

Globalization: What Is It, and What Does It mean for Engineering Education?

by

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Executive Summary. In order for U.S. engineering graduates to be well prepared for the practice of engineering in the 21st century, most observers agree they will need a much better understanding than in previous generations of the similarities, differences, and relationships between global cultures. In particular, they will need to understand the global economic and cultural forces that bear on the practice of engineering, as well as the grand socio-technical challenges that transcend national borders. As a result, many U.S. universities include an opportunity for engineering students to study abroad for one or more semesters at some point within their undergraduate program. However, statistics show that less than 2% of all U.S. engineering students take advantage of such opportunities. In contrast, 20-25% of the graduates of Olin College in the past two years have had such experiences, and some other technical colleges have much high percentages¹. However, there are great differences in the objectives, structure, and outcomes of study abroad experiences across the spectrum of higher education. This paper raises the question of what it means—or should mean—to be prepared for the practice of engineering in the new global economy. Is a study abroad experience appended to a traditional engineering technical education the best way to prepare graduates? What should Olin College's objectives be in this area, and what is the best educational approach for Olin?

Background. Appended to this white paper is a recent publication² that provides an overview of the rationale for global experiences in engineering education. It makes the case that although a study abroad experience is important to an authentic global perspective, the effectiveness of such an experience may be greatly enhanced by developing an integrated program that addresses the full spectrum of teamwork and non-technical skills throughout all four years. The paper also makes the case that the skills most needed for effective global teamwork are not technical but rather interpersonal skills. These non-technical dimensions to the educational program may require a whole new conceptualization of engineering education using the notion of “multiple intelligences” first introduced by Howard Gardner of Harvard University³. The paper also includes a brief overview of the entire Olin College educational experience in the context of these multiple intelligences.

What Constitutes a Global Perspective in Engineering? It is now widely accepted that the practice of engineering in the 21st century will require a global perspective. Many major technology companies are now global in scope, employing engineers on several continents. Both the manufacture and marketing of engineered products often involve transactions in many countries. The work environment for technology companies now frequently involves multinational teams working on a common project or product. This new environment requires increased proficiency with interpersonal skills and a sensitivity to and experience with intense cultural diversity within the business world.

In addition, a global perspective also includes the application of engineering principles to problems and opportunities of global proportion. These might include climate change, sustainable energy, environmental quality and water resources, and affordable healthcare,

¹ Each year, approximately half of the engineering graduates of the Worcester Polytechnic Institute (WPI) have had a study abroad experience.

² Miller, R.K., “*Beyond Study Abroad: Preparing Engineers for the New Global Economy*,” Proceedings, ABET Annual Meeting, Incline Village, NV, November 1-2, 2007.

³ Gardner, H., *Frames of Mind: The Theory of Multiple Intelligences*, New York: Basic, 1983

among others. Application of engineering principles to the challenges in developing countries is of particular concern.

Preparing engineering graduates to make a positive difference with this new and expanded set of expectations and opportunities requires developing an ability to work effectively on diverse teams. It also involves gaining insight into the global market share and economic trends in use of resources across geographical regions, understanding the factors that control the establishment of successful technological ventures in other cultures, and understanding different cultural norms of behavior. Given the natural hesitation of American students to undertake travel to a non-English speaking country, it also requires developing an appetite for international assignments and a "can do" spirit in tackling international projects.

A Few Illustrative Examples of Study Abroad Experiences. The range of objectives included in the spectrum of study abroad experiences within U.S. engineering education is quite broad, leading to a wide range of learning outcomes. For example, at some colleges the international experience is entirely social or cultural, and does not involve any aspects of engineering or science. Students in these programs may select a college or university in any region of the world, and they may choose to study essentially any academic subject. Due to both (1) the difficulty in finding appropriate courses at foreign universities taught in English and (2) the fact that engineering and science courses at foreign universities are often taught at a more advanced level than they are in the U.S., this type of study abroad experience is quite common in the U.S. In addition, since engineering degree requirements in foreign universities are often more narrowly focused on technical courses and in some cases do not include any courses in the humanities, arts, or social sciences, students who choose to study abroad in these programs are unlikely to encounter engineering students in their program.

However, some U.S. engineering programs have developed international experiences that are integrated with engineering technical requirements. One such program that is regarded as very successful is WPI's project-based experience. Their program involves small teams of WPI students together with a WPI faculty mentor traveling together as a unit to a foreign site to work for at least 8-10 weeks on an engineering project. During this period the WPI team works full time on this one project, which typically satisfies a WPI graduation requirement. The projects usually have a client in the host country which typically involves a local company, government, or non-profit organization. Approximately half of WPI's students choose to participate in one of these international projects, which is among the highest percentages in the U.S. for an engineering school. Their faculty report that this experience is often positive and transformative for students. WPI students receive training in teaming and work effectively as a professional team with local residents abroad while immersed in the local culture. However, they do not often team with foreign engineering students on these projects.

Another engineering program that involves engineering students in technical projects overseas is the LeTourneau Engineering Global Solutions (LEGS) program at LeTourneau University in Texas. This small Christian university established a voluntary international experience focused on providing low cost, high quality prosthetic lower limbs for patients in low-income countries. Each student in the program is required to make a commitment of at least 24 months to the program (not all of which is spent overseas), and is also required to provide several thousand dollars in personal funding. Students live for extended periods in developing countries and learn to identify and solve problems independently, work with a team including pre-health science students, and establish long term relationships with patients. The faculty again report that this experience is often positive and transformative for students. The LEGS program (which was inspired in some ways by the Mercy Ships medical program for volunteer surgeons) has had remarkable success in developing quality prostheses that cost less than \$100. It has received considerable media attention and is inspirational in its outcomes. However, it involves a very

small number of students, and does not involve teamwork with engineering students abroad or with major corporations⁴.

The Global Engineering Alliance for Research and Education (GEARE) program in the Department of Mechanical Engineering at Purdue University provides a comprehensive approach that integrates technical education, professional experience, and multinational teamwork in engineering. The GEARE program involves an alliance between Purdue University, the University of Karlsruhe in Germany, Shanghai Jiao Tong University in China, the Indian Institute of Technology in Bombay, and Tec de Monterey in Mexico. The educational requirements for Purdue students include a 24-month program that integrates (1) language education; (2) cultural orientation; (3) domestic and international corporate internships; (4) one-semester study abroad; and (5) a two-semester face-to-face multinational design team project. The internship opportunities and the design projects are provided by global industry partners⁵. The program was established in 2001 and enrollment is still growing. However, it currently involves only 8% of the students in the mechanical engineering program at Purdue, and requires a 3.0 grade point average to be admitted to the program (to enable U.S. students to succeed in the more demanding technical courses overseas, that are not always taught in English). Experience with the program indicates that U.S. students are frequently selected by their peers as team leaders in all countries (except Germany), even though the American students are not usually the strongest in technical preparation⁶.

The current study away program at Olin College is quite flexible, and is designed to allow students to study away for a semester at other U.S. institutions as well as international institutions within a 4-year program. It does not require students to include technical course work, or to team with engineering students from other countries. However, the Olin College engineering program provides pervasive teamwork and project experiences often including some students from other colleges and corporate sponsors. Based on very limited data it appears that interest in study abroad experiences at Olin may be declining. As explained in the accompanying paper, developing an authentic global perspective and an ability to work successfully on international teams may depend more on the entire educational culture than it does the study abroad experience.

Conclusion. Although students from Olin College have been involved in various study abroad programs since the spring of 2002, the College was first able to matriculate international students in the fall of 2007. Interest among international students in applying to Olin College is expected to grow substantially in the years ahead. The time is right for the College to rethink its goals and programs in global perspectives in order to provide the best possible learning experience for our students. This raises a number of important questions that will be explored at the November 12, 2007, meeting of the President's Council.

1. What should Olin College's goals and objectives be in preparing its graduates with global perspectives?
2. What is the best way for Olin College to meet these objectives?
3. What role should a study away experience play in the Olin College educational program and what role (if any) should foreign languages play?
4. What other thoughts or suggestions do you have regarding globalization at Olin?

⁴ Gonzalez, R.V., and Rispin, K.L., "International Engineering Education: A Case Study of Working in Low-income Countries," Proceedings, ABET Annual Meeting, Incline Village, NV, November 1-2, 2007.

⁵ Chiu, G. T.-C., Groll, E.A., and Hirleman, E.D., "The Purdue Global Engineering Alliance for Research and Education (GEARE) Program," Proceedings, ABET Annual Meeting, Incline Village, NV, November 1-2, 2007.

⁶ Professor George T.-C. Chiu, personal communication, Nov.2, 2007.