Gaining International Competence: A Multi-Faceted Approach to International Engineering Education

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Abstract
In direct alignment with Accreditation Board for Engineering and Technology criteria to train engineers who should be globally competent, the International Programs in Engineering office in the College of Engineering at the University of Michigan has created a broad palette of international program activities that will engage both its undergraduate and graduate student populations to develop global skills. Programs range in duration from a few hours to the length of an academic career and include language learning and cross-cultural training. These programs are accompanied by a strategic marketing plan that has resulted in a steady increase in participation, with more graduates who are well-equipped to deal with the challenges posed by working in multi-national corporations.

I. Introduction

Engineers are increasingly asked to work with international suppliers, co-workers, and clients. Global assignments for companies in industries such as communications, information technology, and automotive manufacturing, require engineers to integrate technical knowledge with global competencies. In response to the need for globally competent engineers, the Accreditation Board for Engineering and Technology (ABET) has developed indicators for evaluating engineering technology programs' ability to provide opportunities for students to develop the necessary global competencies. Among the eleven skills and abilities listed in Criterion 3 of ABET: Program Outcomes and Assessment for basic level programs, ABET articulated outcomes such as multidisciplinary team functioning, communication skills, and "the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context"[1]. Program evaluations of international experiences have illustrated that students acquire a variety of desired global competencies as a result of participating in cross-cultural learning opportunities[2], such as an appreciation of other cultures, growth in independence and maturity, greater self-awareness, greater tolerance for different people and ideas, growth in interpersonal skills[3]; and development of a multicultural perspective.[4]

Yet, the integration of international opportunities in an engineering academic program is daunting. Engineering students interested in a traditional study abroad program confront a number of barriers to participation. Core program courses in small departments might be offered only once annually, meaning an automatic delay to degree if students go overseas. Departments

unfamiliar with a host institution might be reluctant to allow transfer credit. They are sometimes also hesitant to recognize upper level technical coursework, allowing only lower level technical courses or free electives to be taken overseas. In addition, engineering students are very task-oriented. They wish to complete their degree in the shortest time possible. They focus summer activity on taking additional courses to move them further toward degree completion, or seeking internships in which they can apply their technical skills. In addition, engineering students have limited foreign language skills, which impedes their immersion in an overseas institution where courses are taught in a foreign language.

The University of Michigan (UM) College of Engineering (CoE) engaged experts from the UM School of Education to determine what deters students from choosing to participate in international programs. This evaluation, conducted by a survey, confirmed some of the barriers outlined above. In addition, findings indicated:

- Pre-college travel or study abroad experience positively influenced student participation
- Positive influence of institutional climate for diversity – structural diversity
- Students valued cross-cultural experiences personally and professionally.[5-6]

The CoE has created a broad range of international programming that aims to develop a more globally competent engineer, while being mindful of the current barriers to traditional study abroad programs that students face. These international program initiatives are designed to attract students of various academic levels and linguistic abilities. They range from short-term one-stop workshops on campus to academic programs that span the entire course of the student's academic career. Opportunities exist for both undergraduates and graduate students and can be fulfilled in Ann Arbor or overseas. By providing a diverse palette of opportunities, we hope students will be inclined to try shorter term programming, which may inspire a longer overseas sojourn later in their academic career.

For those students with a committed interest in learning about other cultures, the UM CoE offers two academic programs to help students acquire knowledge about a particular world region and overseas experience through study and work abroad. These programs are designed to overlap significantly with the general engineering requirements in order to minimize a delay to completing the degree program. These programs are undergraduate programs, although one requires that the student complete a graduate degree as well. All undergraduate engineering programs at the CoE require sixteen credits of humanities and social science courses to be taken by students. On average, between 9 and 12 credits are reserved as free elective credit. Students can fulfill the requirements of these academic programs by carefully focusing these required humanities, social science, and free elective course requirements so they fulfill both the academic program and degree program requirements simultaneously.

II. Program in Global Engineering

The Program in Global Engineering (PGE), which was created with the support of funding from the Department of Education's Fund for the Improvement of Postsecondary Education (FIPSE) requires students to choose a region of the world and focus their regular humanities and social science and free elective degree requirements to gain more in-depth information about that

region. Program templates for the PGE are created to ensure that these courses could be used to fulfill both program and degree requirements.

The PGE consists of 22 credits of coursework, cross-cultural training, and a required overseas sojourn in order to complete the program. Students must study two terms (typically eight credits) of a foreign language spoken in their chosen region, and take eight credits of courses dedicated to the study of the political, economic, or historical background of the chosen region. Students are also required to take part in an international experiential learning opportunity (study/work abroad). Finally, students are required to develop cross-cultural awareness and communication skills by choosing one of a number of for-credit and extra-curricular options.

To fulfill the cross-cultural training requirement, students can choose from a number of courses offered in departments both inside and outside of the CoE. We reviewed courses in place across the University that explore cultural issues. Examples of these courses include comparative anthropology, linguistic, political science, and sociology courses dealing with regional or cultural conflicts. The CoE also offers an *Engineering for Community* course, which explores the importance of understanding the cultural context of the region where engineering solutions will be implemented. Because these courses are not offered every semester, the PGE also permits courses that allow a student to independently focus on cross-cultural issues. Students can use an Independent Study option to work with a faculty member whose research involves working with international colleagues, suppliers, etc. Strict guidelines for the independent study project have been developed (how much interface necessary with international counterparts, plans for personal goals on improving skills, and a reflection paper) to ensure that the student gains insight into cross-cultural challenges. One other option is for students to take part in an Engineering Cross-Cultural Training Series. This option will be discussed in more detail further in this paper.

Students taking part in the PGE program must also study or work overseas for a minimum of eight weeks. Although we do not secure individual work abroad placements, the International Programs in Engineering (IPE) office acts as a central resource for work abroad placement agencies that specifically offer technical placements. The UM campus is a rich resource for such work abroad opportunities, hosting the Japan Technology Management Program, CDS International, which offers placements in Germany, Argentina, and a few other countries, and two student-led work exchange societies, International Association for the Exchange of Students for Technical Experience (IAESTE) and AIESEC. The IPE office also guides students in finding appropriate study abroad options at its partner institutions.

III. Engineering Global Leadership Honors Program

The Engineering Global Leadership (EGL) Honors program is an extremely rigorous program composed of three cores. The technical core consists of the student's regular technical degree program. A business core requires the student to take 12 credits of introductory business courses (finance, accounting, and marketing). A cultural core and foreign language component require the student to demonstrate proficiency of a foreign language through 2nd year, and to take 12 credits of courses focusing on a region of economic importance to the US.

The EGL program requires that a student also complete a Master's degree in an engineering field. The Master's degree does not need to be in the same field as the undergraduate degree. In

fact, of the nine current EGL tracks being pursued, seven tracks cross disciplines. The program's original participants were in the Industrial and Operations Engineering department, but the increased demand by students from other engineering disciplines and faculty recognition of the value of an international component have resulted in the recent opening of this program to all engineering departments.

The EGL program remains the only honors program in the CoE. It requires a 3.60 cumulative GPA to be admitted and students must maintain a cumulative average of 3.40 throughout their course of study. Students take a minimum of 16 credits per semester and typically come to the CoE with a significant number of advanced placement credit that helps to ensure their completion of both the undergraduate and graduate degrees in roughly 5 ½ - 6 years.

Students are also required to take part in a synthesis project which helps to place their technical skills in an applied context. Those students with an interest in manufacturing can apply for membership in the Tauber Manufacturing Institute, which enables them to take part in a summer team project, working together on a team composed of graduate and undergraduate business and engineering students in industry. These projects are jointly overseen by a faculty member from engineering and business. Some of these projects might involve placements in overseas locations as well.

IV. Global Intercultural Experience for Undergraduates

Many students are not prepared to make the commitment that the PGE and EGL programs require. But they may still have interest in learning about other cultures. The University of Michigan has put in place the Global Intercultural Experience for Undergraduates (GIEU) program which aims at encouraging students to explore an overseas location for a short amount of time, together with a faculty member. This program is aimed at students who have never ventured overseas, in an effort to expose them to cross-cultural issues and challenges early in their academic careers. It is attractive in that it allows undergraduate students to work in small groups of 6-10 students on a short academic intercultural project with the leading faculty member. Young undergraduate students typically do not have the opportunity to work this closely with an individual faculty member until later in their career and the research project helps expose them to the research process as well. In addition, team projects expose the students to the importance of developing teamwork skills. The program is also attractive for parents who might be concerned about their child embarking on an overseas sojourn for the first time. The faculty member oversees the group for the 3-4 week summer stay.

The GIEU experience is offered as a two-credit course that overlaps the University's winter and fall terms. Students enroll in UC 275 for one credit during the winter term, when they take part in the individual team meetings with their lead faculty member and participate in the required orientation cross-cultural training sessions and a pre-departure convocation. The two-day cross-cultural training period brings the participants from all GIEU projects together to take part in self-reflection about their current cultural perspectives and how to be cognizant of other cultural viewpoints. Students participate in and write journal entries on experiential activities in Ann Arbor which expose them to other cultures locally. Students are also required to continue journaling activities during their sojourn so as to provide a reference for their final symposium project that is delivered during the fall term. The second credit is awarded in the fall semester

after students have submitted their final projects and participated in a debriefing session and final symposium.

While the topic areas of the 8-12 projects offered each year must be designed to attract students from various units on campus, they can be somewhat focused to attract a specific group of students. The CoE offered its first GIEU project: *What Does it Take to Launch a Successful Global Engineering Operation?* in the summer of 2004. Mechanical Engineering faculty member Jun Ni led a group of students to Shanghai, China, to investigate a global operation set up in Shanghai. The group focused on issues encountered by the automotive industry in ramping up/maintaining operations with global partners. Students visited multiple types of engineering enterprises (state-run, private, and multinational, etc.) and interviewed engineering students as well.

The 2005 engineering project will focus on West Africa, *Modernizing Suame Magazine in Ghana*. A Mechanical Engineering faculty member, Professor Elijah Kannatey-Asibu, will lead a student group to investigate the engineering requirements, as well as economic, legal, and social ramifications of modernizing a vast manufacturing engineering establishment in Ghana - the Suame Magazine. This is a typical informal manufacturing community of self-trained and apprenticed artisans and skilled workers. GIEU participants will work with counterparts at the Kwame Nkrumah University of Science and Technology in Kumasi, Ghana to develop recommendations for the project.

V. Study and Work Abroad

The IPE office works together with its bilateral partners around the world to create relevant programming for UM engineering students. Due to limited foreign language ability, few of our students feel comfortable immersing themselves in a foreign institution to take courses. Our office is working with our partners to develop English language summer courses that allow them to spend a short time overseas taking classes in English, but mixing with other non-native speakers of English. The IPE office underlines its support for those who study overseas by offering a limited amount of study abroad merit scholarships.

Yet our students are most interested in applied opportunities. The College works with its partners to create research and work opportunities that can attract both undergraduate and graduate students overseas. In support of the work effort, the International Programs office is a recipient of a German Academic Exchange Service (DAAD) grant for the German American Initiative for Students in Science and Technology (GAIST). Funding from this grant goes directly to students to support costs they may incur in finding an internship placement in Germany, as well as costs associated with language training (all students must combine their internship with language training).

VI. On-Campus Opportunities

The IPE office is well aware that despite the varied types of overseas opportunities offered to our engineering students to gain a cross-cultural perspective, many will choose not to take part in activities that might require an overseas sojourn. Our commitment to helping students gain the skills outlined in the ABET criteria above require us to provide cross-cultural learning activities on campus. We have developed two programs that allow domestic and international students to

interact and engage in conversations connected to differing cultural and engineering philosophies.

A. The Buddies Program

Originally conceived as a welcome program for our incoming exchange students, this program was expanded in Fall 2004 to include any newly arriving engineering student. Participants are linked with a domestic student in order to facilitate acclimatization in the early weeks of the semester and to maintain a long-term friendship and connection. Current students are recruited in April and apply online, describing their general background and hosting preferences. Concurrently, all newly arriving graduate and undergraduate students are asked whether or not they wish to be paired with a current student buddy. In the early summer months, students are matched with one another. The main aim is to connect students with the same engineering discipline and academic level, while avoiding pairing of current and new students with the same citizenship. We are cognizant that, for instance, our incoming Chinese student population will automatically seek out their Chinese counterparts on campus. This program is designed to ensure that students are paired with peers who are not from their home country, in order to ensure greater cross-cultural interaction.

Buddies and their corresponding incoming students are connected during the summer in order that they can begin an email exchange before the arrival of the students in September. We encourage buddies to be involved in picking the students up from the airport (highly valued by the new students) and bringing them to temporary or permanent housing. The incoming students are also grateful for assistance in navigating to the various administrative offices on campus in order to set up computing accounts, obtaining an identification card, etc. But the buddy program is not intended to be a mere taxi service for the new students. Through social programming throughout the year, the IPE office hopes that the new students and their buddies will continue their relationship into the academic year, exchanging insights into one another's cultures and learning more about their own cultural perspectives. With social programming begins with a buddies welcome dinner in the days preceding the first day of classes. The other programming events are aimed at exposing the newly arrived students to typical American, Midwestern, or University of Michigan traditions, such as attending a football game, having a bowling or pool night, etc. This year, the IPE office matched 150 newly arriving students with 150 peers in the CoE.

B. Cross-Cultural Training Modules

The IPE office piloted cross-cultural training modules aimed at focusing student attention on working on multi-national teams and cross-cultural communication, Students register for these non-credit bearing modules individually or complete the whole series to fulfill the Program in Global Engineering requirement. Past experience with engineering student participation in cross-cultural interactive exercises taught us that students will become actively engaged in such activity only if they see the direct relevance it will have to the engineering profession. Thus, each module has cross-cultural activities that revolve around an engineering project. Cultures presented are fictitious ones in order that students must adapt to a culture that is not their own. Debriefing sessions will be tailored to engage students to talk about their own cultural perspective and perceptions of other cultures. For each module, the IPE office aims to have an

even mix of domestic and international students, in order to ensure that dialogue about cultural differences can extend beyond the fictitious cultures.

VII. Society of the Global Engineer

With the help of a recent grant from NAFSA: Association for International Education, the CoE will launch a new student society, the Society of the Global Engineer, dedicated to international issues in engineering. The Society of the Global Engineer will target PGE and EGL students, returning and prospective study and work abroad participants, and other international and domestic students who share an interest in global issues, but are unable to take part in the academic programs or overseas sojourns because of financial or other academic obligations. This group will provide a common forum to discuss global issues in engineering; to develop outreach programming to the community that would spawn an interest in both engineering and other cultures; and to assume primary responsibility for the buddies program.

VIII. Student Recruitment

The IPE office is at a geographically challenged location on campus. It is not easily visible to regular student foot traffic. Those who have a predisposed interest in other cultures will find their way to the office, but many students are not aware of the existence of an IPE office specifically dedicated to the engineering student population. Mass recruiting campaigns have been launched to make ourselves known to students even before they have matriculated. The IPE office works closely with the Recruiting and Admissions office as well as the Undergraduate Advising Center to make students aware of our programs early in their career. The IPE office has representatives available to answer questions on Campus Welcome Days, when admitted students tour campus with their parents. Orientation tours bring students to the IPE office, where they briefly learn about our academic and study/work abroad programs. In addition to regularly scheduled information sessions about our study/work abroad programs and EGL and PGE, we actively target students who have transferred AP language credit to the University. We also utilize other units on campus to publicize our activities and programs. The International Center advertises all events related to study/work abroad on a weekly basis to an email group list of over 9000 members. Our events are regularly advertised through this medium. The German department has an active applied language program, including courses like *German for Engineers*. The College targets students in this class and utilizes departmental newsletters to students to publicize our German DAAD grant program and the Program in Global Engineering. Finally, we also enlist our incoming exchange students in ambassadorial activities by having them staff information tables in the engineering campus student union building and by presenting at student society meetings.

IX. Assessment of Outcomes

Capitalizing on the expertise of the UM's school of Education, the CoE has also put in place an evaluation system that assesses both the climate for participation in international programs and the development of cross-cultural sensitivity in program participants over time. The climate survey was adapted from a diversity climate survey developed at the Higher Education Research Institute (HERI) at the University of California, Los Angeles. The instrument is designed to capture information about the institution's climate for international diversity (experiences with and perceptions of international peers, faculty, and staff). In order to measure development of

cross-cultural sensitivity, the team administers the Revised Ethnocentrism Scale[7] in a pre- and post-test fashion[8].

Preliminary results of pre- and post-testing indicated little change in a student's cross-cultural awareness as a result of participation in an international program overseas, but we do not have enough data to determine whether or not this varies across program types or length of stay. We anticipate that program length and type play a significant role in the extent to which students' cross-cultural awareness increase, and plan to investigate in subsequent research to validate our hypothesis.

However, student participation numbers have increased significantly in all our programs. We have seen a 157% increase in study abroad participation since 2001. Our academic programs have expanded rapidly as well: the number of students admitted to the PGE program increased by 571% and EGL admissions has increased by 142% in the same time period. In addition, the piloted cross-cultural modules yielded greater participation by those students typically not engaged in international programs, namely graduate students. Participants also gave the modules high rankings.

X. Summary

Through the multiple types of programs offered by the IPE office in the University of Michigan College of Engineering, engineering students of all academic levels and disciplines can take part in gaining an alternate perspective, whether they go overseas or choose to remain in Ann Arbor. These programs are carefully marketed to the College's student body in an effort to make them more globally competent citizens. Future plans for furthering the opportunities to develop cross-cultural competencies include more substantial program options for graduate students, more short-term summer international programs offerings using the GIEU model, and a stream-lined overseas internship program.

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viii Educating for Global Competence: Preparing Our Youth to Engage the World. resource for educators, administrators, policymakers, community leaders, parents, and students.Â â€¢ With some exceptions, educators and policymakers concerned with education, however well meaning, have not themselves had the opportunity to think much about education for a truly global era; and even if they have, their own education has rarely prepared them to undertake such education seriously and effectively. â€¢ Despite scattered calls for 21st-century skills and knowledge, there is no deep desire for such innovative education on the part of most families, or most citizens. Competency-Based Education. associated with CBT is that it is highly contentious as an approach to education and trainingâ€ (p. 11).Â Outside of secondary and higher education, the competency-based education movement also influenced the design and delivery of vocational education in the UK and particularly in Australia, where national reforms in the late 1980s and early 1990s required that all accredited vocational education programs be competency-based (Hodges & Harris, 2012). Additionally, Tuxworth (1994/1989) suggested that competency-based approaches were a prominent feature of health-care related education, training and professional development. facilitating intercultural competence through international student internships; interdisciplinary and cross-cultural contributions from over 19 countries including Japan, Russia, Serbia, South Africa, and Vietnam; the latest research and thinking on global, intercultural, and international learning outcomes, with a unique emphasis on newer voices. Intercultural competence has become an essential element in international as well as domestic education.