

A BROADER VISION: SPACE PROJECTS AND INTERNATIONAL COLLABORATION

Timothy F. Wheeler⁽¹⁾, Sven G. Bilén⁽¹⁾, Kenneth Haugland⁽²⁾, C. Russell Philbrick⁽¹⁾

⁽¹⁾The Pennsylvania State University Department of Electrical Engineering,
318 Electrical Engineering East, University Park, PA 16802 USA
Email: tfw1@psu.edu; sgb100@psu.edu; crp3@psu.edu

⁽²⁾Andøya Rocket Range, P.O. Box 54, 8483 Andenes, Norway
Email: kenneth@rocketrange.no

ABSTRACT

The success of the recent ESPRIT student rocket, along with high student interest and administrative strategic initiatives has led faculty at The Pennsylvania State University (PSU) to establish a broader vision for student participation in space-related projects. The newly organized Student Space Programs Lab (SSPL) at Penn State provides opportunities for undergraduate and graduate students to participate on projects on nanosats, balloons and rockets. International collaborations and exchanges under development for SSPL support the PSU College of Engineering's (CoE) strategic initiatives for "training the world-class engineer". Using ESPRIT as a framework, a Memorandum of Understanding (MoU) between PSU and Andøya Rocket Range (ARR)/the National Center for Space-related Education (NAROM) is being developed to formalize a commitment to work together toward a common goal of encouraging well-trained scientists and engineers to pursue careers in space-related disciplines.

1. INTRODUCTION

Beginning in the 1990s, Penn State saw a need to provide students with professional development opportunities beyond the laboratory experiences of core curriculum classes. The purpose of these programs was to challenge the students to take a comprehensive responsibility to design, fabricate and test instruments for use in space and thereby to develop professional skills and experience that would provide an advantage for them and their employers as they began careers in space-related fields [1]. For example, under the NASA Get Away Special (GAS) program, Penn State students built experiments that flew on the space shuttle in 1986, 1996, and 2001. Other examples include the ongoing participation in the University Nanosat Program (LionSat and NittanySat) and three SPIRIT rocket flights in 2000, 2004 and 2006. With this last SPIRIT flight, called ESPRIT, the student-built payload included participants from three Norwegian universities and was launched from Andøya Rocket Range (ARR) [2]. Now, all these types of program have been pulled together within the Student Space Programs Lab (SSPL) that will coordinate student work on a number of space

platforms, with an emphasis on a systems engineering approach to complex projects.

Parallel to the move toward experiential programs, there has been an initiative to include a more global perspective to the engineering training in the College of Engineering (CoE) at PSU. "Developing world-class engineers" is seen as a prominent strategic goal for the CoE [3]. It was natural for these parallel developments to come together. Space, after all, is a global environment and the desire to explore space appears to motivate students without regard to national boundaries.

In this paper, we will report on the new student projects lab and the emerging vision for "world-class" engineering at Penn State. We then discuss the MoU under development between PSU, and the Norwegian National Center for Space-related Education (NAROM), along with ARR. For several reasons, the timing is propitious for establishing student exchanges and collaborative programs.

2. STUDENT SPACE PROGRAMS LAB

The creation of the Student Space Programs Lab (SSPL) has brought together the various elements of undergraduate and graduate space-related student project work at PSU into a single organizational unit [4]. This new formulation has a number of advantages over the series of singular projects that preceded it:

- It provides a central organization for presentation of topics and skills that are common to all the student projects. For instance, systems engineering concepts and the engineering design process can be taught to all incoming students. The standardization of project development processes should provide flexibility for students to move from one project to another.
- It boasts a more solid organizational structure that will make it easier to attract steady funding. Past opportunities often have been limited by insufficient funding. Under SSPL, the sharing of capital resources and a steady stream of diverse projects should make the program attractive for year-after-

year funding from private companies (which have an interest in hiring these students as graduates), as well as from government funding agencies that support project-based education.

- The pool of SSPL students will provide a more manageable way for students to be assigned where they are most needed. This will isolate the project scheduling imperatives from the complex problems related to shifts in student schedules and priorities.

- It is hoped that a legacy of student designs can be developed over time that might be applied to flight opportunities as they arise. For instance, if SSPL students could boast of flight testing of one of their designs, this would strengthen a proposal for further flight opportunities. Similarly, if students were to develop an instrument that is well-adapted to ionospheric measurements, it could itself be marketed to bring in further flights.

- From an educational standpoint, instructional models beyond the standard lecture course are used to involve students in the projects, based on the students' learning preferences and interests [5]. A particular strength of these projects is to develop skills not available in the classroom, such as team building, group learning and mentoring [6, 7].

The educational structure of SSPL includes three interdependent components: academic coursework (including physics of the space environment and space systems-related courses), project work, and research. Students, both at the undergraduate and graduate levels, are offered a still-expanding series of courses in the EE and AERSP Departments at Penn State, including a range of topics related to systems engineering, space physics, and space vehicle design and performance.

A Certificate of Space Systems and Engineering has recently been established as a way to acknowledge the students' project work on their academic record. The certificate plays a dual role. It encourages students to identify themselves with space engineering early in their academic careers [8] and it also provides official documentation of their experience as they enter the job market [9].

3. PSU ADMINISTRATION'S VIEW OF INTERNATIONAL PROGRAMS

Students often cite the desire for "hands-on" experience as the justification for committing their time and energy to student projects courses. This is an important factor, but project work is valuable for many other reasons, among them: social interaction and professional development, such as experience with scientific research

methods, managing complex projects, employing the engineering design process and teaming.

A further dimension of professional development, seen to be increasingly important in the global market place, is experience in an international setting [2]. For this reason, the Penn State College of Engineering has identified being "sensitive to cultural differences, environmental concerns, and ethical principles" [3] as necessary attributes of engineering graduates. This is part of the strategic goal of training "world-class engineers" and it is the basis for a new emphasis on developing international exchange opportunities for Penn State students. In the ideal case, these exchanges would include coursework as well as projects. In order to facilitate the process for approval of student participation in an exchange, it is proposed that a "template" or approved track be established beforehand. This would make approval for participation in the exchange a routine procedure. Under this arrangement, completion of a pre-approved course or series of courses at a cooperating institution could be used toward a Penn State student's graduation record. Pre-approval of particular course offerings would be based on the content of the course, the level of instruction and the degree to which that course is a direct substitute for a Penn State course. The student, of course, must still work with an advisor to determine the suitability of the pre-approved courses to his or her graduation requirements and interests. It will be important that students not need to delay their graduation date in order to participate.

Although other programs exist at Penn State CoE that include a form of international experience, the programs envisioned for the SSPL would be unique as the only program to use space-related research and technology as a basis. As a consequence of this emphasis, SSPL projects can be expected to be highly technical. They should also include many opportunities for gaining the real-world experience that students' value in several high-demand specialties. Since the motivational appeal of space transcends national boundaries, it is an appropriate topic for educational programs that would emphasize global and multicultural issues. Since both Norway and the US have well-established and vigorous space research programs, this is a natural environment for scientific collaboration between our nations. The importance each country places on this national agenda makes it necessary for our universities to consider ways of guiding the best engineering and scientific students towards space-related careers. The SPIRIT Program [5], among others, has shown that project-based learning is an effective way to involve students in space-related work and to motivate them to continue their studies in this direction.

4. MEMORANDUM OF UNDERSTANDING WITH ARR/NAROM

SSPL at Penn State provides an excellent platform for implementing these goals through routine international collaboration. To that end, a program of collaboration and exchange is envisioned between PSU and ARR/NAROM (representing Norwegian universities). This joint program would feature a program of joint projects for the benefit of our respective students. A foundation agreement is under development that would provide the framework for such an ongoing collaboration.

From the Penn State side, establishing a steady program is an important step in implementing the College of Engineering strategic goals described above. Such a program will build seamlessly on a long history of cooperative research projects involving Penn State and various Norwegian institutes over the past thirty years, but would now establish NAROM as a coordinating body to facilitate the tasks of developing projects and attracting Norwegian students to the effort.

NAROM is ideally positioned to be a partnering institution in this effort. Over the past ten years, NAROM has signed agreements with eleven Norwegian universities and technical colleges. NAROM has a mandate to support space-related education in Norway and so they have resources and connections that are useful for ensuring that the joint projects move forward. In overseeing these educational projects, the symbiotic relationship between NAROM and ARR is also important. While ARR supports the technical aspects of the projects (as it has done with the recent ESPRIT mission), NAROM arranges and supports the educational aspects. NAROM, through its relationship to ARR, can also play a role in bringing together the extensive scientific resources at ARR for the benefit of these educational projects. The RMR Lidar at ALOMAR Observatory, and the EISCAT Radar in Tromsø provide two prominent examples. Both collaborated in the ESPRIT project by special arrangement and proved immensely valuable for coordinating the ESPRIT rocket launch and in developing analysis of the data from that mission.

Finally, the tasks of recruiting and training Norwegian students in rocket techniques will also be handled by NAROM. NAROM has experience in organizing workshops, rocket camps and field station programs for the benefit of students at Norwegian universities.

For ARR, this first international educational agreement is a significant step toward a vision of becoming a comprehensive technical and educational center for space science. This role makes sense in the broader

picture of ARR's efforts to provide a comprehensive slate of rocket/balloon launch and support services.

The portion of the MoU relating to joint projects should be seen as a formalization of the commitment on the part of PSU and ARR/NAROM to increasing routine collaboration for educational purposes. We should be able to move forward on the basis of the momentum established by the ESPRIT project. However, to fully realize the potential of this unique relationship, future project work will also be augmented by student academic exchanges, including internships, research assistantships and coursework in the students' program of study in Norway and in the USA.

ARR has taken a first step in this direction, having recently sponsored two students from Sydney University in Australia to work on computer software for launch systems and on aerodynamic analyses related to an ongoing sounding rocket project. Through this work, these students fulfilled a work experience requirement for their home institution and earned academic credits [9].

The opportunity for the students to earn academic credit is important to the study abroad experience. This means that the procedure for awarding academic credit, the equivalence of the respective courses and availability of those courses (in English) must be planned in advance. At present, the Office of the Dean of the College of Engineering at Penn State is involved in working out the details of such exchanges, along with the Penn State International Office.

The envisioned level of participation (approximately 3 students per year) will require a steady stream of student projects. These projects may be long-term projects, such as ESPRIT, or they could be smaller scale projects that would be completed in a semester. Rocket performance analyses and the development of instrumentation and rocket systems hardware are some examples.

The MoU represents a commitment to address our shared goal of providing well-trained engineers and scientists for the space-related challenges in the years ahead. These professionals need to be comfortable in the multicultural teams and projects that such careers will require. The agreement is intended to encourage a long-term relationship between PSU and NAROM (and participating institutions) and it should include the flexibility to expand. It will be guided by a joint steering committee, consisting of representatives from PSU and NAROM, to maintain the vitality of the cooperation.

5. CONCLUSIONS

The momentum from the highly successful ESPRIT Project, which launched from Andøya Rocket Range on 1 July, 2006, has resulted in an environment favorable for establishing routine international collaboration between The Pennsylvania State University and Norwegian universities as represented by NAROM and ARR. At Penn State, space-related student projects (including SPIRIT, University NanoSat, and GAS programs of the past decade) have been consolidated into a Student Space Programs Lab which should be an effective organizational structure for supplying committed and well-trained students to the projects as they come available. Concurrently, a strategic commitment on the part of the Penn State College of Engineering to increase opportunities for students to gain experience in an international setting has encouraged plans to develop more ambitious academic cooperation, including student exchanges, research partnerships and internships. An MoU or foundational document is moving forward that would be the basis of such cooperation. Space is a logical common ground since both Norway and the US, based on a tradition of excellence in space research, are eager to encourage the best science and engineering students to pursue careers in the global space-related industry and research enterprises of the future.

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