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VIRTUAL SPACE ACADEMY

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Abstract

The space sector needs highly trained personnel. This calls for a continuous learning process comprising post-graduate educational programs. However, the offered programs differ substantially in scope and characteristics, coverage and focus, quality and organization and lack inter-program coordination. To remedy this, a Virtual Space Academy has been initiated which allows coordination of post-graduate space education and realizes cross-fertilization between the programs to enhance and stimulate space education. The paper addresses the process of setting up the Virtual Space Academy from a European nucleus and details its objectives. The opportunities that the academy offers in providing a continuity of highly qualified space engineers and managers, maintaining a knowledge-base in line with current technology standards and trends, realizing cost savings through harmonization and cooperation within the virtual setting of the academy are also addressed.

INTRODUCTION

The need of space industry, space agencies and other space-related institutions to increase their performance drives human resources management to a growing effort in training and education of staff in a continuous learning process. Furthermore, the space sector, which has traditionally been organized along technology and programmatic lines, is facing challenges which require integrated approaches involving particularly business and systems engineering mind sets[1,2,3]. To meet these demands, there is a growth in the number of post-graduate educational programs on space-related subjects, particularly in Europe. Existing programs differ, however, substantially in scope and characteristics, coverage and focus, quality and organization. More importantly, these activities are until now not coordinated.

To respond to this need, a Virtual Space Academy has been initiated in May 2008. The Virtual Space Academy will harmonize these programs and activities and will allow coordination of post-graduate space education. This, in turn, will realize cross-fertilization between the programs to enhance and stimulate space education.

To that extent, a minimum standardization of the courses and their contents is targeted without reducing their diversity. In that process, the feedback of the needs of industry and organizations, such as ESA and national space agencies are important to increase the quality and value of education. Cooperation within the Virtual Space Academy will allow mutual access to academic resources, experiences, laboratories and tools that would otherwise not be available to individual initiatives. In a later stage, the curricula can even be complemented with courses offered by partner organizations.

The paper provides an introduction to post-graduate space education together with an analysis of key characteristics of selected programs. Then, the mission and primary objectives of the Virtual Space Academy are presented together with their opportunities and prospects. Finally, conclusions are drawn which address also next steps in implementing the Virtual Space Academy.

POST-GRADUATE SPACE EDUCATION

In the following, the present-day status of post-graduate space education is characterized by describing its context and defining its scope.

Context

Space education is typically limited to Bachelor, Master and PhD programs at universities. This traditional setting can nowadays neither provide the quantity nor the quality of work force needed in the space sector. By the end of 2008, 26 percent of the U.S. aerospace work force will be eligible to retire[4].

Fig. 1 Intensive coaching within a post-graduate space education program (SpaceTech)

New approaches have to be implemented prior, within and past an academic curriculum to satisfy these needs. Excitement about space can e.g. passed on to pupils with projects such as CanSats[5] or with Information and Communication Technology (ICT) based tools[6,7]. Within the university curriculum, integrated approaches of space engineering can be covered through the implementation of miniaturized satellite missions, such as CubeSats[8,9]. The training of professionals for a changing and evolving space sector is what is understood as post-graduate space education in this context.

Scope

The Virtual Space Academy shall have a focused scope. Thus, neither regular graduate space programs nor programs which do not primarily focus on space have been considered. An example of the vast amount of space-related educational opportunities is given by the "Institut des Sciences Spatiales et Applications de Toulouse" (ISSAT) which lists a total of 127 entries only for France[10]. A non-space related post-graduate educational program is the "System Design and Management Program" (SDM) of the Massachusetts Institute of Technology (MIT).

Post-graduate space education is either provided internally within an organization, such as an agency or a company, or realized through sending individual professionals to programs and courses. Apart from highly specialized trainings, the space sector demands more and more managers, engineers and scientists with a broad overview of the space arena, a system view and an instinct for business able to work in a multi-disciplinary and multi-cultural environment.

Types of Programs

Existing programs differ widely in scope and characteristics, coverage and focus, quality and organization, as well as entry qualifications and required time effort. Furthermore, they may provide certificates or even Master degrees.

SpaceTech of the faculty of Aerospace Engineering of the Delft University of Technology (TU Delft) and the International Space University (ISU) both provide internationally recognized master programs. Individual universities in Germany, United Kingdom and Italy have developed further space post-graduate programs often in close cooperation with space industry. Companies such as EADS provide e.g. an internal Systems Engineering Basic Training Program for their employees. The typical focus of these programs is in classical space application areas such as telecommunications, navigation, Earth observation and space exploration. Some programs include further modules for space law, management, systems engineering, business engineering and personal skills development.

In the following a sample selection of well-established European and U.S. programs is described in further detail.

SpaceTech

The Delft University of Technology was the first European university to offer a Master's degree in Space Systems Engineering as part of its post-graduate program SpaceTech[1], established in 1995. SpaceTech is an international post-graduate program for experienced high potentials seeking expertise in space systems and business engineering. Its ten month program is centered around five two-week sessions[11] which take place at attractive locations at European space centers and allow the participants to stay on their regular jobs. The program offers end-to-end systems competence in an international and multidisciplinary environment. Participants bring prior acquired knowledge and know-how into the heart of the SpaceTech program: the Central Case Project (CCP). Here, they must show that they are able to develop a technically feasible system based on systems engineering processes and tools, and, at the same time, come-up with a viable business case. Highly skilled and experienced coaches provide continuous guidance over the CCP (cf. Fig. 1). Over 80% of the graduates have made major career steps within three years of graduation as a result their participation in SpaceTech.

Master Space Studies, Master Space Management

At the International Space University (ISU) near Strasbourg, France, more than 2400 students have graduated over the past 20 years[12]. Major programs are the two-month Space Studies Program (SSP) as well as the twelve-month programs on Master in Space Studies (MSS) or a Master in Space Management (MSM). Both

Tab. 1 Key features of selected well-established post-graduate space education programs.

Affiliation	Delft University of Technology	International Space University	Politecnico di Torino, SUPAERO, University of Bremen	Naval Post-graduate School
Program	SpaceTech	MSS, MSM	SEEDS	N.A.
Objective	International post-graduate program for high potentials seeking expertise in space systems and business engineering	Graduate level training in space in a interdisciplinary, inter-national, and inter-cultural environment	Harness recent development lines in the space strategies of both the European Union and the USA on exploration	Lead in transformation and manage change in tomorrow's complex and technically challenging world
Focus areas	Systems and Business Engineering	Management	Exploration	Design and integration
Participants	Mid-career professionals	Young space professionals	Young space professionals	Officers
Sending institutions	Agencies, industry	Agencies, industry	Agencies, industry	Navy
Duration	10 months	1 (– 7) years	15 months	
Degree	Master Space Systems Engineering	Master Space Studies, Master Space Management	Master Space Exploration and Development Systems	Masters Space Systems Operations, Master Astronautical Engineering

are graduate-level degrees designed for individuals seeking professional development or further academic study. The master study is structured in five modules which may be taken over a period of up to seven years. The ISU aims at implementing diversification through the selection of students and faculty based on international, intercultural and interdisciplinary criteria[13] and at restoring gender balance in the space sector. Team projects are part of the study which are divided in business and management, Earth observation, exploration, near-Earth objects, space applications, science and others[12].

SEEDS

Being an international postgraduate master course in "Space Exploration and Development Systems", SEEDS focuses on space exploration and the systems for its development, rather than on space utilization. The program is rooted within three European cities and regions in Torino, Toulouse and Bremen which have both academic and industrial space activities, such as Politecnico di Torino, SUPAERO and University of Bremen on one side and Thales Alenia Space, ASTRIUM and OHB on the other side. Young professionals work for 14 months comprising a six months lecturing phase and an eight month project work phase (Chiocchia priv. comm.). SEEDS puts major emphasis on a large project work to be sequentially performed through three successive internships in companies and centers. The three geographical centers contribute in different levels to the program.

US

Among the various programs in the U.S., the Space Systems Academic Group (SSAG) at the Naval Post-graduate School (NPS) in Monterey, California, provides masters on Space Systems Operations and Astronautical Engineering. The Space Systems Engineering program for example provides officers with the theoretical and practical skills required to design and integrate military space payloads with other spacecraft subsystems. Officer graduates will be prepared to manage the technical aspects of a space system life cycle including requirements definition and analysis, design, development, installation, and operations[14]. In this framework, the NPS tries to couple space research with the graduate education of military officers.

Synopsis and Analysis

Core criteria to compare post-graduate educational programs are objective and content, addressed participants and sending institutions, as well as program duration and degree. These criteria are collated in Tab.1 for each of the selected programs.

It is obvious that the programs have pronounced commonalities but each of them has at the same time a particular focus. They do typically share sending institutions which, together with the overlapping content, makes them partially competing against each other.

Particular differences between the programs are found for the characteristics of addressed participants (Tab. 2).

Tab. 2 Key characteristics of well-established program from a participant's perspective.

Programs	Space-Tech	ISU	SEEDS	NPS
Participants experience [yrs]	5-10	0-5	1-5	0-5
Program parallel to job	Yes	No	No	No
Nationality	Int.	Int.	Eur.	U.S.

The typical professional experience of participants when entering a program can vary and range up to 10 years. Some programs require participants to quit or pause their current job, while others allow continuation on the regular job in a parallel setting. The nationality of participants can vary from programs focused on single countries up to fully international teams of participants.

Although information on existing programs in post-graduate space education is, in principle, freely accessible through the internet, the quality, content, timeliness and coverage of program descriptions makes comparison and selection difficult for sending institutions and potential participants likewise.

VIRTUAL SPACE ACADEMY

Need

Space industries, space agencies and space institutions require highly trained and educated staff calling for a continuous learning and training process. This demand is particularly visible in Europe as well as in the United States. In addition, recent developments will generate a growing demand in Asia over the next years.

From a user's perspective, the landscape of post-graduate space education is fragmented, uncoordinated and difficult to access. On the other hand, existing programs lack information on the content and organization of other programs and may face constraints regarding access to facilities and venues, lecturers and faculty, as well as coverage of specific content.

Mission

To remedy these shortcomings, a kick-off for a Virtual Space Academy was held on May 14th 2008 at the Delft University of Technology. The goal was to identify the need, define the mission and objectives of the Virtual Space Academy as well as to discuss ways of implementation.

Derived from the identified needs, the mission statement is described in Fig. 2. The above overview has shown that, in general, major areas of space are currently covered in existing post-graduate education. As a consequence, a Virtual Space Academy should not offer an own self-standing educational program. Instead, existing programs should become partners of the Virtual Space Academy to benefit according to the objectives described below.

The word "virtual" describes the fact that the Virtual Space Academy does not attempt to create its own post-graduate education but provides information and coordination services internally among its partners and externally to its users. It also covers networking aspects such as e-learning and distance learning.

> The *Virtual Space Academy* coordinates space education for post-graduate students and professionals and realizes cross-fertilization between the programs to enhance and stimulate space education.

Fig. 2 Mission statement for the Virtual Space Academy.

Objectives

Key stakeholders of the Virtual Space Academy are the users and the partners. Users are potential individual participants and sending institutions. Partners are institutions which offer an existing program of post-graduate space education or such programs itself. Furthermore, an advisory board within the Virtual Space Academy will consist of selected members from industry and agencies which advise the academy on content, organization, marketing and funding.

Thus, regarding the objectives of the Virtual Space Academy, a distinction has been made between objectives for users (seeking for post-graduate space education) and objectives for internal partners within the Virtual Space Academy.

For users, the key objectives of the Virtual Space Academy are

1. Allow sending organizations and individuals to overview existing programs
2. Improve and support mobility of participants
3. Inform about internships, thesis opportunities, stages at the different partner organizations.

Programs in this context are understood as short-, mid- and long-term post-graduate space education activities. The mobility of participants can be supported by, e.g., distance or e-learning methods.

For partners, the key objectives of the Virtual Space Academy are

1. Establish a truly international database on existing programs.
2. Improve and support mobility of lecturers.

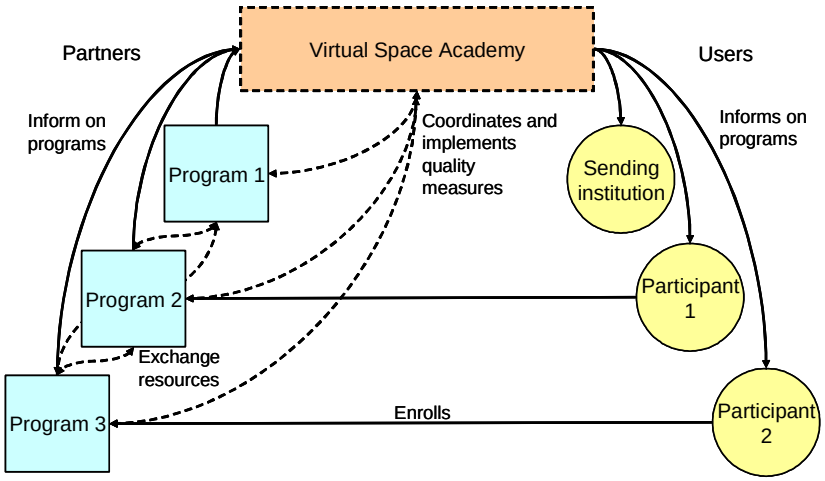

Fig. 3 Schematic interfaces between partners, users and Virtual Space Academy. Dashed lines indicate coordinating activities.

3. Increase value of education by involving industry and agencies.
4. Establish networking in the broadest sense to implement new ways of sharing education
5. Enable quality assurance of post-graduate space education.
6. Allow partners access to academic resources, experiences, sites, laboratories and tools which would not be accessible for individual programs.
7. Complement curricula by courses or modules offered by other programs.
8. Save cost through increased efficiency.

Increasing the value of education through involvement of industry and agencies is already done on individual program level. The cooperation between industry, agencies and academics within the Virtual Space Academy can generate information on future needs and trends in space. Such involvement can be implemented through the advisory board by regular meetings or, e.g., the exchange of information through a web-based portal.

The objective of networking in the broadest sense to share education highlights the virtual character of the academy. Examples for sharing education are e-learning, distance learning provided by world-class experts, or the involvement of individual lecturers in several programs.

The quality of existing programs differs as well as the offered certificates or degrees. Moreover, different accreditation schemes are applied in each country. Thus, the academy shall identify and implement measures such that the quality of programs can be assessed and adapted. In this context, a relation to the PEGASUS network (Partnership of a European Group of Aeronautics and Space Universities) is important with its objective to optimize services in Europe to attract the best students and to offer highly relevant educational and research programs. Quality assessment is relevant for users and partners alike. Common quality standards could act as necessary prerequisites to allow and exchange modules or lecturers between programs. Investigations on regulatory aspects related to the Virtual Space Academy are required.

The Virtual Space Academy can realize cost savings through, e.g., improved visibility and harmonization of existing courses, the availability of lecturers and visits of laboratories, distance and e-learning as well as the sharing or exchange of modules.

Implementation and Next Steps

The concept and interfaces of the Virtual Space Academy are depicted in Fig. 3. The organizational form of the Virtual Space Academy shall be an association or consortium with a board of founding partners. The founding committee comprised members of the Faculty of Aerospace Engineering of the Delft University of Technology (The Netherlands), the Politecnico di Torino (Italy), Telespazio (Italy), the l'Institut Supérieur de l'Aéronautique et de l'Espace ISAE (France) and the European Space Agency (ESA). The founding partners shall be determined in a workshop of the Virtual Space Academy to be held in fall of 2008.

Business opportunities for the Virtual Space Academy have been identified. This comprises, among others, a support from the European Space Agency and national space agencies as well as through the 7th framework program of the European Union.

SUMMARY AND CONCLUSIONS

A Virtual Space Academy has been initiated. The academy will coordinate space education for post-graduate professionals through international cooperation and realize cross-fertilization between the programs to enhance and stimulate space education. For external users, this will ease the access and comparability of programs and improve the value of education provided by the programs. For participating partners, the academy will be a remedy against a lack of coordination between existing programs. Even more importantly, the academy will establish a broad network supporting quality assurance as well as access and exchange of resources. This will strengthen the programs through increased efficiency while minimizing overhead through the virtual setting of the academy. The Virtual Space Academy will be a key asset in promoting professional space education in the future.

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