadership training

- Product development management (including financial elements)

136   In respect of these groups, the areas of training need implied by the two latter groups are not ones in which there is an evident under-supply of relevant courses. It seems possible that business concerns here reflect lack of knowledge of available provision, access issues (such as cost of training or its location), or a perception that training in these areas is not sufficiently tailored or sufficiently specific to the particular needs of the space industry or the particular business.

137   In respect of the first group, which contained the largest number of mentions, there may be a more pronounced under-supply of relevant training. The particular challenge, as discussed in respect of some earlier analyses is of generating a viable response to the somewhat disparate and diverse nature of demand.

138   What is more certain is that the demand for provision, whatever its distribution across subjects and themes, is weighted to provision at under-graduate level and above (see Figure 23 below):

Figure 23: Proportions of businesses that cited a lack of available external training that cite each of a range of levels for which training was perceived as missing or under-supplied (where cited lack of available external training)
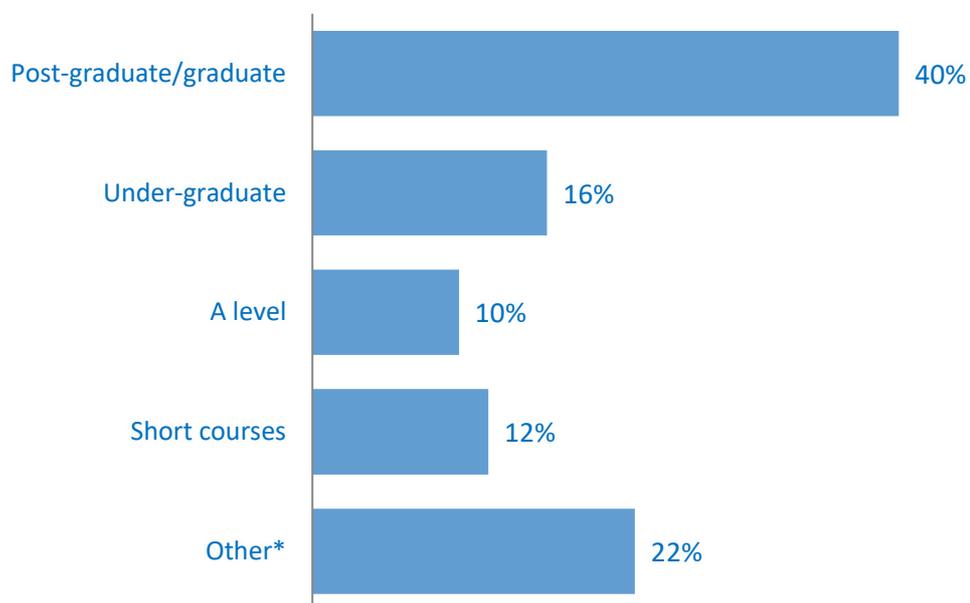
73 'mentions' (multiple response) Q28a   *includes unspecified, multiple levels, or descriptive such as 'managerial level' or 'specific'. *For example: 40% of businesses cited a lack of available external training at a post-graduate/graduate level.*

139 Given this apparent demand for training at under-graduate level and above, it may not be surprising that businesses responded positively to the concept of a new Graduate or New Entrant Training Programme (see Table 5 below). Only 3 businesses in the sample responded negatively to the concept though rather more (40%) gave a conditional response, perhaps reflecting the need for specificity of training which has been noted above. It is also noticeable that micro-businesses (1-9 employees) were a little more straightforwardly positive about the concept than other businesses:

Table 5: Proportions of businesses of different employment sizes that would consider a new Graduate or New Entrant Training Programme to assist small and medium enterprises in the industry valuable (all respondents)

		Employment size		
	Total	Less than 10 employees	10-49 employees	50+ employees
Yes – would be valuable	56%	62%	53%	52%
Depends on content, cost etc.	33%	30%	33%	38%
Would need to have more details	7%	5%	7%	10%
Not/probably not valuable	3%	3%	7%	0%
Sample bases (no. of businesses)	*96*	*37*	*30*	*29*

Q30 *For example: 62% of businesses with less than 10 employees said 'yes – would be valuable'*

140 The 'specificity' issue is apparent again in responses to the survey's request that respondents identify subjects or skills which the prospective new programme might include.

141 Indeed, asked this question, several respondents mentioned the diversity of need including one respondent who typically answered: 'The space sector is very diverse – you possibly need lots of different programmes, each covering a different discipline e.g. satellite earth observation, SatNav, SatComms, Space Science etc.'

142 This type of observation is emphasised by the many different suggestions for syllabus content which other businesses proposed, ranging over the three-fold 'space specialism', 'generic technical', and 'management/commercial' breakdown which was suggested earlier. Just some examples were:

- 'Project management, budget management, dealing with conflict, giving feedback'
- 'Cryptography design; signals'
- 'Data science'
- 'Autonomy, CAV, velocity'
- 'Flight dynamics'
- 'Images, optical engineering, silicon device design'
- 'Launch vehicle development and operation'
- 'Fluid behaviour in microgravity; composite propellant tanks'
- 'Space governance'
- 'Orbital mechanics, commercial pipeline of getting on a launch, power electronics'
- 'Robotics automation'
- 'Languages including Python, GIS training using QGIS, EGNOS training'

- 'Downstream data applications'
- 'Law, regulation and policy'
- 'Commercial marketing skills'
- 'Satellite remote sensing'
- 'Defence use of space'

...and so on.

Responses to skills challenges: summary

143 A high proportion of space businesses (80%) had responded to their skill challenges by, within the 12 months prior to the survey, training one or more of their staff.

144 This included both formal, off-the-job training, by 54% of businesses and less formal but still intentional training, by 73% of businesses.

145 Training most frequently comprised the upskilling of existing staff in space skills but work placement schemes for university students, graduates, and post-graduates and apprenticeships, including high-level apprenticeships, were also widely used.

146 Training was most often supplied by internal staff of the business (either specialist trainers or other staff) but private training companies were also used frequently (particularly by micro-businesses) as were universities and professional associations or sector-bodies.

147 Only a small proportion of businesses had not trained staff in the 12 months prior to the survey. Almost always these were micro-businesses which reported that their staff did not need training.

148 Four in ten of all businesses (40%) believed that some training or education was not available or was in short supply.

149 This missing or under-supplied training fell into 3 broad groups: space specialist training, generic technical training, and management and commercial training.

150 Since training in the latter two groups is generally available, it is speculated that the issue here may be lack of business awareness, problems with accessing it (such as cost or location), or a perception that what is available is not sufficiently tailored to the needs of the space industry or the particular business.

151 The missing or under-supplied training identified in the 'space specialist group' was very varied and raises a challenge as to how this variety could be met by a single or small number of enhancement(s) to training provision in the UK.

152 What was less varied, however, was the expected level of training – most businesses would expect this training to be at least at under-graduate level and often at graduate or post-graduate level.

153 There was a general positive response to the concept of a new Graduate or New Entrant Training Programme for the space industry, though some of this response was conditional on the content, cost and other characteristics of the programme.

154 In respect of the prospective content of the Programme's syllabus, this again reflected the broad division between space specialist, generic technical, and management/commercial content; and, again, proposed themes for the space specialist element were widely varied.

Looking to the Future

155 The nature and scale of skills demand in the space industry in future years will depend on two key features – one, whether UK space businesses individually grow; and, two, whether the UK industry as a whole retains its competitiveness within a global market for space-dependent products and services which is anticipated to expand rapidly and, hence, to increase opportunities for the space industry businesses which supply that market.

Business growth

156 Overall, three-quarters (75%) of businesses in the sample predict that their business will grow over the next three years and a fifth (21%) predict stability. Only 4% expect to shrink or to sell or merge, or are uncertain about the future.

157 Space software businesses were most confident of growth (see Figure 24 below):

Figure 24: Proportion of businesses engaged in different types of space activity that expect growth in the next 3 years (all respondents)
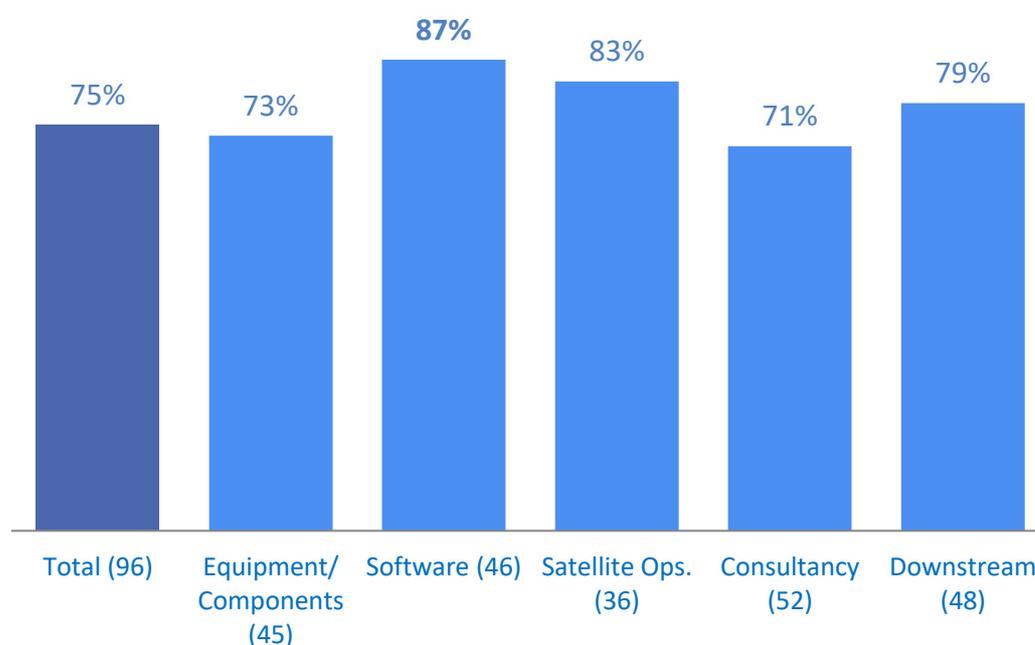
Bases in parentheses (no. of businesses) Q32 *For example: 73% of businesses that manufacture equipment/components expect growth in the next 3 years* **Bold font indicates statistically significantly higher than average to a 95% confidence level**

158 Expectation of growth was also strongest in the mid-sized businesses (10-49 employees) in the sample at 90% (expect to grow) rather than in micro-businesses (less than 10 employees) where 62% expect to grow, or in larger (50+ employees) where 76% expect to grow.

159 This latter finding may bear some correspondence with the findings of the London Economics report (Size and Health of the UK Space Industry 2018) which noted that industry growth between 2016 and 2018 was faster (at 31% per annum) in larger SMEs than in very large enterprises (at 2% per annum).

160 Growth was expected in employment only by 7% of businesses but by both employment and sales in 67% of businesses.

161   Including recruitment driven both by growth and for staff replacement, 85% of all businesses in the sample expected to recruit managerial, scientific, engineering or technical staff within the next 3 years – including 97% of mid-sized businesses (10-49 employees), 90% of larger businesses (50+ employees), and 73% of micro-businesses (less than 10 employees).

162   Corresponding to the constitutions of their current workforces, largely made up of higher level staff, 90% of those businesses expecting to recruit expect to recruit professional staff, 41% expect to recruit associate professional and technical staff, while 4% expect to recruit at managerial level.

163   Corresponding with the earlier detailed breakdown of recent recruitment difficulties, the occupations which businesses anticipate recruiting in future are very diverse even within the limited professional, technical, and managerial spectrum within which most recruitment will take place. Examples include:

- Systems engineers
- Propulsion engineers
- Remote sensing specialists
- Data scientists
- Cloud development systems engineers
- Antenna engineers
- Ground systems engineers
- Flight systems engineers
- GNSS engineers
- Product assurance engineers
- Project managers
- Technical launch vehicle staff
- Supplier network lead
- Plasma physicist
- Oceanographers
- Marketing executive
- EGNOS specialist
- Network architects
- General management
- Business development staff
- Machine vision engineers
- Senior space lawyer
- Orbital analyst

    …and so on.

164   Reflecting on prospects for ease or otherwise of recruitment of such staff, the great majority of respondents expected recruitment to be very or somewhat difficult (see Table 6 below).

Table 6: Proportions of businesses expecting to experience difficulties recruiting different grades of staff within the next 3 years (all respondents)

Row percentages	Recruitment will be very difficult	Recruitment will be somewhat difficult	Recruitment will not be difficult
Expect to recruit managerial staff (3)	33%	67%	0%
Expect to recruit professional staff (70)	36%	64%	0%
Expect to recruit associate professional or technical staff (32)	22%	63%	15%

Sample bases in parentheses (no. of businesses)   Q35   *For example: 33% of businesses that expect to recruit managerial staff expect recruitment of these staff to be very difficult*

Confidence in the competitiveness of the UK space industry

165   Beyond their own business' expectations of growth or otherwise, businesses reported their level of confidence in the proposition that the UK space industry would at least maintain its share of the global market for space technologies and services over the next 10 years (see Figure 25 below).

166   Confidence was mainly moderate rather than high and nearly a fifth of businesses (18%) were not very or not at all confident, roughly balancing those that were very confident (16%).

Figure 25: Proportions of businesses with different levels of confidence – very confident, moderately confident, not very confident, not at all confident – in the UK Space sector being able to at least maintain its share of an expanding global market for space technologies and the services it provides over the next 10 years (all respondents)
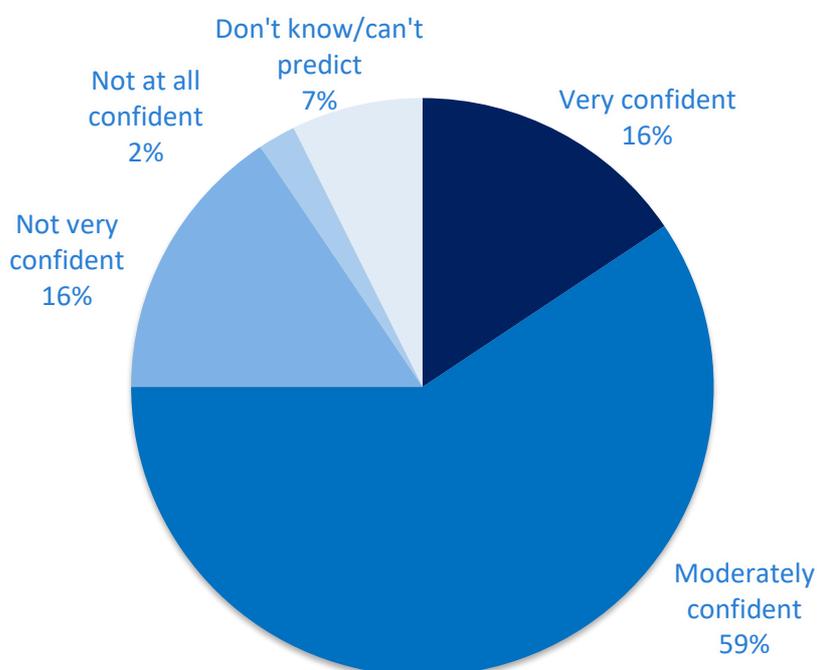
Sample base = 96 businesses   Q37   *For example: 16% of businesses are very confident*

167   Confidence levels did not vary greatly between different activity or size groups of businesses in the sample but confidence was somewhat higher amongst businesses which themselves expect to grow than it was amongst businesses which expect to remain stable in size.

168   Thus, for example, 18% of 'growth' businesses were very confident about the UK industry's future compared with only 9% of 'stay stable' businesses, whilst 'stay stable' businesses constituted all the businesses which said they were not at all confident about the UK industry's future.

Looking to the future: summary

169   There is an expectation of business growth over the next 3 years amongst the greater proportion of businesses in the sample (75%).

170   An even larger majority, 85% of businesses, expect growth or replacement needs to require staff recruitment over the same period.

171   The great majority of recruits will be at professional or associate professional and technical level spread across a wide variety of individual, mainly specialist, job types. Nearly all these job types are expected to be very or moderately difficult to recruit.

172   Confidence in the longer-term future competitiveness of the UK space industry as a whole is mainly in the moderately to high range but around a fifth of businesses in the sample are less confident than this.

4. Qualitative survey findings

Introduction

173 As noted in the first section of this report, 21 semi-structured, depth interviews were undertaken in addition to the interviews which constituted the quantitative element of the study, the findings of which have been described in preceding chapters. These 21 interviews were undertaken by telephone rather than face-to-face because of Covid-19 constraints. They were based on a discussion guide as set out in the appendix at the end of this report. Their content allows more detailed insights into some skills issues in the industry. These insights are reported below.

Skills necessary for the space industry workforce

Participants cite a breadth of scientific understanding, primarily in maths and physics, as the most necessary 'skill' for working in the space sector

174 Given the scope of the UK space industry, which covers many disciplines and delivers a wide range of products and services, participants struggled to pinpoint any specific skills or knowledge that would apply to the sector as a whole.

> *"[Specialist knowledge in the space sector] can be any aspect, it can cover anything from space mission science the whole way through to front end, really commercial, user end."* ***Anonymous***

175 However, the majority of participants note that a fundamental grasp of maths and physics is essential to understanding space and working in the industry. Those who have these skills are more likely to be able to work collaboratively as they will have a general understanding of how their systems and outputs interlink with those of other teams, as well as how they will operate in space.

176 It is accepted that those working in the space industry usually have this foundational knowledge of maths and physics and it is not seen as a source of skills gap in the sector. This is unsurprising given the high levels of education employees often have to obtain before entering the sector[5]. Though this is especially prominent in the upstream sphere, because of the need for a general understanding of maths and physics across the sector, and the fact that many businesses straddle both upstream and downstream activities, those in the downstream sphere are often highly educated too. However, some academic participants with strong backgrounds in maths and physics did suggest that those with more 'hands-on' skill sets used in the manufacturing of spacecraft and satellites sometimes do not entirely appreciate how their designs will operate in space.

> *"The main thing about the space industry is that you need general skills, specialist skills are often not that useful, because you make mistakes because you don't appreciate the implications of doing things. My observation as a whole is that physics is a very good background, whereas people who have done engineering degrees may not realise the implications of working in a vacuum, or the thermal implications."* ***Chris Chaloner, Director, Trym Systems Ltd.***

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[5] Most respondents stated that it is not often that employers in the sector hire people who do not have at least a Master's degree, and a PhD is preferred by many, especially within the upstream sphere

Softer skills, such as 'agility' and communication skills, are becoming more and more valuable for businesses

177   Since the sector encompasses many disciplines it is highly collaborative, with teams often working internationally and across cultural and language barriers. Therefore, communication skills are extremely important, as they are needed to work effectively in collaborative teams. The ability to translate highly technical ideas into non-specialist terms also makes collaboration with other industries and public engagement possible, which provides more business development opportunities.

> *"The ability to communicate the importance of some elements of the space industry to laymen is very important."* ***Anonymous***

> *"You need to be able to write clearly and coherently. Decent writing skills are very important, and often missing. You need to be able to be thrown in to a meeting full of people from different nationalities, different skills, and different backgrounds, and relate to them, ask them questions, tell them things, and communicate with them fairly rapidly. You have to be able to talk without using colloquialisms, and use international simplified English."* ***Chris Chaloner, Director, Trym Systems Ltd.***

178   Participants also mention the benefits of having an agile workforce. As the space industry grows and develops, it is important that companies are able to adapt to market needs and, in turn, employ candidates who can adapt to changing job expectations. This is particularly important for start-ups, which often need to build an efficient workforce with limited resources, but equally those in larger companies could be more adaptable in order to respond to changing external needs. The industry also needs people who are not fixed in their thinking and are adaptable to new ideas.

> *"Senior management need to be open for change, we need agile and flexible employees, who aren't stuck to a certain mindset or idea. They need to be open for communications and discussion, open for change. We are looking for people who see the bigger picture. This is a soft skill that's lacking in senior management, as they have worked their way up and struggle to look outside the universe of their company."* ***Elvis Eckardt, Global Talent Sourcing Consultant, OneWeb***

Commercial awareness and business acumen are growing as important and necessary skills for employees of the space industry to have

179   Knowledge of the space industry from a commercial viewpoint appears to be growing as a necessary skill for those working in the sector, especially for more senior members of staff who now have a stronger involvement in business development and commercial partnerships. On top of this, start-ups are important in the industry, and founding CEOs are looking for employees with strong experience in the space industry, but also an ability to sell services, and network both within, and outside of the sector. They need to succeed within a competitive environment.

180   For these more outward-facing businesses, employees now need to understand how and where to find customers, and identify what their needs are. Consequently, employees with commercial awareness are becoming highly sought after. An important aspect of this is familiarity with the industry-specific language, writing proposals, and following specifications, and an ability to translate technical language from the academic to the business.

"[The space sector] is quite government funded, but it is becoming more commercial, and so students having those business skills is really helpful. And there's a lot to learn from getting business minded people in from other sectors." **Portia Bowman, UK Innovation Manager, D-Orbit UK, Co-founder, SpaceCareers.uk**

"At the moment, the critical area is not space sector specific, it's around how to deliver to customers in ways that are scalable and well matched to needs. The space sector is still a new industry, and traditionally relied on engineers to do things in a technical or research orientated way. What the industry is trying to learn now is how to do things in a more commercial and scalable way, which fits with what customers expect. We need to learn as much as possible from organisations outside the space sector." **Kim Partington, CEO, Geocento Ltd.**

In an industry where learning on the job is the norm, there is also a need for staff with mentoring and teaching skills

181   Companies often hire graduates without the specific skill sets necessary, with the intention to train them in-house. This is usually out of necessity rather than choice. As a result, more senior members of staff develop and train junior employees, ensuring that they have the skills necessary to move up in the businesses.

182   As such, many companies see the importance of tutoring and mentoring skills, as well as the ability to show patience when educating entry-level hires. Though this is not a prominent skill set that is required, and only appears to be a secondary 'nice to have' skillset, it does appear to be growing in importance, as it becomes more difficult to hire people with specific experience and, therefore, it becomes more frequently necessary to train people on the job. It seems that many professionals in the industry do not currently have these skills and for many, teaching and mentoring is not a natural ability.

"There's a lot of in-house training done at the moment, we're hiring a senior management level role to create and lead in house training solutions. At the moment we get our senior engineers and team leads to do the training on side, it's all learning as you're doing." **Elvis Eckardt, Global Talent Sourcing Consultant, OneWeb**

"Most staff have experience of teaching. There's a certain degree of mentorship and coaching. Some people in the organisation are better than others at this, for some people it's second nature." **Telespazio VEGA UK Ltd.**

For graduate roles, employers like to hire those who have already had a high level of exposure and work experience in the space industry

183   There are many graduates who are highly educated and passionate about working in the space sector, and often entry-level positions receive a lot of applications, allowing employers the luxury of choice within the graduate market. As a result, it is often a prerequisite that graduates have had some exposure to working in this industry. They believe this exposure demonstrates passion, which makes them stand out from other applicants.

184   These skills can be gained by entering student competitions, as these competitions teach valuable skills that are needed in the industry, such as adaptability, commercial awareness, and some hands-on building experience. As such, employers find that those who have previously taken part in these kinds of competitions are excellent candidates. Furthermore, these competitions often require people to follow industry specifications, which gives people the opportunity to familiarise themselves with industry language, follow size and weight guidelines, and write proposals and reports.

"The reason I say competitions are great is because they made me flex my mind and think about what actually is the best way to design a lunar rover or deflect an asteroid." **Andrew Bacon, Co-founder and Chief Designer, Space Forge**

"[Satellite building projects] provide a nice, practical skill set that a company like ours can really make use of." **Mark McCrum, Technical Director, Bright Ascension Ltd.**

Skills gaps and recruitment difficulties in the space industry

Though most applicants have a good academic understanding of maths and physics, there are many roles with more specific skill sets that are difficult to fill

185 There are some positions which many employers find difficult to fill, which can be split into three categories: sector-specific (specialised) roles, non-sector specific (transferable) roles, and those with hybrid skills. These three categories are expanded below.

Sector-specific roles

186 Participants expressed difficulty recruiting employees with skills in and knowledge of[6]:

- Modelling

- User terminal architects

- Development operations (DevOps) engineers

- Satellite specialists

- Hardware specialists

- Thermal analysis specialists

- Antenna Feed operations engineers

- Software developers

187 This is particularly pronounced at the more junior level, which appears to stem from a lack of these subjects and skills being taught at universities. It has also been noted that graduates lack hands-on experience, which is essential to certain areas of the space industry such as hardware development. This may reflect the focus on theory rather than practical application of learning on many relevant university courses. Therefore, when taking on graduates, businesses need to find the resource to provide on-the-job training; to develop the graduates' job-specific skills. Some businesses, especially smaller companies, are unable to find this resource, resulting in fewer people being trained in than are needed in the industry.

"On the architectural side of things there are only a handful of people in the world who can do that job, so headhunting here and trying to poach some talent from competitors. There is no real fresh talent here, you learn on the job so there are no junior hires around." **Elvis Eckardt, Global Talent Sourcing Consultant, OneWeb**

"People that have significant hands-on experience with real hardware, this is something that's missing in the lower grades. […] The particularity of space is we need people to handle equipment that is very expensive, and once in operation you can't do anything to fix it if

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[6] These roles are illustrative only and varied depending on each participant; the quantitative information will provide more of an indication of the shortages of roles across many different businesses

*things go wrong, from a hardware perspective." **Maria Kalama, Director for Business Development, Lacuna Space***

188   While many who learn these skills stay in the sector, movement between organisations appears to occur three to six years after a graduate establishes a skill set. At this stage, they are thought to be more likely to leave their current position, as they know their skills are in high-demand. Much of this is attributed to pay grade, and the issue of insufficient benchmarking for the sector. Graduate salaries are high, but many HR professionals do not believe the pay acceleration in the industry matches the growth of their skill set.

189   Many employees in this group go to smaller companies which offer more money, but as these smaller companies cannot afford to train graduates, those in this group do not go on to train others, causing a gradual decline of those with these core skills across the sector.

> *"It's really hard to find anyone with 10 plus years of experience who's an expert in the subject, to be the fountain of knowledge as it were. It's easy to recruit young people who are very capable, but they don't have the experience…Retention is quite bad, there are the diehard space enthusiasts who love it, but I can see people who I graduated with who are leaving the sector because there are more highly paid jobs outside the sector." **Portia Bowman, UK Innovation Manager, D-Orbit UK, Co-founder, SpaceCareers.uk***

Figure 26: A chart illustrating the perception of salary increase in relation to time spent working in the sector
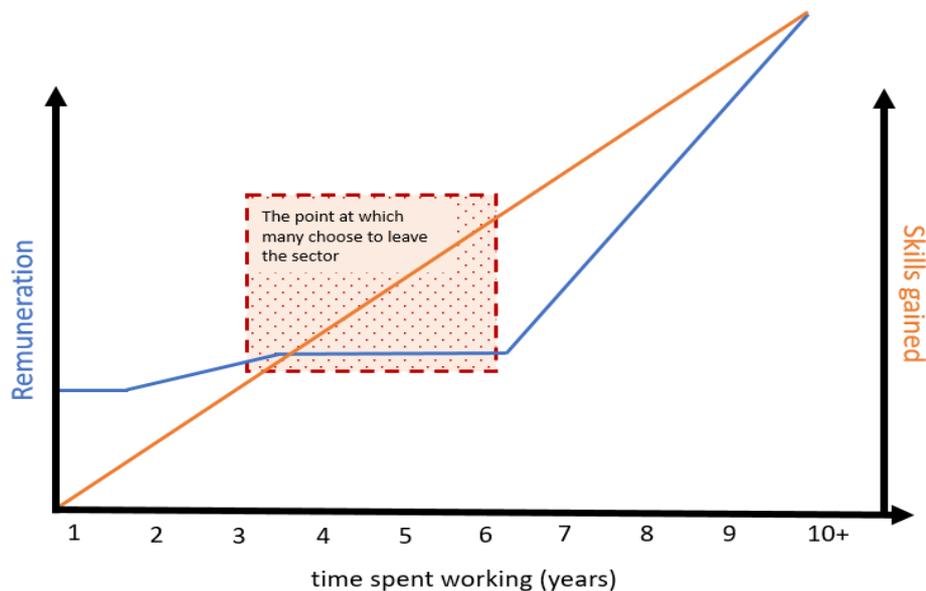
Non-sector specific roles

190 Some roles are difficult to recruit for because they are not sector specific, and so are competing with many other, often more profitable, industries. Software engineering and coding skills (e.g. in Python or MATLAB) were the most prominent examples amongst participants of this type of role.

191 These skills are transferable across sectors, and so many employees tend to leave the industry to go to work for companies wherein higher salaries are offered, such as financial services, consultancy, and Big Tech. Smaller companies are further disadvantaged in this respect, as those with software skills who do stay in the space industry tend to be offered higher paid positions in the larger companies which will find the capital necessary to attract them, where smaller companies often cannot.

> *"We're more limited in salaries, we're competing with industries that make a lot of money."* **Anonymous**

> *"Software is a really important skill, but we can't really afford to pay people the same as outside of the space sector."* **Portia Bowman, UK Innovation Manager, D-Orbit UK, Co-founder, SpaceCareers.uk**

Hybrid skill sets

192 The challenges of hiring people with both sector specific and non-sector specific skills is exacerbated when recruiting for those roles requiring a combination of skill sets. This is especially difficult for start-ups, which often need to employ people who can work across a range of different positions, as these start-ups do not have the resource to be able to hire for many different roles. In particular, it is difficult to find the following combinations:

- Recruits with non-sector specific skills who also have basic understanding of maths or physics
- Recruits with both software and hardware knowledge
- Senior recruits with experienced space sector knowledge combined with business acumen

193 First, most candidates with non-sector specific skills do not have the basic understanding of maths and physics necessary to work in the space industry. For example, software engineers with knowledge of the space industry are highly sought after, but they are rare.

> *"The space industry is relatively small, so the pool of people who know how to program and have had exposure to the space industry is likely to be similarly small. There's probably not so much exposure at university level to doing this sort of thing either. It means that the people in the organisation who have that skillset become a bottleneck."* **Mark McCrum, Technical Director, Bright Ascension Ltd.**

194 Similarly, there are very few people working in technical roles within the sector with prior knowledge of project management, which can be problematic as they are often asked to take on a role as a project manager, especially in smaller companies where resource is tight.

195   Second, it is rare to find candidates with both software and hardware knowledge, as people tend to be labelled as either one or another, and there do not appear to be many opportunities to develop both skills. Those who do have both skillsets have often been working in the industry for a very long time and have a lot of experience, and this, coupled with the fact that it is a rare combination, pushes up their market value to almost unattainable levels.

> *"We need someone who has software and hardware skills, and that's a bit more difficult to find. From education, people are usually labelled as a hardware engineer or a software engineer, therefore they probably go down this path for their career."* **Maria Kalama, Director for Business Development, Lacuna Space**

196   Third, the growth of innovation and start-up businesses in the sector has highlighted a shortage of senior employees with experience in the space sector, who also have commercial and business acumen. Many companies are looking to increase their offerings to the commercial market, to innovate, develop, and grow revenue. To do this, they need senior management with the gravitas to be able to speak coherently and confidently with clients about their product, but they also need to have the skills to identify market opportunity, and pitch products to a range of audiences.

> *"You'll find a lot of engineers going on to be managing directors or business developers, but I think a different perspective is useful. The reason it doesn't happen is that there's a steep learning curve, so you want someone who can come in and understand the status quo and hit the ground running. This is a bit short sighted though, and it'd be good to learn things from other sectors."* **Portia Bowman, UK Innovation Manager, D-Orbit UK, Co-founder, SpaceCareers.uk**

It is difficult to find skilled people at mid-level and senior management with experience in the space industry

197   The shortage of mid-level and senior management appears to be a well-known and recurring problem across the space industry. The reasons for this appear to be two-fold:

198   First, as aforementioned, many of those who enter the sector as graduates tend to leave after three or four years.

199   Second, with more companies diversifying into the space industry, such as consultancies, there is emerging competition from types of business which have not traditionally worked in the space sector which can now offer more attractive salaries.

200   As a result of these two factors, there appears to be a 'brain drain' at the middle management level, leaving a very small candidate pool.

> *"It's not hard to hire graduates, but keeping them until they reach the next level is difficult as people in this industry tend to move around a lot or get poached from other companies or other industries."* **Anonymous**

> *"Consulting companies are moving into the space industry, and they pay ridiculous salaries and we can't compete with that."* **Anonymous**

201   Senior management positions within the space industry are very difficult to fill, with participants reporting that it can take months to find the right fit. As is the case for middle management, it is hard to find people with the combination of managerial experience and a

space background which are essential to senior level or director roles. Additionally, participants suggest that another reason it is so difficult to recruit senior managers or directors is the unique character of space work which sees extremely long lifespans for projects and requires knowledge of various funding streams. As a result, many managers are hired on an ad-hoc basis; however, this is often done without a solid managerial structure in place, resulting in not enough permanent members of the space industry's workforce being taught managerial skills.

> *"We can recruit most roles ok, we are coping, not struggling. But it's just senior managers at the moment. It's the seniority throughout the whole company we need, because they are usually quite set in their roles. There are only a handful of really good people who we can approach, and they are usually not looking." **Elvis Eckardt, Global Talent Sourcing Consultant, OneWeb***

> *"It's really difficult getting a good shortlist. If we're lucky, we get a couple of people who we think are perhaps good enough, but there's a big risk that they might not accept an offer or we take a larger risk than we feel comfortable with. The pool of candidates we have that we're confident that are good for the job is smaller than we would like." **Kim Partington, CEO, Geocento Ltd.***

How the space industry is responding to skills gaps in the sector

The industry is aware of the shortage of mid-level employees and larger organisations are responding by trying to bring in more graduates

202   As mentioned earlier, there is a shortage of mid-to-senior level employees with business development skills. To address this skills gap, the sector has responded by recruiting more graduates and training them internally. Positively, attracting graduates is not a challenge, as it is seen as an exciting career that students are interested in pursuing. In fact, it appears easy to find 'the best and the brightest' graduates, and one participant mentioned that for a single position he had received over 300 applications, with the majority of those applying highly educated and qualified.

203   Sectoral efforts have been made to keep this interest high, mainly through work experience and internship opportunities. Many companies have taken advantage of the UK Space Agency's Space Placement in Industry (SPIN) scheme. Individual companies have also created their own internships and often take on students for their year in industry.

> *"The UK Space Agency's efforts to increase internships in space are very welcome. Internships are particularly valuable because students get to experience what it's like to work with real data in a company environment and a commercial business context, and hopefully that experience then stays with them." **Chetan Pradhan, Head of Institutional Engagement, Earth-i***

204   Many larger businesses prefer to recruit graduates and try to ensure they are retained, and they are able to mould the skills and knowledge base of the new recruit so that it perfectly fits the vision of the business. However, relying solely on graduate recruitment is a bigger burden for smaller companies and start-up businesses, as they often have fewer resources to provide this training, and cannot often train their graduates quickly enough, causing problems for their growth and development.

> *"In 10 years, there's going to be a massive problem, and there simply won't be enough people to fill those places unless you start to recruit more graduates." **Portia Bowman, UK Innovation Manager, D-Orbit UK, Co-founder, SpaceCareers.uk***

"We're looking for youngsters from university, mostly from system's engineering courses, that's where we want to get people in from. We're working with places like the University of Manchester, Bristol, Cranfield, and Imperial College London, these are our go-tos. We're looking for high-end talent to start their journey with us." **Elvis Eckardt, Global Talent Sourcing Consultant, OneWeb**

Many businesses use their networks to recruit

205   A lot of recruiting within the industry is done through informal networks. The space sector is small, and employees generally know other people in the sector, either personally or at least by name. By extension, they also know their reputation, skill sets, and interests.

206   This results in three methods that businesses in the sector may use to recruit:

- First, when a role comes up, many organisations will go out to their networks informally to let them know there is a role available, and the news of the vacancy is spread by word of mouth which may generate some interest from people already working in the sector;

- Second, individuals may indicate a desire to work on a certain project, mission, or change area. They too will communicate this, and organisations can create opportunities which match the skillset and interests of an interested candidate, thus ensuring good talent is recruited into their business.

- Third, a combination of these two approaches may happen. A role may come up which does not quite fit the interests or skill set of a particular applicant, but if that applicant is interested in the role, and the organisation believes they are a talented candidate, they may shape the role to fit the candidate's requirements. This flexibility in recruitment approaches is necessary for higher level recruits, as there is a shortage of talent with enough experience.

"A lot of recruitment is around knowing people, and attracting them from other organisations, giving them the opportunity to develop their career." **Tanya Boardman, Senior Project Manager, Goonhilly**

"We take the view that if someone is needed in a more senior position, then we have to go through our personal contacts. We find it difficult to get the right balance of skills and experience through general recruitment agencies" **Kim Partington, CEO, Geocento Ltd.**

Many businesses try to promote internally to encourage the retention of their staff members

207   Businesses are aware that there is a strong desire for career progression amongst staff, particularly amongst those in the first three to five years of their careers when, as noted earlier, their skills growth out-performs that of their salary rates. In order to combat this, many businesses promote often, where possible. They will often try to ensure that members of staff across the businesses are able to work to the expected standard, and so train them to be ready for a promotion once the opportunity arises.

208   It is not uncommon for staff to be promoted to backfill positions when a senior employee leaves the organisation. Many senior company directors have started from graduate level and worked their way up throughout the business. Employers believe that by ensuring career progression employees will be less likely to leave the business.

> *"We like to get juniors in... It gives everyone a chance to be promoted, and so our senior members are aware of what has happened in the company before [as they were promoted from junior positions]. And as a graduate, it's reassuring to come in and see people who have come in and worked their way up."* **Telespazio VEGA UK Ltd.**

And businesses working within the sector try to ensure that their retention rates are high by offering interesting projects and missions to their workforce

209   Many organisations also try to retain employees by working on interesting projects or missions. Many staff members join the space industry because they are highly passionate about it; it is something of a childhood dream for many. As a result, if this passion is not sustained, they are likely to leave.

210   As a result, many organisations do what they can to increase innovation in their businesses, so that they are competitive and able to offer cutting edge design and technology work to their employees, thus differentiating them from competitors, and ensuring their current workforce do not leave.

> *"It can't just be money that turns people's heads! We hope to catch them with values and their passion for satellite navigation, we have a lot to offer, and our mission statement is unique and really something which people can get behind. It's not done anywhere else."* **Elvis Eckardt, Global Talent Sourcing Consultant, OneWeb**

> *"We've had to adapt. Move people either into other functional areas or even sometimes to other physical locations, sometimes for whatever reason people want to leave but maybe there's an opportunity and some people have moved countries and entities within the group. Obviously to retain good people you need to try to understand what they're doing and try to adapt within the business to give them further opportunities"* **Paul Harris, Director Sales Engineering, Intelsat**

Reasons for recruitment and retention difficulties in the space sector

Due to the unique nature of the space industry, there is a perception amongst external applicants that it is not possible to enter from a different sector with transferable skills

211   There appears to be an underlying assumption that the space industry is difficult to enter; this is exacerbated by a portrayal of the industry as being almost 'magic' or 'fantastical.' Therefore, those who have not had direct experience with the sector often do not believe that they have the skills to be able to apply, even if those skills are highly transferable.

212   This is true for those who have both technical and non-technical experience; for roles such as project management or HR, many are put off applying as they do not have the foundational knowledge of maths and physics that many businesses believe are essential. Those with technical knowledge such as engineers are put off applying because they may not come from a space background. This has the adverse effect of limiting the recruitment pool, as fewer qualified candidates feel that they can apply.

> *"There's an issue of perception of space engineers, whenever you read a news story about space its usually accompanied by some fantastical statement. These statements make it sound like magic, but it's not. So, there's a perception that you need to be a super genius to work in the space industry which is not true at all."* **Andrew Bacon, Co-founder and Chief Designer, Space Forge**

> *"It would be useful to have a generic overview of what the different aspects involved in the space industry are, so that people can see where their skills fit in, and where they might be of interest. And how their knowledge can be applied to the space sector." **Tanya Boardman, Senior Project Manager, Goonhilly***

213   Participants believe that there needs to be more focus on promoting all aspects of, and roles within, the industry, not just the highly technical side, as this would make space more relevant and interesting to a lot of people.

This perception may be true, as it appears that many businesses in the sector are hesitant to hire those without direct experience in the space industry

214   Many hiring managers are hesitant to take on personnel who come from different backgrounds, and often are unable or unwilling (through time and resource constraints) to train those who come from outside the sector. This is true across levels, as even interns and graduates are expected to have some kind of on-the-job training or exposure to be hired. However, to be able to gain this exposure many students need to secure funding; as a result, only a select few can offer these desired skills and experiences to employers, again drastically limiting the applicant pool.

> *"This creates a biased selection to students who have personal funds or whose universities have money, so that is a bit of an issue. The availability of funding for those extracurricular activities that really make an engineer stand out doesn't seem to be easily available everywhere." **Andrew Bacon, Co-founder and Chief Designer, Space Forge***

215   Another reason that organisations appear unwilling to recruit from outside the sector is the tight-knit nature of the space industry community. When hiring, references and sector reputation play a large part in the hiring process, and many companies like to hire those they already know, or know of. This again lessens the potential recruitment pool, as many are unwilling to hire candidates they have not heard of, or met through networking events.

> *"It's such a small sector so it's kind of about who your mates are. There's a disconnect for people who are coming in, and who are seen as any kind of an outsider. There are people at these conferences who've been working their whole lives, they've had these mates for 30 years who are all friends, and a lot of deals get done that way. I think this really needs to change to encourage innovation and growth." **Portia Bowman, UK Innovation Manager, D-Orbit UK, Co-founder, SpaceCareers.uk***

216   The hesitation to hire from outside the sector may be due to the fact that in-house training tends to be informally done by seniors, which can take valuable resource. As such, those with prior and in-depth knowledge of the space sector are more able to work with more autonomy, thus taking up less senior resource.

> *"There's no formal programme of training, there's informal learning and having people work together and sharing the knowledge that way." **Tanya Boardman, Senior Project Manager, Goonhilly***

The space industry has seen large growth over the past few years, meaning there is more competition for people with experience in the industry

217   The space industry has grown over the past few years in the industry, and there has been an increased need for talented staff to work in newly-founded companies. As there are now more opportunities available and a small pool of applicants, many organisations are now starting to struggle to find appropriate candidates.

*"I think the reason that is, is that the space sector has grown so much. You almost can't get people with 10 years' experience, because 10 years ago the sector was so much smaller… we're getting to the point where we almost can't keep up with the growth, everyone struggles to recruit." **Portia Bowman, UK Innovation Manager, D-Orbit UK, Co-founder, SpaceCareers.uk***

For those who already work in the space industry, there are limited opportunities for them to build on their skills or move across to different departments within the business

218   As well as the aforementioned difficulties in recruiting those from outside the sector, there are also very few opportunities for those already working within the space industry to develop their skills and move across businesses into different areas. This appears to be due to an underlying perception that those in the industry specialise in very specific skill sets, and therefore cannot learn or transfer these skills to other areas of the business. This too is limiting the recruitment pool, as it is difficult to find those with multiple skills sets, or hybrid skills, as a result.

219   One respondent observed that conversion courses for those working within certain areas of a business would help to expand the skill set of many, but would also benefit those from outside the sector. It could provide them with the learning and training opportunity to utilise their current knowledge base, and transfer their skills so that they are directly applicable to roles within the space industry. This lack of education and learning opportunities at a professional level appears to be hindering the talent pool, and could be addressed with some formal training programmes in places.

*"It's clear there is a real opportunity for our sector to come together to develop a conversion course to attract more talent to join us from other sectors of industry, as well as improve skills transfer within it. Wider and better access to certified training and professional development for the many different roles that exist in the space sector will also help create a more balanced, diverse and skilled workforce". **Amy Freeman, Human Resources Business Partner, Thales Alenia Space UK***

The highly skilled nature of the space industry is narrowing its talent pool

220   The space industry is one of the highest skilled industries in the UK. Consequently, there appears to be a perception amongst industry employers that those without a degree, or even those with only an undergraduate degree, are not academically qualified to work in the industry.

221   Some believe that this should change in order to attract more diverse talent, with some suggesting a down-skilling of certain positions, especially amongst those working for organisations where a strong academic background is not a strong requirement. One way to do this could be through apprenticeships. While this view was not common, when prompted, many believed this would be a positive way to train those who may not have the opportunities to go to university, or who cannot afford further education, opening up the industry to a more diverse cohort, while also ensuring a wider talent pool for the future.

*"Because you need to come in with a lot of education and internships et cetera, it's a lot harder for first generation university students. There should be more paid internships, paid apprenticeships etc. More could be done here." **Anonymous***

*"There's some work to be done, especially with lower socioeconomic backgrounds, who might not be thinking of going to university but who might still be very capable, and we could do more to get them in to the sector." **Portia Bowman, UK Innovation Manager, D-Orbit UK, Co-founder, SpaceCareers.uk***

Diversity within the space industry's workforce

Men still dominate the space industry, but there is a perception that this is beginning to change

222   The STEM subjects that are necessary for a career in the space industry - maths, physics, and engineering - still appeal more to male than female students, which is mirrored in the industry's workforce. However, women who do apply for roles within the space industry are usually very highly qualified, often more so than their male counterparts, and have diverse educational and professional backgrounds. One participant suggested that this may be because women still feel that they have to prove themselves in a field that has traditionally favoured men.

223   While there are some industry-wide strategies to encourage women to enter the sector, the majority work alone in trying to promote diversity amongst their workforce, primarily through creating diversity and inclusion policies. This also appears to come primarily from HR professionals working in the sector, rather than from hiring managers themselves. Instead of this being a conscious bias, however, it does seem to be purely circumstantial and participants note that traditional male, white managers are becoming more open to schemes and initiatives which promote and drive gender equality, though not perhaps at the required speed or on the necessary scale.

*"Women going into the space industry commonly have a more diverse background as unfortunately it's not seen as a traditional path. Often the ones that do apply are exceptional candidates because they're well driven as they have had to fight harder to be there." **Andrew Bacon, Co-founder and Chief Designer, Space Forge***

Multiculturalism is prized due to the internationalism necessary for the sector, though the workforce is predominantly white

224   Many state that the industry is predominantly white, but it is felt that this is down to the ethnic makeup of the UK rather than any prevalent bias. In fact, space is seen as an industry that prizes internationalism and multiculturalism.

225   The industry traditionally hires people from across the world, particularly from Europe, which means that companies tend to incorporate a mix of cultures. This is seen as an advantage as it results in a lot of cultural sharing within the industry, which not only gives employees a larger knowledge base, but also makes communication with foreign partners and clients easier.

*"The space sector is a wonderful clash of cultures, you're working with a lot of the European nations and actually it really helps to have someone in your team who has knowledge of Italian or French culture, for example, to help you work better as a team. I have worked in a company of 100 people where there were 17 different nationalities, and it was highly innovative because of it. I don't think there is a serious diversity problem, it's certainly an industry where it's often prized, as it should be." **Andrew Bacon, Co-founder and Chief Designer, Space Forge***

Looking to the future

There is an overarching belief that the aforementioned skills gaps may be rendering the UK space sector less internationally competitive

226   The difficulty in acquiring certain skills has had negative impacts on individual companies and the sector as a whole. When employers are unable to find candidates with the necessary skills, they are less responsive to customer needs, struggle to meet deadlines, and cannot always provide products and services. In fact, participants note that they often cannot keep up with demand as there is much more work than there are people with the skills required. As a result, the industry's productivity and economic growth may be stunted as it is unable to produce what is needed.

> "If you haven't got the right people, you are less responsive to your customers and ultimately not able to provide timely solutions. There's a risk of decline." **Paul Harris, Director Sales Engineering, Intelsat**

> "When people muddle through, everyone does their work very professionally but it's harder than it should be and not really feasible in the long term. Muddling through can restrict growth a bit I think, it doesn't free up people's time to be more creative or innovative."
> **Tanya Boardman, Senior Project Manager, Goonhilly**

227   If the UK space industry is unable to meet demands, it becomes much less competitive in the international market. One participant used the lack of software engineers in the industry to illustrate this. With a shortage of candidates with software engineering skills entering the sector (for reasons outlined earlier), the UK space industry has instead focused on developing hardware and launch capabilities. Consequently, very little resource has been put into the software side of the industry, and there is a perception now that the UK's software potential is much more limited than that of other nations, leaving it at a disadvantage when competing for business.

However, there is a lot of business development in the industry, showing positive change

228   In recent times, the UK space industry has seen a lot of business development, demonstrating that the sector is continuing to innovate despite skills gaps. The industry is home to many start-ups, and since the industry is very collaborative, the increase in the number of companies working in the industry is considered positive and it is thought to promote innovation. Additionally, start-ups tend to be more agile than larger companies, which helps them to succeed when it comes to business development, as they are able to change and adapt to customer demands more quickly.

> "It's an 'up and coming' sector, a growth sector. Everyone uses space, or data from space, whether they know about it or not. And there's the defence and security aspect. It is exciting, and gets people interested in STEM too. In three years' time I think we'll see the differences, there are some really good people and they could be launching small satellites and developing applications from data that are used in everyday life." **Tanya Boardman, Senior Project Manager, Goonhilly**

229   To allow for the industry to become more agile and flexible in the face of increased commercial pressures, it is essential that people with commercial expertise are brought into the workforce, again highlighting the need for experienced managers with business acumen):

It is anticipated that software skills, AI, and machine learning skills will be in greater demand in the future

230   As space equipment becomes more complex, and computing capacity in space increases, it is anticipated that there will be a need for those with the skills to deliver this. Software engineering, artificial intelligence, and machine learning skills as important to the future of space. Therefore, the industry will need to train and hire more candidates with these abilities.

231   This is not unique to the space industry; these skills are becoming more and more important to a vast range of industries as the influence of AI increases. This is both a positive and a negative for the UK space industry. On the one hand, the overall, cross-industry demand for these skills means that a lot of effort is being put into advertising these career paths, and universities and other education providers are already offering appropriate courses and training for people to develop these skills. This gives the space industry a very large potential candidate pool for these kinds of roles.

> *"Machine learning is a hot topic at the moment, we can piggyback off what's going on already."* **Mark McCrum, Technical Director, Bright Ascension Ltd.**

> *"We'll probably need more coding and software type skills within the industry, and managing data too. Machine learning and big data, such as receiving data or creating data, these will all be growing, so there will be more opportunity in the future for this.".* **Anonymous**

232   On the other hand, however, this raises the question of how the space industry can attract more long-term talent to the sector given the ability of other sectors to offer higher salaries. The problem regarding competition for software engineers is already, as noted earlier, an issue for the UK space industry, and as these become more important, the sector may particularly struggle to recruit candidates with these essential skills.

Universities and industry could work together in the future to give students the right skills

233   Whilst noting, as earlier, a perceived lack of university courses for specific space skills, respondents also recognised that universities do attempt to offer some courses that provide students with the technical skills needed to succeed in the space sector. However, participants noted the need for academia and industry to work together in order to offer a better understanding of what to expect in the space sector.

234   There is a perception amongst some that academia can work at a slower pace than industry, meaning the courses universities offer are not always providing the future workforce of the space industry with the up-to-date skills needed by employers. Some believe that this could be resolved through a collaborative approach to designing courses and modules, where both academics and industry experts are consulted. Additionally, it is felt that academic knowledge alone is not enough to prepare students for careers in space, as softer skills such as writing, communication, and commercial skills are not worked into the courses enough.

> *"Teaching people the application of these skills and how they can be applied in the real world and within industry. That's the main thing that educators need to get across, that these skills can be applied to real life situations."* **Alistair Salisbury, Exploration Geologist, Cornish Lithium**

235   Currently, formal collaborations between universities and industry tend to focus on research partnerships rather than recruitment. However, participants believe industry and education providers could also work together to create more opportunities for internships and work experiences. Being able to do this would allow students to put their knowledge into practice before entering the job market.

" Being able to provide internships where we can show them how their skills are really useful within the company and showing them that that's an option." **Alistair Salisbury, Exploration Geologist, Cornish Lithium**

"The best thing is to do placements. Give the opportunity to students to do more placements, more hands-on work, more collaboration with industry." **Portia Bowman, UK Innovation Manager, D-Orbit UK, Co-founder, SpaceCareers.uk**

The concept of a UKSA graduate or new entrant training programme was generally well received, but participants suggest it should be open to all levels

236   Participants were interested in a UKSA Graduate or New Entrant Training Programme and believe it would be of value to their companies, especially given how important hands-on experience and industry knowledge is to the sector. As the industry is so big and covers many different disciplines, participants would like to see a training programme that gives students the opportunity to specialise in one or two areas, and to experience working in different roles within those areas to develop a range of hard and soft skills.

"The challenge with 'space' training for graduates is how to focus it, as space is a very broad domain. Rather than try to cover everything, it would be more valuable if students were able to choose one or two areas of focus, and gain more of an in-depth understanding of those areas. This is likely to be more valuable in the long run to future potential employers." **Chetan Pradhan, Head of Institutional Engagement, Earth-i**

"[It] would involve placements of a reasonable length of time with industry, moving from one employer to another. Something that provides a natural route to employment." **Mark McCrum, Technical Director, Bright Ascension Ltd.**

237   Smaller companies would particularly benefit from a UKSA Graduate or New Entrant Training Programme as it is not always possible for them to create their own due to lack of resource. This kind of programme would remove some of the burden on smaller employers by giving candidates a certain level of industry knowledge.

"It wouldn't be practical to run our own graduate scheme, but something that would take people in and give them the skills they need could be really beneficial." **Mark McCrum, Technical Director, Bright Ascension Ltd.**

238   Participants suggest, however, that the training programme should be open to a much wider range of people rather than just graduates. Given the skills shortages the industry is currently facing, it is felt that a new entrant training programme would be more appropriate. As such, those who are looking for a career change, but who already have transferable skills such as communication or project management, would be able to gain space knowledge and awareness through the programme. Additionally, as the need to deskill space manufacturing becomes more acute, a new entrant programme could also be well placed to attract school/college leavers who are interested in the space industry. This would help the industry adapt to new commercial demands.

"The challenge of getting students excited about space is relatively straight forward to meet. It's the encouraging people in other industries who are a bit later on in their career to move into space, I think is a bigger challenge but potentially could have a bigger impact… Only

*bringing in graduates creates a pyramid of knowledge which means you end up having a teaching bottle neck." **Andrew Bacon, Co-founder and Chief Designer, Space Forge***

The anticipated impact of Brexit on skills in the space industry

Many participants are unable to say how they believe Brexit will impact the industry, but many believe that it could have a negative impact on recruitment as it becomes more difficult to recruit talent from Europe

239   Whilst some employers are unsure about what the long-term implications of Brexit may be in terms of recruitment, some have already seen an adverse impact as they are beginning to see fewer and fewer European applicants when a position is advertised, and one participant noted that their company had already seen the departure of European colleagues. Though the European labour market has always been an option available to the UK industry, and employers have always received a good proportion of EU applicants when advertising roles in the past, many organisations are now poised for this to change.

240   Immigration policy is driving this, but some participants also believe that general restrictions and tariffs on trade and freight transport may have an impact too. At present, it is not uncommon for those working in the sector to send machinery components to companies abroad in the morning, only to have it sent back later on in that week, after European colleagues had tested it or worked on it in some way. This is a positive way of working, as it speeds up processes, ensures quality and learning, and ensures that the industry is connected across Europe. With the UK out of that model, if this learning becomes more difficult, then talented staff may start to use France or Germany[7] as their country of preference.

> *"At the moment, one company may have some kit somewhere, and you can decide at 9am to send something over and it'd be fixed by the end of the day. Now in order to do that you have to get a carnet and a load of bank guarantees. It will be much easier not to bother with us, they'll go to their local suppliers." **Chris Chaloner, Director, Trym Systems Ltd.***

> *"In the UK we're quite lucky because we pay higher salaries, so can recruit lots of people from Europe, but obviously Brexit has put a bit of a…a lot of my European friends have exited the country because of it, so we need to be training up people from UK universities." **Portia Bowman, UK Innovation Manager, D-Orbit UK, Co-founder, SpaceCareers.uk***

Some are worried about the impact of reduced funding streams on the recruitment pool, as fewer funding opportunities could lead to less exciting projects

241   There are also concerns noted around the opportunity for international funding and grants. Companies with more money are often able to offer more exciting projects and missions. As mentioned earlier, staff retention is often impacted by the perceived level of 'excitement' that a mission elicits from the staff working on the project.

242   The more funding that is available to a project, the more exciting and appealing to staff it tends to be. As a result, if the EU is no longer able to give grants or funding to UK businesses, there may be difficulties in innovating and growing the workstream, or expanding the scope of opportunities available for staff to work on. As a result, competition from other industries

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[7] Several participants believe that the future of the space industry is in France and Germany, which are emerging as powerhouses in the industry; there is a danger that some UK companies will relocate here.

within the UK, and some staff could make the decision to relocate to other European countries, further declining the talent pool within the industry.

"Brexit will damage the industry completely. Europe is big customer, Galileo is a big customer, EU money goes into research activities. UK activities get a lot of money from the EU at the moment, which they won't." **Chris Chaloner, Director, Trym Systems Ltd.**

Additionally, fewer funding opportunities would render the UK space sector less competitive than its international counterparts, driving talent overseas

243   With Brexit approaching, some in the industry question the extent to which it will be able to maintain the level of business development previously seen. Not only does the industry employ many EU nationals, but the UK space industry has European customers and funding. The UK currently enjoys funding for research activities and universities from a number of organisations across Europe, the loss of which could have a devastating effect on the progression and development of the UK industry. Additionally, the future of business relations with EU customers and partners remains unknown. With Brexit negotiations still underway, there is a fear that disadvantageous customs tariffs and barriers could end a lot of intra-continental trade as EU member countries may choose to avoid doing business with the UK space industry in favour of local suppliers.

244   The potential loss of EU customers and funding streams is especially worrying for companies in the UK because the domestic market is relatively small. To counteract this, the sector would like to see more government investment in the UK space industry. The government is not presently seen to be very supportive of the sector; however, a government customer would provide a secure and ongoing demand which would absorb some of the potential excess supply caused by a deterioration of EU and UK trade relations after Brexit.

"At the moment we don't have the continuing work, the industry is in such a poor state in the UK, and there's not a lot of stability. The problem is that we don't have a domestic customer. France at the moment is the big one because they have a long-term plan, and Germany to some extent. Decisions are all made in Paris, Toulouse, or Cannes. There's the problem here of not having a national market which is a big cloud over the whole sector. There are no UK owned companies of a significant size." **Chris Chaloner, Director, Trym Systems Ltd.**

The perceived impact of Covid-19 on skills in the space industry

Coronavirus does not appear to have had a significant impact, but has in fact made the sector more appealing to many

245   In contrast to many other industries operating during the Covid-19 pandemic, the space sector appears to have been relatively unscathed. Many businesses are still looking to recruit, and there does not appear to have been a negative impact on the growth of the sector. In fact, the opposite appears to have occurred; as the importance of the Internet, television, and global communications soared during the pandemic, so too did the importance of the space industry.

246   As well as economic growth, the industry's adaptation to working from home also seems to have had a positive impact on recruitment. As many businesses operating in the space sector are concentrated in 'pooled locations', such as Harwell, this could cause difficulties in traditional recruitment. However, many respondents now believe that this barrier has been lifted, as applicants are now able to work remotely, and travel into the workplace less frequently than they would have been required to before the pandemic. As such, the talent pool for businesses has been geographically expanded, resulting in more interested applications from around the UK.

"I'm hoping it's [coronavirus] going to be a positive impact. It seems that most of the work can be socially distanced or online. We've pivoted to working entirely remotely, which is quite common, and we can do our jobs from home, it hasn't really had an impact, and this is a positive as it's forcing companies to change." **Portia Bowman, UK Innovation Manager, D-Orbit UK, Co-founder, SpaceCareers.uk**

5. Overview

Perspectives from the quantitative survey

247   The sample achieved in the quantitative survey, though modest in size, achieved representation across the whole spectrum of industry businesses in terms of their employment size (and, by inference, in terms of their sales revenues). Thus, the sample extended from micro-businesses with fewer than 10 employees to large businesses with 1,000 or more staff.

248   Similarly, the sample included businesses across all segments of the industry in terms of their business activity. Analysis of participation according to different activity areas confirmed that businesses are often not active in one area only. They are likely to be active in more than one of the sub-divisions of 'upstream' business and in a third of cases are active in both the broad 'upstream' and 'downstream' divisions of the industry. Larger businesses are, of course, more likely to have a wider distribution of business activities than smaller ones.

249   Geographically, the sample had some concentration in the South East and London. Broadly, this distribution corresponds with the known distribution of the whole population of space businesses in the UK.

250   In order to ensure that the sample was very substantially based only on businesses which can very clearly be designated as 'core space' businesses, the sample was drawn from UKSA databases of businesses with which UKSA has contact and knowledge. It was not therefore formally representative of a wider space industry containing businesses which are less intensely engaged in space activities.

251   Nevertheless, the wide 'size' and 'activity' characteristics and its conformity with the wider industry's known distribution suggest that survey findings may reasonably be assumed to apply to many more businesses in the industry, beyond those which were sampled here.

252   In general terms, the industry was revealed as a dynamic one, in the senses that:

- Recruitment for core industry skills – those at managerial, professional, and associate professional and technical level – was frequent.

- Industry businesses are heavily involved in training and staff development, including the frequent provision of opportunities for the development of under-graduates, graduates, post-graduates, and higher-level apprentices.

- They are generally supportive of a prospective new Graduate Training or New Entrant Programme.

- Three-quarters of businesses predict that they will grow over the next 3 years.

253   Some simple comparisons (mainly with data from the UK Employer Skills Survey 2019) were used to suggest that the space industry is significantly more active in some of these respects (such as recruitment, training, and engagement with Apprenticeship) than is typical of employers in the UK economy as a whole.

254   Some caution is necessary in respect of these comparisons. The surveys were not undertaken at the same time and question wording was not identical.

255   And, as above, the space industry sample, for example in respect of the size distribution of businesses sampled, may not be strictly representative of the population of businesses in the wider space industry. However, differences between space industry statistics from this survey and statistics from the UK Employer Skills Survey are sufficiently large as to suggest that a

space industry businesses are more active in respect of some labour market and skills indicators.

256   However, a corollary of greater activity may be that active businesses more frequently encounter challenges to the success of that activity.

257   Hence, high levels of recruitment difficulty in respect of key occupations and of internal gaps in key industry skills were observed and staff retention difficulties affected a quarter of businesses.

258   Brexit and perceived shortfalls in the availability of relevant training may exacerbate the problem, but the general picture presented by the survey is of underlying shortage in the high-level technical skills on which the industry demands – simply, there are more jobs requiring these skills than people who have them. In some cases, this applies to the pool of generic technical skills on which all UK advanced manufacturing and technology businesses draw. In other cases, it applies to the narrower pool of specialist space skills for which space industry businesses compete.

Perspectives from the qualitative interviews

259   Qualitative interviews enriched these findings from the quantitative survey element of the research.

260   Thus, a first point was to emphasis the breadth of skill needs in the industry. The quantitative survey, as earlier, showed that there is demand for a large number of technical skills in the industry and also identified the sector's needs for soft skills. The qualitative survey confirmed the former demand but also amplified the second. These more detailed interviews showed demand for skills in collaborative working, in commercial awareness and sales and marketing, in proposal writing, in mentoring and teaching junior staff, for an 'agile' and flexible workforce able to respond to innovation in technologies and materials, for particular skill combinations across the 'hard'/'soft' divide, and for middle and high-level managerial skills.

261   Given this complexity and breadth of demand, it is unsurprising that respondents in the depth interviews identified shortfalls in supply, both in technical and non-technical areas.

262   A number of factors which helped mitigate this situation were identified:

- The industry is extremely attractive to a large number of young people who see it as an exciting and attractive area in which to work, with many being passionate in their enthusiasm to enter the industry – any underlying widespread aversion to working in the industry is not a problem.

- The industry is perceived to be culturally and ethnically diverse, welcoming many recruits from Europe and elsewhere in the world.

- Pay levels for entrants are competitive with those of most other sectors for comparable skill levels.

263   However, a lengthy list of issues precluding these factors from 'solving' the skills supply issues was also identified:

- Simply, as a first general point, growth in the industry in recent years has placed stress on skills supply – growth in the number of people with the required skills has not kept pace with growth in demand.

- The industry has very high expectations of recruits exemplified not only by the breadth and blends of skills expected (as described above) but also by the industry's

frequent expectations of skills, particularly technical ones, being supported by qualifications at post-graduate level and/or by experience in the industry.

- Somewhat paradoxically, some respondents in the depth interviews also suggested that the industry's specialised and high-skill character was off-putting for some potentially employable individuals who perceived the industry as too rarified for their talents and qualifications.

- In the light of these constraints on external recruitment, the industry suffers from an internal, inward-focused approach to recruitment, with preferences for 'network' recruitment of experienced and known recruits – extending to staff poaching on occasion. This approach essentially moves skills shortages and gaps around, rather than contributes to their reduction; and decreases industry's total training effort as experienced people already in the industry are preferred to external candidates recruited and then trained up to meet particular job needs in the industry.

- There are limitations in the training infrastructure, with identification of:

    - Courses in universities, though space-oriented, lagging behind industry developments

    - Absence of conversion courses to allow people with relevant technical skills and qualifications to add a 'space' dimension to these

    - Lack of resource in small space businesses to supply internal training (hence, as above, a frequent preference for recruitment of experienced staff from within the industry)

    - Concomitant with the industry' s focus on high qualifications, the absence of a training-supported entry route for young people at the 'A' level point

- Whilst the industry recruits easily across cultures, ethnicities, and nationalities, the number of women employed in the industry is limited. Female recruitment suffers from the historically lower proportions of girls and young women studying STEM subjects in schools and universities and, perhaps, from an image of the industry as a home for male 'nerdy' or 'boffin' types of people.

- Brexit has made it more difficult to recruit from Europe and has encouraged some European staff to return to their original countries. The prospect of losing European collaborations and funding may reduce the innovation and 'excitement' factor which attracts people in to the industry and retains them in it.

- It was suggested that, whilst the industry offers good and competitive pay to its highly-qualified entrants, it may also struggle to increase pay at a point several years beyond recruitment – with consequent loss of high skills (particularly in software) to other sectors.

264   Participants in the depth interviews reported a number of responses to counter these skills difficulties, including internal and external training, offering promotion wherever possible, and providing interesting and innovative work projects to assist retention.

265   A number of perspectives on the industry's future, particularly in relation to its skills and labour force were also offered, including:

- The prospect of limitation on productivity and growth because of skills shortages.

- Shortage of software, rather than hardware, skills potentially becoming a source of UK industry disadvantage.

- Growing demand for skills in Artificial Intelligence, Machine Learning, and associated software. With this demand being shared with several other sectors, there is likely to be a growing pool of people with these skills but also wider competition to recruit them.

- It is likely that there will be a constant stream of 'agile' start-up businesses, driven by technological innovations and ideas – but, while these businesses will need commercial skills to move into successful growth stages, these skills are often in limited supply.

Quantitative and qualitative findings: a way forward

266 The skills issues highlighted by both elements of the study are obviously not easy to resolve. However, progress may occur or be generated in two broad areas.

267 There may be beneficial development in the *broader environment* in which the space industry, as other sectors, operates.

268 First, with a final Brexit settlement, some of the negative consequences of the drawn-out Brexit negotiation period may lessen as uncertainties as to labour market movement and international collaborations are resolved, perhaps with favourable outcomes for the industry.

269 Second, the UK's general problem with initial 'STEM' skills supply from the educational system may reduce in the longer term, with public initiatives such as T-levels and Higher and Degree Apprenticeships making a contribution to this.

270 Third, there has been prolonged effort to encourage women to widen the career options they consider, particularly to include options which depend on STEM qualifications and skills. Supported by wider social forces which encourage increasing proportions of young women into Higher Education, the pool of skills on which technology sectors, including the space industry, can draw may slowly increase.

271 However, the effects of such changes may be somewhat marginal and, in the latter two cases, only slowly incremental in their impact. More critical, perhaps, is what the *industry*, including its supportive associations and agencies, can itself achieve.

272 In this respect, the survey offers a number of pointers.

273 The survey suggests that there is a mismatch between what skills the industry needs and what skills the UK Higher Education system produces. Aspects of this include simple shortfall in numbers and perceptions that HE courses lag rapidly advancing technologies or lack specificity to the space industry's particular needs.

274 However, it is also evident from the survey that meeting industry needs is not a straightforward matter. On the industry side:

- The lists of particular occupations suffering skill shortages and gaps and of under-supplied training courses are long and highly specialised.

- The industry has a strong focus on recruitment of people with high, often post-graduate, qualifications.

- The industry would ideally like recruits who have combined skills in more than one technical specialism and often including 'soft' business and team-working skills.

275 It is obviously difficult for an HE sector, increasingly commercial in its orientation, unless it has a demonstrably viable financial basis (founded on student demand and employer or public support) to respond. One route towards improvement may simply comprise a greater commitment by the industry to its training efforts and budgets. Though the survey suggests

that the industry may already count, in UK relative terms, as a 'high training' sector, in view of its specialised demands, it may need to go further.

276   Additionally, the survey makes the point that industry collaborations with HE are mainly confined to knowledge transfer and technological development rather than including major collaboration on course development. Movement towards the latter may be beneficial.

277   An alternative, or perhaps complementary, approach may be for the industry to review its current focus on very highly skilled recruits. Respondents raised the idea of 'down-skilling' its entry requirements and, as above, increasing its support to training, either internally or via external conversion courses to add specialist space emphasis to more generic technical or software skill sets or to add the commercial or business skills which technological recruits are perceived as lacking.

278   Finally, in respect of enhancement to the sector's overall training capability, the prospect of a UKSA-sponsored Graduate Training or New Entrant Programme was positively received by respondents in both quantitative and qualitative elements of the study. In the light of the points above, however, a number of queries were raised in respect of the programme, as to:

- How it could be structured to respond to the many and varied specialisms within the industry.

- How it could address the technical/commercial skills blend which is often sought.

- Whether it could be constituted as a 'new entrant' programme (rather than as a specifically 'graduate' programme) in order to allow entry to capable non-graduates and to candidates with experience in other sectors looking to convert into the space industry.

Appendix I

The following is an outline of the survey methodology.

Survey methodology

The survey involved both quantitative and qualitative approaches to data collection:

- 96 structured interviews by telephone (38) and online (58)

- 21 semi-structured, depth interviews by telephone

These interviews were completed in September, October and November 2020.

Quantitative survey

The following outlines the methodology employed for the quantitative survey. In order that the survey should focus strongly on core space businesses, rather than include those which, as above, have a more peripheral part in the industry, the main source of contacts for the survey was a database of businesses developed by UKSA itself. These businesses are known to be wholly or strongly focussed on space operations either 'upstream', 'downstream' or both. Thus, 91 of the 96 respondents were derived from this source while only a small number, a further 5 businesses, were identified by a separate internet search. One result of this focussed approach was that there was a very high response rate to requests for survey participation.

Businesses invited to take part in the survey were asked for their preference regarding a telephone or online mode, with the majority opting for an online survey link. This survey link was emailed to these respondents and this unique link ensured that their participation was recorded and their responses included in the survey dataset. Up to two reminder emails were sent out to contacts who did not respond within an initial timeframe, each a week apart. Following the second reminder, if the contact had not yet taken part in the survey, their details were added to the list of telephone contacts and efforts were made to complete an interview over the telephone (via Computer-Assisted Telephone Interviewing – CATI).

Those respondents who initially opted for a telephone interview were interviewed accordingly using the same CATI method and survey questionnaire.

Individual respondents were the individuals in the business who identified themselves as best able to answer questions on skills and employment matters on behalf of their business. Thus, email respondents confirmed that they were the right person to speak to, or identified someone else to contact. Telephone interviews involved determining the person best suited to answer the questions during the introduction to the interview proper. Overall, respondents were mainly the managing directors or general managers of smaller businesses or the human resource or training managers/directors of larger ones.

To ensure that respondent businesses were, as anticipated, significantly engaged in the industry, a 'filter' question checked that the business activity included any of the following:

- Manufacture of, or researching the manufacture of, equipment or components which are used in space operations;

- Development or researching the development of software for use in space operations;

- Research, management or other involvement in ground control, launch or satellite operations;

- Research or consultancy related to space activities or operations;

- Research or operations that are substantially or critically dependent on the capabilities or information supplied by satellites and related technologies;

- Another function in or related to the space sector, not covered in the above activities.

Further, respondents had to confirm that their organisation employed at least one person among their managers, scientists, engineers, technical staff or skilled operations that have:

- Specialist space-related knowledge and/or experience;

- Knowledge and/or experience that, although not specifically space-related, is relevant and could be transferred to the space sector.

'Interviews', either by online completion or by telephone, lasted on average around 20 minutes. Key themes of the questionnaire included:

- Organisation characteristics (so-called 'firmographics') including types of activity undertaken, organisation size, number of sites, and location;

- Skill shortages and skills gap, including issues around staff retention;

- Organisation responses to skills issues, including training activity and engagement with good practices to improve skills supply;

- Interest in a prospective Graduate or New Entrant Training Programme for the space sector;

- Expectations regarding future business performance/growth and the implications of those expectations for skills needs.

A further aspect of the survey was that it took place over a period in which Covid-19 concerns and constraints were significant. Intuitively this may have impacted on business activities such that, for example, forms of training normally involving off-site course attendance or visits by external training specialist may have been disrupted. To counteract this effect on survey findings, respondents were asked, where relevant, to 'normalise' their responses by answering as they would have answered in non-Covid-affected conditions.

At the end of the telephone interview respondents were further asked if they would be happy to take part in a depth interview exploring recruitment and skills issues within their organisation and across the Space industry in more detail. There were 68 positive responses to this request from which the 21 respondents in the qualitative interviews which contribute to this report were selected.

Qualitative survey

The qualitative discussions were guided, but not structured, thus allowing participants to give a more detailed account of the changing skill needs of the space sector and their interpretation of how these changing needs can be addressed. The discussion guide for these in-depth interviews is reproduced in the Appendix of this report.

The objectives and themes of the discussion guide are summarised below:

- To explore the skills that employers need within their businesses:

  - To include both upstream and downstream employers

  - To include a variety of levels of seniority within the space sector (e.g. entry level to senior management)

- To understand how employers currently ensure these skills are met (e.g. through partnerships, collaborations, apprenticeships, funding, etc.)

- To discover the current concerns or difficulties employers experience in finding these skills in the current market (i.e. external recruitment difficulties and internal skills gaps) and understand why they believe these difficulties occur

- To compare these current concerns to any future concerns that employers may have

- To discuss how employers would recommend addressing skills shortages and gaps to include exploration of educational issues, collaborative skills development, and retention strategies

Some further objectives were also included in the qualitative discussions:

- To explore gender and ethnic diversity in the industry and its impact on the sector:

  - To include exploration of the issues regarding diversity

  - To include exploration of how diversity could be encouraged, and what impact this may have

  - To identify any perceptions of longer-term skills needs in the sector

  - To include an exploration of technological advances, future projects, and emerging industry priorities

  - To explore employers' perceptions of how education providers and businesses in the sector may need to respond to emerging skills needs

A total of 21 in-depth discussions with UK space industry professionals were held, with a balance between those operating in upstream and downstream areas. These discussions were conducted between 30th October and 18th November 2020. Each discussion lasted between 30 and 45 minutes. Due to the ongoing Covid-19 restrictions at the time of research, interviews were held over the telephone or via Microsoft Teams. The table below shows the organisations that were involved in these discussions.

Table 7: An overview of qualitative interview participants and the organisations they represent

Number of participants	Stream	Organisation
8	Upstream	Trym Systems Ltd D-Orbit UK Space Forge Goonhilly Bright Ascension Ltd Raptor Aerospace Ltd Craft Prospect
5	Downstream	Geocento Limited University of Aberdeen Earth-i Cornish Lithium Defence Science & Technology Laboratory
8	Upstream and Downstream	BAE Systems Applied Intelligence Telespazio VEGA UK Ltd. Intelsat Glas Data RHEA Tech Ltd Thales Alenia Space UK OneWeb Lacuna Space

Those who took part in the conversations came from a range of different backgrounds, including academics teaching Space Science to students, HR and recruitment professionals working within large and established organisations, industry consultants, and industry start-up entrepreneurs.

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Appendix II

Questionnaire employed in the quantitative survey

UK Space Agency skills survey 2020
Employer questionnaire

CHECK COMPANY NAME

Take correct company name if necessary

ASK TO SPEAK WITH NAMED CONTACT

IF NAMED CONTACT NOT AVAILABLE ASK TO SPEAK TO THE PERSON AT THE SITE WHO IS MOST KNOWLEDGEABLE ABOUT SKILLS REQUIREMENTS, RECRUITMENT AND TRAINING ISSUES

Good morning/afternoon, my name is xxx and **I'm calling on behalf of the UK Space Agency from BMG Research about skill needs within the space sector and within industries closely related to or supplying the space sector.**

The UK Space Agency is gathering feedback in order to represent sector organisation's interests and to provide appropriate support for these organisations in the next few years.

They would appreciate around 20 minutes of your time to get some feedback from your organisation.

CHECK PERSON IS QUALIFIED TO ANSWER: **Are you the most appropriate person to speak with about space-related skills requirements for your establishment or organisation?**

IF NECESSARY; **That would generally be someone with responsibility for recruitment and/or training issues.**

IF YES CONTINUE; IF NO, ASK FOR REFERRAL/TO BE PUT THROUGH

Yes	1	CONTINUE
Referred to someone else at establishment NAME JOB TITLE TEL NUMBER (IF NECESSARY)	2	TRANSFER
WANTS REASSURANCES	3	SHOW REASSURANCES/SEND REASSURANCE EMAIL

Is it convenient to speak to you now or would you prefer to make an appointment for another time?

MAKE APPOINTMENT IF NECESSARY, OR CODE OUTCOME ACCORDINGLY

GDPR CONSENT

The information you provide will be used for research purposes only and will be treated in the strictest confidence. BMG Research will not disclose to the UK Space Agency who has taken part in the research or divulge specific details about your organisation unless you agree to this at the end of the survey.

You can find out more information about our surveys and what we do with the information we collect in our Privacy Notice, which is on our website (IF NECESSARY: www.bmgresearch.com/privacy)
All calls are recorded for training and quality purposes.

REASSURANCES TO USE IF NECESSARY

The interview will take around 20 minutes to complete.

Please note that all data will be reported in aggregate form and your answers will not be reported to our client in any way that would allow you to be identified.

If respondent wishes to confirm validity of survey or get more information about aims and objectives, they can call:

MRS: Market Research Society on 0800 975 9596
BMG: Emma Osborne on 0121-333-6006
Space Agency: Kathie Bowden on xxxxxxxxx

ASK ALL

Z1.   Before I continue, can I just confirm that you are happy to participate in the survey on this basis? *SINGLE CODE*

Yes, agreed to participate in survey	1	CONTINUE
No, declined to participate	3	CLOSE

S1   Thank you. Could I just confirm your name and record your job title?

Name:

Job title:

ASK ALL

Q1. **To help us classify the type of work your organisation does, could you say which of the following apply to your business?**

READ OUT ALL; CODE ALL THAT APPLY

You manufacture or research the manufacture of equipment or components which are used in space operations	1
You develop or research the development of software for use in space operations	2
You research, manage or are involved in ground control, launch, or satellite operations	3
You undertake research or consultancy related to space activities or operations	4
Your research or operations are substantially or critically dependent on the capabilities or information supplied by satellites and related technologies	5
You have another function in or related to the space sector which isn't covered above SPECIFY; Could you describe this?	6
If none of Categories 1-6: So you aren't actually part of or related to the space sector at all?; IF THIS CLOSE; IF HAS RELATIONS ASK TO CLARIFY AND WRITE IN UNDER CATEGORY 6	7

ASK ALL

Q2 **Is this establishment (that is the site at which you work) … ?**

READ OUT. SINGLE CODE

The only establishment in your organisation, or	1
One of a number of establishments within a larger organisation	2

ASK IF MULTI-SITE ORGANISATION (Q2=2)

Q3 **Is this site the Head Office of your organisation? PROBE AND CODE ONE** ONLY

Yes – Head Office	1
No - Branch or subsidiary	2
Don't know	3

ASK IF MULTI-SITE ORGANISATION (Q2=2)

Q4 Approximately how many people work in your organisation across the UK as a whole - By that I mean both full-time and part-time employees on your payroll, as well as any working proprietors or owners, including any that are furloughed, but excluding the self-employed, outside contractor or agency staff?

AS NECESSARY:
Include full and part time staff
Include temporaries/casuals, but not agency staff
Exclude self-employed
Exclude owners/partners, but other directors count as employees
PROBE FOR BEST ESTIMATE AND RECORD NUMBER

Don't know	X
Refused	Y

(IF ANSWER GIVEN, CATI CODE RANGES AUTOMATICALLY)

ASK IF DON'T KNOW EXACT ORGANISATION SIZE (X, Y)

Is it roughly...

READ OUT. SINGLE CODE

Under 10	1
10-49	2
50-99	3
100-249	4
250-999	5
1,000+	6
DO NOT READ OUT: Don't know	X
DO NOT READ OUT: Refused	Y

ASK ALL

Q5 How many people work at the site at which you're based for your organisation, including yourself, all others on your payroll and any working proprietors or owners, including any that are furloughed, but excluding the self-employed, outside contractor or agency staff?

AS NECESSARY:
Include full and part time staff
Include temporaries/casuals, but not agency staff
Exclude self-employed
Exclude owners/partners, but other directors count as employees
PROBE FOR BEST ESTIMATE AND RECORD NUMBER

Don't know	X
Refused	Y

(IF ANSWER GIVEN, CATI CODE RANGES AUTOMATICALLY).

ASK IF DON'T KNOW EXACT SITE SIZE (X, Y)

Is it roughly...

READ OUT. SINGLE CODE.

Under 10	**1**
10-49	**2**
50-99	**3**
100-249	**4**
250-999	**5**
1,000+	**6**
DO NOT READ OUT: Don't know	X
DO NOT READ OUT: Refused	Y

CATI TO only allow numbers smaller than or equal to THE INTEGER GIVEN AT Q4, OR THE HIGHER END OF organisation size BANDING given AT Q4

ASK IF MULTI-SITE ORGANISATION (Q2=2)

Q6. When answering questions about the space-related skills requirements for your organisation, would you prefer to respond on behalf of your site or your UK organisation as a whole?

SINGLE CODE

Establishment / site at which I work	1
UK organisation	2

Thank you, for the rest of the survey please think about the space-related skills requirements of your [Q6/1: site] [Q6/2: organisation as a whole in the UK].

READ OUT – Covid-19

These are unusual times and Covid-19 has impacted a lot of businesses in different ways. When thinking about your answers to the following questions, please try to respond as you would have done 'pre-Covid-19'. I'd like you to think about your business needs in the 12 months leading up to the Covid-19 outbreak.

Q7. Which of the following groups of staff does your [Q6/1: site] [Q6/2: organisation] employ?

READ OUT ALL. CODE ALL THAT APPLY   USE CRIB LIST TO CATEGORISE STAFF

People with specialist space-related knowledge and/or experience (e.g. Managers, scientists or engineers, technical staff, or skilled operatives)	1
People with knowledge and/or experience that, although not specifically space-related, is relevant and can be transferred to the space sector (e.g. Managers, scientists or engineers, technical staff, or skilled operatives)	2
Other staff in support or production roles, such as those in admin, finance, HR, clerical or semi or unskilled occupations	3

I'm now going to ask you some questions about [Q7/1: People with specialist space-related knowledge and/or experience] [Q7/1 AND Q7/2: AND] [Q7/2: People with relevant knowledge and/or experience that can be transferred to the space sector]

IF Q7 = 3 ONLY THANK AND CLOSE: Thank you but the questions in this survey mainly relate to specialist space-related knowledge and experience.   Thank you for your time.

Q8. So thinking about recruitment in 2019 and early 2020; how many people with specialist knowledge did you try to recruit?

… And how many with relevant knowledge?

IF NECESSARY; **your best guess will be fine …**

RECORD A NUMBER FOR EACH, ZERO IS ACCEPTABLE

8a. Specialist knowledge	Write number	DK but tried to recruit someone	DK
8b. Relevant knowledge	Write number	DK but tried to recruit someone	DK

IF TRIED TO RECRUIT - Q8a OR Q8b >0 OR DK BUT TRIED TO RECRUIT SOMEONE

Q9. Did you experience any difficulty in recruiting that/ those staff member(s)?

   CODE ONE

Yes	1
No	2
Don't know	3

ASK IF EXPERIENCED ANY DIFFICULTIES - Q9=1

Q10. Which roles did you have difficulty recruiting? WRITE IN JOB TITLES (UP TO A MAXIMUM OF 5) (CODE TO 3 DIGIT SOC)

   (1)   _____

   (2)   _____

   (3)   _____

   (4)   _____

   (5)   _____

ASK IF EXPERIENCED ANY DIFFICULTIES - Q9=1

Q11 Do you think any of the following were reasons for your recruitment difficulties?

READ OUT ALL. CODE ALL THAT APPLY

Applicants lacked the required specialist skills, knowledge, or qualifications	**1**
Applicants lacked the required experience	**2**
Applicants lacked the required behaviours, attitude, motivation or personality	**3**
There is a lot of competition from other businesses in space-related activities	**4**
There is a lot of competition from businesses in other sectors to which potential recruits are attracted	**5**
The pay or conditions you were able to offer was uncompetitive	**6**
There is no or insufficient appropriate specialist training provided by UK educational institutions	**7**
There is an underlying shortfall of young people who want to undertake technological, scientific, engineering or mathematical education and training	**8**
It is difficult to attract people to move or travel into your locality. This could be say, because of local living or housing costs, competition from more attractive regions, access problems or other factors which have a negative effect	**9**
Brexit has reduced your ability to attract people from Europe	**10**
Are there any other factors involved? PROBE AND WRITE IN ALL MENTIONED	**11**
Don't know	12

ASK ALL

Q12. Thinking now about your current workforce, is its proficiency hindered by any skills gaps or skills limitations?

CODE ONE

Yes	1
No	2
Don't know	3

ASK IF LIMITED PROFICIENCY - Q12=1

Q13. Do any of the skills gaps or limitations relate to scientific, engineering or technical functions?

CODE ONE

Yes	1
No	2
Don't know	3

IF LIMITATIONS RELATE TO SCIENTIFIC OR TECHNICAL FUNCTIONS – Q13 = 1

Q14. Are the skills gaps or limitations in scientific, engineering or technical functions in any of the following areas?

READ OUT ALL; CODE ALL THAT APPLY

Engineering or electronics design	1
Mechanical engineering at professional level	2
Electronic engineering at professional level	3
Telecoms engineering	4
Thermal effects and processes	5
Radiation effects and processes	6
Radio frequency engineering	7
Calibration and testing	8
System engineering	9
Optical systems and opto-electronics	10
Software engineering	11
Computer hardware operation and maintenance	12
Image processing and interpretation	13
Operation of advanced production equipment and machinery at technician or skilled operative level	14
Procurement of equipment, components, materials or technical services	15
Data analytics	16
Artificial intelligence and Machine Learning	17
Robotics	18

Are there any other technical skills limitations not yet mentioned IF 'YES' PROBE AND WRITE IN	19
Don't know	20

ASK IF LIMITED PROFICIENCY - Q12=1

Q15. Do any of the skill gaps or skills limitations relate to managerial or entrepreneurial functions?

CODE ONE

Yes	1
No	2
Don't know	3

ASK IF LIMITED PROFICIENCY IN MANAGERIAL/ENTREPRENEURIAL FUNCTIONS – Q15=1

Q16. Are the skills limitations in managerial or entrepreneurial functions within any of the following areas?

READ OUT ALL; CODE ALL THAT APPLY. RANDOMISE

Leadership or motivational skills	**1**
Business planning or foresight	**2**
Project management	**3**
Optimising workplace organisation and work scheduling	**4**
Team working and managing interpersonal relationships	**5**
Managing employee relationships and disputes	**6**
People development training and career progression	**7**
Personal time management and task prioritisation by senior staff	**8**
Financial control	**9**
Obtaining external loan or capital finance	**10**
Business marketing	**11**
Presentation skills at events and pitches	**12**
Client management skills	**13**
Are there any other management skills limitations not yet mentioned IF 'YES' PROBE AND WRITE IN	**14**
Don't know	15

IF LIMITED PROFICIENCY – Q12 = 1

Q17. What are the main causes of skills gaps or limitation you've mentioned? Is it because…?

READ OUT ALL; CODE ALL THAT APPLY

Staff with skills limitations are new to their roles	**1**
Staff have not received training	**2**
Some staff training is only partially completed	**3**
Staff training has not been effective	**4**
New products or services have been introduced	**5**
New working practices have been introduced	**6**
New technology has been introduced	**7**
You have been unable to recruit staff with the necessary skills	**8**
Staff with the necessary skills have left	**9**
Staff lack motivation	**10**
Are there any other reasons? PROBE AND WRITE IN	**11**
Don't know	12

ASK ALL

Q18. Has your [Q6/1: site] [Q6/2: organisation] experienced any difficulties in retaining staff in scientific, engineering or technical roles within the last 12 months? *CODE ONE*

Yes	1
No	2
Don't know	3

ASK IF STAFF RETENTION ISSUES – Q18=1

Q19. What do you see as the main causes of these difficulties in retaining staff within these roles?
PROBE AND CODE ALL THAT APPLY

Competition from other businesses in space-related activities	1
Competition from businesses in other sectors to which potential recruits are attracted	2
Uncompetitive pay or conditions	3
Uncompetitive or unfavourable conditions of employment	4
Unfavourable location e.g. local living or housing costs, competition from more attractive regions, access problems or other factors	5
Lack of careers/skills development opportunities	6
Brexit (led to staff moving out of the UK)	7
Other factors PROBE AND WRITE IN ALL MENTIONED	95
Don't know	97

IF HAD RECRUITMENT DIFFICULTY - Q9 = 1 OR SKILLS LIMITATIONS - Q12 = 1 OR STAFF RETENTION DIFFICULTIES – Q18 = 1

Q20. You mentioned that [If Q9=1 **you've had recruitment problems**] [**and**] [If Q12 = 1: **you have some limitations in workforce skills**] **[and]** [if Q18 = 1: **difficulties retaining staff**].**

Have these issues with regard to [Q9 = 1, Q13 = 1, Q18 = 1: **managerial, scientific, engineering or technical] [**Q9 = 2, 3 and Q13 = 2, 3 and Q15 = 1: **managerial] skills had any of the following effects on your business?**

READ OUT ALL; CODE ALL THAT APPLY

Loss of business to competitors	1
Delay in service or product development or reduced level of innovation	2
Difficulty in meeting quality standards	3
Higher operating costs	4
Reduced productivity	5
Difficulty in introducing new working practices, processes or technology	6
Weakness in responding to market changes	7
Weakness in organisational or financial management and control	8
Weakness in developing or exploring business opportunities	9

Failure to win contracts which might otherwise have been won	10
Increased workload for other staff	11
Outsourcing or subcontracting of work which might have been done in-house	12
Any other impacts? What are these? PROBE AND WRITE IN	13
Don't know	14

IF HAD RECRUITMENT DIFFICULTY - Q9 = 1 OR SKILLS LIMITATIONS - Q12 = 1 OR STAFF RETENTION DIFFICULTIES – Q18 = 1

Q21. Overall, would you describe the skills issues you've faced as having a major impact on business performance and growth, a moderate impact, only a minor impact, or no impact at all?

PROBE AND CODE ONE

Major impact	1
Moderate impact	2
Minor impact	3
No impact	4
Don't know	5

ASK ALL

Q22. Could we look now at what your [Q6/1: site] [Q6/2: organisation] does to secure or increase its supply of technical, scientific or managerial skills? In the last 12 months has your business done either of the following in respect of staff who need skills of these types?

READ OUT ALL; CODE ALL THAT APPLY

Provided or supported formal, off-the-job training for relevant staff or employed trainees	1
Provided less formal but intentional on-the-job training that is activities which would be recognised as training by the staff, not just learning by experience which takes place all the time	2
Neither of these	3
Don't know	4

ASK IF PROVIDED TRAINING - Q22 = 1 OR 2

Q23. More particularly, have you provided any of the following in respect of managerial, scientific, or technical skills development?

READ OUT ALL; CODE ALL THAT APPLY

Upskilling of existing staff to develop specialist space-related skills which the business needs	1
A formal graduate or post-graduate traineeship	2
A substantial work experience placement of 3 months or more for an undergraduate undertaking a 'sandwich' degree or its equivalent	3
A vacation work placement (for example: SPIN – Space Placements in Industry) of less than 3 months for an undergraduate or university student undertaking degree training	4
A degree or higher apprenticeship programme within the national government apprenticeship programme (level 5 and above)	5
A lower level technical apprenticeship within the national government apprenticeship programme (level 4 and below)	6
A formal company traineeship below graduate level outside the national apprenticeship programme	7
None of these	8
Don't know	9

ASK IF PROVIDED TRAINING - Q22 = 1 OR 2

Q24. Thinking of all the *off-the-job training* you supplied, was that provided by any of the following?

READ OUT ALL; CODE ALL THAT APPLY

Specialist trainers employed by the business	1
Staff in the business but not specialist trainers	2
Private training company(ies)	3
University(ies)	4
FE College(s)	5
Professional associations or sector bodies	6
Was any other source of training used? What was used? PROBE AND WRITE IN	7
Don't know	8

Q25. Does the fact that you haven't recently supplied training to any of your staff reflect your belief that no training was needed or would you ideally have liked to supply some training but it was not possible for some reason? *PROBE AND CODE ONE ONLY*

Staff didn't need training	1
Would have liked to supply training but couldn't do so	2
Don't know	3

Q26. What were the obstacles to you supplying training?

READ OUT ALL; CODE ALL MENTIONED

Cost of training	**1**
Can't afford time off the job	**2**
Appropriate training not available at all	**3**
Appropriate training not available locally or in right format or at suitable time	**4**
Training needs are specialist whilst training courses are too generic or are not sufficiently specific to company needs	**5**
Staff are resistant to training	**6**
Don't have time or resources to identify training	**7**
Is there any other obstacle? What were they? PROBE AND WRITE IN	**8**
Don't know	9

ASK ALL

Q27. Thinking about external training, is there any type if training or education which you would like to be available either for your own staff or to improve skills supply into the space sector more generally but which is not available or is in short supply? *CODE ONE*

Yes	1
No	2
Don't know	3

ASK IF CITE LACK OF AVAILABLE EXTERNAL TRAINING - Q27=1

Q28. Could you please describe the type of provision for which there is a shortfall as specifically as possible? Think of the type of training or education (e.g. subject matter) and also the level (e.g. undergraduate, graduate, post-graduate, managerial, etc.)?

It doesn't have to be a full-time course, it could be short, specific training not necessarily leading to a formal qualification.

PROBE FOR SUBJECTS AND LEVELS AND WRITE IN UP TO 3 EXAMPLES; IF GIVES A MORE GENERAL DESCRIPTION OF NEEDS FOR PROVISION WRITE IN TEXT BELOW

Subject/ type of training   Level

(1)   _____   _____

(2)   _____   _____

(3)   _____   _____

Any descriptive text _____

Q29. Which of these would you say are the most important to your [site/organisation]?

PROMPT WITH Q28 RESPONSES IF NECESSARY AND CODE ONE ONLY

ALL IMPORTANT 99   DON'T KNOW 97

ASK ALL

Q30. Specifically, the UK Space Agency is considering whether a Graduate Training Programme for the space sector might be developed, particularly to assist small and medium sized businesses in the sector. Do you think this would be valuable? *PROBE AND CODE ONE*

Yes	**1**
It would depend on its content, cost, etc.	**2**
Don't know – would need to have more details	**3**
No or probably not	**4**

IF CODED 1-3 AT Q30

Q31. Off the top of your head, are there any particular subjects or skills which the programme might cover in order to for it to be valuable to your organisation?

PROBE FULLY AND WRITE IN VERBATIM

Nothing 0   Don't know X

ASK ALL

Q32. Turning to the future, which of these do you see as most likely for the [Q6/1: site] [Q6/2: organisation] over the next 3 years?

READ OUT; CODE ONE

Your [site/organisation] will grow	**1**
You'll stay about the same size	**2**
You'll shrink	**3**
Your [site/organisation] will seek a sale to, or merger with, another organisation or site	**4**
Your [site/organisation] will close	**5**
Something else PROBE AND WRITE IN	**6**
Don't know	7

IF EXPECT THAT THEY WILL GROW – Q32 = 1

Q33. Do you expect growth in sales turnover or in employment or both? *PROBE AND CODE ONE*

Sales turnover	1
Employment	2
Both	3
Don't know	4

ASK ALL

Q34. Over the next 3 years do you expect that you will you need to recruit managerial, scientific, engineering or technical staff either for growth or to replace staff who move on? *CODE ONE*

Yes	1
No	2
Don't know	3

IF EXPECT TO NEED TO RECRUIT – Q34 = 1

Q35. Which roles or occupations will you need to recruit? WRITE IN UP TO 3

(1)　　　　_____

(2)　　　　_____

(3)　　　　_____

ASK FOR EACH ROLE MENTIONED AT Q35

Q36. Do you think it will be difficult to recruit these roles or occupations? If so, how difficult do you think it will be?

Do you expect that it will be difficult to recruit (EACH TYPE)?

(1)　　　PIPE IN ROLE 1

(2)　　　PIPE IN ROLE 2

(3)　　　PIPE IN ROLE 3

Very difficult	1
Somewhat difficult	2
Not difficult	3
Don't know	4

ASK ALL

Q37. Looking ahead even further, over the next 10 years, how confident are you that the UK space sector will be able to at least maintain its share of an expanding global market for space technologies and the services they provide?

CODE ONE; PROMPT AS NECESSARY

Very confident	1
Moderately confident	2
Not very confident	3
Not at all confident	4
Don't know/ can't predict	5

Q38. That's all I want to ask you today. Do you have anything else you'd like to say about recruitment and skills issues within your organisation and/or across your industry or the Space sector overall?   *LISTEN, PROBE AND RECORD VERBATIM – PARTICULARLY ANY KEY POINTS MENTIONED*

PERMISSIONS TO PASS DATA

Q39. Thank you very much for all that information. Just very finally, would it be possible for a member of our higher-level research staff to have a more open discussion with you about the sector and the skills issues it faces. This would be to get more depth on the issues than the structured interview has allowed?

Yes	1
No	2

IF YES: **Thank you. Someone from BMG may get in touch with you again in the next few weeks, hopefully to arrange a telephone or face to face discussion as you prefer.**

REGION/POSTCODE

THANK AND CLOSE

Discussion guide employed in the qualitative depth interviews

Organisational and respondent background

1. **First, could you start by telling me a little about your organisation?** *Probe on location, size of company, and an outline of organisational work*
2. **And could you give me a bit of an outline of your role at** [ORGANISATION]**?** *Probe on job title, remit of role, and length of service*

Perspectives on specialist knowledge needed within the Space sector

1. **When you hear the term 'specialist knowledge in the Space industry' what sort of skills and knowledge do you think of? Why?** *Probe on soft skills and hard skills*

2. **And which of these skills do you believe are the most important to the industry in general? Why?** *Does this differ between levels of seniority? How? Apprentices/ graduate trainees/ juniors/ managers/ seniors*

3. **Would you say these skills are important to your organisation? Why?** *Does this differ from the sector in general? How?*

4. **And of these specialist skills, which ones would you say are the <u>most important</u> for your organisation? Why?** *Does this differ between levels of seniority? Why? Which specific skills does your business need to succeed?*

Current and anticipated future difficulties in recruitment

1. **Thinking about the people who currently work in your organisations, do you believe they have the necessary skills?** *If yes, where have they learnt them? If no, why not? Can they learn them? Where?*

2. **Are there any skills gaps in your current workforce you believe is hindering your organisation's growth/or could be improved or addressed?** *If yes: Which areas of the organisation particularly? If yes: How is this impacting your organisation?*

3. **And are these skills gaps prominent across the industry?** *Probe on which specific skills gaps exactly*

4. **Have you had difficulties in trying to recruit people with these skills and knowledge base?** *Probe for examples: Who, level of seniority, which specific skill sets etc. Why do you think you have struggled to recruit these roles? Probe: knowledge, benefits, location, competition, salary*

5. **What impact do you think skills shortages have had on the sector as a whole? And on your organisation in particular?** *What do you think the long-term impact of skills shortages will be?*

6. **And what you do think are the main causes of these shortages?** *Training, recruitment, salary, competition, etc.*

7. **What are your views on diversity within the Space sector?** *What are the issues, if any? How significant are these issues in the context of any skills gaps/shortages? How do you think diversity amongst the skilled workforce in the Space sector should be encouraged, if at all?*

8. **How do you anticipate skills shortages changing in the future <u>for your organisation</u> in a) three years' time? b) ten years' time? Why do you think this will be?** *Probe: Brexit and Coronavirus. How would this impact your organisation?*

9. **How do you anticipate skills shortages changing in the future <u>for the sector</u> in a) three years' time? b) ten years' time? Why do you think this will be?** *Probe: Brexit and Coronavirus. How would this impact your organisation?*

Current training and skills development which ensure these skills are met

1. **Do you believe the sector as a whole is aware of the causes of skills gaps? Why/why not?** *Probe on why high/low levels of awareness and what this could mean for the future of the industry*

2. **Generally speaking, do you think the sector is doing anything to address these skills shortages?** *What is it doing? Who for? In which businesses specifically? Is there a focus on training people already in the sector or retention of current staff? What about attracting new talent?*

3. **And what has your organisation done to address these skills gaps?** *What sort of training has it provided to current employees? What obstacles have you come across to providing training? Probe on shortages for formal training/courses etc.*

4. **Do you have any current collaborations with education providers to ensure you're able to recruit in the future?** *Undergraduate/ apprenticeship training/ recruitment of new talent etc.* What impact has this had on your organisation a) now and b) in the future?

Recommendations and suggestions for future proofing skills in the industry

1. **Are there any particular skills or subjects which you think will be more necessary in the future?** *What are they, and why? Probe on changes to technology, working patterns, knowledge, Brexit, etc.*

2. **Is there anything you think that schools, universities, or training providers should be doing to help ensure skills are met in the future?** *Courses, careers fairs, etc.*

3. **And what do you think employers could be doing to ensure future skills are met?** *Retainer schemes, work experience, apprenticeships, graduate fairs, etc.*

4. **The UK Space Agency is considering whether a Graduate Training Programme for the space sector might be developed. Do you think this would be valuable for you? How viable would it be for your organisation to participate in?** *How do you think this would look? What would make it valuable? Why?*

5. **Is there anything else you think that UKSA could do to help ensure skills needs within the Space sector are met in the future?**

With more than 25 years' experience, BMG Research has established a strong reputation for delivering high quality research and consultancy.

BMG serves both the public and the private sector, providing market and customer insight which is vital in the development of plans, the support of campaigns and the evaluation of performance.

Innovation and development is very much at the heart of our business, and considerable attention is paid to the utilisation of the most up to date technologies and information systems to ensure that market and customer intelligence is widely shared.