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Five years of the international SEEDS Master Course A contribution to Space Exploration

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Abstract. After five successful editions the international post-degree programme SEEDS (SpacE Exploration and Development Systems) deserves some reflections to take advantage of the past experience and to provide some hints for its future continuation. Its original formula based on four main features: i) the focus on space exploration (rather than on space utilization), ii) the European dimension, iii) the ambitious project work activity performed in three countries and iv) the approach based on system engineering, demonstrated extremely fruitful from the point of view of the stakeholders (the European space industry and Agencies) but was difficult to manage in absence of a constantly assured support at the continental level.

1. Introduction

This paper illustrates SEEDS'original idea, outlines its realization and developments in the past five years, points outs the main critical issues and finally describes the present stand and the possible perspectives. SEEDS (SpacE Exploration and Development Systems) is a postgraduate Master Programme enrolling owners of a MSc in Engineering or Physics.

2. SEEDS' original idea

According to its original concept, students are recruited in three European sites hosting significant industrial and academic activities in

Fig. 1.

the domain of human space exploration. An

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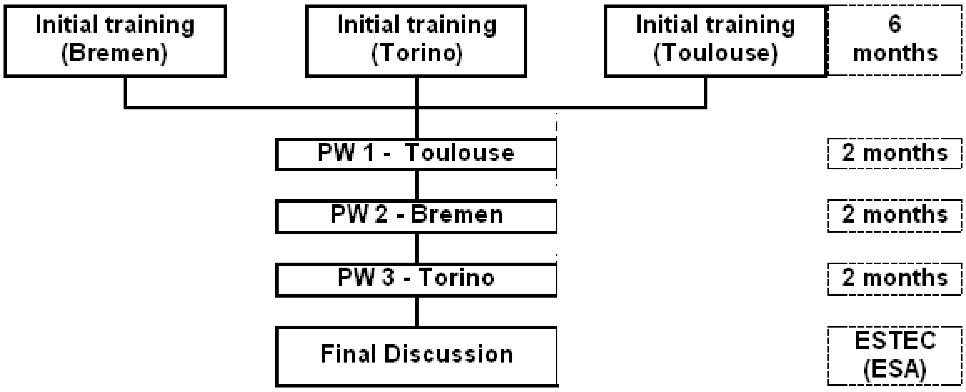

Fig. 2.

initial 6-month phase of preparatory training is offered in each town to the students there recruited. This phase is necessary to provide them with the common bases of knowledge and with the tools needed to face the subsequent project activity. It is foreseen, in fact, that the selected graduates arrive from different scientific and engineering MSc curricula, a fact which, in spite of being strongly requested by the multi-disciplinary nature of the activity to be performed, makes an initial harmonization phase necessary. In each town the teaching and training responsibility are shared between the local academic institutions and industries.

In the following 6-7 months all students work together in cross-national teams to develop an extensive research (Project Work, short PW hereafter) under the guide of experienced senior tutors, mainly of industrial provenance. The PW is one of the main characteristic features of SEEDS. It is divided into three phases hosted in a temporal sequence by universities, industries and centres of the three associated European towns (the sequence indicated in the diagram is only for exemplification purposes and may be changed from cycle to cycle). Each PW phase lasts 2 months and is dedicated to a special aspect of a manned space exploration mission, according to the best competences and traditions available in the hosting town.

This scheme is absolutely peculiar in that it displays four unique features:

1. SEEDS focuses on (human) Space Exploration and the systems for its development, rather than on space utilization.

- other European master programmes are either focused on space sciences or (if on space engineering) are general or concentrated on aspects related to utilization
- SEEDS aims to safeguard the European knowledge and skills in Space Exploration in the perspective of a renewed emphasis on it in US and EU

2. SEEDS is European, but not in a general way.

- Its true international nature perfectly matches that of the Space Exploration activities in Europe:
- it has been originated from three Institutions selected why located in three town (Bremen, Torino and Toulouse) already linked by old dating industrial relations in space activities, thus providing an exceptional environment for students education and training
- most other master programmes originate solely from academic collaborations (with possible later industrial involvement)

3. SEEDS Project Work is a very special activity.

- SEEDS puts major emphasis on a large PW to be sequentially performed through

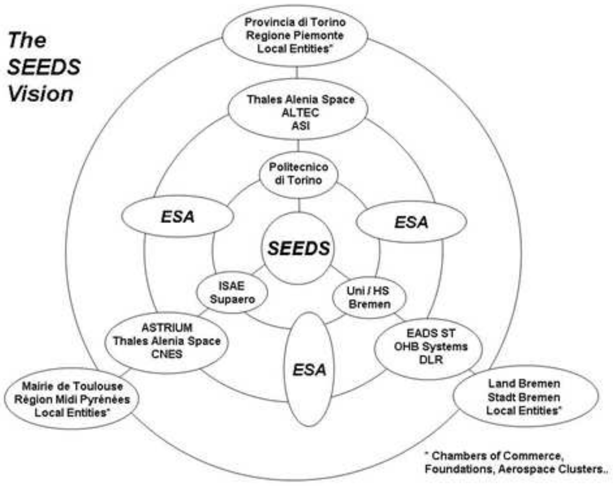

Fig. 3.

three successive internships in companies and centres of all three towns:
- the time allocated to the PW and to the related report dominates over that allocated to the lectures and the exercises (6-7 months vs. 5-6)
- the PW itself is a high quality coordinated activity, leading to reports to be discussed in ESA
- No existing master programme provides this opportunity (only shorter internships in a unique company and country are usually provided)

4. SEEDS'approach is system engineering oriented, not discipline focussed as in the academic tradition.

- Differently as in the existing academic MSc programmes on space engineering, SEEDS emphasizes the system vision:
- individual disciplines are not deepened beyond the minimum necessary level;
- graduates from different branches of engineering and physics are recruited, resulting in a class provided with a manifold of knowledge and potential competences and SEEDS shows them how to work together

It can also be stated that the blend of these four unique features is just SEEDS'most unique feature. In fact each one of the four SEEDS characteristics

- Focus on human Space Exploration
- Differently as in the existing academic MSc programmes on space engineering, SEEDS emphasizes the system vision:
- Rooted in three European towns already linked by industrial space activities
- Dominant role of an ambitious Project Works performed on EU scale
- System Engineering approach

is by itself very special. As a result the following skills are expected from SEEDS'graduates:

- Experience to work in international teams, open to the world, ready to "cross the borders"
- Multidisciplinary, nonspecialized approach
- Integrated vision of the Space Exploration, attitude to think in terms of systems
- Knowledge "from inside"of more than one European environment active in space (companies, agencies and research centres)
- Experience in dealing with borderline problems through challenging Project Works activities confronted in an international environment

All this led to a "SEEDS Vision"in which SEEDS is the centre of gravity of a systems including not only the main academic institutions and the space companies located in Torino, Bremen and Toulouse, but also the national Space Agencies and the local Authorities. The European Space Agency ESA provides the necessary connection at the continental level among all involved subjects.

3. The history of SEEDS: a short outline

Outlining SEEDS'history is an interesting exercise to help understanding the present difficulties and the possible ways out from them. A simple chronology report is sufficient to this purpose.

- 2004: thanks to the personal engagement of prof. Vallerani, Politecnico di Torino proposes SEEDS to the selected academic partners of Bremen and Toulouse.
- 2005: a meeting on SEEDS took place in Bremen (participants were Universität Bremen, ZARM, EADS ST, OHB, Senat Bremen, Faser Inst.,). A Memorandum of Understanding on SEEDS was agreed.
- 2005: In Toulouse Supaero (now ISAE) associates to SEEDS through its existing TAS-Astro post degree programme;
- 2005: SEEDS starts in Torino ("0 year") with 60 applications and 15 selected students. All are Italian. The beautiful SEEDS logo is designed and adopted.
- 2005: Universität Bremen establishes a SEEDS MSc programme for 3 years under the condition that it be self-financed
- 2006: at year's begin the situation of SEEDS looks extremely promising:
  - ESA D/HSF is supporting SEEDS (opening and closing week hosted at ESTEC, initial grant, lecturers)
  - Tutors for the first Project Work are made available in all three towns, particularly by the TAS-I in Torino, EADS and OHS in Bremen
- 2006: signature of a "Trilateral Agreement"on SEEDS by Politecnico di Torino, Universität Bremen and Supaero Toulouse. The solution adopted for the degrees was:
  - Students enrolled in the three countries are awarded with their national degrees
  - All together receive also the SEEDS Certificate, actually a label without a legal value, however subscribed by all three partner institutions

Since 2005 five SEEDS editions have been started and successfully concludes. Project Works have been developed on the following themes:

- SEEDS 1: "Human Lunar Initial Settlement for Space Exploration"
- SEEDS 2: "Permanent Human Moon Base"
- SEEDS 3: "Lunar Orbiting Space Operation Centre"
- SEEDS 4: "Lunar Itinerant Caravans"
- SEEDS 5: "Mission to Asteroids"

Every project is summarized in an Executive Summary which can be discharged from the European SEEDS website www.seeds-master.eu.

All 46 graduates from the first 4 SEEDS editions are employed (only 2 to 4 in non-space activities). The majority of them have been hired by TAS-I, but several other are spread in EU. All this led to an excellent external image of SEEDS. For instance:

- Results from the PWs have been presented at the IAF Conferences and also to other world events
- SEEDS has been invited to join a few other post-MSc programmes in proposals to EU (e.g. "Virtual Space Academy")

4. Critical issues of an innovative project

In spite of these undeniable successes some critical elements emerged. The most important one was the difficulty to efficiently recruit students on a true European and worldwide basis. Only 7 out of the 54 graduates from the 5 SEEDS editions are non Italian (2 from France, 1 from Germany, 1 from Spain, 1 from Romania, 1 from Venezuela and 1 from

Uganda) As a first consequence, in 2008 the University of Bremen withdrew from SEEDS due to the impossibility to recruit students in Germany (on that occasion it was realized that the idea to attend further study programmes after the MSc is by no way familiar in Germany). This situation is regarded as very critical by ESA. In spite of a grant accorded in 2008 to encourage the enrolment of non Italian students from ESA (or ESA candidate) countries, the recruitment of SEEDS-5 did not improve. Also the space industry of Bremen is no more able to further support SEEDS without:

- an academic SEEDS Partner in Bremen
- a sufficient outflow of German SEEDS graduates looking for a local employment

But without industrial and academic partners in Bremen SEEDS would risk to collapse to little more than a national initiative and both its outstanding features and its positive image would be lost.

5. Present stand and perspectives

After completing 5 editions and providing the European Space Exploration with more than 50 highly qualified specialists, a pause of reflection"had been decided. SEEDS-6 will not start before Fall 2011. During this pause a new "SEEDS formula"will be sought in order to solve the main problem, namely "More recruitment of EU students from outside Italy".

Some perspective paths may be followed:

- to involve new EU countries (UK, NL)
- to recruit at the undergraduate (BSc) level instead at MSc level (or in addition to it)
- to interact with other existing MSc space programmes, also by exploiting the opportunities of the ERASMUS project
- to involve ESA more deeply in the SEEDS conduction and in the definition of the PW topics
- . . . other ideas are welcome

6. Conclusions

Unfortunately the present moment is not as favourable to the human Space Exploration as the past decades: budgets are cut, the return on the Moon is delayed However, a great body of knowledge is owned by expert engineers who are retiring or already retired. These are the people who participated to the glorious activities of the 60's and the 70's. If they will not have the possibility to transmit their experience to the young people of today, all this will be lost for the day in which human Space Exploration will be started again (and, sooner or later, it will!). This is maybe the most important mission of SEEDS.