Exchange Programs as a Means of Increasing Engineering Student's International Study Options

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ABSTRACT: *All engineering graduates from Union College are required to complete the "Other Languages; Other Cultures: Other Disciplines" portion of the College General Education program. Students can meet this requirement through completing three courses in a modern language, completing a three course cultural diversity track (Africana, East Asian, or Latin American Studies), or participating in a variety of programs that require travel abroad. Approximately 89% of the engineering students at Union opt for actual international travel. The authors believe that Union is unique in having such a large percentage of its students experiencing first hand the culture of another country.*

This paper will describe each of the international travel options in some detail, then will present an analysis of why developing engineering exchange programs may be a cost effective way for universities to increase international experience opportunities for engineering students. It is a win-win situation, as students are able to keep up with their engineering studies while gaining an international perspective. However, developing and running engineering student exchange programs are not without their potential pitfalls. Two major hurdles to overcome are language proficiency considerations and convincing students that it is important for their professional development to spend a semester at a particular university abroad. The paper will describe Union College's experiences with and lessons learned from engineering exchanges, and its ongoing program to develop more exchange opportunities.

1 INTRODUCTION

Union College, located in Schenectady, NY, is a liberal arts institution with strong programs in engineering and computer science. Union 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 300, or 15%, are engineers and computer scientists. This proportion is lower than historical levels, with the target for growth being to increase the proportion to 20%. Union's academic calendar has three terms per year, each with ten weeks of classes followed by a week of exams. The engineering curricula at Union are designed so a student can be away during certain terms and still take all required courses to graduate on time.

This flexibility is necessary because all engineering graduates from Union College are required to have completed the "Other Languages; Other Cultures: Other Disciplines" portion of the College General Education program. This requirement can be met in several ways. The International Language Tract requires any sequence of three courses in a classical or modern language. Students can either begin a new language or be placed at the appropriate level in a language studied in high school. If a student places into higher level language, only two courses are required. The Cultural Diversity Studies Track can be completed by taking three courses in Africana Studies, East Asian Studies, or Latin American Studies. These are each degree granting programs, so they are not mere assemblages of survey courses. Although the above two options do not require international travel, they at least introduce the student to other cultures. They also may be the only way for certain students to meet the requirements. Union requires that students have at least a 2.3 cumulative average to participate in a program requiring international travel. Also, some students have family or other commitments that make it difficult for them to travel abroad for an extended period.

2 OPTONS REQUIRING INTERNATIONAL TRAVEL

All of the remaining options require some period of travel to another country. The International Study Track is any Union Term Abroad with associated prerequisites, or equivalent international study (Union allows a certain number of students to travel on non-Union. terms abroad each year). Union's Terms Abroad office does everything it can to accommodate engineering students who want to take a term abroad. One problem is that some terms abroad have language prerequisites. Unless an engineering student has four years of a language in high school, it can be difficult for him or her to meet the prerequisites. Also, Terms Abroad programs require substantial monetary commitment on the part of institutions. They are not self-supporting. Therefore, it is probably not realistic to expect to have enough terms abroad opportunities to accommodate all students.

Exchange programs with international engineering schools seem to be an ideal way of increasing the number of experiences available to engineering students. Since students are going in both directions, there is theoretically no net expense to either institution so long as the numbers are equal. Additionally, students don't have to worry about falling behind in their engineering studies, as they can take engineering courses at the host institution. However, there are limiting factors. Some international institutions offer all or a good percentage of their courses in English. Others offer only a few, or none, in English. There may be differences in curriculum, calendar, or grading systems that make it difficult to mesh with the average U.S. engineering curriculum. You also have to be concerned about the equivalency of courses, especially in the design area. Thorough documentation needs to be gathered to convince ABET program evaluators that the courses are indeed equivalent to those at the U.S. institution.

Mini-terms are shorter, intense immersions in another culture accompanied by further study at Union. A series of seminars are held the term before the international travel. These encompass cultural expectations, technical and social issues associated with the theme of the mini-term, and pre-travel logistics. Students are also required to take at least one additional academic course related to the culture studied in the mini-term. The time spent abroad is typically three weeks, and occurs during summer or intersession to avoid conflicts with regular classes. Mini-terms involve extensive touring around the host country to compliment the theme of the mini-term. The student group for a mini-term is half engineers and half liberal arts students. Interdisciplinary teams complete a comprehensive report on a topic related to the mini-term. Union has received several grants to help develop and run mini-terms. To date interdisciplinary mini-terms have been conducted in Australia, New Zealand, Brazil, Scotland, and Spain. Two of the mini-terms illustrate the diversity of themes that have been developed. In New Zealand, the mini-term studied the technology and economics of power generation, transmission, and retailing. New Zealand has a unique mix of hydroelectric, geothermal, wind, and both traditional and advanced thermal power production. They have also recently deregulated their electricity markets, similar to what has taken place in the U.S. All of this, plus the fact that New Zealand is a beautiful country, made for a very successful mini-term. An equally successful, but altogether different mini-term was conducted in Southern Spain. Its theme was the technology and cultural issues that made Cordoba the cultural capital of Europe in 1000 AD. Visits to Roman ruins, antiquities museums, and archeological sites not yet open to the public provided a rich background for the students in their projects.

In the International Virtual Design Studio (IVDS), students interact over the Internet with students at an international university on a cooperative design project. The project culminates in travel to the international institution for a design competition. In some instances groups from the international institution also travel to the U.S. To date the only significant IVDS program is with the Middle East Technical Institute in Ankara, Turkey. However, faculty are being encouraged to develop other IVDS programs.

Union students can also receive international experience credit for an international term in industry. Depending on the length of the internship, the student may have to take at least one academic course at Union pertaining to the culture of the host country. International internship opportunities are limited, although Union is working to increase the number available to students.

Table 1 gives the breakdown of international experiences among the various categories for the class of 2003, and for the last four classes. The data show that over the four years approximately 89% of the engineering students at Union went abroad for some type of international experience.

Table 1. Engineering Student's International Experiences

Type of Experience	2003	Four Year Average
Regular Term Abroad	19.4	21.4
Exchange	25.4	29.1
Mini-term	38.8	32.5
IVDS		4.9
International Term in Industry	3.0	1.5
Other (Not involving international travel)	13.4	10.7

The low relative ranking of regular terms abroad is not because of a lack of opportunities. It can be at least partially attributed to the language requirements of several of the terms. Language study at the college level is very demanding, and engineers as a group seem to be less skilled at language learning than other students. Therefore, most of them shy away from terms abroad that require language proficiency. Efforts are now underway at Union to encourage more engineering students to study modern languages during their college years.

Exchanges are the largest component of the international experiences. Further investigation shows that most of the exchanges result from one program with the Czech Technical University in Prague. The Prague program is very popular because all of the classes are in English, and Prague is a delightful place to visit in the fall. However, this reveals vulnerability in the system that needs to be addressed.

The lack of IVDS experiences for the class of 2003 was a result of the transfer of the principal organizer in Turkey to a new position. It is expected that this will be a temporary hiatus, but does illustrate the danger of having any program dependent on particular faculty.

3 FUTURE DEVELOPMENTS

It is the goal of the engineering programs at Union to have sufficient number and variety of international experiences available to allow all students to participate in a program that is of interest to them and meshes with their professional and personal interests. In a period of fiscal belt tightening, it is unlikely that many additional terms abroad will be developed. Mini-terms are certainly an option. However, they are highly dependent on faculty interest, as they have yet to be institutionalized in the manner of terms abroad. It is also unclear whether students and parents will be willing to shoulder the extra expense after the initial development grants run out. The Union administration has made it clear that the institution does not plan to subsidize mini-terms. There are also some influential faculty who refuse to recognize the academic rigor of mini-terms, although close examination shows the rigor is there.

The IVDS program is very consumptive of faculty time with little return other than personal satisfaction, so it will probably never contribute significantly to the increase in international study opportunities. The first author is presently working with universities in Germany, France, and Mexico to develop additional IVDS partnerships.

4 INCREASING OPPORTUNITIES

That leaves exchanges as the most likely vehicle to significantly increase the number of opportunities. Union is now negotiating with universities where French, German, or Spanish is the native tongue to develop programs that require anywhere from minimal to high language proficiency.

Relative Costs of Programs

Table 2 shows comparative duration/cost data for the four programs used most frequently by Union engineering students to fulfill their international experience requirements.

Table 2. Duration of International Travel and Cost of International Programs at Union College

Type of Experience	Duration (weeks)	Cost/Student
Regular Term Abroad	10	$6980
Mini-term	3	$3750
Exchanges	10	$1840
IVDS Internet Projects	1	$1440

Note that the durations given are the length of international travel, not necessarily the length of the program. For example, mini-terms have a series of seminars before the trip, and a post-trip comprehensive paper. Also, where appropriate, the costs include administrative costs, and the equivalent cost of uncompensated faculty time. The data would suggest that exchanges have the most impact per dollar spent.

Theoretically, exchanges should involve no net cost to either institution, so long as the numbers of student participants are balanced between the institutions. However, some costs arise because of the differences in calendars between terms and semesters, and because of an extra allowance given to Union students for food while they are abroad.

Issues Favoring Exchanges

Exchange programs have many features that contribute to their attractiveness. First of all, they have a strong engineering component, which many international educators and practitioners feel is important in developing the global engineering perspective needed by graduates (GAIN 2002). Students will be able to take engineering courses which may substitute for required courses in the home institution curriculum, or may be supplemental technical electives.

Exchanges can be better cultural immersion experiences than regular terms abroad. A significant fraction of regular terms are held at special institutes set up specifically for terms abroad to avoid problems in calendar incompatibilities. The term abroad students may live together, eat and drink together, and go to class together. They may have little contact with students from the host countries. Exchange students generally will not experience the same cultural isolation. They will be in smaller groups, or alone, and will be taking normal classes with the host country students. Exchange students are likely to interact with a broader spectrum of international students.

Exchange programs have the additional advantage of bringing international students to the Union campus. Thus Union students will have continuous interactions with students from other cultures.

When exchanges are balanced, it minimizes the cost to both institutions. Furthermore, exchanges may lead to further collaborations, including faculty exchanges for research or teaching, and collaborative design or research projects involving students of both institutions.

Types of Exchanges

The classical type of exchange is a one for one exchange of students for a semester or a whole year. If both institutions provide student housing, the exchange agreement can cover waiver of tuition, room, and board. In instances where universities do not have housing, or the housing is run by an independent agency, exchanges are usually tuition only, and the students are responsible for paying for room and board, although the receiving institution should still be responsible for arranging housing.

There are many variations on this theme. Differences in calendars, or other factors, may make it desirable to send X students abroad for the whole year, and receive 2X in return for one semester. Another possibility is a half year exchange followed by a half year industrial internship. Even industrial internships alone can be exchanges. For example, a multinational company could send U.S. students to

one of their branches in another country, and receive students from the other country for internships in their U.S. plant. This would be an excellent way for companies to identify potential future employees with a global perspective, who would also be very familiar with the company's international branches. For universities that are so equipped, students might be able to take one or more courses from the home institution through distance learning facilities during the exchange or internship.

Other shorter term exchanges include the IVDS or Internet design projects; summer research projects; or multicultural/multi-university summer programs for public service projects or technical/cultural/industrial orientation visits. These would all provide an international experience without missing classes at the home university, and would solve many of the calendar conflicts between institutions.

Developing Exchanges

Developing successful exchanges involves an important "getting to know you" phase. Academic programs have to be somewhat compatible to sustain exchange experiences. Some differences are good, because they give the exchange students options not available at their home institution. However, the basic educational philosophy needs to be compatible. Differences in program size may have some effect, but are generally not critical so long as the general respect and attention shown students are similar. Web sites can help, but nothing beats visits of exchange organizers in both directions to learn about each others programs and to meet as many faculty as possible. Support services can also better be evaluated during a visit.

It is best to sign some sort of mutual exchange agreement. Most agreements will be amended over the years, and will eventually be pretty much forgotten. However, they provide an initial statement of expectations and responsibilities on both ends. Agreements should also have a fixed life, usually three to five years. This provides an out for either institution should the exchange prove to be one sided or not mutually beneficial.

After the programs know each other, and the formal agreements are signed, it is time to implement the exchange. This involves selling the program to the students, convincing them that it is in their best interest to leave their home institution and travel abroad to attend classes at the international partner for a semester or a year. Careful selection of exchange partners in the first place, and careful preparation of students with respect to language proficiency and the need for a global perspective in engineers should make the task easier. Union students have the extra incentive that they are required to have some sort of international experience.

Support Services

Generally, but not always, students on exchange programs will have a smaller peer support group than students on regular terms abroad Also, faculty from the home institution seldom accompany exchange groups. The exchangees may be attending classes where they know no one, are coping with understanding lectures in a language other than English, and everyone else knows each other.

Therefore, adequate support services before and during the exchange are important if students are to cope with these new challenges and achieve the maximum benefit from their experience. Prior to traveling students need guidance, and sometimes assistance, in obtaining the necessary visas, passports, airline tickets, and any other required travel documents. Housing at the exchange university should already have been reserved for them, and they should receive details on what will happen when they arrive. Either before the leave home, or immediately after their arrival, they need to be given a cultural orientation on what to expect and how they should act. It may be possible to use the Internet for this orientation.

It is important that the international office at the host institution continue to provide support services throughout the exchange stay. Social and recreational opportunities should be provided. Continued contact after the exchange can be useful for follow up, assessment, and continued collaboration.

5 OBSTACLES TO BE OVERCOME FOR SUCCESSFUL EXCHANGES

Exchanges are hard to nurture if there are not primary contacts at each end who know and work well with each other. An adequate student support office is also critically important. Exchanges should not be dependent on one person to keep them going. Other possible obstacles include language barriers, schedule

differences, academic credit evaluation, sustainability, visa requirements, and international currency fluctuations.

Language Barriers

U.S. engineers are at a competitive disadvantage if they are not proficient in a second language. Almost all graduating engineers in Europe, Asia, and Latin America are proficient in at least two languages, usually their native language and English. Many are proficient in three or more. At a recent workshop on international engineering internships, German engineers stated that the expectation in German industry is that entry level engineers be tri-lingual (GAIN 2002).

Engineering exchanges are an excellent way for students to increase their language proficiency. However, they need to be functional in the language of the host country before traveling abroad. Unfortunately, U.S. secondary schools do not give language instruction a high priority. In a recent study, only 33.6% of the incoming freshmen engineers at Union had four or more years of language instruction in high school (23.0% Spanish, 6.2% French, 2.2% German, and 2.2% other). A full 14.6% had no language background, and the remaining 51.8% had between one and three years of instruction (Jewell 2002). There is no requirement for engineering students at Union to take languages, but some do because they are interested in them, or want to take a term abroad that has language proficiency requirements. We are doing everything we can to encourage the taking of languages, starting with advising during freshman orientation.

Schedule Differences

As can be seen in Figure 1, conflicts can easily arise in trying to schedule term or semester exchanges without impinging on the next term or semester at the home school.

Type of Calendar	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Union Trimester			FFF	FFF	FF		WW	WW	W	SSS	SSS	S	
U.S. Semester		F	FFF	FFF	FFF	FF	S	SSS	SSS	SSS	SS		
German Semester				WW	WW	WW	WW		S	SSS	SSS	SSS	
French Semester			FF	FFF	FFF	FFF	FF	SSS	SSS	SSS	SSS	S	
Spanish Semester			FF	FFF	FFF	FFF	FF	SS	SSS	SSS	SSS	SSS	
Mexican Semester		FF	FFF	FFF	FFF	F	SS	SSS	SSS	SSS	SSS		

Figure 1. Comparative Academic Calendars

Union ends up having a preponderance of its exchanges during our fall term. Even at that, exchanges with German, French, or Spanish schools have to be truncated before their normal completion so students can get back to Union for the start of the winter term.

Miscellaneous Obstacles

Academic credit evaluation can be a problem with exchanges. Europe now has the European Credit Transfer System which aims at standardizing credits and simplifying transfer credits from one country to another. However, the system does not address differences in rigor or content of courses. Also, no similar standards exist between European and U.S. universities. U.S. engineering programs have the added concern of documenting outcomes required to meet Accreditation Board for Engineering and Technology, ABET, criteria. The best way to overcome this obstacle is to have faculty in each discipline examine and approve courses the students will take at the international location, and to keep thorough documentation concerning the course content and outcomes. This will have the added advantage of getting faculty to buy into the whole exchange concept.

It may be difficult to sustain exchanges over the long haul, especially if the number of students going between the partners is unbalanced in the same direction for several years. It is generally acceptable for the numbers to vary from one year to the next, so long as the aggregate numbers balance out over a three

to five year period, or whatever is specified in the agreement. It is best not to develop exchanges in the first place that students are not going to have interest in. However, once you get a few students to go on an interesting exchange, word of mouth will be a powerful tool to encourage students to apply for subsequent offerings. For exchanges to endure, they have to be a win/win situation for both institutions.

Visas are not so much an obstacle as a time consuming necessity when required by the host country. Student support services on either, or both ends of the exchange should help students acquire, fill out, and submit the necessary paperwork. And finally, international currency exchange rate fluctuations are something none of us has much control over, but they can play havoc with a student's cost of living projections. Whenever possible, rates for housing or other advance payments should be quoted in the currency of the home country. That way the student knows the amount to budget.

6 SUMMARY AND CONCLUSIONS

Academic exchange programs can be extremely valuable experiences for engineering students in their efforts to understand the globalization of engineering practice. Not only will they become familiar with another culture, but they will also become familiar with how engineers function in that culture. Exchanges have the added benefit of bringing international engineering students to the Union College campus where they can interact with both our engineering and liberal arts students. Even though there may be some costs involved in developing and maintaining exchange programs, the benefits to the institution and the students far outweigh the costs.

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