

Space Universities Network - supporting Space Science and Engineering Higher Education Community in the UK

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Abstract—The world space economy is expected to grow to \$400 billion by 2030 and to provide 100,000 jobs. In the UK we currently have 38,500 directly employed with a further 70000 jobs dependent on the space sector. By 2030 the UK aims to have a further 100,000 new people employed within the sector. Training space engineers and scientists is critical to fulfilling this need. The UK-based “Space Universities Network” (SUN) was formed in 2016 with the aim of enhancing the quality of learning and teaching by providing support and resources to the Space science and engineering higher education community. SUN’s objectives are to facilitate the creation of a skilled workforce of graduates who can meet the challenges of future scientific and commercial exploitation of space. The network addresses this need by helping to inspire students to join the space sector and ensuring they are well

equipped at University to contribute. SUN enables the developing, sharing and promotion of effective practice and innovation in the delivery of university-level space science and engineering curricula. It does this through workshops, offering opportunities for networking to support the space teaching community and a web-based repository of resources. This paper describes the process that led to the foundation of SUN, its objectives, modes of operation, prime activities, evaluation and future projects. Once firmly established, it is hoped to expand the network through partnerships with similar organisations in other countries.

Keywords—higher education; community; network; resources;

I. INTRODUCTION

The world space economy is expected to grow to \$400 billion by 2030 and the UK has ambitious plans to secure 10% of the global market, growing the workforce by a further 100000 jobs. Training new space engineers and scientists is critical to fulfilling this need. In the UK, accepted University undergraduate places have increased from 271000 in 1994 to 535000 in 2016 [1]. This has meant that popular science and engineering departments have struggled to maintain the level of laboratory participation and build and test projects. It is recognized that there is a shortfall in Science, Technology Engineering, and Maths (STEM) graduates and a report by the industry body, Engineering UK, suggests that this is as much as 20000 graduates a year [2]. An accreditation body called the ‘Institute of Engineering and Technology’ has produced a report on skills based on surveys of employers. These established that 62% of UK engineering employers are concerned about graduate skills, of those, 59% say that is because Engineering and technology degrees do not develop sufficient practical skills and 68% are concerned that the education system will struggle to keep up with the skills required for technological change [3]. Against this backdrop, the UK-based “[Space Universities Network](#)” (SUN) was formed in 2016, with the aim of enhancing the quality of learning and teaching in Space Science and Engineering. SUN members wish to enable the development, sharing and promotion of effective practice and innovation in the delivery of university-level space science and engineering curricula.

II. AIMS AND OBJECTIVES

The value of the Space Universities Network comes from the collective intention to advance learning in Space Higher Education with a particular focus on space science & engineering. Eventually, the experiences and learning of the community will develop into a shared repertoire of case studies, contacts, questions, equipment, concepts and perspectives.

The overall aims and objectives of SUN are to:

- Improve the competitiveness of the UK’s future Space workforce and address the shortage of skilled Science Technology Engineering and Maths (STEM) graduates.
- Share space teaching ideas, providing new ideas, broadening topics covered and enriching the curricula
- Liaise with industry on graduate requirements to meet the increasing demand for professional scientists and engineers, and to promote subsequent career development
- Encourage increased reflection in space education practice and material
- Provide a coherent approach to trialing and evaluating new pedagogical methods across multiple institutes and a wider student base
- Provide awareness of space degrees and space employment market, with commensurate increase in student numbers
- Provide opportunities for networking and collaboration in

teaching and research

- Provide access to resources: facilities, equipment and specialist expertise
- Influence policy on the teaching of space science and engineering to produce graduates prepared for tomorrow’s industry and research.

III. EVOLUTION OF THE NETWORK

The community was started by 3 members of the Space Engineering community who met to discuss ideas for teaching and learning in 2015. It has then spread by open invitation to UK Higher Education institutions. The first workshop was held in June 2016 with 25 members present. A debate was held to discuss the necessity and UK strategic context for the community. Key issues to be addressed by the community were identified during the workshop. All participants wrote down their own issues and challenges that they faced in their everyday experience of teaching and learning space science and engineering. Then together they formulated some ideas and solutions which could help with some of these issues. A list of potential useful resources, tools and methods were discussed (see section V. Methods). Next the necessary infrastructure of the community was suggested to consist of a website, an academic listserve email list and networking workshops. After this workshop, the next step was to apply to a competitive funding call and to be awarded funding by the UK Space Agency. This paid for the commissioning of the database-backed website which would host many of the resources and for the launch of the organization at the UK Space Conference in Manchester in May 2017 (Fig.1).

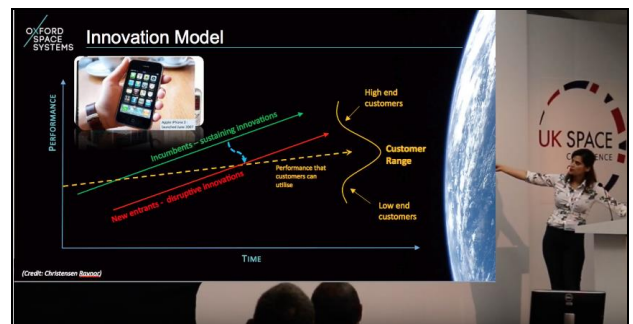


Fig. 1: “What does the Space Industry want from graduates?” Shefali Sharma from Oxford Space Systems at the SUN workshop in May 2017

Establishing a core group who would drive forward the community was key. This group is called the SUN working group and holds regular meetings (aimed roughly at the solstices and equinoxes!) Subgroups were formed later to look at various work streams, proposing ideas for events, driving the collection of resources, looking for funding and liaising with industry and media. A set of Terms of Reference and a

Strategy document were written jointly by the group and these have helped focus efforts. Celebrating the successes of the members and the network is done regularly via the medium of an email newsletter.

IV. MEMBERSHIP

The membership of the network has grown from 3 to 52 over the past 2 years. These members come from 28 different Higher Education Institutions in the UK (as at Feb. 2018). A list of current members can be found at: <https://spaceuniversitiesnetwork.ac.uk/members>. All Institutions of Higher Education interested in Space in the UK are invited to join. The majority of members are in Engineering departments, but at a recent meeting, the community wished to emphasise the welcome to space scientists and Earth observation scientists as well. SUN works hand in hand with partner organizations including the student organization: Students for the Exploration and Development of Space (SEDS), the Satellite Applications Catapult (a government innovation hub), the Space Action Network (a network focused on research) and ESERO-UK (European Space Education Resource Office) and others.

V. METHODS

The aim of SUN is to support the Space HE community in the UK by sharing and encouraging effective practices in space teaching and learning across the UK University sector. The main method of communication between members is the email list, through which members put out notices of events that they are running (either for students or for staff), posts that they are advertising, outreach events, collaborations they are seeking etc. The newsletter is also used to draw members' attention to joint events, new website resources initiatives and there is an interview with a different member each month. Annual workshops have been centered on topics of interest to members, who are always striving to provide the best learning experience for their students by keeping themselves up to date with emerging technologies and themes in the space business. One of the goals of SUN has been to liaise with industry about curricula and skills, so the theme of the 2017 workshop was proposed to be: "What does the Space industry want from graduates?" Leaders of successful space companies, agencies and accreditation institutions were invited to give talks to SUN members about the qualities and skills they were looking for in University graduates. The main messages of the industry leaders were summarized in an article on the event by a student careers organization here: https://spacecareers.uk/?p=article_public&id=224.

The talks were filmed and are available at SUN YouTube here: <https://www.youtube.com/channel/UC0jythXs3CuC-Ld2i-qVDpg/videos> (Fig. 3). Workshops are also about understanding new developments in the space sector. For example, in 2018 members have chosen to learn about new uses of space data and will be attending a workshop on

downstream applications of satellite services. Ordinarily, SUN members might only attend a workshop centered on their research domain, so these workshops will broaden their knowledge and keep them up-to-date with developments outside of their specialist areas. This in turn will be of benefit to their students. Short courses on specialist subjects open to students have also been organized by individual members. These have been arranged in tandem with the student organization UKSEDS, who promoted them. For example, the University of Leicester has provided a course on orbital mechanics and Kingston University London a course on rocketry.

One of the other key attractions of SUN is the curated web-based repository of resources to support teaching and learning which has been created. This is being built up by members of SUN who can log on to the website themselves and view, upload and download resources. These resources are visible (but not downloadable) at:

<https://www.spaceuniversitiesnetwork.ac.uk/resource-bank>.

The resource bank (Fig. 2) contains:

- Case studies of practical teaching ideas - satellites built in soda cans, water-powered rockets, incident investigation reports for space mission failures.
- Class resources – videos clips, icebreakers, useful articles on scholarship of teaching and learning
- Question bank of questions on specific space topics with topic tagging for search purposes
- Database of guest lecturers and topics
- Database of external examiners
- Database of laboratory and test facilities including specialist equipment for satellite testing
- Links to our partner space careers website: spacecareers.uk and ESA UK outreach website [ESERO UK](https://esero-uk.org).

Resource Bank

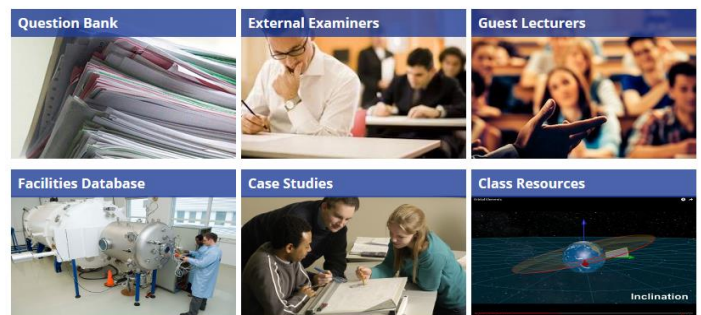


Fig. 2. Space Universities Network website resource bank.

VI. EVALUATION

It is challenging to evaluate a network such as this. Some of the benefits are difficult to measure, for instance the evolution of connections among practitioners, relationships based on trust, and a language and context shared by

community members. The joint projects coming from the community are also evidence of success of that community. Evidence to date includes: members being invited to other institutions to give guest workshops on teaching ideas that they have developed, members being invited to be external examiners at other institutions, the highlighting of academic facilities to potential UK users, for example specialized laboratories at Kingston University London and the University of Birmingham, new ways to introduce younger colleagues to other experienced academics in space, sources of enriching/enhancing ideas for courses, e.g. inter-university competitions to build rockets and CanSats or microsatellites.

An anonymous electronic survey of all SUN members was performed in November 2017, and 13 members responded. The results from the survey indicated that 30% of responders had attended both workshops, 69% had met someone new at the workshops, 92% read the SUN emails, 61% had passed along a piece of information or request from SUN, 85% had gained a useful piece of information from SUN, 62% had learned about something new and 31% had implemented a new teaching idea and 15% had tried a new suggestion.

Answers to the survey question: “what, if anything, have you gained from SUN?” included:

- *So far, it's early days, but I think it's helpful to build a network of practice in Space-related teaching.*
- *Developed links for outreach activities and potential extra-curricular competition development*
- *Didn't know about GMAT orbit modelling software before*
- *Access to high quality teaching material, for example course on use of orbit modelling*
- *Being part of a supportive like-minded community.*

Answers to “how can SUN improve?” included:

- *More website resources*
- *Links to other equivalent networks in other countries might be useful - both for training (placements, internships, exchanges) and/or for resources.*
- *Having a regular meeting to allow academics to meet, at a site where space science and engineering activities are taking place, to share best practice, brainstorm and address strategic challenges facing the space and higher education community in the UK*

VII. FUTURE WORK

Whilst value to some of its members has been established, it is harder at this stage to measure the impact on the students, who are also stakeholders. Resources have been uploaded to the website from which students can directly benefit if they are taught by SUN members. Further work continues to build up the teaching resources on the website, including a series of case studies which will be produced in the next year.

Currently further funding is being sought in order to expand the network to space science, as well as engineering. Also, modes of continuing the dialogue with industry will shortly be established, as industry have shown a great interest in working with the network. They cite the ease of access to the community as their interest.

VIII. CONCLUSIONS

The Space Universities Network (SUN) is a community of space science and engineering Higher Education staff at UK Universities. The members are interested in developing their teaching and learning skills. This work has described the evolution of the network, the membership, the methods, the way the network has been evaluated and some ideas for future work. This work demonstrates the value of such a community to its members and other stakeholders even in the first years of its inception.

ACKNOWLEDGEMENTS

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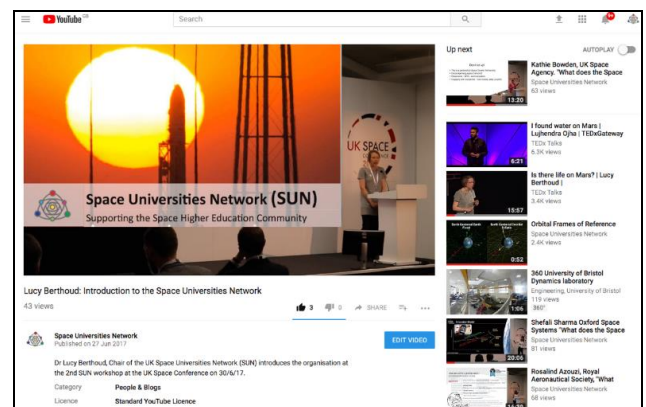


Figure 3: SUN YouTube channel shares workshops and videos publicly