ENHANCED STUDENT PERFORMANCE THROUGH INDUSTRY ADVISORS

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Abstract – Undergraduate students that complete their degrees and enter industry are seldom prepared for some of the realities of the work force. The expectations of academic reports for laboratories and course projects have strong theoretical considerations that often focus on small sub-problems manageable within a laboratory, unit, or at most a course. This exposure is very different from long term industry projects where designs not only have to work in isolation, but must also adhere to customer specifications, strict timelines, and limited budgets. In order to bridge the gap, the University of Manitoba introduced industry advisors into the team competing in the Canadian Satellite Design Challenge to design, build, and test an operational triple pico-satellite (T-Sat). The advisors attend internal reviews and provide feedback on many areas including designs and documentation. In addition to aiding students in their performance at the competition, the process also provides motivation for long-term career goals, networking opportunities for students, and a strong foundation on many desirable skills for successful careers as a Professional Engineer.

This paper describes the process of integrating advisors and the observed benefits from the experience at the University of Manitoba.

Keywords: Complex projects, experiential learning.

1. INTRODUCTION

The engineering curriculum is filled with theoretical and practical concepts that serve as the foundation for the design process. For the most part, courses consist of a themed collection of ideas that are evaluated through assignments, laboratories, projects, and exams that highlight the key concepts emphasized in the course. However, academic reports are very different from industry expectations where detailed interface specifications, thorough performance reports, verification plans, and overall description of how small components fit into a larger system are required. One approach to compensate for this and prepare students for future careers is to introduce industry advisors in the educational process, and in particular, in student design competitions that expose the entire design process from concept, through implementation, integration and testing. One example of such competition is the Canadian Satellite Design Challenge (CSDC). In this challenge teams of undergraduate and graduate students from Canadian academic institutions must design, build, test, and launch an operational triple pico-satellite (T-Sat) carrying at least one scientific experiment. The University of Manitoba team consists of over 100 students from five faculties working on the T-Sat project [1]. The students are exposed to the industry expectations through a team of 50 external advisors that provide feedback and challenge the design decisions to serve as motivation while also setting high expectations for the project.

2. INDUSTRY EXPECTATIONS

Regardless of the engineering discipline, students are expected to obtain a number of attributes and skills in their undergraduate education to succeed in industry. These skills can be classified into (a) technical skills that include elements of design, exposure to state-of-the-art tools, and analysis techniques, and (b) soft skills that include communication skills, ability to work in a team, and professionalism.

2.1. Technical Skills

The technical skills are often the focus of educational institutions. Curricula are filled with exercises that cover
the mathematics, physics, electronics, statics and other topics discussed in classes. These are complemented through laboratories where students get some hands-on exposure to tools used to apply theories covered in the classroom. This exposure to problems is very much limited to small problems or pieces of problems that are manageable within the time span of a class, unit, lab, or at most a course. Consequently, it is very difficult to select the appropriate examples that are both representative of real scenarios and that emphasize the key concepts from the lectures, as often, the real examples require substantial lengths of time to explain fully to the students. This leads to many educators teaching examples in isolation from reality depriving students of the system level understanding.

As a consequence, most students do not get an exposure to important skills for industry such as the full project lifecycle, the application of systems engineering to understand how their piece fits into a larger system, which are important skills for industry [2]. In particular, the process of deriving requirements and drafting verification procedures with appropriate tolerances is often not even a part of many capstone projects, causing students to have to learn these very critical skills on the job where the margin for error is much smaller.

Furthermore, the classroom experience does not expose students to the concept of multiple stakeholders with interdependent requirements and project schedules. Although some of this is experienced in a small portion of capstone projects, the average student works within a confined environment where changes to the design at any stage are acceptable. Thus, students can often blend the line between design and implementation, as small changes are welcome to improve the performance by small amounts, rather than accepting a satisfactory solution that meets customer specifications.

2.1. Soft Skills

In addition to many technical skills, there are elements that are more difficult to teach in a classroom setting such as communication, teamwork, and professionalism. Although the Canadian Engineering Accreditation Board (CEAB) identifies these and many other skills are required graduate attributes for every engineering student, the interpretation and emphasis can vary between industry and academia. For instance, the format, style, and language use in technical reports in academia is very different from the expectations from industry. Academic reports are filled with references to similar work done by others and often regurgitate large portions of background theory that could simply be cited as a means of demonstrating that the student understands the material and can express it in its own words. While industry reports are commonly driven very concise explanations that show that the design meets the customer requirements. The theory is often included in appendices and is based on well-established technologies rather than the latest conference or journal publications where the state-of-the-art is still being developed.

Similarly, students are taught both explicitly and implicitly how to work in a team and be professional about their work, but some of those elements can be enhanced through exposure to large complex projects with multiple stakeholders.

3. INTRODUCING ADVISORS

Industry involvement in universities can help students transition into the work force. In order for this to be effective and worthwhile for both professors and professionals there are a few fundamental components that must be met such as identifying the right project, selecting the advisors to match the needs of the project, and integrating them into the project carefully to maximize their impact on the students.

3.1. Selecting Appropriate Projects

In order to maximize the effect of industry advisors, it is important to select appropriate projects where their contributions can be noticed, as the experienced factor becomes to play a role in the design. For instance, short course projects lasting a term are often characterized by spending the first half identifying the topics and the second half of the term designing and implementing. During the initial phase, students are often researching the topic, thus although it is possible to meet advisors early on, it is often best to wait until the students have established a foundation of knowledge to make the interaction worthwhile for both parties. Longer-term projects that last at least one year allow students to explore the topic on their own, then use a meeting with the advisors to ask more advanced questions, clarify concepts from the literature review, and obtain feedback on design concepts.

Furthermore, the projects must be complex relative to the experience level from the students in order to maximize the impact from the advisors. The complexity comes from many areas including technical, managerial, and interpersonal, as described in [3]. Technical complexity includes studying the trade-offs, part-selection, feasibility, and interactions between electrical and mechanical designs. In these complex cases, advisors use their experience to help separate the “needs” and “wants” of the project as well as the feasibility of the implementation based on personal experience. Managerial complexity comes from considering budgets, timelines with interdependent schedules, and even legal issues pertaining to the design. Finally, the personnel complexity deals with the division of labor within a large team and interactions with many project stakeholders.
For example, the two-year T-Sat project provides enough time for students and industry to interact, while exposing the students to many layers of complexity as described in [3] and in latter sections of this paper.

3.2. Selecting Advisors

There are a number of elements to keep in mind while selecting the advisors for a project, (i) number of advisors for a particular project, (ii) background and expertise, (iii) availability and commitment from advisors, and (iv) expectations from the advisors. All of these criteria are interdependent and without a definite solution.

In the case of the T-Sat project, a team of fifty-two advisors was established that included academics, industry professionals (including a large group with an aerospace background), business professionals, military, and amateur radio. The advisors then become stakeholders in the project as shown in Fig. 1. This wide range of background addresses multiple needs for the project well beyond the technical complexities of building a spacecraft that the academics and aerospace professionals offer. As other industries provide expertise in related fields, business professionals help in the promotional aspects of the project, the military provides logistics support, and the amateur radio community aids in the ground station support (as the satellite must communicate using amateur bands). Therefore, it is their combined effort that makes the group more effective.

The advisors for the T-Sat projects are expected to attend up to three evening meetings to review the progress of the project. Since there is a large number of advisors, if a few have time conflicts with other projects, the rest can still attend and fill the void to provide the continuity required. The expectation is that the advisors provide feedback on designs, share insight based on their experience, and question the design decisions from the students. Under no circumstances can they provide solutions, as this would defeat the purpose of the learning exercise and violate CSDC rules.

3.3. Integrating Advisors into a Project

As mentioned in Sec. 3.1, the timing and process for integrating advisors is very critical. It is important for students to obtain the necessary background knowledge in order to make the first meeting with the advisors worthwhile. That is, for students to ask insightful questions such that the advisors would feel needed, motivated to help, and intrigued to do more.

The T-Sat project began in October 2010, and the first meeting with the advisors was not scheduled until May 2011. This allowed students to organize themselves, acquire a base of knowledge, and prepare presentations on their proposed solutions. In this meeting, the students presented their ideas and received lots of feedback, primarily that they lacked a systems engineering approach to oversee the design of the entire satellite. Since the students showed that their willingness to work hard and motivation, the advisors responded by offering additional help in the form of a Systems Engineering full-day workshop and meeting with smaller groups on a regular basis to offer additional feedback on some of the more difficult tasks of the project such as attitude determination and control.

4. CONCLUDING REMARKS

Since the beginning of the T-Sat project, the students have hosted four internal reviews with the advisors and numerous other meetings to discuss small subsystems. The external advisors, primarily industry members, help reinforce many of the concepts taught in the classroom by asking questions, challenging designs, and offering feedback.

The impact of advisors is a more focused group of students whose appreciation for both the project and course work is increased by establishing links between real applications and the theoretical background. Furthermore, the student-advisor interaction serves as a networking opportunity for students to learn more about different companies while employers get a prolonged period to both mentor and learn about students that could potentially work for them in the future. Many meetings have concluded with informal discussions about career advise and opportunities for summer employment.
Within the CSDC, the T-Sat advisors have offered valuable feedback to the University of Manitoba team that has served as motivation for the first two phases of the competition and acted as a catalyst for top three rankings after the first two milestones. Meetings scheduled one month prior to competition deadlines have helped tweak submissions to improve clarity and resolve technical issues.

Plans are already underway for a final meeting with the advisors prior to the end of the CSDC and a thank you meeting after the competition.

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References

