Internationalizing IE: A Unique Minnesota - Sweden Case

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Abstract

Engineers are working in a global setting as never before. The University of Minnesota Duluth (UMD) has a unique exchange program with the Luleå University of Technology (LUT) in Sweden that has proven beneficial with undergraduates, graduate students, and faculty members at both institutions. The Industrial Engineering program at UMD and the Manufacturing and Materials Engineering program at LUT have exchanged faculty and students since 1997 in what has become one model of institutionalizing the curriculum within the University of Minnesota system. Courses in Sweden apply toward the BSIE degree requirements in Minnesota, and vice versa. This paper will describe the evolution of this exchange program, the benefits to students and faculty, and the challenges and opportunities it presents, including accreditation considerations. A review of other types of study abroad experiences for engineers and recommendations will assist others in exploring how to internationalize their IE programs.

Introduction

A variety of factors are driving the internationalization of the industrial engineering profession. Free trade agreements make it easier for foreign companies to sell their goods and products in the United States, just as it makes it easier for American companies to sell their goods and products in foreign markets. Manufacturing facilities are increasingly relocated overseas to take advantage of lower production costs, access to raw materials, less stringent regulations, or taxation considerations.

IE students should have an opportunity to understand how their professional careers may lead them to many different assignments around the globe. In the case of the University of Minnesota Duluth, many students come from rural settings and have not traveled extensively, especially overseas, and a good appreciation of international opportunities and challenges can be difficult to develop. This situation is probably similar at many other universities.

There are many different types of study abroad opportunities for college students. Due to the rigors of engineering degrees, many engineering students do not consider studying abroad as they believe it would delay their graduation, not apply toward their degree, and would cost too much. The BSIE program at UMD has a track in which students can take their senior year
courses in the Materials and Manufacturing Engineering program at Luleå University of Technology in Sweden [1].

LUT has approximately 11,000 students and is situated in Luleå, a city of about 80,000. It is located in northern Sweden, about the same latitude as Fairbanks, Alaska, but the weather is more similar to Minnesota due to the Gulf Stream. The Norbotten region of Sweden produces steel, paper, and a variety of manufactured goods. Luleå is a major port on the Baltic Sea’s Gulf of Bothnia. UMD has approximately 10,000 students and Duluth, a major seaport on the Great Lakes, has a population of approximately 90,000. The similarities in physical geography, population, recreation, and industries are striking. A map of Sweden showing Luleå is given in Figure 1.

![Map of Sweden showing Luleå](image)

Figure 1. Luleå is located in the county of Norbotten in northern Sweden on the Baltic Sea [2].

The first section of this paper describes this unique exchange program for industrial engineering students. The second section describes how the exchange has developed. The benefits of the
program are discussed in the following section and the challenges and opportunities follow. Other types of study abroad programs for engineering students at other universities are discussed to offer the reader an idea of the different approaches that could be considered. For programs that wish to develop their own exchange program, recommendations are included before the summary and conclusions.

**International Engineering Track in IE at UMD**

The Industrial Engineering program at UMD has a hands-on approach with an emphasis on manufacturing [3]. Students who wish to go to Luleå for their fourth year consult with the department head during their sophomore and junior years to ensure they have the proper preparatory courses. Most of the junior year is the same as with all IE students, but the Luleå-bound students also take the ME CAD-CAM class to develop expertise in IDEAS design programming.

The fourth year for IE students at UMD includes required courses in simulation, manufacturing systems integration, and two semesters of project management and senior design. The senior design projects are team-based and are frequently sponsored by industrial clients. The remaining courses are technical electives and social science and humanities electives. This relatively open schedule was developed so that this exchange could be facilitated when the University of Minnesota system switched from quarters to semesters.

The fourth year for IE students going to Luleå requires that they take courses in simulation, automated systems integration, a team-based industry-sponsored capstone project, computer integrated manufacturing, a technical elective, and an integrative course in Swedish language, culture, and history.

The program is an exchange. Students from Luleå also come to Duluth to study at UMD. Luleå students take a variety of courses, but typically take fewer engineering courses and more business courses. UMD students technically enroll in Foreign Studies credits at Duluth and pay tuition to the University of Minnesota during the exchange. Swedish students do not pay tuition *per se*, as higher education is considered a social right and is paid by the government, so long as they are qualified and make satisfactory progress toward a degree. Students from both schools are directly responsible for their housing, meals, books, travels, and incidentals.

**LuTH, Duluth, Sounds Similar! The Development of the Exchange**

Initial contacts between the programs were rather serendipitous. One UMD faculty member went to Luleå in the 1980s for a mining engineering conference (and to play golf at the northernmost golf course in the world). While there, he met a member of the international studies staff, who happened to originally be from California.

In the spring of 1996, two researchers from Luleå were presenting papers in San Diego and noticed Duluth on the globe and remarked that it would be interesting to visit since the initials
for LUT at the time were LuTH for Luleå Tekniska Högskolan. They contacted the international studies staff in Luleå, who remembered the UMD faculty member, and initial contacts were made. The Swedish Institute, a branch of the Swedish national government, had set aside funds to assist with initiating study abroad opportunities and the first trip to Duluth was arranged.

The researchers visited Duluth for two days to tour the industrial engineering labs, meet the faculty, and discuss possible arrangements for exchanging faculty and students. Upon their return to Sweden, they successfully proposed for assistance from the Swedish Institute to fund a similar visit for two faculty from UMD to Luleå to finalize exchange arrangements in November, 1996. The author was selected to go to Luleå for seven weeks from January to March, 1997, where he helped teach the Industrial Project course in manufacturing engineering (equivalent to UMD’s senior design), establish contacts for research, and get to know the Swedish system for educating engineers. A materials engineering professor from Luleå came to help teach the Materials Science course at UMD from March to May, learn the American system of education, and establish research links.

The first students to take advantage of the exchange agreement were for the 1997-98 academic year. The author spent the same year in Luleå on sabbatical, teaching a PhD course and the Industrial Project course, doing research on technology assistance and development in small and medium-sized enterprises (SMEs), and taking the Swedish language, history, and culture class the students take. Being on-site enabled the first UMD students to have an advisor readily available for course evaluation.

In the years since, UMD has had between one and four students in Luleå at any given time, and this is the same with LUT. One PhD student from Luleå came to UMD for research, and UMD has hosted two faculty members for research. Two UMD IE faculty members have visited Luleå to discuss courses, lab development, and research with the MME faculty, and have met with UMD students about their experiences to date.

Benefits to the Exchange Program

There are a number of benefits of the UMD-LUT exchange program. These benefits accrue to students, to faculty, to both departments, and to both universities.

Benefits to Students. Students learn a tremendous amount about themselves and the world as well as learning important information. These can be categorized as:

- Language, communication, and lifelong learning.
- Time management.
- Team contributions and individual responsibility.
- Increased cultural awareness and appreciation.
- Risk taking and approach to challenges.

Most industrial engineering students do not have the flexibility to study a foreign language beyond the entry requirements to the University of Minnesota (2 years of a high school foreign language), but they learn to be conversant in Swedish while in Sweden. This compares to the
Swedish students, who are fluent in Swedish, English, and typically either French or German, and who have also studied a third foreign language for several years in their high school. Our students learn that communication is extremely important and that lifelong learning is not an abstract idea, but is a critical element to surviving as an engineer.

Luleå has a unique system of scheduling classes. Classes may meet for a quarter (a half semester) or for two quarters (in a single semester or spanning two semesters). Courses meet on different days with varying lengths of time, and may meet in different buildings and rooms. The Industrial Project course is scheduled for a full week in February, for example, to facilitate a study trip to central Sweden; this does not interfere with other classes the students are enrolled in. Students must keep a daily planner in order to know when to be where. This system requires the students to learn to manage their time and to be flexible. This major difference in course scheduling is an especially powerful experience for industrial engineers because they understand that drastic changes to a process are possible that may not normally be considered; this experience gives them the skill and the wherewithal to question why processes are done the way they are and to challenge basic assumptions.

Senior level courses in Luleå emphasize effective teamwork as projects are significant. Teams can often have 6-10 students (or more) on large projects. Students are responsible for dividing work and then integrating results. Because many of the projects are sponsored by large companies, the students feel the pressure to be responsible for their results. Teamwork is facilitated by the Swedish notion of lagom (log'-ohm), which roughly means that everyone should pull their share and it is expected that everyone will be successful, but not too successful. Another aspect of responsibility development is that many of the Swedish students are two years older than the typical American student, thanks in part to starting public education at age 6 and civil service duty following high school graduation of between 6 months and a year.

Being in a different culture increases their awareness and appreciation of culture. Experiencing different customs, different foods, different music, and living in a setting where a 500 year old church is considered “new” make students see their place in culture in a different light. The experience gives them much greater appreciation of differences and helps them see that there is a great deal to learn outside of textbooks. Students on the exchange take frequent advantage to be able to travel inexpensively around Europe, and experience a wide variety of museums, theaters, festivals, and visits sites of great historical and cultural significance.

Students learn that they can successfully approach any project. Living in a foreign country where day-to-day living can be challenging at times because of communication issues teaches individuals that they can overcome many challenges. They develop a good ability to work in uncertain conditions and they understand that moving outside of one’s comfort zone can provide significant rewards.

Benefits to Faculty. Faculty members can take advantage of several aspects of this exchange:

- Temporary reassignment.
- Sabbatical leaves.
- Learning from exchange students and students returning from exchange.
- Networking and research opportunities.
As mentioned in the discussion on the development of the program, faculty can be temporarily reassigned to work at the other institution. Because of the close relationships between LUT and UMD, the people in human resources know what paperwork is required and what sort of arrangements should be made. This is communicated to the faculty members so they do not have to worry that many things may fall through the cracks.

Because of the established relationships, sabbatical leaves are fairly easy to approve and arrange. Two faculty members have come to Duluth on sabbatical leaves from Luleå, and the author went to Luleå. Persons can go to other sites for sabbaticals, of course, but the opportunities to continue to build the relationship and build research programs are definitely advantageous. Another aspect to a sabbatical is the experience of the family members, which can be a richly rewarding life-altering event.

The faculty at both universities can learn from the visiting students how their courses compare and contrast with the classes at the other university. Discussing methods, material, and applications can enrich the classroom for the faculty and students who do not travel overseas. For example, a Swedish student who had worked with SSAB (a Swedish steel producer in Luleå) contributed greatly to discussions in a course on product positioning by providing a European perspective on production and purchasing in the European Union.

Networking is especially important. As a result of the PhD student who came to Duluth to conduct some of her research on learning in SMEs, a colleague of one of her Swedish advisors has since come to Duluth to study the tourism industry of northern Minnesota and has extended the network to include faculty in the business schools at both schools.

Benefits to Departments and Universities. The departments and universities benefit from exchanging students and faculty. These can be categorized as:

- Recognition.
- Exposure.
- New ideas.
- Research opportunities.

Cooperating with this exchange broadens the opportunities for exposure. Each department advertises the program in its material, thereby indirectly advertising the capabilities of the other. When our students work on a project for Volvo or ABB, the Swedish firms learn about the University of Minnesota Duluth. Similarly, when LUT students work on a project, Minnesota companies learn about the engineering programs at Luleå.

Having an exchange program like this can lead to positive recognition. In the University of Minnesota system, this program is recognized as a model for study abroad in an area which is not typically conducive to study abroad [4, 5]. Similarly, other educational institutions that collaborate with UMD and LUT become aware of this program.

The departments gain new ideas in technology, practice, and pedagogy. Students returning from exchanges are very willing to discuss their experiences with faculty to offer suggestions on new
approaches to teaching, lab development, or projects. This leads to important and meaningful discussions on what technologies are important to adopt or adapt, how to provide good learning experiences, and how the curriculum could or should be changed.

Research opportunities develop as part of the collaboration between departments and colleges. The work has so far been focused on process improvement in small manufacturing firms, but has expanded to include tourism research with the business school faculty, and could lead to materials engineering collaboration in the near future. By leveraging the resources at the partner school, the facilities on a university campus can be enhanced.

**Challenges and Opportunities**

The exchange program of UMD IE and LUT MME students is now in its seventh year. The number of students taking advantage of the program has ranged between one and four students in any given year, representing between 3-15% of the graduating BSIE class. Although a target percentage has not been established, having around 10-25% of the class take advantage of study abroad (at Luleå and at other schools) seems to be a realistic and reasonable goal.

Students may have a number of reservations about choosing a study abroad. In a 2002 survey of 920 seniors across the four campuses of the University of Minnesota, the most cited barriers included cost (74%), delay of graduation (48%), time away from on-campus studies (36%), concern about applying credits to requirements (32%), and disruption of work/internship experience (23%). Surprisingly, only 12% of students expressed a concern for health or safety as a barrier to study abroad [6].

With respect to this specific program for industrial engineering students at UMD, discussions with students indicate that the chief reasons they do not wish to study abroad are that they believe it will delay their time to graduation, the cost is prohibitive, courses will not apply toward their degree, not being in Duluth during their senior year will make it harder to land their first job, and that they will miss many of the senior year events because they are overseas. Of these, only the last can be convincingly argued. The students pay tuition to the University of Minnesota, and housing and food are comparable in each city; the additional price for travel can be covered with an increase in financial assistance and is partly offset because the students do not pay many of the fees to the university since they are not physically on campus. The courses all apply toward their UMD degree, and the program is described in our advising material to show that the courses apply to the program. The alumni who have been to Luleå often are hired no later than the Duluth-bound students, and many are actually hired faster because of their experience in Luleå. It is true that students in the program miss some of the activities and events during their senior year; this is a legitimate concern that must be balanced with the unique activities and events that they could experience in Luleå.

An initial concern to the faculty was that ABET would question the exchange program. This has not been a problem, however. The feedback has been very positive, on the other hand, and the exchange program is a particular strength of the IE program. As long as the foreign university is accredited or approved in its own nation and the courses taken have been evaluated using the
same process as those taken at any other university, there should not be a problem with the courses. In this case of Luleå, the on-going relationship and understanding of the other school’s curriculum serves as a quality check.

While the objections represent challenges, they also provide opportunities. This year, two UMD students are studying abroad in Australia during their junior year. A senior in mechanical engineering took machine design and several technical electives in Växjö, Sweden, for a semester. Having the program in Luleå has made these students aware that other study abroad opportunities exist that may be a better fit for their personal interests.

Another opportunity is the development of other teaching and exchange programs with other universities in France and Germany by using the network available through the contacts at Luleå. Still another opportunity is the development of a joint course using the internet and teams in Duluth and Luleå. Using virtual teams can provide some amount of international exposure within the confines of traditional classes on campus.

**Other Models of Study Abroad for Engineering Students**

The University of Rhode Island has a five year program in which students earn a BA in German, in addition to their engineering degree. Students take courses in German, some that are specific for engineers, and perform a 6-month internship in a German-speaking country in their fourth year. Students can have an optional semester or year of study abroad at Technische Universität Braunshweig and a capstone engineering course taught in German [7].

A similar program at Lafayette College gives engineering students two degrees in five years. The program features a semester of study abroad and a semester long capstone work experience abroad in the fifth year. This program builds an in-depth knowledge of foreign language and culture. Another opportunity that Lafayette offers is a 3-week intersession foreign study course led by on-site Lafayette faculty [8].

At the University of Wyoming, civil engineering students can integrate a study abroad experience and optional internship abroad with foreign language studies to receive their degree with no significant increase in credit hours [9].

A French approach for preparing engineers for the telecommunications industry is at the Ecole Nationale Supérieure des Télécommunications de Bretagne. Their program also seeks to provide competency in a foreign language and experience of work or study abroad [10].

**Recommendations for Implementation Elsewhere**

Several recommendations for successful implementation can be made so that other institutions can be proactive about establishing an effective study abroad option.

The most important step is to decide how study abroad fits into the department’s vision and educational objectives and find a program that is compatible. The match in courses, research
focus, and learning philosophy between UMD and Luleå is very close, so these departments are extremely compatible. Both programs have a philosophy of hands-on, laboratory intensive education, emphasis on applied research, and interest in assisting with regional economic development with SMEs (small and medium enterprises) as well as large companies.

Decide which level of students should be served. UMD selected seniors because that is the year with the most flexibility for course selection (and the courses in Luleå at that level could be delivered in English). Other programs feel that the sophomore year is better because courses like statics, dynamics, differential equations, electrical circuits, and thermodynamics are fairly generic. Matching courses for course equivalency can be challenging, so it is best to agree philosophically which level is the target.

Decide the length of the exchange. Many programs are one semester to allow students to take a language class, a class in culture or history, and one or two classes in the student’s field of study. This can provide a good introduction to the other country. In the opinion of the author, two semesters require the students to immerse themselves in the host culture and really learn from the experience. The UMD-LUT program is set up for UMD students to spend a year in Luleå, but several have been there for one semester or for three quarters. Luleå students now typically come for one semester because the Swedish government would rather give twice as many students the opportunity to study outside of Sweden for one semester.

If possible, have a faculty member visit the university to help establish the program. The UMD IE experience has found it invaluable to have a person on staff who has been through the process of teaching a course in Luleå, been through their process of course assessment and improvement, and understands the expectations of the host department. It also provides a single contact point who can serve as a coordinator.

Take advantage of the work that others have done in blazing trails. Developing contacts through networks is a traditional IE technique, and study abroad programs are no exception for networking.

Consider a variety of models. This paper has emphasized a formal year-long exchange. A different approach is to develop a course that meets overseas; for example, the University of Minnesota Twin Cities has a course in Mechatronics that meets in Lucerne, Switzerland, every other year for three weeks in May. Another approach would be to have a summer or semester of liberal education courses through established programs such as the Council on International Educational Exchange, CIEE [11], or the Institute for the International Education of Students, IES [12]. The five-year, two degree model have been very successful, as discussed at the University of Rhode Island and at Lafayette College.

Internationalization in the curriculum takes work. It requires a champion who can be recognized for the effort required. It provides many opportunities for personal and professional satisfaction.
Summary and Conclusions

This paper has described the exchange program between the Industrial Engineering program at the University of Minnesota Duluth and the Manufacturing and Materials Engineering program at Luleå University of Technology in Sweden. The development of the program and the benefits have been discussed, and recommendations for implementation at other universities have been offered.

Globalization is making it more important for industrial engineers to understand how they may be involved in working in various countries. They need to be exposed to international issues as part of their undergraduate development. Studying abroad is challenging, stimulating, rewarding, and is often described as a life-changing experience. There are many ways to provide undergraduate IEs with these opportunities.

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3. The University of Minnesota Duluth Mechanical and Industrial Engineering department website is located at http://ie.d.umn.edu.


12. The Institute for the International Education of Students offers a variety of international experiences in conjunction with universities and its website is located at http://www.iesabroad.org.

13. The Learning Abroad Center at the University of Minnesota serves students at all four campuses of the U of M system and its website is located at http://www/umabroad.umn.edu.

**Biography**

DAVID A. WYRICK, P.E., is professor and head of the Department of Mechanical and Industrial Engineering and Director of Engineering Management Graduate Studies at the UMD. He is a member of ASEE, ASEM, ASME, IIE, and Tau Beta Pi. He serves on the University of Minnesota Study Abroad Curriculum Integration Committee, funded in part by the Bush Foundation, and on the International Education Sub-Committee at the University of Minnesota Duluth. He speaks French and Swedish, and is known for being willing to eat practically anything regarded as a local delicacy.