

Globalization of the Union College Engineering Programs

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Abstract - Seventy percent or more of Union College engineering students have some type of international experience requiring travel to, and immersion in, a foreign culture before they graduate. Our goal has been, and continues to be, to have 100% of eligible students participate in an international experience. In the Class of 2007, 23% went on a non-engineering term abroad, 34% participated in an engineering exchange, and 13% went on a three-week mini-term program. An additional 18% met their international experience requirements by taking modern language courses. Previous classes have had up to 88% of the graduates participating in some type of program that required international travel. These numbers are among the highest percentages of any engineering programs in the country. This paper will provide details on how the Union College engineering programs maintain such a high rate of sending students abroad, to include a historical perspective on how international programs were developed and implemented, administrative and faculty support for international programs, advising, efforts to develop more programs specifically aimed at engineering students, and lessons learned and pitfalls to avoid.

Index Terms – Globalization, Global Perspective, International Programs, Terms Abroad.

INTRODUCTION

The engineering programs at Union College continue to be among the nation's leaders in sending students abroad to help them prepare to compete in the global engineering marketplace. Seventy percent of the Class of 2007 engineering graduates spent either a full-term or mini-term in study abroad. An additional 18% met their general education requirements by studying a modern language. Of those going abroad, 23% went on a non-engineering term abroad, 34% participated in an engineering exchange, and 13% went on a mini-term. Engineering students went on terms to Australia, China, Germany, Greece, Italy, and Tasmania. Engineering exchanges included students going to the Czech Technical University in Prague, and ESIGELEC in Rouen France. Engineering exchanges are an excellent way for our students to gain international experience. In addition to being immersed in the culture, they can also take engineering courses at the host institution. As part of the exchange, engineering students from the host institution come to Union and take classes with our students. Mini-

terms are three-week immersions in an international culture, with additional study about the country and its culture at Union. Class of 2007 graduates went on mini-terms to Brazil, New Zealand, and France. .

BACKGROUND

Union College is a liberal arts institution with engineering and computer science. It is located in Schenectady, NY, and was one of the first colleges in the country to offer a degree in engineering (Civil Engineering, 1845). Out of the total student population of slightly more than 2000, approximately 240, or 12%, are engineers. This proportion is lower than historical levels, with the target for growth being to increase the proportion to 15-20%.

Union has traditionally maintained an active terms abroad program. Approximately 60% of all Union students go on some form of study experience in a foreign country during their tenure at the College. Union ranks near the top of all schools in the nation in percentage of students going abroad.

Engineers have always been eligible for terms abroad, but before the Class of 1999 students were not required to complete the section of the General Education requirements that included terms abroad. Prior to 1996 Union's engineering curricula were not set up with terms abroad in mind. Since the programs are relatively small, most required and elective courses in the major are offered once a year. Therefore, it took very careful planning and advisement to allow students to go abroad without seriously jeopardizing their chances of finishing in four years. Union bucks the national trend in that most of our engineering students graduate in four years.

Students who were successful in juggling their schedules invariably came back from their foreign study saying it was well worth the effort, and many said that it was a life changing experience. However, it took the Accreditation Board for Engineering and Technology (ABET) Engineering Criteria 2000 (EC2000), and their emphasis on a global perspective, to inspire the engineering faculty to think seriously about requiring a foreign study experience.

A thorough curriculum review of all the engineering programs was undertaken as part of our preparations for a pilot visit under EC2000. The Dean of Engineering at the time strongly encouraged all of the engineering programs to embrace the concepts of global perspectives, and to take this opportunity to make the

curriculum sufficiently flexible so students could be away for a term and still graduate on time. The engineering programs responded by realigning their curriculums, and as a body voluntarily assumed the College general education international experience requirements [1]. The engineering programs established the goal of having 100% of eligible students participate in some type of experience that requires international travel during their undergraduate tenure. To be eligible a student must maintain at least a 2.5 grade point average. There are also some eligible students who do not go abroad for a term because of sports commitments, personal

situations, or because they are themselves international students. For such students, there are other ways of satisfying the general education requirements for international experience, including taking modern language courses, or taking classes in one of the cultural diversity tracks, such as East Asian Studies, offered at Union.

Table 1 shows the way Union engineering graduates have satisfied the international experience requirements. Union is on the trimester system, so the word term is used instead of semester.

TABLE 1: ENGINEERING STUDENTS' INTERNATIONAL EXPERIENCES

| Type of Experience | 2007 | 2006 | 2005 | 2004 | Five Year Average (99-03) |
|--|-----------|-----------|-----------|-----------|---------------------------|
| Term Abroad (non-engineering) | 23% | 19% | 15% | 13% | 19.7% |
| Term Abroad (engineering) | 34% | 30% | 31% | 40% | 31.1% |
| Mini-term | 13% | 23% | 34% | 31% | 31.5% |
| International Design Projects | | | | 2% | 4.2% |
| International Internships | | | | | 1.2% |
| Other (Not involving international travel) | See Below | See Below | See Below | See Below | 12.3% |
| Cultural Diversity Track | 13% | 15% | 11% | 6% | |
| Language | 18% | 13% | 9% | 8% | |

A term abroad (non-engineering) is any one of the 19 programs offered through Union's International Programs Office that are open to all students. With one exception, engineering courses are not available to students on these programs, and engineering students who participate in them enroll in non-engineering courses. Term abroad (engineering) refers to engineering exchanges that have been developed specifically for engineering students, and are discussed in detail later. Mini-terms are programs with three weeks of international travel during the winter or summer breaks. International design projects involve collaboration over the Internet with students in engineering programs overseas, with approximately one week of travel to the international university at the end for some type of design competition. These projects took a three-year hiatus, but there has been a resurgence of interest on the part of faculty for these programs in the 2007-08 academic year, which will be reflected in the data for the class of 2008.

The data show that the percentage of engineering students going abroad was highest during the period 1999-2003 (about 88%), and has dropped off fairly consistently in the years since. There are two primary factors that are believed to be responsible for that. The weakening dollar has made programs more expensive, so even with increasing budgets the number of term abroad slots has decreased.

Then three years ago the College instituted a policy of requiring a \$3,000 fee for mini-terms. Prior to that mini-terms had been supported by grants. Union has recently committed funds to increase both the number of students going on terms abroad, and the variety of programs available. This should help reverse the trend. At the same time the engineering programs will develop additional exchange and other international experience opportunities. In the future efforts will also focus on increasing international internship opportunities.

A multilingual engineer is a valuable, if scarce, commodity. While some engineering students are interested in language study, many seem reluctant to study a second language in college. This may be due in part to the intensity of typical engineering programs. Union does not require engineering students to take a second language, but it is highly recommended. This makes it difficult to slot engineering students into international experiences for which there are language prerequisites. Flexibility is also limited by the languages being taken by incoming engineering freshmen. Sixty-two percent of the aspiring engineers in the class of 2011 at Union took Spanish in high school. The next highest was French at 19%, with a smattering of other languages totaling 8%. The admissions database indicated that 11% of the incoming engineers took

no language in high school, which could mean they actually didn't take language, or that it just wasn't reported on their application. Regardless, the data show that a very large proportion of the students took Spanish in high school, which limits the pool for international programs requiring other languages. Furthermore, only 38% of the entering freshmen took four years of language in high school, with a similar percentage breakdown by language, while about 35% took three years of a language. Thus engineering students aiming for language proficiency would have to take several classes at Union.

Union recently updated the general education requirements, which weakened the requirement for the general student population to go on an international program. However, the engineering programs are maintaining their goal of 100% participation by those eligible. The following information has been added to the College Catalog:

Engineering has become a global profession. As a graduate you will likely find yourself working on an international team in a global company, working for an organization with international clients, or being dispatched to international locations to negotiate or oversee work. Thus it is critically important that you understand the nuances of other cultures, and the proper way to communicate. One of the best ways to accomplish this is through an international experience as a student. Therefore, engineering students, except under extraordinary conditions (as approved by the student's academic advisor and department chair), are expected to meet the Linguistic and Cultural Competency requirements of the Core Components Curriculum by participating in some type of international experience. For engineering students, possible experiences include: 1) terms abroad, 2) international internships in industry, 3) mini-terms abroad, 4) collaborative international design projects, and 5) summer international experiences.

ADMINISTRATIVE AND FACULTY SUPPORT

The administration at Union is extremely supportive of the efforts to have all eligible engineers participate in some type of international experience. Although engineers are not overtly favored in the term abroad selection process, they are generally looked on as interesting additions to student mixes in programs. The Dean of Studies makes every effort to count courses taken by engineers on terms abroad as part of their general education requirements, even though the courses may not explicitly have general education credit.

Faculty members in engineering have developed and led a number of interdisciplinary mini-terms and collaborative design projects, and several faculty members have led non-engineering terms abroad to places such as China and Vietnam.

ADVISING

The advising of engineering students about international programs starts as soon as they arrive on campus. They are told about the various options during freshman orientation. The instructors in the freshman engineering course emphasize the importance of international programs. The last common hour of the course is a presentation by the Director of International Programs for Engineering. Freshman language backgrounds are checked, and students with strong high school language experience are encouraged to continue their language instruction to meet the prerequisites for one of the terms abroad requiring language proficiency. Advisors talk with their advisees at least once a term (three times a year, as Union is on the trimester system), and continue to emphasize international programs. During the sophomore year, additional seminars are provided on international program opportunities.

NEW OR EXPANDED OPPORTUNITIES

Although our percentages are already high, Union's engineering programs continue to improve the quantity and quality of opportunities available to students. Our goal is to convince engineering students that they cannot afford to miss this experience.

One of the areas that Union pioneered was collaborative engineering design projects with international universities, which Union named International Virtual Design Studio (IVDS) projects [2]. Early projects were undertaken with the Middle East Technical University in Ankara, Turkey, and Ecole Supérieure d'Ingenieurs en Genie Electrique (ESIGELEC) in Rouen, France. Teams of students at Union collaborated with teams of students at the international university in a cooperative design project. The culmination of the project involved the Union students traveling to the international university, the combining of their prototypes, and participation in some type of design competition. This effort was successful, despite the limitations of electronic communication.

However, this type of program is very dependent on faculty commitment on both ends. A large amount of coordination and faculty supervision is required, normally without adequate faculty compensation in the form of either salary or recognition. This, along with staff changes at the international schools, led to a hiatus of several years in the projects. However, this year one of our faculty members reestablished ties with a colleague in Turkey, and has reinstated the projects with five students participating in 2008. This was motivated in part by the increasing number of mechanical engineering majors, and their need to find senior design projects. Efforts will continue to be made to institutionalize this type of project, and to provide adequate support to faculty members who supervise the projects.

The German government, through the German Academic Exchange Program (DAAD), offers a number of excellent programs for U.S. students to study in Germany, some with generous scholarships [3]. The problem is that so

few of the students entering the engineering programs have taken German language in high school (Only one engineering student in the class of 2011 had taken German previously.).

The engineering programs are working with the Career Development Center to develop international internship opportunities for our students. Although some possibilities have surfaced, the effort is hampered by the lack of a person in the CDC responsible for developing these opportunities.

Union recently started a chapter of Engineer's Without Borders, which should lead to increased opportunities for engineering students to work with other cultures in a technical and social environment.

EFFORTS TO DEVELOP MORE EXCHANGE OPPORTUNITIES

From both a student and an administrative perspective, engineering exchanges offer the best benefit/cost ratio of any international experiences [4]. Union College presently has active exchanges with universities in the Czech Republic, Germany, France, Mexico, and Turkey. However, only about a third of the engineering students are now going on exchanges. That is because some of our exchanges are fairly new, and do not yet have significant participation numbers. The exchanges in Germany, France, and Mexico will probably never attract large numbers, as they require some level of language proficiency. Also we have found that some exchanges, although conscientiously developed and implemented, just do not work out for various reasons. However, once an exchange reaches critical mass for sustainability, it can be one of the most stable sources of international experience opportunities. Therefore, increasing the number and variety of exchanges will be an important aspect of meeting our goal of 100% eligible participation [5].

Engineering exchanges are an excellent way to prepare graduates to compete in the global engineering marketplace. Students gain independence, and are better able to understand and work with other cultures. They learn about another culture's approach to engineering, including engineering philosophy, and ethics. Having a wider range of engineering exchanges will allow students more flexibility in finding programs that meet their personal, professional, and academic goals. Engineering exchanges allow students more complete immersion in the host country culture in that they include immersion in engineering culture. Many international programs are conducted by special institutes that cater to students from outside the host country. Thus U.S. students may live together, take classes together, and take excursions together; producing a very shallow immersion in the culture. Exchange students, on the other hand, will interact with the engineering faculty, and will most likely take classes with other international students and students from the host country. They may live in home stays, in a dorm with other international or host country students, or in a private apartment, [6] all of which add to their cultural immersion.

Engineering exchanges are approximately revenue neutral for the institution, while non-exchange terms abroad are a financial drain, especially in times of unfavorable exchange rates. Normally exchange students pay their tuition and fees to their home institution, so the home institution sees no difference in student revenue. There may be some imbalances in exchanges for special circumstances. For example, Union incurs some net housing costs in our exchange with the Czech Technical University in Prague, because 10 Czech students come here for the full year (three terms), while we send 20 students to them for the fall semester. We also give Union students going to Prague an extra meal allowance, as our students, on average, seem to eat more than the Czechs. Larger costs can be incurred if the number of students going in either direction becomes unbalanced. This is, in fact, the reason for many exchanges being abandoned.

Union as a whole benefits from engineering exchanges. When engineering students go on exchange programs, additional non-engineering term abroad slots open up for the rest of the Union students. Engineering has been sending students on international experiences at a higher rate than the rest of the student population. In a dwindling term abroad market, any lessening of impact of engineers is much welcomed by the rest of campus. Union also benefits from the exchange students coming here from the international university. These students are well accepted by the college community, offer a refreshing new perspective in class, help to enhance the global perspective of students and faculty, and are generally a delight to have around.

LESSONS LEARNED AND PITFALLS TO AVOID IN EXCHANGES

Developing new international experiences for engineering students takes time, and a good deal of personal effort. On-site visits to coordinate, observe facilities and personnel, and develop personal relationships among administrators at both institutions are essential to developing and maintaining successful exchanges. Each host institution must provide administrative and support services to the incoming exchange students. The quality of this service can best be ascertained by talking with students who have been on programs at the institution, or with program administrators from other U.S. colleges or universities that have a relationship with the foreign university.

U.S. colleges and universities must make sure they have adequate housing and support services to accommodate international exchange students. The number of students may be approximately the same because of the exchange, but the requirements of the small number of exchange students will be significantly different than the normal student population in terms of visa requirements, housing preferences, language skills, etc.

Once an exchange agreement is signed, the program must be publicized, and students recruited to participate. Word of mouth from returning students is the

best publicity any program can receive. If negative, new students will not be attracted. Thus it is important for staff at the U.S. institution to follow-up with returning students, and if the input continues to be negative, to consider dropping the exchange. Generally the language of agreements allows this.

To succeed, exchanges must be with institutions from which students can afford to travel to, and live in the U.S. Many foreign institutions have good quality programs, and would love to have U.S. students attend, but some view exchanges as a means of increasing revenue. When a program is not approximately revenue neutral, it can no longer be considered an exchange.

Careful consideration must also be given to the quality of courses at the international university. The appropriate engineering program should be enlisted to evaluate the courses offered. Programs must be able to demonstrate that courses given for major credit meet U.S. accreditation requirements. Some of this can be ascertained ahead of time, but much of it must be evaluated by feedback from students after they return from overseas, or by examining student work and portfolios. There are also an increasing number of international programs applying for ABET accreditation, which should relieve much of the angst for these programs.

ASSESSMENT

Assessment of international programs at Union has been fairly ad hoc in the past. A questionnaire was given to students when they return, but they were not required to turn it in. This will change, as a required on-line questionnaire is being developed. Resident faculty will also be required to fill out an evaluation.

Engineering programs have been using a graduation survey to help assess attainment of ABET Outcomes (a) – (k), including understanding engineering in the global context. Although the questions asked are too generic to gather specific information on the impact of international programs, responses do show that students are comfortable dealing with engineering in a global context. Student responses are on a scale of five to one, with the following labels:

- 5 = agree
- 4 = agree somewhat
- 3 = neutral
- 2 = disagree somewhat
- 1 = disagree

The electrical engineering seniors were asked to respond to the following statement; “I have a broad education necessary to understand the impact of engineering solutions in a global and societal context.” The average response was 4.5. The mechanical engineering survey had two items pertaining to a global context. They were; “I feel I am able to interact comfortably with people of other cultures,” and “I am able to function comfortably in a foreign country.” The average response to each item was 4.4.

Last year a new questionnaire, specific to international programs, was developed and given to all of the engineering graduates of the class of 2007. Twenty-six out of 54 graduates responded. Seven of the 26 met their general education requirements with other than an international experience; however none of the seven had been disqualified because of low grade point averages. Two claimed that sports were the reason they couldn't go, two applied but didn't get into a program, two met the requirement by taking language courses, and one said his/her schedule was too tight. None of these reasons are compelling as to why they didn't go on an alternative form of international experience. There are programs at all times of the year, and programs that are begging for participants. Therefore it is clear that we have some work to do on the marginal cases.

Of those who participated in an international program, all thought that the experience would help them after they graduate. Although most did not think their international experience would help their technical proficiency directly, most felt they had grown considerably as a person, could understand other cultures better, and would be more prepared to function in new and uncomfortable situations.

CONCLUSION

Union College is dedicated to continually improving the international experience of our engineering graduates. Increasing the number and variety of opportunities will help in this endeavor. Exchanges are excellent ways of increasing opportunities, but IVDS and other short term opportunities are also valuable. In the future we hope to follow-up quality engineering exchanges with internships in industry in the host country. Concurrently, we are striving to increase and enhance the language experience that our students receive in conjunction with their international programs.

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