Extended Abstract – Creating a First-Year Engineering Program with One Faculty Member: Integrating Community Engineers and Partner Universities to Create a Robust Freshman Experience

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***Abstract* - In an effort to increase the number of engineering graduates within Alaska, a one-year Pre-Engineering program was created at the University of Alaska Southeast, an open-enrollment liberal arts college. The program was created by hiring one engineering faculty member to teach freshman engineering courses and to advise pre-engineering students. The challenges faced by creating this "satellite" first year engineering program are much the same as those faced by community college pre-engineering programs, including meeting curricular needs for multiple independent engineering programs, creating a robust introduction to the field with limited faculty, and encouraging student transfer and engineering degree completion. Partnerships with the local engineering community and engineering degree-granting Universities through a freshman engineering seminar course and collaborative, blended distance/onsite course offerings are used to augment the curriculum. Initial response from students has been promising, with high retention and subsequent transfer rates among pre-engineering students (85.7% of students completing the Pre-Engineering certificate program transferred into a baccalaureate engineering program, n=7). The methods employed at UAS could be a model for other community college-University partnerships to enhance transfer and degree attainment rates.**

Index Terms – first year engineering, community college-University partnerships, transfer students, freshman engineering seminar, collaborative learning

BACKGROUND

Engineers in Alaska face unique challenges due to the lack of transportation infrastructure, remoteness, extreme climate, vast natural resources and sensitive environmental conditions. In addition, many industries and government agencies have difficulty recruiting and retaining engineers from outside of the state. Therefore, the State of Alaska embarked on an Undergraduate Engineering Expansion initiative to double the number of engineering degrees awarded within the state by 2014 [1]. As part of this initiative, a Pre-Engineering program was created at the University of Alaska Southeast (UAS), a small, open-enrollment liberal arts college located in Juneau, Alaska. The only engineering degree-granting Universities within the state are located at the University of Alaska Fairbanks (UAF) and the University of Alaska Anchorage (UAA), both of which are more than 500 miles away from, and not connected by road to, Juneau. Pre-Engineering students at UAS can now take first year introductory engineering courses on campus as well and math, English, and science prerequisites in preparation for transfer into the second year of an engineering program. The program was created by hiring one engineering faculty member to teach freshman engineering courses and to advise pre-engineering students.

While engineering in Alaska has many unique attributes, the challenges faced by creating a "satellite" first year engineering program are much the same as those faced by community college pre-engineering programs. These challenges include: teaching to a wide cross section of student preparation [2]-[3], meeting curricular needs for multiple independent engineering programs [4], creating a robust introduction to the field with only limited engineering faculty [5]-[6], and encouraging student transfer and engineering degree completion [7]-[9]. Conversely, the small setting associated with these schools can create enhanced educational opportunities for students such as lower professor-student ratios and opportunities for field trips and hands-on activities that may be unmanageable with a larger number of students. This paper will focus on partnerships with the local engineering community and engineering degree-granting Universities to augment the curriculum delivered by a single engineering faculty member to create a robust first year engineering program that attracts, retains, and encourages transfer and degree completion for pre-engineering students.

FRESHMAN ENGINEERING SEMINAR

As opposed to the more common senior or graduate-level seminar course that is geared towards topics and research in the field of study for students ready to graduate, a freshman engineering seminar was developed as a way to expose students early in their undergraduate education to career opportunities in engineering. The freshman engineering seminar is a one-credit course with no pre-requisites, making it openly available to any student interested in engineering regardless of preparation.

The course is structured so that most class periods (approximately 8 out of 14) are dedicated to guest speakers from the local engineering community. Practicing engineers from a variety of fields, public and private employers, and at various stages in their careers, are invited to speak about their experiences as an engineer – including interesting projects, challenges unique to Alaska, and any advice they have about getting through school and career pathways. In addition, engineering faculty from partner Universities are also invited into the classroom through the freshman engineering seminar as a way to strengthen the connection between UAS and the engineering-degree granting Universities in the state. Many have argued that effective partnerships between community colleges and Universities must go beyond simple articulation agreements to increase transfer rates and degree attainment [8], and the freshman engineering seminar has become one venue to achieve this goal. During their seminars, faculty members are invited to discuss the availability of various engineering programs at their University, their personal research interests and projects, and student opportunities through undergraduate research, student chapters of professional societies, and engineering organizations such as *Engineers without Borders.*

The remaining class periods are dedicated to discussion of the engineering profession including requirements for licensure, similarities and differences between science and engineering, and engineering ethics through case studies. A key to the structure of the seminar is ensuring adequate time for open discussion with students and keeping the weekly schedule flexible to accommodate changing speaker availability.

COLLABORATIVE COURSE OFFERINGS

While the freshman year prerequisite courses in math, science, and general engineering are offered through UAS, some required specialty engineering courses, such as UAF's *EE 102: Introduction to Electrical and Computer Engineering*, are not feasible to offer independently on campus at UAS because of relatively low demand and lack of a qualified instructor. *EE102* is a three-credit pre-calculus circuits course with a project-based laboratory component which introduces students to the design process and common test/simulation/manufacturing tools used in electrical engineering. Since this course is a pre-requisite for all other courses in the Electrical and Computer Engineering department at UAF, and is only offered in the Spring semester, students who don't have access to this course during their freshman year would have to wait a full year after transfer to UAF prior to enrolling in sophomore-level electrical engineering courses.

To address this particular issue, UAS and UAF have partnered to offer *EE102* through a blended distance/on-site delivery focusing on collaborative, inter-campus lecture, laboratory and team work. Distance students participate in lectures synchronously through videoconferencing, and the laboratory portion of the course is facilitated with identical physical and computer simulation equipment by the pre-engineering instructor on site in Juneau. All students are required to watch pre-recorded laboratory lectures from the instructor in Fairbanks. Students from both schools are combined into inter-campus teams and tasked with designing, simulating, constructing, and testing an electronic device. This requires the students to overcome communication and technical challenges similar to those faced by practicing engineers in a global workplace, including lack of locally available materials, and the subsequent impacts to the project posed by shipping costs and delivery time to and from remote locations.

While distance courses are certainly not new, effective, distance delivery of engineering laboratories has proved difficult [10]. In addition to relieving the bottleneck, motivation for distance-delivery of *EE102* in a collaborative manner is intended to enhance the effectiveness of the laboratory by: 1) fully incorporating the distance students into the course, reducing isolation and increasing their social capital and sense of belonging to the learning community, 2) allowing deeper discussion of variations and outliers in measurements through student shared experimental data, 3) providing added value to the labs and team design project by encouraging collaboration in a way that reflects our global work environment, and 4) extending the experiences of the inter-campus teams to all students, both on site and distance, through class presentations of their design project.

In 2001, Etcheverry, et. al. [11] showed that social capital has a positive effect on the retention and academic achievement of students. Etcheverry defines social capital as consisting of "exchanges that arise through the interactions between students and professors and among students as they cooperate in learning the material". Research in social capital in engineering education is still mostly unknown. Brown, et. al. [12] investigated social capital in a sophomore electrical engineering lab and found that need and lack of resources were key aspects that helped develop social capital. He then asks the questions, "… should engineering curriculum and laboratories be designed to encourage the development of social capital?" We hypothesize that inter-campus collaborations have the potential for development of social capital among students at different campuses, and thus may increase transfer rates and subsequent degree completion.

PRELIMINARY RESULTS

The freshman engineering seminar has been offered during the Spring semester for the past two years. Enrollment in the engineering seminar course has been roughly twice that of the Fall *Introduction to Engineering* course each year. Feedback from students has indicated the course helped them better understand the role of engineers in society and professional obligations:

"This class showed me what an engineer really is. The engineers … brought in were from many different fields and helped us to get a sense for what is awaiting us at the end of our education. I believe this should be a required course for all who wish to pursue this career path."

"This course was fundamental in teaching students the professional nature of engineering. Successfully licensed engineers served as role models, emphasizing the importance of good practice and a comprehensive understanding of the projects they were involved with."

One student specifically addressed the benefit of the course with respect to transfer issues:

"This course was very helpful to me by providing an opportunity to learn about engineering fields. The wide variety of speakers invited to speak to this class provided useful information about the type of work done by engineers. The speakers from the engineering departments at UAA and UAF were very informative about transferring into a four year degree program. The variety of speakers … provided me with quality information and helped [me] decide what degree program I will pursue."

During the Spring semester of 2012, a pilot offering of *EE102* through blended distance/onsite delivery to UAS was launched. Development of the collaborative teams provided substantial challenges in terms of communication and construction of the actual electrical device. Initial student feedback through self and team formative assessments indicated that even students not part of the collaborative teams had recognition of the challenges faced by the inter-campus teams and the relevance of such collaborations to professional practice.

CONTINUING WORK

Through the incorporation of community engineers and collaborations with partner Universities, we hope to enhance student interest and persistence in engineering, while incorporating many skills that have been the focus of recent engineering education research – including practical, non-technical, communication, and teamwork skills – along with the development of social capital. The methods employed at UAS could be a model for other community college-University partnerships to enhance transfer and degree attainment rates. Initial response from students has been promising, with high retention and subsequent transfer rates among pre-engineering students (85.7% of students completing the pre-engineering certificate program at UAS transferred into a baccalaureate engineering program, n=7).

We are currently in the process of developing methods to assess the effectiveness of these practices, and to secure funding to continue to develop *EE 102* for effective distance delivery, with plans for expansion to rural, native-serving community colleges in Alaska. Due to the relatively small number of students, we plan to use a case study approach to assess student experiences and development of social capital through the pre-engineering program and subsequent transfer for engineering degree attainment.

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