BUSINESS AND ENGINEERING PROJECT INTERACTION

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Abstract — As a result of industry feedback and the ABET 2000 criteria, Seattle Pacific University (SPU) has introduced a multidisciplinary interactive experience between the business school and the electrical engineering department. This paper reports the way this interaction was implemented through a teaming effort undertaken between the School of Business & Economics and the Department of Electrical Engineering, utilizing professors from both departments who all possess considerable industry experience. A primary objective is to provide the student with experiences associated with high-tech business operations. The effort, now in its fourth year, consists of cross-discipline instruction for a Business Operations Management class and an Electrical Engineering class, inter-disciplinary combined class workshops, and classroom and laboratory exercises for student teams, with each team comprised of members from both the business class and the engineering class. One key activity is for the business students to educate their engineering counterparts about their analytical work on a business case study, and do it well enough so that the engineering students will be equipped to make a formal Power Point presentation on it to a plenary session of students and faculty. Similarly, the engineering students are required to prepare their business counterparts to make the same kind of presentation on one of their projects or some technical principle of electrical engineering. These experiences provide powerful "hands-on" venues in which students from differing disciplines are exposed to the diverse vocabularies and modes of thinking representative of actual professional working environments. This paper provides the basic classroom/workshop/laboratory activities that were undertaken, an indication of the educational experiences involved, a sampling of student verbal feedback, and future expansion considerations for this multidisciplinary interaction.

Introduction: Industrial Involvement

Since it's inception in 1985, Seattle Pacific University's (SPU) Electrical Engineering Program has had a history of industrial involvement. The senior design sequence was originally developed by Jon Parle from the Fluke Corp. and continues to have active industrial participation in the form of numerous design reviews. Originally Don Bowie served as a loaned executive from The Boeing Company and developed a junior design course with a project management emphasis. Currently he has been spearheading significant project management and business issues into design courses based on his experience and from advisory board feedback. In the academic realm it is all too easy for faculty and students alike to become so focused within the narrow confines of their discipline that they loose perspective on the fact that products and services are developed by cross-disciplinary teams.

To address this issue, Don Bowie has recently teamed with Don Peter, the regular instructor for SPU's junior electronics sequence, and Jim Rand, a management professor from the School of Business and Economics to provide a realistic interactive experience between engineering and business students. All three are especially sensitive to the importance of cross-disciplinary instruction because each has had extensive industrial experience before entering academia, and understands first hand the importance of being able to interact effectively with professionals of other disciplines. In fact, Jim Rand's keen enthusiasm for being the business professor participant was a direct result of his work experience outside of academia, and without his support this venture most likely would not have developed. The fundamental purpose of this effort is to transcend discipline-based academic barriers. Business and engineering were chosen because, in the real world, effective communication and understanding between these two professions are vital to corporate success in the high-tech industry.

A Work in Progress

This effort was initiated Spring Quarter of 2001 when Don Bowie and Dr. Jim Rand, agreed to work together by teaming the School of Business and Economics' senior course in Operations Management (BUS4644) with the Electrical Engineering Department's junior Engineering Design Course (EE3730). Don Bowie had been encouraged by the department chair, Dr. Anthony Donaldson, to innovate on the course content with respect to cross disciplinary interaction, in keeping with the ABET related goals. Don and Jim decided to implement their plan via three key activities of (1) exchanging professors as guest lecturers, (2) participating in joint workshops, and (3) having student teams become intimately involved with each other's class projects. It was hoped that these activities shared by engineering and business students would expose them to the ways of thinking, vocabulary, and activities of the other's profession.

The engineering lecture to the business students consisted of explaining engineering project management and then showing how the basic concepts apply in the business world such as in consulting efforts. The business lecture to the engineering students explained differences between strategic and tactical thinking and how tactical actions are appropriate for solving immediate problems; however, the need for strategic thinking is required to maintain a viable continued operation. A workshop expanded on these concepts by having combined business and engineering teams reduce the time required for a hands-on assembly process through tactical improvements and then obtain further significant time reductions by applying strategic thinking. In addition, the engineering students hosted the business students in the electronics lab to both introduce them to the lab environment and to demonstrate to them an electronic circuit, concept or theory. Students were required to write short reflection papers on these experiences. Below are images of these activities.



Figure 1 Dr. Rand explains process mapping vs. strategic thinking



Figure 3 Business students learn about audio amplifier design



Figure 2 Business and engineering students try their hand at timed assembly



Figure 4 An engineering student explains the use of brain waves in a biomedical design

The centerpiece of this interaction was to be the team based projects. The business students in the Operations Management course were required to analyze a case study from business and devise a recommended plan of action to alleviate a defined set of problems. An example would be advising BankOne Financial Corp on how to manage volatile currency exchange rates between their U.S. and Mexico based centers. The engineering students in the Engineering Design course were required to develop an electronic design project, including specifications, research, design, implementation, and documentation. An example would be a wireless headphones system for unencumbered music listening in their dorm room. Each business team working on a case study was paired with each engineering team working on an electronic design. First, they were to meet outside of class as much as necessary to educate each other as to the details of their respective projects. Next, they were to prepare a Power Point presentation of their project to be used by their counterpart team in an oral presentation to a plenary session of both classes. For example, the engineering students had to learn enough about the case study so that they could intelligently explain it, and the business team's recommended problem solutions, by utilizing the Power Point material supplied to them. They also had freedom to edit the presentation file as they saw fit to enhance their effort. Similarly, the business students had to become well enough acquainted with the details of the electronic design so be able to make a credible presentation on it to a plenary session. The team oral presentations were

then graded by their respective instructor. Below are images of these presentations.



Figure 5 A business student explains shortwave digital radio



Figure 6 A business student explains student design diagnostic instrument for an on-campus need



Figure 7 Engineering students explain Toyota's car seat manufacturing line problem



Figure 8 Engineering students present recommendations for promoting a new Burger King sandwich

A number of positive, negative and humorous items of verbal student feedback were received such as: "I didn't realize how much I have learned until I explained my project (case study) to my counterpart." "What a great way to have business and engineering students learn together," "...and I thought all engineering students were nerds." "...and I thought all business students were 'bean-counters'." "Business students really need to know how an engineer thinks." "You're just adding ambiguity to my life." and "This is just more work for a time-starved student." These representative remarks seemed to indicate progress toward the defined goals. It seemed to help bridge gaps of ignorance about each other and establish valuable personal relationships as well. It also served to be a confidence booster to engineering students, helping them to realize that they really did know quite a lot about their field after all. Students came to realize the challenge of communicating effectively with someone who was not well versed in their specialty. They found themselves searching for the right analogies and terms to use so that business students could understand technical issues. They also found out it was fun.

Taking Stock: Initial Feedback

Despite the noted positive results of this first attempt, some problems were identified, both by the instructors themselves, and by reviewing feedback from student questionnaires. It was a clear reminder that we were learning as we went. The most glaring issue was the sheer magnitude of the workload required for the EE3730 students when this interactive element was added to an already packed course. Most of the students enjoyed and valued the experience, but complained, some vehemently, that it was simply too much. Even before attempting this, Don Bowie had expanded content of the course by including more non-technical topics of the engineering profession like management of self, effective communication, relationships with others, design methodology, decision economics, career planning, leadership, and ethics. This was *on top* of an ambitious design project with substantial documentation requirements. Students complained, and rightly so, that the non-technical aspects were robbing them of time they needed to work on the electronic designs themselves. Some who especially had a difficult time appreciating the development of "soft skills" complained that they did not major in electrical engineering to learn about business!

In light of this recognized burden, it was decided to offload some non-technical topics from the Spring Quarter course into Winter Quarter Electronics II course (EE3722. Consequently, in the 2002 course sequence this was done, as well as some other lesser improvements. This proved to be a help, but it was still too much to cram into a single course without losing substantial time for technical learning for EE3730. It also generated some conflict with some technical content coverage in the electronics course.

After this second round, it was decided to restructure the paradigm and redesign the non-technical content and business interaction to span an entire academic year. This way the content could be metered out over a longer calendar span. Another motivator came from the business students themselves. Dr. Rand's BUS4644 Operations Management course is offered every quarter, so it was only those students taking the Spring Quarter section that had the benefit of working with engineering students. Others heard about it and wanted to have the same experience! Progress up to this point was documented and reported at the 2002 Frontiers in Education Conference in Boston, Massachusetts¹

Expanding and Refining

In consultation with EE Department Chair Anthony Donaldson, Bowie, Peter, and Rand drew up a plan for spanning the entire 2002-2003 academic year. By this time Peter was the primary instructor for EE3730, with Bowie serving in a support role. Following is how the year was partitioned with respect to business and engineering interaction.

Academic Quarter	Interactive content
Autumn 2002	Dr. Jim Rand speaks on "Thinking and Acting Strategically" in EE3730 Prof. Don Bowie speaks on "Engineering Project Management" in BUS4644

	Joint Workshop on "Process Mapping and Strategic Thinking"
Winter 2003	EE3730 students hosting BUS4644 students in the lab
	EE3730 students attend BUS4644 class session for case study presentations.
Spring 2003	Dr. Jim Rand speaks on "Project Metrics" a "go / no-go" analysis methodology for business projects in EE3730 Prof; Bowie speaks on "Engineering Project Management" in BUS4644
	BUS4644 Teams present EE3730 Design Projects EE3730 Teams present BUS4644 Case Studies

During the course of Winter Quarter Dr. Rand suggested a replacement for the attendance of the BUS4644 case study presentations. Over the span of our interaction it had become evident that the students enjoyed, and learned from, their personal interactions with each other, so we opted for a joint workshop on "Ways of Thinking", which was based on an evaluative instrument and small group discussion similar to the Myers-Briggs metric for learning styles. One major goal of this exercise was to help students understand themselves better in the context of working in teams. In this way, they could consciously make adjustments as team members and thereby contribute to positive team effectiveness. Some typical responses to this event in their reflection papers on their experience were: "...gaining better understanding of my thinking styles gave me valuable insight into how to be a better team member.." "...I thought this was valuable, but I was hoping to interact more with the business students..."

This paradigm seemed to reflect an improvement in the overall experience for the students. However, with another post mortem and consideration of student feedback, it was clear that more improvement was needed. This included reaching clearly documented equity for grading between the two courses, so that students will know that their interactive activities will be graded with the same criteria and weighting. Also, business students again did not want to miss out on the project oral presentations. We still received complaints from engineering students for mixing business and engineering content in an engineering course. They wanted to retain the interactive experience with the business students, but expressed a preference for a separate course for other non-technical content.

Changes targeted for the 2003-2004 academic year were as follows.

- Require Power Point based oral presentations every quarter, so that BUS4644 students have a uniform experience. Since the engineering students only have a design project during Spring Quarter, it will be replaced in the other quarters by a presentation on some theory, circuit, or concept from electronics, e.g. Ohm's Law or Op Amps
- Develop clearly documented requirements and grading criteria for the team oral presentations. For both classes it will represent 10% of the course grade.

- Another key change will be to require the submission of "before" (as presented by the authoring team) and "after" (after any editing by the receiving team) versions of the Power Point files.
- Partition out the other non-technical content of the engineering courses and merge with other existing courses to create a year long set of one credit seminar type courses

Autumn Quarter 2003 was the first time we implemented Power Point based oral presentations outside of the Spring Quarter EE3730 course. Engineering students had the freedom to choose their topic and be as creative as they wished in preparing their material. They chose such topics as : voltage and current concepts, audio amplifiers, Ohms' Law, how capacitors work, operational amplifier characteristics and uses, low pass filters, and the electrical power grid. Below are some examples from their presentations.



Figure 9 From a voltage and current concepts presentation



Figure 10 From presentation on capacitors

So far the experience this year has been encouraging. Here some comments received this past Autumn Quarter: "I really liked the idea of the business presentation..I would have liked you to go over how you will be grading the presentation.." "I was not too excited about working with a bunch of business students, but because Mychal requested a certain group, we got to work with some guys that we knew who were both smart and studious, so everything worked out..I regret trying to teach them op amps. The topic was just too complicated and large.." "My experience was good. I enjoyed the small glimpse I had into the minds of the business students. I also think it was good to formally introduce the engineers to the business students before unleashing them unto the workplace, as [they] will undoubtedly have to work together at some time in the future..I think it would be a good idea to go over 'the basics of presentation' before giving the presentations.." "...good opportunity to refresh our basic knowledge of electronics [and] get to know students outside of [my] major..I didn't know WHY I was learning about this business plan of theirs.."

Future Possibilities

We are continuing to garner new insights into how to improve this interactive learning venture and expand its visibility on-campus. The dean of the School of Business and Economics is now interested in exploring even broader ways to engage students in cross-disciplinary undergraduate experiences. Some other possibilities are:

• Design business content into the year long microcontroller based capstone senior design sequence, in the form of partnering with business students from SPU's Entrepreneurial Management course to write a business plan and explore the

viability of product implementation

- Have business students participate in an IEEE meeting and have engineering students participate in a comparable business meeting
- Provide a "hands-on" lab experience for business students
- Have engineering students develop their own case study recommendations rather than just reporting on them
- 1. Donald L. Bowie, Anthony Donaldson, Don Peter, Jim Rand, "Business and Engineering Project Interaction" In *Proceedings of the 2002 Frontiers in Education Conference* (on CD-ROM), Boston, MA, November 6-9, 2002.

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