

## **AC 2008-1701: IMPLEMENTING INTERNATIONAL REQUIREMENTS IN UNDERGRADUATE INDUSTRIAL ENGINEERING PROGRAMS**

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# Implementing International Requirements in Undergraduate Industrial Engineering Programs

## Abstract

Recognizing that engineering is an increasingly global profession, the Department of Industrial Engineering (IE) at the University of Pittsburgh is committed to providing its graduates with the skills they need to compete on an international basis. This commitment has led to the recent development and institutionalizing of an international requirement for all of our undergraduate students. All students will be required to take course work with a global studies emphasis. Most of our students will also participate in one of any of a number of available international travel/study experiences. The experience can range from a full semester abroad to an approved academic program with a short term foreign travel component. Factors influencing the decision to require students to obtain this international experience included the increasing demand for engineers capable of working in a global organization and who possess cross-cultural awareness and understanding of global business practices. In addition, ABET outcomes h (the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context) and j (knowledge of contemporary issues) have certainly influenced the move. In this paper, we will describe our international requirement and discuss and compare it with similar efforts currently underway at other engineering programs across the country.

## Background and Motivation

Universities across the U.S. now recognize that responding to globalization is key to the success of American competitiveness. This global theme was defined and identified in well known works such as Thomas Friedman's *The World is Flat* [1] as well as *Educating the Engineer of 2020* [2] from the National Academy of Engineering. International experience actually provides students with a distinct advantage to potential employers. The cover story of the summer 2007 edition of the American Society for Engineering Education's *Prism* [3] magazine provides further evidence of this trend. Most companies and organizations no longer conduct business from a regional or even U.S. perspective, but rather from a global perspective. Because the IE field traverses both the engineering and business world, it is particularly important that IE curricula provide students with this advantage.

A challenge facing engineering educators is how best to take advantage of the global, flattened, technology-enabled playing field to improve engineering education, and as Friedman, and others have proposed, enable the U.S. to retain its lead in innovation and university education and research. Further, to meet and exceed accreditation requirements, it is necessary to demonstrate that program graduates have the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context as well as knowledge of contemporary issues. [4]

There is no doubt that today's graduates must obtain the skills to compete on an international basis. In addition to broadening the perspective and knowledge of IE students, an international experience is known to energize and challenge students to be motivated to a higher level of commitment to the enterprise of learning.

## Approaches

There are a few international efforts at departmental levels within engineering schools across the U.S. North Carolina State, for example, promotes its own study abroad program specifically for IE students [5]. Although the program is not required it is highlighted and students are encouraged to consider travel and study abroad. More common are programs at the school or university level. A number of these programs have presented their efforts at prior ASEE conferences and are recognized as leaders in the effort to "internationalize" engineering education. We discuss some of these programs here.

The engineering program at Union College is a leader in ensuring that its graduates have an international advantage. Since 2004 Union has required that every one of its engineering students have an international experience prior to graduating [6]. Students can meet the requirement through terms abroad, international internships, international design projects, mini-terms abroad, or other experiences. According to their website, 69% of their 2007 engineering graduates had at least one international experience that involved travel while the remaining students satisfied the requirement in a manner not involving travel. It is clear from the way the requirement is presented that the college's intent is to ensure that all students eventually meet the requirement in a manner involving travel to a foreign county.

Other engineering schools are currently placing a strong emphasis on international programs and study abroad opportunities. Virginia Tech for example, has established an international department at the Dean's level in the College of Engineering in an effort to raise the percentage of engineering students that go abroad. [7] The establishment of the department demonstrates a commitment to international programs and the college is devoting significant resources to this effort including the hiring of a study abroad advisor.

MIT's International Science and Technology Initiative (MISTI) is a broader example of a successful model of how a university can commit the resources necessary to increase the percentage of undergraduate students that study abroad. [8] This program offers tailored programs for MIT's students for international internships, study abroad opportunities, workshops, and so forth. According to their website [9], MISTI will send 315 students abroad this year.

Prior research has shown that there are a wide variety of ways in which universities as well as engineering colleges and schools are attempting to meet the demands of globalization [10]. There are, however, very few well known cases of programs that are currently requiring students to travel and study abroad.

## Approach at the University of Pittsburgh

The Department of Industrial Engineering is not the only program at the University of Pittsburgh concerned about their students' ability to compete on an international basis. The University's Center for International Studies has been addressing this issue for some time with a focus on a variety of ways to increase the number of students studying abroad and bringing more international students to Pitt's campus [11]. The School of Engineering at Pitt has been introducing international content into coursework for some time and currently offers students a number of international experiences through courses with travel components and full semester study abroad opportunities. Freshman engineering (and business school) students can take advantage of a unique opportunity with our "Plus3" program which is a three-credit, two-week travel and learning experience that they may take between their freshman and sophomore years (the travel portion of the program runs immediately following the spring term and writing components are completed over the summer). There were four such programs (Brazil, China, Chile and Germany) offered in the summer of 2007 and the program is continuing in 2008. The School of Engineering's and the University's Study Abroad Offices provide numerous alternatives and opportunities for international travel and some of these have an engineering learning component. We have also joined a consortium of schools in The International Association for the Exchange of Students for Technical Experience (IAESTE) to provide additional engineering related international opportunities for our students. Additional programs exist and are being developed. Until now however, an international experience has not been a required part of a student's degree completion in any department at the school. The IE Department is leading an effort to ensure that all of its graduates have an international experience.

Discussion amongst the IE faculty at Pitt regarding implementing the international requirement has been ongoing for well over two years. We wanted to go beyond simply requiring students to take international or global coursework. We believe that the best way to ensure that our graduates are prepared for the global market, have a basic understanding of global and cultural issues, and can utilize this understanding in an engineering context is to require an international travel experience. However, there were clearly some serious issues and obstacles to consider before proceeding with such a requirement.

A survey of sophomore, junior and senior students in the industrial engineering program was done in the spring of 2007 to gauge current student reaction to the implementation of an international requirement. The survey asked a variety of demographic questions and, relevant to this paper, asked such questions as:

- Should there be an international requirement for graduation?
- Would this requirement have impacted your choice of major?
- Have you studied abroad or are you considering it? (Note that "study abroad" included any full semester experiences such as Semester at Sea or one of the various 3-credit electives that include coursework at Pitt and a short travel experience such as the Plus3 program.)
- If you have not, why not? What may have been your constraint?
- What student concerns do you have about an international requirement?

A total of 71 IE students responded to the survey. Of the students surveyed, 68% agreed that there should be some international requirement while 25% said maybe, with the rest either not responding or disagreeing. A small percentage of the students (13%) believed such a requirement would have impacted their choice of major while 44% indicated it would not have and 44% replied maybe. As expected, the number one concern expressed by students in the survey regarding an international requirement was the cost of a study abroad experience (45% of respondents listed cost as a concern). Students were able to list multiple concerns and their responses included: the requirement is not fair (10%); it is a burden to fit into the academic schedule (7%); classes overseas may not be competitive (6%); the impact on a student's graduation date (6%); safety (5%); no desire to study abroad (4%); the language barrier (3%); conflicts with the Cooperative Education program (3%); and lower numbers of students selecting IE (3%). Only 4% of respondents had no concerns.

A surprising 26% of students stated that they had already completed a study abroad experience while an additional 25% indicated that were thinking about it. The primary reason given why students had not studied abroad was again cost (46%), while other reasons indicated were time constraints (14%); conflicts with co-op rotations or summer internships (12%); not being interested (12%); and personal reasons (12%).

After studying the survey results, faculty discussion continued on how best to implement and present the requirement in order to address student concerns. Because the school's Senior Associate Dean for Academic Affairs is extremely supportive of and involved in international programs (evidenced by the recent creation of a Director for International Engineering Initiatives position at the school level), there are many scholarship and stipends that the school offers to students interested in studying abroad. For example, juniors and seniors wishing to participate in the course, Product Realization for Global Opportunities (ENGR 1610) this spring will travel to the University of Campinas in Brazil over spring break to collaborate on real world sustainable development product needs. Each student will receive a stipend of approximately \$750.00 to help cover some of the costs of travelling to Brazil.

The IE faculty also considered how to address the concern about international requirements resulting in conflicts with co-op rotations and summer internships. We made a commitment to ensure that students can participate in a variety of international programs as well as co-op yet still graduate on time. When our international requirement was first finalized it stated:

“The Department of Industrial Engineering is committed to establishing its identity and competitiveness through international experiences that provide students with a distinct advantage to potential employers. Most companies and organizations must conduct business from a global perspective and because industrial engineering traverses both the engineering and business worlds, it is important that our curriculum fill this need. Beginning with incoming 2007-08 industrial engineering sophomores, all IE students are required to obtain **an international experience and two globally focused Humanities or Social Science (H/SS) courses**. The **international experience** is defined as an approved engineering academic program of a minimum of 3-credits or an approved

international internship or co-op of a minimum of 8 weeks. Optimally the **H/SS courses** should be related to the international experience.”

Because we felt it was critical to have senior administrative support of this initiative, we asked the Provost’s Office for input. They expressed serious concern that requiring students to complete international travel would pose administrative problems and open us to other types of student problems that would not be easy to manage. Thus we revised the policy and included an option for satisfying the requirement that does not include international travel. *The international requirement currently reads as shown in Figure 1.*

Note that “globally focused” Humanities/Social Science electives are defined as languages as well as those courses falling under the headings of “Foreign Culture/International” or “Non-Western Culture” in the University’s general education requirements catalog. These include courses in a wide variety of areas such as: languages, anthropology, history, economics, sociology, and religious studies. A student that travels to China with the Plus 3 program for example, might choose to take “CHIN 0070 Exploring China Roots to Blooms” and “HIST 1420 Ancient China”. A student that travels to Brazil with the EMPOWER program might choose to take “ANTH 1528 South American Archaeology” and “PORT 0002 Elementary Portuguese 2.” There are over 500 courses from which students can choose and we are encouraging our students to consider the myriad of opportunities available to them at Pitt to explore other cultures.

The international requirement was officially approved, communicated to faculty, staff and students throughout the IE department as well as the school, and published on our website in September of 2007. The requirement will apply to all incoming sophomore students entering the IE department in the fall 2007 term and beyond.

#### Student Reactions and Results to Date

The IE Undergraduate Program Director met with incoming sophomores in the fall of 2007 to present the final version of the international requirement. Student reactions were for the most part positive likely because the requirement had been clearly defined and students were presented with a variety of ways in which it could be satisfied. During registration for spring 2008, each sophomore student met with their academic advisor (IE faculty members serve as academic advisors) to discuss how they planned to meet the international requirement. Since sophomores are scheduled to take a Humanities or Social Science elective in the spring of their sophomore year, they were encouraged to take a globally-focused course as defined in the requirement. Students and advisors were encouraged to discuss if and how the student planned to meet the travel portion of the requirement (Option A in Figure 1). Many sophomores have already completed the travel requirement since they have participated in the Plus3 program. Some plan to take one of the technical electives now being offered that include a travel component. Still others are planning a full semester abroad. There were admittedly a number of students that have chosen to satisfy the requirement with the coursework (Option B in Figure 1).

It is too early in the implementation process to observe any definitive impacts of the requirement on educational outcomes and in fact, it may take several years before we can show specific “lessons learned.” When our paper is presented at the conference in June, we hope to be able to

provide further results regarding whether selection of the IE department by freshman students has changed (either increased or decreased) due to the new international requirement and how the current sophomore group is fairing with respect to meeting the requirement.

Recognizing that engineering is an increasingly global profession, the Department of Industrial Engineering (IE) is committed to providing its graduates with the skills they need to compete on an international basis. Such skills will enable Pitt IE graduates to not only have a distinct employment advantage, but will also provide them with a cross-cultural awareness that will enhance their leadership abilities.

Beginning with the incoming 2007-08 industrial engineering sophomores, all IE students must either:

A. Successfully complete **an approved international experience** and **two globally focused Humanities / Social Science (H/SS) courses.**

The **international experience** is defined as an approved engineering academic program with a minimum of three-credits, an approved international internship, or an approved international co-op rotation of at least eight weeks. The two **H/SS courses** should be related to the international experience and may fulfill two of the six H/SS requirements. Appropriate language courses may be used to satisfy this requirement.

OR

B. Successfully complete an integrated, **globally focused set of four H/SS courses.** This set must consist of one humanities and one social science course plus two courses in the same area (depth). Students who elect this option must have it approved by both his/her advisor and the undergraduate coordinator prior to completing the sequence.

#### **International Experience Options:**

The University of Pittsburgh provides a wide spectrum of options that may be used to satisfy the international experience. These options are sponsored directly through Pitt's Office of Study Abroad as well as offered by Pitt affiliated institutions. All of the School of Engineering's programs may be used as a technical elective. Specific examples include:

- Term(s) abroad or exchanges including Global E3, SIP (Germany)
- International co-op or internship including IAESTE internship
- Integrated Field Trip Abroad (IFTA); e.g., Plus3, INNOVATE or EMPOWER
- International design course/experience.
- Engineers Without Borders (EWB) or Engineers for a Sustainable World (ESW) with significant international field experience.

The School of Engineering has its own study abroad office extension in B-80 with full-time personnel to help you. See <http://www.abroad.pitt.edu/engrng/index.html>. Students interested in international co-ops or internships should contact the appropriate School of Engineering Office in B-80.

#### **H/SS Course Options:**

There are over 500 acceptable international oriented humanities/social science electives. These may be found on either the approved H/SS list or on the CAS globally focused general education requirements list under "Foreign Culture/International" or "Non-Western Culture." See [http://www.as.pitt.edu/undergraduate/requirements/general\\_education\\_catalog.pdf](http://www.as.pitt.edu/undergraduate/requirements/general_education_catalog.pdf). Up to two language courses may be used to satisfy this requirement.

Figure 1: International Requirement in Industrial Engineering at the University of Pittsburgh

## Conclusions

The IE department at the University of Pittsburgh has taken a somewhat bold step at being (as far as we are aware) the first IE program in the U.S. to implement an international requirement that includes an out of the country experience for its undergraduate students. This decision was not taken lightly and took a great deal of time, effort and discussion to make and implement. The faculty feel that this decision was warranted and are convinced that this requirement will not only prepare Pitt IE graduates for a successful engineering career in a global environment, but also help to give them a competitive advantage over other IE graduates who may not have an international experience. We are in the early implementation stages of this decision and suspect that there may be some further tweaking of the requirements. We are committed to continually improving our academic program and although we are confident in our decision to implement the international requirement, time will judge the success of this decision.

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