Space Innovation and Growth Strategy
2014 - 2030
Skills Theme Report

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Introduction

The Space Innovation and Growth Strategy, published in February 2010, was a successful cross-sector and Government growth initiative. It brought industry, academia and Government together around the common cause of driving economic growth and provided the foundation for a transition of the UK space sector from a relatively niche industry towards a high-tech, main stream, industrial and science sector. In a period characterised by austerity it acted as the focal point to secure increased Government commitment and investment in the sector. Industry is now turning that investment into missions, UK activity and jobs.

The landscape for Space in 2014 is different to 2010, with very significant progress having been made in the sector over the last four years. The publication of the original 2010 Space IGS led to substantive changes in the structures and governance of the space sector in the UK. Since then, many of the actions in the 2010 IGS have also been completed and, additionally, many of them have been taken further by the new institutions created. This has stimulated the need for the creation of a new 2014 Space Innovation and Growth Strategy.

The overarching objectives of the Innovation and Growth Strategy in this update for 2014 are to develop the new recommendations and actions that will deliver the ambitions set in 2010: a target for the UK to achieve 10% of the space economy by 2030, which, in today's terms, would lead to sector with a £40 billion per annum UK space-enabled turn-over by 2030 and the creation of 100,000 new jobs.

This report is part of a set of documents that have been produced as part of the IGS 2014-2030: Space Growth Action Plan. In particular, it must be read in conjunction with the Executive Summary and Recommendations report that is available at: https://connect.innovateuk.org/web/space/space-igs-2014-30

Background and Rationale

The UK Space Innovation and Growth Strategy 2010-2030[1] identified a number of key issues that needed to be addressed in order to support the growth predicted for the space sector. The most fundamental was, and remains, the fact that overall there are too few graduates from numerate disciplines (physics, engineering, computer science and other STEM subjects) in the UK to fill the jobs that need their skills. Those graduates that there are, have a wide choice of careers across a variety of sectors, both in high tech industry and in the financial sector. In some mitigation, the Higher Education Funding Council for England's (HEFCE) recent report[2] on the "Impact of the 2012 Reforms" suggests that prospective undergraduates are refocusing on STEM subjects (applications up by 7% in 2013 compared to a 2% decline on the previous year in 2012) in the expectation that their employment prospects will be enhanced. Physics in particular has seen a 19% increase in accepted applicants and engineering whilst presenting a more mixed picture across the specialisations shows a 20% rise for chemical, processing and energy engineering.

The effects of some of the changes implemented within higher education will not be visible yet. The first cohorts of students who are being encouraged from year 1 to access additional elective (e.g. languages) or co-curricular courses (communication skills, report writing) have not yet graduated, and work experience and placements are not yet widespread. Increasingly universities are building employability and enterprise more firmly into their strategies. Expansion of work experience opportunities is central to this, although universities and colleges may find it difficult to realise the growth in opportunities that they wish to see here[2]. Those students who are accessing placements are learning how their studies are applied, and gaining first hand experience of the importance of particular skills.

The Innovation and Growth Strategy (IGS) Restack Skills Theme Working Group reviewed relevant recent reports (see references for the most pertinent) and also carried out informal interviews with a broad range of employers across the sector, both nationally and internationally, to gauge their experiences. A number of the employment issues that were identified as problems for the space sector were mirrored in reports from other high tech sectors:

- A shortage of numerate graduates
- A lack of technical computing and programming skills in the workforce as a whole and recent graduates in particular
- A lack of understanding of the importance of professional communication
- A lack of project management skills and experience
- Too few skilled technicians
- A reliance on English and lack of knowledge of other languages

- The complexity of the sector (upstream – designing, building and managing spacecraft and downstream – using space derived data and services) can make requirements difficult to quantify, although increasingly all require novel problem-solving skills.

In general, and subject to the constraints above, employers did not have difficulty filling positions since the pool of applicants is global. Where indigenous graduates might lack the modelling and mathematical analysis skills these skills can be sourced from overseas. If employer organisations have strong constraints from a security or immigration perspective, then these positions can be difficult to fill.

Recent and New Initiatives

Qualifications

The Northern Ireland Council for the Curriculum, Examinations and Assessment (CCEA) has developed a new QCF Level 2 Space Science Technology qualification. Having been accredited by Ofqual, it will be taught from September 2013 with the first assessments in June 2014. It is aimed at giving learners aged 14-16 the chance to learn about the latest skills and practices relevant to the emerging UK Space Sector.

Learners will explore the life cycle of stars, human space travel, Dark Skies initiatives, satellite technology and composite materials, as well as a wealth of topics closer to home such as climate change, weather monitoring, geo-referencing and earth observation projects.

Many of the topics studied will have a local perspective, helping learners become better equipped to meet the needs of Northern Ireland's economy in an international context.

It is envisaged that those studying the Space Science Technology qualification will build upon their existing skills in science, maths, engineering and ICT, and will use their new-found knowledge to solve real-life problems.

National Space Academy Programme and Space Studio Banbury

The National Space Academy Programme (www.nationalspaceacademy.org) consists of student master classes, teacher Continuing Professional Development (CPD) and careers events delivered by a network of outstanding teachers and project scientists. The programme uses the context of space to teach physics, chemistry, biology, mathematics, geography and applied science to GCSE, A-level and BTEC students and their teachers. Its purpose is to materially enhance the size and quality of the science and engineering skills pool.

A three year pilot Space Academy programme has proved successful in boosting student attainment, teacher effectiveness and influencing course choices at A-level. The National Space Academy is extending its reach throughout England and through the UK from 2015.

The Space Studio Banbury (www.spacestudiobanbury.org) is being established as a new, unique school catering for 14-18 year olds with an active interest in Science, Maths, Technology and Space. The first students will join the faculty in September 2014. The aim is to develop a very high quality Science and Maths education. This will prepare students for careers in space related industries, through a focussed curriculum combined with exposure to positive role models from within the sector.

The Space Studio will have a challenging, engaging and innovative approach to curriculum delivery using a wide range of learning strategies. Students at the Space Studio will also benefit from the active involvement of employers and universities and real world opportunities to experience science and technology.

Apprenticeships

Government's renewed emphasis on vocational education as a direct route to employment has led to a refocus on apprenticeship programmes for a range of age groups and competencies. The space sector's top priority remains an enhancement of its profile and of the size and quality of the science and engineering graduate and post-graduate skills pool. There is a growing interest in the role that high quality apprenticeships might play in the provision of technicians who have both the engineering and employability skills to make a positive contribution to upstream manufacturing businesses.

Studies such as that written by Paul Lewis, of Kings College London[3], suggest that upstream manufacturers experiencing a shortage of skilled technicians are turning to apprenticeships as a means of developing such workers in-house. Several such employers have, however, experienced difficulties in finding colleges willing to offer the technical courses required by prospective apprentices.

Higher Apprenticeships in Space Engineering

One potential solution to this problem lies in the development of the recently-launched Higher Apprenticeship in Space Engineering. This aims to provide a balanced academic/vocational route to employment in the space sector. This two year programme incorporates work-based training in practical engineering skills as well as a Foundation Degree. Apprentices will have the option to progress to a full BSc in their third year of the programme should they and their employer so wish. The course is to be delivered at a number of colleges in the space sector heartlands from 2014 onward.

Programmes such as this have proven to be extremely popular both with young people and employers in the aerospace sector. Employers such as BAE Systems, Airbus and Rolls Royce praise Higher Apprenticeships for making it possible to develop technicians with a good blend of practical and theoretical skills. These young people can apply their theoretical knowledge to good effect in the workplace, and are typically more loyal to their employer than their graduate counterparts[4]. The Higher Apprenticeship in Space Engineering could prove a highly attractive alternative to a traditional degree course for both employers and employees. It needs significant employer support and buy-in to find its feet, demonstrate its worth and so become sustainable. Initial private sector interest in helping develop course content and considering the course for recruitment and skills development is encouraging.

Co-curricular and elective university courses

Many universities have introduced co-curricular or elective courses to develop skills outside the core degree curriculum. These changes and additions to courses are offered to students either as part of their degree or as part of Training and Development Awards (e.g. elective language, computer programming and business courses) and have followed the publication of a number of reports identifying particular skills that employers across this, and other high tech sectors find that their recruits lack. The disadvantage of many of these courses is that they are taken at the discretion of the student, and unless the student has a clear view of the advantage conferred by the course they are not incentivised to participate.

Other work has identified good practice across higher education where organisations have successfully engaged with employers to improve the employability of their graduates by encouraging placements from a few weeks to a year. Universities vary in their success rates for developing and maintaining the links that forge good placements. Some leave it entirely in the hands of the student to seek out, and win the opportunity. This means that proactive and confident students will stand a better chance of success, than their less confident or socially aware and more diffident peers.

The effect of the introduction of these courses may not be appreciated yet in the workforce, since the first cohorts of students who have been exposed to them have not yet graduated.

SpIN and Graduate Training Programme

A number of studies have highlighted two aspects pertinent to recent graduates; their lack of experience of the work place and the lack of a formal training and development path particularly within SMEs. This can clearly be a barrier to SME growth and their recruitment of less qualified staff. The Space Leadership Council has recognised the former and initiated the pilot Space Internship Network (SpIN).

In 2013 this scheme placed or supported 45 undergraduate students into placements throughout the sector with excellent results. The SMEs involved have seen the interns making a real difference to their businesses over the 8 weeks of the programme and are very keen to see it continue in 2014. Interns have made significant and tangible contributions in all the organisations they've been working in and have all developed new skills. One of the most important outcomes has been the appreciation by the students of the importance of the subjects they are studying, and the place of that knowledge in the workplace. It has also highlighted the benefit of attending the co- curricular course in programming or languages. In 2014 the interns will be offered the opportunity to participate in a 2-day Software Bootcamp to fast track those who will need those skills during their projects.

Most importantly they have been made aware of the breadth of the sector in terms of careers that could be available to them and of the number of companies that

exist, following the launch of the scheme with an Induction Day. This was held at the Satellite Applications Catapult, where companies from across the sector described their businesses and the opportunities they offered. This was a revelation for many of the students who did not appreciate the scope of the sector, or its size.

Other sectors with similar issues are considering innovative graduate training mechanisms. Rio Tinto (mining sector but a space user) have described how the mining sector recognising a similar problem has collaborated through a professional organisation (AIMM) to develop a generic Graduate Training Programme which can be accessed by any member organisation for their staff.

Airbus Space and Defence have also noted that there would be advantages to collaborating with their supply chain organisations to assist by offering places on their training programmes.

Finally, as noted above, one of the potential benefits of taking Higher Apprentices is that, because they receive more work experience, they are more able to apply their knowledge in the workplace than many graduate recruits, and display a much higher degree of long term loyalty than graduates.

Massive Open Online Courses (MOOCs)

MOOCs have become the buzz phrase of the education sector over the past 18 months. Their popularity has increased amongst universities, beginning in the US, particularly because they remove the requirement for students to be physically present on site and can be popular for those who would have visa, cost and attendance issues. MOOCs have been launched in the UK through FutureLearn, the private company owned by the Open University, where they can capitalise on the Open University's unparalleled expertise and experience in delivering distance and open learning.

21 universities from around the world are collaborating to provide courses across subjects and disciplines, but very pertinent to the space sector are those offered by universities already with strong links to the industry. These include Southampton (Electronics, Computer Science, and Oceanography), Reading (Business, Climate, Agriculture, and Systems Engineering) and Edinburgh (Artificial Intelligence Planning and Astrobiology).

MOOCs are designed to fit into the life of the individual, making it easy for them to learn something new or develop their existing knowledge. The courses are accessible and clearly state their intended length and whether any prior knowledge is required. Course content is delivered in bite-sized chunks so learning can be paced to suit the individual. They are self-directed so the student can follow the course materials, complete the readings and assessments and get support from the online community.

Although the courses do not have formal credits associated with them, some courses offer Statements of Accomplishment upon completion to the requisite quality assured standard.

A recent report from the Open University[8] notes, however, that MOOCs have a very high fallout rate, typically 20,000 learners will register with only 5-10% reaching the end point. They are regarded as an innovative, evolving and expanding area for learning.

Continuing Challenges

Apprenticeships

The space sector does not have a broad-based track record in using apprenticeship programmes, although technicians make up 20% of the upstream manufacturing workforce. Apprenticeships are well-regarded in other sectors such as aerospace for the way in which they provide young people with a good blend of technical and practical skills.

EADS Astrium takes on 12 apprentices per annum for a two year course, at the end of which those that meet the requisite standard move on within the organisation. SMEs that need, perhaps, just one or two apprentices on an irregular basis may be more reluctant to commit the time and effort required to learn how to run an apprenticeship programme.

It has been suggested that larger companies (such as Astrium) might consider whether they could help smaller firms (in their supply chain, for example) take apprentices. The larger companies could help with the programme management and by allowing apprentices employed by those SMEs to undertake some of their training alongside the large firms' own apprentices. Large manufacturers in other high-tech industries already do this.

Employers who have been considering setting up apprenticeship training programmes have found it difficult to persuade further education colleges to offer the kind of off-the-job training that employers want their apprentices to have (in particular, Higher National Certificate in electronics). The problem reflects the fact that each individual employer often wants to train too few apprentices to make it worthwhile for the college to put on the relevant course.

The introduction of the Higher Apprenticeship in Space Engineering might help to address this problem. If it generates sufficient interest from employers in the space heartlands, their total demand for apprenticeship places might be enough to engage colleges in offering the relevant courses.

Skills Shortages

Whilst many employers report that they can always fill vacancies by recruiting internationally, this is not an option for companies where security issues are crucial. The first IGS identified that training for the next generation of space engineers and scientists was going to be critical. Many key government bodies working in this area have raised their efforts to work with the education sector and to raise the profile of STEM subjects.

A number of recent studies from different sectors have described the need to recruit bright and innovative STEM graduates. They also describe areas where the industry

sectors see themselves with ongoing and developing skills shortages. A range of industrial and research organisations including the Association for Independent Research and Technology Organisations (AIRTO)[5]and the Natural Environment Research Council (NERC)[6] have produced these studies and have all reached broadly similar conclusions. High tech industries recognise their need for graduates from pertinent science subjects who are numerate and computer savvy.

The challenge for the space sector is to be recognised as a growing, innovative and exciting place to work in the UK. A number of downstream employers in the space sector commented that these (sought after) graduates were not aware that they could seek specialist employment as space specialists within their own industry (for e.g. in the water industry). As noted above, the SpIN interns commented that their eyes were opened to the diversity of opportunities within the sector that they had been blind to before they attended the scheme induction day.

It is imperative that awareness is raised within universities of the sector. For many SMEs and downstream employers, their recruitment teams and the number of graduates they require, are too small to justify spending much time and effort participating in graduate fairs. However, there is a clear reason for inviting these professionals to talk to students.

Exposure to employers whilst at university comes in a number of forms (careers fairs, lectures, placements and internships) and clearly makes a difference to employment prospects. Larger employers have developed ambassador schemes with their 'known' sources of recruits, but small organisations might also find that encouraging such links through their own supply chains might prove beneficial for relatively low effort.

Consideration was given for a recommendation that a National Skills Academy for Space should be established. However, after much discussion it was agreed that further investigation needs to be undertaken due to the comparatively small size of the space sector and the diverse nature of the future work force, as it is predicted that the downstream sector will grow significantly. Therefore, it is suggested that an in depth skills analysis is undertaken to identify the future work force and the industry's skills requirements. It is also necessary that the space industry are consulted and their views sought on the establishment of a National Skills Academy for Space as it is essential that industry support this initiative for it to succeed.

Degree Modularity

In general we found that employers are broadly satisfied with the level of technical knowledge with which graduates entering their organisations leave university, and the experience they demonstrate lies within the employers levels of expectation. There was concern about the level of modularity of courses, and a growing appreciation that it was not necessarily the grade gained on graduation but the modules attained during the process, which could be particularly important to the employer.

Downstream organisations could find themselves facing more challenging technical deficits than upstream companies. A number of factors can cause this e.g. SMEs requiring people with a broad range of skills who can cover for each other; downstream organisations employing from a broader range of degrees, some of which may not be overtly numerate, or have changed their syllabi since the employer studied the subject.

Feedback from the SpIN students following their placements has highlighted their lack of exposure to any programming training during their undergraduate studies. Physics students in particular have asked for advice on sourcing appropriate training, which is frequently available through their universities, further education colleges and software providers.

Co-curricular and Elective Courses

Many universities have introduced these training courses as detailed above, but they are not universal. The advantages to universities from their increased involvement with employers, the benefits of providing these courses and thus graduating more employable students will feed into the public statistics on employability provided by all higher education Institutions.

It is worth noting that by encouraging students to do work placements during vacations (like the SpIN scheme) they return with a clearer appreciation of the requirements for these extra-curricular skills.

Re-skilling and Up-skilling

Organisations have a need for continuous education and re-skilling to keep abreast of new developments, to reinforce best practice, and as part of company-wide capability improvement initiatives. Some of the skills gaps, including technical deficits in graduates, can and are rectified through further study options. These range from short courses, either in-house or open public courses, through to full Masters Degrees.

There are a few areas where specialist training is provided through workshops or short courses in particular subject areas. ESA certify colleges to deliver technical skills such as high reliability soldering, whilst higher education institutes and some specialist manufacturers offer courses, for example, in data assimilation, hyper-spectral image processing and radar remote sensing. There are also courses available in the management of projects and systems, skills which are vital in technological projects typical of the space sector. Some of these courses could be ‘rebadged’ from one subject area for another, e.g. data assimilation, used extensively in meteorology, is also used within the oil and gas and insurance sectors but termed differently (‘History Matching’ in Oil & Gas).

In the past, data suppliers have provided introductory workshops to the potential end users of their data in the use of various different data types. However,

reductions in profit margins, and the proliferation of different data types marketed by sole providers have made such generic introductory 'courses' unviable. The expectation of employers is that undergraduates will have been introduced to the basics whilst still at university.

In addition to graduate and technician recruitment, it is expected that additional or new skills will need to be acquired throughout organisations by up-skilling of staff with space domain knowledge or re-skilling of experienced staff from other sectors through in-house, bought-in or public training.

Experience from the higher education sector delivering training to industry indicates that there is benefit to organisations from short, focussed deliveries, typically in 3 or 5 day blocks. However it is currently only some of the larger organisations that have the capacity to run regular programmes of this type of development.

It can be envisaged that the SME community could also realise benefits from this type of training, but currently there is insufficient coordinated demand to be viable for the deliverers. SMEs also find it difficult to release staff for even a few days at a time which makes the current style of delivery unattractive to this community. This in turn means that those deliverers have not targeted the SME community to promote the benefits that this kind of development could bring.

There is a clear understanding throughout the sector that since the UK space sector is relatively small, indigenous recruitment is severely limited if restricted to those who already have space-domain experience.

Graduate Training

A number of SMEs have commented that they prefer not to recruit recent graduates preferring those who had spent 2-3 years in larger organisations where they may have completed a graduate training programme. The reasons cited were often that in the early years after graduation, the recruits tended to have a rather unprofessional attitude to the workplace and an overinflated appreciation of their place within it.

Companies like EADS Astrium (now Airbus), also commented that they saw the corollary to this, and tended to lose staff after about 2-4 years as they migrated to smaller companies. As a whole we do not see this migration between organisations as a bad thing for the sector, and indeed even Astrium acknowledge that it can lead to strengthened links with SMEs in the supply chain.

To add to this experience, through the SpIN scheme in 2013 a number of SMEs have been encouraged to reconsider their approach to recent graduates as the students they have hosted have demonstrated maturity, independence and a focussed approach to their work.

Doctoral Training

Higher level, more skilled and in depth training and experience is provided and gained during the course of PhD programmes. Companies accept that they frequently do not give due acknowledgement to recruits who have PhDs, in that they may be fast tracked into teams but they also enter through regular graduate recruitment channels and are therefore employed on the same basis as a recent graduate. In other organisations however they can find themselves bypassing recruitment quotas and rising rapidly up the management ladder. The depth of expertise and experience that a PhD can confer may be essential for SMEs developing new and innovative technologies, which do not have the luxury of time to nurture particular skills.

Actions to mitigate the challenges

UK Space Agency should appoint a national space skills point of contact, to support the growth of regional space sector SMEs, in both technical and business skills, engaging with existing networks and support mechanisms, facilitating a network of contacts and using web-based tools.

The national space skills point of contact should:

- lead engagement with existing networks and support mechanisms including Knowledge Transfer Networks and Partnerships, Learned Societies, Professional Institutions, Trade Associations, the Sector Skills Council for Science, Engineering and Manufacturing Technologies (SEMTA) and the National Centre for Universities and Business (NCUB) to facilitate the cross fertilisation of ideas and methods between these organisations and space SMEs;

- use established best practice within the sector to establish a generic space graduate development programme, utilising regional providers, skills agencies and professional institutions to support SME recruits;

- develop the Space Internship Network (SpIN) scheme, taking it forward as a robust programme for the future in order to provide a ready source of work prepared and enthusiastic graduates;

- promote awareness of vocational education and training, such as the Higher Apprenticeship in Space Engineering, help to assess demand from the sector and how vocational training, including skills development for existing employees, might best be delivered, actively provide feedback to the colleges and promote the development of relationships between companies and their nearest, accredited college providers, and consider whether collective action by groups of space employers can help to ensure that there is sufficient demand for training to make it worthwhile for providers to offer it;

- work with UK Space Agency and UKspace to ensure that there is a space presence at student oriented careers fairs and conferences, particularly those focussing on the STEM sector and centred in the regions;

- engage with space employers, to encourage their staff to promote the sector (and their organisations) to local universities and their own alma mater (c.f. Astrium's University Ambassador Programme);

- provide an Online Skills Portal to raise awareness of the training available in both academic and commercial environments for all employers across the sector and throughout the regions. This should include, but not be limited to, sector specific CPD courses to address identified skills gaps. This facility will

be open to all relevant providers who are able to deliver into this sector, and should be in place for Sept 2014.

Financial Support should be provided by the UK Space Agency and appropriate Research Councils for a cross disciplinary Space Doctoral Training Centre. This would support PhD Studentships that are cross disciplinary, include business skills, and are targeted at the upstream and downstream space sector.

A Space Doctoral Training Centre will be established by a consortium of research organisations specialising in the doctoral research training of highly skilled people to support the space sector in collaboration with partners from the industry. Funding for the DTC should be drawn from those research councils who support space related research (NERC and STFC, and preferably EPSRC) with an emphasis placed on cross disciplinary, upstream and downstream linked research. This action supports the analyses of skills shortages by research councils such as NERC.

It should:

- aim to fill some of the recognised existing skills gaps in this area and create a highly skilled workforce with skills transferable across the space and wider environment sector;

- ensure that graduates are provided with particular, specialist skills that are linked to the strategic priorities and skill needs identified in this refresh of the space strategy;

- provide a concentrated national focus for doctoral training to support the space sector, bringing together a minimum of 3 eligible research organisations which will provide cross disciplinary and pan sector training to ensure that the skilled graduates have a clear understanding of the scope and range of the sector;

- through Research Council funding also leverage funding from industry. The funding provided should support at least a notional 10 students per year for 3.5 years. The consortia of research organisations should also be able to match these studentships through direct investment or through joint industry partnerships (i.e. A total of 20 studentships p.a.);

- not be a physical entity but will utilise the existing facilities within the research organisations, and employ a Coordinator who will be able to ensure the engagement and collaboration of all involved entities. The organisation can build on existing experience by several research councils in managing DTCs.

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