Educating the Global Engineer: A Program to Promote Study Abroad, International Exchanges and Diversity in Undergraduate Engineering

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Introduction

More than 96% of humanity lives outside the borders of the continental United States. Of the 15 million Americans studying in higher education in the United States each year, only about 1% go abroad as part of their undergraduate educational experience. Moreover, less than 3% of this 1% are engineering students, (although the numbers have increased in the last few years.) These figures, in and of themselves, mandate that we do more to encourage an international experience on the part of our own undergraduate engineering students. This is particularly important since technology has been a (if not *the*) dominant driver for development in the United States both from a technological as well as financial point of view. Information Technology specifically has dramatically shrunk our world and made it a virtual work place with telecommuting and distance learning. Multinational companies have become the rule and not the exception. Consequently, the impact of technology is felt both in a cultural and societal sense overall, especially in the pervasive fields of Information Technology and Biotechnology. Any one of these statements and certainly all of them taken in their entirety suggest that an international experience be part of the fundamental education of the 21st century engineer. This will require both a technology pull from the industrial sector coupled with a technology push from educational sector.

This paper describes the Global Engineering Education Exchange (Global E^3) program, which offers American engineering students the opportunity to study engineering abroad for credit, and for international engineering students to study in the United States. It describes the program development, current status, and future directions and challenges such programs face. It especially emphasizes the importance for United States undergraduate engineering students to have an international experience.

Background and Program Development

Program History and Design

With a focus towards off-campus initiatives, in 1995 a group of 15 U.S. and Western European universities formed the American-European Education Exchange (AE3). This has since been expanded to include other world regions (Asia, Latin America, Western and Eastern Europe) and was renamed the Global Engineering Education Exchange, or Global E^3. The primary goal of the program from the U.S. perspective is to provide academic and practical training opportunities at international institutions, specifically to U.S. undergraduate engineering students, focusing on their junior year. At the same time, the program seeks to minimize the increased cost and time in completing degrees usually associated with traditional study abroad programs. By forming a consortium, each member has access to a wide range of foreign institutions. A U.S. member, for

example, is able to send one of its students to Germany and receive a student from Singapore without the need to achieve parity in individual exchanges, as is the case in most bilateral linkages based on a Memorandum of Understanding (MoU). In addition, each school agrees to establish a net flow of zero over a multiyear period. As such, this program permits integration over time as well as geographical location. Participating universities agree to a "tuition swap" whereby outgoing students pay regular tuition to their home universities while tuition waivers are granted to incoming foreign students. Paid internships in industry also help offset costs for students while abroad. Room and board are paid by the student to the host university, as they would be to the home campus. Students' costs usually increase only by travel expenses incurred.

Credit Transfer

The issue of receiving credit for equivalent course work done abroad has been resolved by preparing an approved "program of study" for each student prior to departure to the host university. As part of the application process, students, with their academic advisor's approval, list courses that must be taken in order to complete their degree and provide course syllabi and other documentation on these courses for the review of prospective host campuses. Advisors at the host campus recommend equivalent courses and provide similar documentation for the student's own advisor, who then approves this plan of study before the student departs for overseas. ABET was consulted on this method and has endorsed this general approach. To complement the credit transfer process, a course databank was recently created, listing courses that US students have taken at member institutions abroad for which they received credit at the home campus. It is expected that as this databank grows, it will decrease the amount of time that individual faculty members need to spend determining course equivalencies. (This databank may be viewed at: http://www.iie.org/pgms/global-e3/COURSE_DATA_BANK.xls)

Language of Instruction

Language has traditionally been seen as a barrier to study abroad, especially for engineering students who often lack the flexibility in their course schedule to continue studying foreign languages as undergraduates that they may have learned at home or in high school. Global E^3 has minimized this challenge by identifying abundant opportunities for students to take engineering courses abroad in English, even in countries where the native language is not English, In Europe, Asia, and other world regions, university partners are developing selected courses which are available in English, not just for visiting Americans but to lure international students from around the world. To supplement English-language offerings in the major, host institutions also encourage study of the host country language by offering free language courses in the summer and during the academic year. Of course, many opportunities exist for the student to be fully immersed in both the local culture and language, including opportunities to study engineering in the host country language, housing with students from the host country, and a myriad of cultural activities. As such, the traditional stumbling blocks of effecting credit transfer, differential tuition costs, and issues of foreign language have not only been mediated, but are essentially overcome by the Global E^3 program.

Administration

In the United States the program is administered centrally by the Institute of International Education (IIE) based in New York City and in Europe by GE4, thereby minimizing the paperwork of individual member universities. IIE and GE4 oversee the student application and

placement process, helping to insure that a balance or zero net flow is maintained for each university member integrated over a few years. The two administrative organizations also arrange an Annual Meeting for deans, faculty, program administrators, and industry to gather at one of the member institutions to update themselves on new aspects of the program and to encourage dialogue between and among member institutions, administration, and industry. Sites for the annual meetings alternate between the U.S. and Europe, with side trips arranged to various member campuses nearby the host campus. In addition, IIE and GE4 also recruit new member institutions, procure financial support for the program and for scholarships, and publicize the program in the media and at engineering education and study abroad conferences.

An Executive Board, elected by U.S. consortium members, determines overall program policy. The current members of the Executive Committee are: Lester Gerhardt, Rensselaer Polytechnic Institute (Chair); Steve Melsheimer, Clemson University; D. Joseph Mook, University of Buffalo, SUNY; Marianne Machotka, University of Wisconsin; Billy Wood, University of Texas-Austin; Thomas Regan, University of Maryland, James Cunningham, Embry Riddle University; and Peggy Blumenthal, IIE (Ex Officio). All hold senior administrative positions in their organizations, and six of the eight hold teaching positions as well.

Program Funding

The program received initial three-year funding support from the AT&T Foundation to launch the program. This funding was supplemented in August 1995 when Global E^3 received a three-year grant from the National Science Foundation (NSF), which provided additional administrative support, as well as funds for scholarships, international curriculum development, language programs, and a one-time summer program called "I SEE IT (International Summer Engineering Education and Industry Tour)." The I SEE IT program resulted from suggestions at the March 1997 Annual Meeting of Global E^3 members, where it was suggested that IIE conduct a short 'sampler program' of participating countries for students between their freshman and sophomore years. Participants would gain exposure to life in another country while learning about engineering education and industry in the countries they visited. They would hopefully be inspired to return the following year (with some of their peers) for a full term or year of overseas academic study and/or internship in industry. Collectively called "I SEE IT," seventeen students participated. They then served as 'ambassadors' to recruit others.

Beginning in 1998, industrial support was sought, and Ford Motor Co. became the first industrial sponsor, signing on for a three-year commitment. In 2001 ABB Inc. became the sole corporate sponsor with a commitment for three-years of support and funds for scholarships for U.S. women engineering students. At a press conference announcing ABB's support, D. Howard Pierce, President & CEO, ABB, Inc. commented that, "I didn't have to think very hard [about whether or not to support Global E^3], because the program just seemed to me to fit so well with a number of issues that are high on ABB's priority, and actually high on my personal agenda for things that I think we need to accomplish." Aside from encouraging more women in engineering, he emphasized that "it's really important that we do what we can to get more young Americans, particularly engineers to go abroad." NSF has also provided additional grant support for a study of program outcomes assessment. U.S. member universities also pay a small annual membership fee to support program administration.

Global E^3 strongly promotes faculty involvement not only implicitly through student advising, but explicitly through international curriculum development and faculty exchanges. In February 1996, eight pairs of American-European engineering institutions received funds from the U.S. Department of Education's Fund for the Improvement of Secondary Education (FIPSE) to aid in curriculum development and coordination. International university teams reviewed and analyzed curricula offerings at their universities emphasizing compatibility of programs. This was done in 6 different disciplines in 5 countries. The detailed results are presented in the FIPSE report cited in the bibliography, as Project # P116J60061.

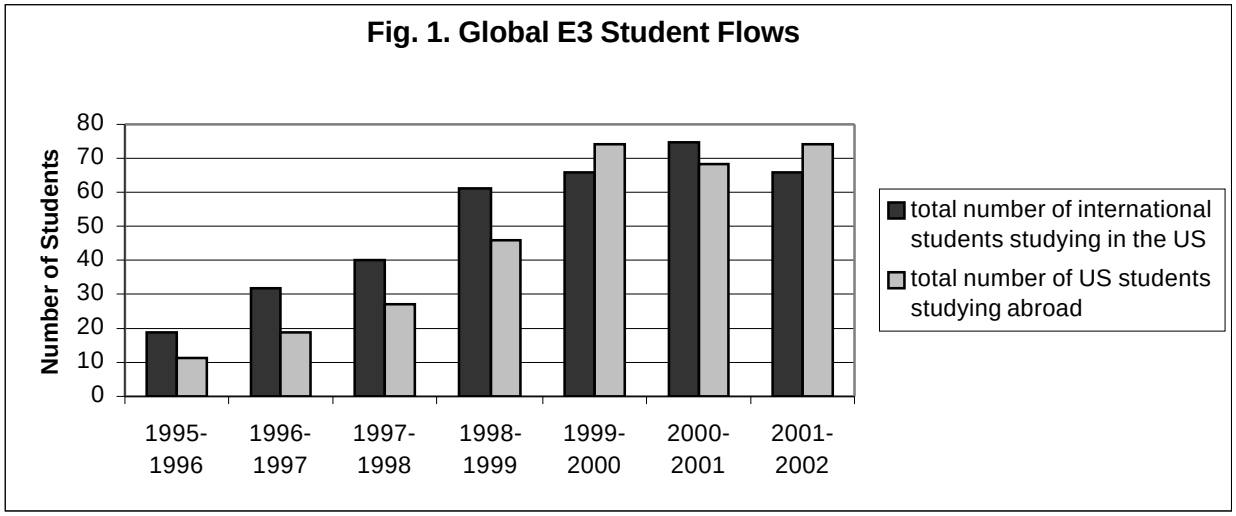
Current Status of the Program – Institutions and Students

IIE maintains an extensive program web site (http://www.iie.org/pgms/global-e3/) that describes the program in great detail. The website provides members and interested potential new member institutions information about the program. Students access the site for program information, as well as to submit on-line applications. Password protected areas allow advisors access to contact information, updates, and student on-line applications which they can view and approve.

As of early 2002, the Global E^3 Program includes 84 member universities, 34 in the United States and 50 worldwide, representing 17 countries. Internationally the most recent additions are Finland, Hong Kong, Italy, and Sweden. Helsinki University of Technology and Tampere University of Technology both in Finland were welcomed as members in 2002. The most recent additions on the United States side include Drexel University, Morgan State University, and the University of Missouri-Columbia. A list of the full membership may be viewed on-line at: http://www.iie.org/pgms/global-e3/links.htm. To date, the program has implemented close to 700 exchanges. At the current rate of growth, it is expected that in a period of less then 8 years from program inception, more than 1000 exchanges will have been conducted. Table 1 reflects the top ten U.S. university participants, as measured by the number of students they have sent abroad.

Table 1
Top Ten U.S. University Participants

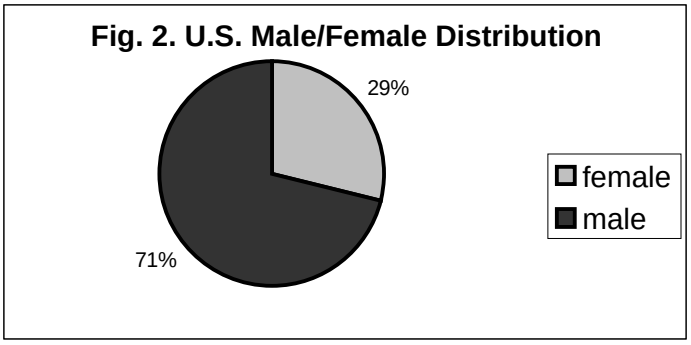
University of Wisconsin, Madison
State University of New York at Buffalo
University of Texas at Austin
Rensselaer Polytechnic Institute
Virginia Polytechnic Institute
Embry Riddle Aeronautical University
University of Maryland
New Jersey Institute of Technology
Georgia Institute of Technology
University of Washington



The Global E^3 student flows since the inception of the program through the 2001-2002 academic year is shown in Figure 1. The total number of students to date as shown in this figure is 695, which includes the 17 students who participated in the one-time "I SEE IT" summer program in 1998-1999. These 17 students visited Germany and France as a pre-cursor to a full semester or year abroad to familiarize them with the opportunities available. The total number of international students studying in the United States is 359 and the United States students studying abroad numbered 336. The total for the academic year 2001-2002 is 140 students.

It should be noted that while the numbers are roughly equal, a large percentage of international students study in the U.S. for a full academic year, whereas many of the American students study abroad for just one semester. Global E^3 is beginning to notice an interesting trend among a growing number of American students on this program – they study abroad in one country for a semester, and recognizing the value of the experience, chose to study abroad again in a different country in a later semester. Generally the biggest challenge that we face is to interest American engineering students to incorporate a study abroad experience as part of their undergraduate program. The program has consistently seen a larger demand of international students requesting to study in the United States than United States students' requests for studying abroad. In recent years, the program is closer to reaching parity of numbers of students, but to some extent this is achieved by limiting the number of in-coming international students to the actual number of out-going American students, to maintain the balance.

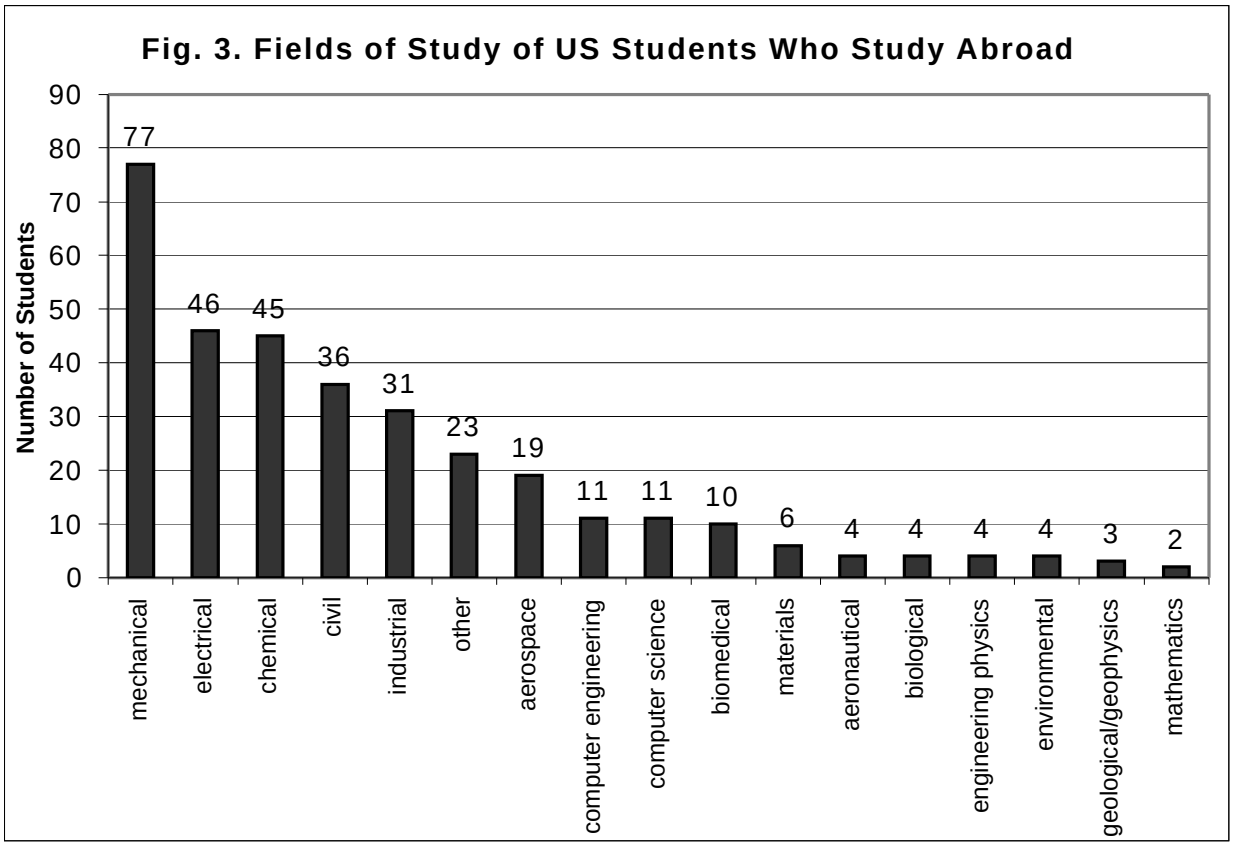
The following figures reflect aspects of U.S. students who study abroad through the Global E^3 program.



Global E^3 is proud of the participation rate of female engineering students, as reflected in Figure 2. The female distribution at 29% is substantially higher then the nominal 20% enrollment of females enrolled in U.S. undergraduate engineering programs, and also higher then the 23% of females employed in the science and engineering workforce in the United States. Moreover, it should be pointed out that in the spring semester, the rate of participation by females in this exchange program is generally even higher. For example, in the spring of 2000, the female distribution rate reached 45%.

An international experience is clearly very appealing to the female portion of our engineering student population, in larger proportions then represented by females in the universities or in the workforce in these disciplines. We anticipate that this distribution will continue and, in fact, even grow to reflect a larger percentage of females in the exchange program. This will be promoted by such things as the ABB scholarships for women that were initiated in 2001, as well as increased emphasis in certain fields which have inherently attracted more women then other engineering disciplines, such as biotechnology and information technology. It is our hope that more females will be drawn to the field of engineering as they recognize that studying engineering does not mean that students must give up on study abroad ambitions (as it did in the past). Since women outnumber men by 2 to 1 in the overall study abroad profile of American students, we expect that providing a realistic study abroad option will enhance the attractiveness of the engineering field to women.

Figure 3, is a plot of the number of U.S. students who have studied abroad through Global E3 by their discipline. The largest numbers of participants by field are concentrated in Mechanical Engineering and the second largest in Electrical Engineering. One must keep in mind that these are typically the two largest departments in terms of number of faculty as well as numbers of students in schools of engineering in the United States, so this distribution is not entirely unexpected. Moreover, almost all schools of engineering have programs in mechanical, electrical, chemical and civil engineering which are the four largest shown in this figure as well. Note the category of "other" includes a wide variety of disciplines not otherwise mentioned.



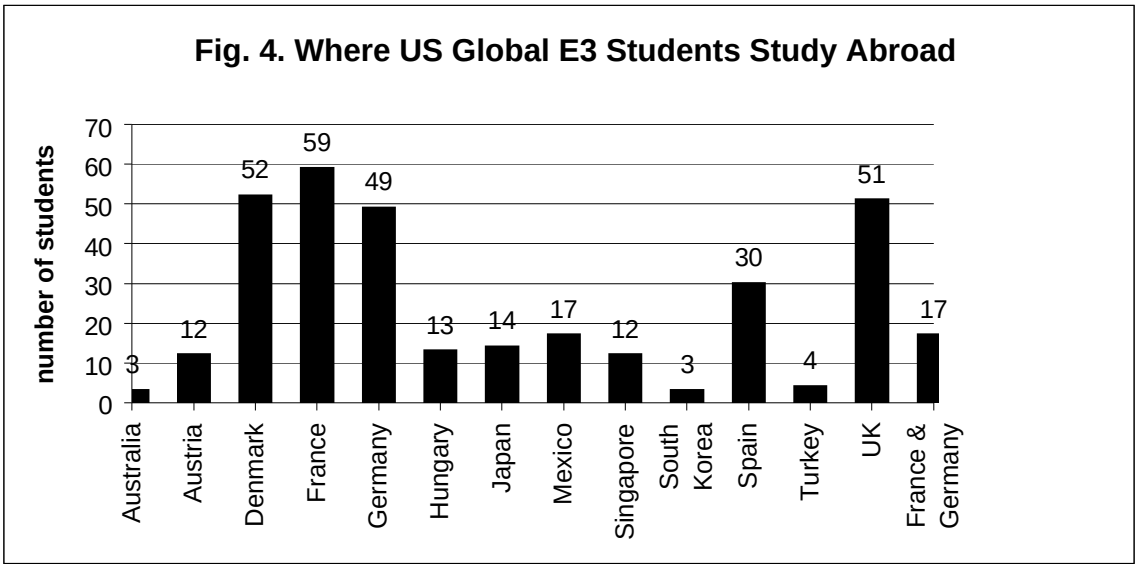


Figure 4 illustrates where U.S. Global E^3 students study abroad by country. Thirteen countries are shown. Missing are the most recent additions – Hong Kong, Sweden, Italy, and Finland. (Anecdotal evidence from the 2002-2003 application cycle indicates that a large number of

students (10-15) are applying to study in Hong Kong in its first year in the program.) As reference, it should be pointed out that considering all the United States students who go abroad (not only under this program and not only in engineering) approximately 20% go to the United Kingdom and 10% to Spain, according to IIE's annual study abroad survey published in Open Doors.

A number of observations may be based on this plot. One must keep in mind that these countries have joined the program at various times and that some countries have many more universities then others. For example, France was one of the original countries in the program and has a large number of participating universities, whereas Denmark joined at a later date and has only one participating university, the Technical University of Denmark (DTU). Spain is an even more recent addition with several member universities. Although a relatively new member country, Spain has attracted a relatively large number of American students. Likewise, although there is only one school in the United Kingdom, Swansea, the UK has traditionally attracted large numbers of students from the United States. As noted above, both these countries attract very large numbers of American students in all fields.

It should be noted that the schools in Australia, Denmark, Hungary, Japan, Singapore, South Korea, Turkey and the United Kingdom all conduct their programs for exchange students in English. The total number of U.S. Global E^3 students to study in these countries is 152. On the other hand, it is important to note that the majority of students participated in an international exchange which required a total immersion in the culture and in the language of the country. As can be seen, 184 students represent this component, a number exceeding that for those studying in English only. The influence of the growing Hispanic population in the United States and in higher education may help account for the relatively large combined number (47) of U.S. students going to Mexico and Spain on this program.

Even with these high numbers, a number of institutions in countries such as France and Germany, that have not previously offered programs in English, are beginning to create such programs, specifically to make their institutions more attractive to American and other international students. And, while Australia is a popular destination for Americans who want to study abroad, it is one of the few countries in the program that does not have many out-bound students, and for that reason, it is difficult for them to maintain parity of numbers. The result is that there is a greater demand of American students interested in studying in Australia than can be accommodated.

The last column reflects the 17 students who participated in the one-time "I SEE IT" program in which students conducted a short study-tour of both France and Germany, as mentioned earlier. Although the I SEE IT program was only offered once, Global E^3 has built on its success by researching and identifying summer programs for engineers at member institutions and others. However, Global E^3 has not tracked the participation rate of these programs.

Program Results to Date

The Global E^3 program has grown to become a significant component of the study abroad national initiatives for undergraduate engineering students in the U.S. and has been cited as a success by government agencies, corporations, universities, and most of all by its students. With an established Executive Board and IIE as the central administrative arm, it continues to grow nationally and internationally with new university members, and ever increasing numbers of student participants. Some of the campus-, faculty-, and student-level metrics of success are now summarized.

Campus-level benefits

In terms of campus level success, Global E^3 demonstrates the value of a large consortium as opposed to bilateral linkages, in facilitating sustained exchanges among engineering programs that may lack long-standing existing bilateral linkages. It allows U.S. campuses to choose from a wide range of potential partners, thus maximizing the placement possibilities for their students each year who are considering study abroad in a variety of different destinations. An almost six-fold increase in the number of university members in as many years, speaks to that success.

Faculty-level benefits

Global E^3 helps engineering faculty who support study abroad but may not have access to on-campus staff or mechanisms to implement this activity, by letting them "buy" central services from an experienced outside administrative hub (IIE), while retaining the academic oversight by maintaining their control of quality of courses and students by serving as the 'gatekeeper' for course transfer approvals and review of incoming student dossiers. Through its Annual Meeting, Global E^3 provides a forum/venue at which exchange partners can meet face to face in a concentrated 3-day session, building and renewing relationships that help smooth the on-going communications by email and phone. Meetings have alternated between U.S. and European hosts. The most recent meeting was held at the Sagamore Hotel on Lake George, NY and at Rensselaer Polytechnic Institute in June 2001, hosted by Rensselaer Polytechnic Institute. The next meeting in June 2002 will be in Munich, Germany, hosted by the Technical University of Munich.

Faculty are attracted to Global E^3 because it provides an interesting venue for faculty to meet their overseas counterparts, holding meetings overseas every other year. It also offers a chance for international curriculum and program development. Further, by identifying partners (such as DAAD) or securing our own funds (from FIPSE) Global E^3 is able to provide funded opportunities for U.S. faculty to travel abroad in engineering relevant activities. As a result, we are continually expanding the number of "champions" of study abroad among U.S. engineering faculty.

Student-level benefits

At the student level, Global E^3 advantages include scholarships available only through the program for women (ABB), under-represented minority students (IIE core funds), and internships (NSF), thereby providing incentives that make study abroad more feasible to engineering students who otherwise might not consider them. Global E^3 also identifies

opportunities for discounted summer study abroad for engineers (though this is not a direct component of the program, this is an advantage offered to students). As Global E^3 is housed within IIE, advisors are kept informed of new and unique scholarships available for study abroad, such as the Freeman Awards for Study in Asia (which provide funds for American students to study in East and Southeast Asia), the Gilman Scholarships (for American students receiving US Federal Financial Aid), and the National Security Education Scholarships (NSEP, which provide funds for students studying in geographically "non-traditional" countries). These opportunities also help attract students to study abroad by making it financially more feasible. Additional benefits to students are the ability to put applicants in touch with Global E^3 alumni giving students someone to talk with, even if nobody from their own campus ever went to the site they are considering.

Consortia-level benefits

One of the primary benefits of the program to member institutions is that Global E^3 provides a coordinated way to seek outside funding for scholarships and administrative support (from NSF, FIPSE, ABB, etc) keeping the annual costs to each member to a minimum. Further, Global E^3 allows for a great deal of flexibility, enabling the many member institutions to expand or contract the program to meet their individual and policies needs. Our system of getting approval of transfer credit before departure helps insure that students continue to make progress towards their degree at home, usually without any delay, and the newly created course databank helps advisors to determine credit transfer by providing information about other member campuses' past decisions on credit transfer. Our new NSF-funded effort to track outcomes should be a very useful tool in encouraging more participation in the future.

Finally, Global E^3 is a network of professionals – in engineering, study abroad, and international student advising. If someone has questions or they need advice/references for themselves, or to pass on to others on their campus, the Global E^3 network can provide them with answers and support in all of these areas.

Navigating the Future of the Program

The landscape of the future will be substantially different in certain respects, requiring significant accommodation, even perhaps a change in mode of travel when navigating the international waters of student exchange. Consider how we will deal with the increasing heterogeneity of students coupled with the trends towards more homogeneity in our educational processes worldwide, and maintain individuality under the pressures of establishing a base of common practice and standards. How the perception and reality of worldwide safety of individuals in the aftermath of the events of September 11 will affect those seeking educational opportunities in the US, may be as profound as the psychological bursting of the 'go anywhere do anything insulating' bubble that has been such a fundamental part of the culture of Americans traveling abroad. How this program can continue to attract and expand the ever-important female engineering population will become more critical than ever before. There is also the handling of the changing nature of the competition in higher education with corporate-based universities and distance learning-based universities going head-to-head with the more traditionally campus-based universities, and the role an international exchange component will

play in that regard. These are now discussed further as each may impact the future of international educational exchanges.

Competition or Cooperation/Diversity or Uniformity?

Higher education has already experienced the era of global competition, particularly at the graduate level. Many engineering schools in the United States now enroll more international students in their graduate programs than U.S. citizens. Europe has been aggressively trying to attract international students to its doctoral programs as well as for post-doctoral positions. On the one hand, the dominance of international graduate students in programs in the United States offers the opportunity for increased internationalization at the undergraduate level. There is the ability to expose larger number of undergraduate students on their own campus to the cultures of other societies without the need to travel abroad, as well as to encourage more travel abroad. All such opportunities must be enhanced and leveraged for the future especially given the relatively few United States students that continue to seek international experiences abroad. On the other hand, it is not unreasonable to think that what has already happened at the graduate level will begin to manifest itself at the undergraduate level in years to come, that is participating in an international experience abroad as well.

As these international flows continue to increase, it is imperative that we accommodate this increased diversity of students with an improved degree of uniformity in our educational processes. It is important to differentiate the uniformity that we propose in the process from the diversity of students that we seek and from the diversity of products and cultures that we seek to retain. This is not necessarily a trade off. We can accomplish both concurrently. As the Euro common currency in Europe was initiated in January 2002, the commonality of the currency does not imply or require commonality of cultures, products or exports. Likewise, establishing more common academic practices will permit an enhanced flow of international students around the world but at the same time is not intended, and if properly orchestrated, will not compromise the diversity of cultures from which they come.

As an example of such trends toward cooperation, yet maintaining a degree of competition at the same time, consider the Erasmus program established between European nations in the mid-1980s. The goal of the Erasmus program was an attempt in establishing large-scale partnerships between universities in different countries, by offering scholarships for temporary study in other European countries, as well as financial support for numerous joint degree programs and for professors to teach at foreign universities in Europe. The European Credit Transfer System (ECTS) is yet another example of the trends toward the establishment of common practices, procedures and standards within Europe. The ABET 2000 goals, emphasizing outcomes assessment, offers greater flexibility to credit transfer, and a new mechanism for faculty to evaluate courses taken overseas.

More recently, at the end of the last century, the Bologna Declaration was established with a 2010 goal to create a European higher educational arena characterized by more unified higher education approachs among the European countries. The Bologna process is a major step towards establishing common standards, practices and processes between these European countries. This includes the need to reform degree structures by introducing a two-cycle bachelor's – master's system across Europe. In addition, it calls for the creation of a credit

accumulation system. For example, countries like Germany and Italy have not had any credit systems in existence. Another important objective is to create quality assurance and accreditation systems everywhere and strive for a common if not similar set of systems throughout Europe. Similar, but perhaps not yet as extensive steps, are emerging in the ASEAN community and elsewhere.

There are several universities that, in fact, are teaching many of their courses in English, despite several centuries where they taught in the native languages only, in a further effort to compete for international students. In the Global E^3 program, for example, the Technical University of Denmark (DTU), Budapest University in Hungary, Tohoku University in Japan, the Fachhochschule in Munich, and a number of institutions in France, among others all have many course offerings taught in English. It is significant to note that the Technical University of Munich has recently begun to offer master's degrees in key areas of technology, such as information technology, taught in English and offered free of charge to international students, thereby combining all the points made above. Likewise, the schools within the Global E^3 program in Hong Kong, Singapore, South Korea, and Turkey all teach their complete program in English, recognizing it as the international language of the 21st century. It is important to recognize that these trends are not meant to emulate those of the United States, but merely to set up a system of common practices which will be better able to accommodate the international flow of students which will be a natural and growing phenomenon in this era of globalization.

As a result, for the future, with the already abundant number of international graduate students on our campuses, the opportunities to expose larger numbers of undergraduate students on site to different international cultures will become easier. Moreover, we anticipate that this exposure will motivate increasingly larger numbers of U.S. students particularly to do an experience abroad during their undergraduate years. Additionally, as the standards, practices and processes, become more common throughout the world it will make it easier to develop international cooperative partnerships, exchange course credits and embark upon distance learning as a modality so as to insure lifelong learning independent of where an individual chooses to pursue their career or life. As a result, we see the need for a global experience as early as possible in the educational program increasing, and the ease with which this can become accomplished increasing as well. This hopefully will lead to a time when more then half of the undergraduate engineering students will graduate with an international experience.

Safety

In the aftermath of the events of September 11, we wondered what the effect would be on study abroad and the field of international education. Already at the beginning of the Fall 2001 semester we were concerned that the economic downturn might lead to a reduction in applications, and it was unclear how much more September 11 would push down the economy. Further, we wondered if fear in the post-September would discourage students from participating in a study abroad program (and their parents from supporting them to travel abroad). In fact, we did not see a drop in student applications for the spring 2002 semester, and as of this writing, we have not noticed a drop for the 2002-2003 academic year. If there is a decrease, we feel it will be slight. Assuming that the overall number of students in United States universities remain stable, we feel that the number of U.S. students studying abroad through this program will likewise remain stable.

The biggest impact, both short and long term, of September 11 may be in reduced numbers of international students coming to the United States. This, of course, is a serious consequence for this program since we seek to maintain a balance of incoming and outgoing students so as to maintain our no tuition exchange scenario. Consequently if international students coming to the U.S. are reduced for any reason, we would have to reduce the number of U.S. students going abroad. Optimistically we do not think there will be a decrease in applications. However, we believe that international students may encounter more difficulties in the required processing time to get a visa. There will certainly be more scrutiny of their visa applications, and the process will take longer, may get more expensive, and some student visa applications may be rejected that otherwise would not encounter difficulty. Most of Global E^3 member institutions are in countries that are not on the State Department's list of countries requiring longer waiting periods and extra visa applicant scrutiny. Consequently, we expect the impact on this program will be relatively minor. Nonetheless, we do have students from some of these countries enrolled in member institutions and they may face some delays/difficulties in getting their visas.

It is our hope that the lessons of September 11will focus student, administrative and faculty attention on safety and security concerns in general, but that the long-term impact will not be to deter international mobility. Based on short-term feedback from member campuses, we believe it will actually lead to increase of U.S. applications to study abroad, as people begin to realize that Americans do not travel enough and need to open our minds to other parts of the world rather than let terrorists close our minds and our borders.

On November 13, 2001, during the observance of International Education Week sponsored by the United States Department of Education and the Department of State, President George W. Bush made the following remarks that we hope become a standard for future academic exchanges:

> "We recognize that trust, unity, and peace between nations are built on understanding and that real understanding comes from communication."
>
> "In light of the extraordinary times we are facing following the September 11 terrorist attacks, International Education Week provides an occasion to acknowledge the necessity of developing and strengthening international ties. We must also reaffirm our commitment to promote educational opportunities that enable American students to study abroad and to encourage international students to take part in our educational system."
>
> "Americas leadership in national security rests in our commitment to educate and prepare our youth for active engagement in the international community."

Women's Participation

One of the biggest challenges that face the engineering profession, both in engineering education and industry is the education and recruitment of women. We speak often of the underrepresented minorities but we also need to do more for the *underrepresented majority – women*.

Undergraduate enrollment of women students now exceed that of men in most colleges and university programs in the United States with the notable exception of engineering disciplines. The average enrollment of women in engineering programs nationwide is about 20%. At some institutions where they have had aggressive programs to attract, enroll and retain women in engineering programs, this number is somewhat higher. The percentage of women in the science and engineering workforce is only at about 23%. Finally, the number of women faculty members in academe in the United States is too low by more than a factor of 10 in most engineering focused universities when compared to the population. All three of these dimensions need to see significant improvement in percentages of women.

As noted above, the Global E^3 program has attracted almost 30% women on average and has reached a high of 45% in the spring semesters. Consequently this program and the fields that it represents are particularly attractive to women. This should be used as a leveraged advantage to further the number of women in our undergraduate engineering programs. In addition we have been able to secure, through ABB, special fellowships for women that participate in this international program. We anticipate that through these special fellowships, coupled with the natural attraction of an international experience for the female population, this program and others like it will become a major attractive force for member institutions to help promote the population of women in their engineering programs, graduates and those entering the workforce.

The Changing Face of Competition: Virtual Mobility

Regarding undergraduate education, we believe this will continue to be pursued primarily on the traditional campus-based universities. However, it is clear that graduate education has already dramatically changed. People who become employed after the Bachelors degree, seek continuing life-long education through various distance learning mechanisms and this has been very successful. The more traditional campus-based universities will see increased competition from the so-called distance learning universities typified by National Technological University and Phoenix University. They will also see significant competition from the so-called industry-based universities typified by Kettering University (what used to be General Motors Institute and then GMI) as well as Motorola University. All of these constituencies are interested in being responsive to the continuing education role as well as aspects of training, and have effectively used, to various degrees, distance learning modalities in a significant way. Not only theory courses, but hands-on training courses as well as laboratory experimentally based courses have now been successfully run by distance learning in both synchronous and asynchronous modes.

Our hope is that these constituencies will learn to complement each other rather than to compete with one another. It is the intention of some universities to develop a system of both course exchanges and even joint or dual degrees between institutions. As the criterion for student exchanges has become netting the flow of student semesters to and from each institution to be zero over a period of years in Global E^3, it would be similarly possible to do the same thing in terms of student credit hours. That is, various institutions could offer courses by distance learning to other institutions and to effect the balance of total student credit hours over a period of years in a similar way so the net flow is zero. Consequently, in this way we could integrate the offerings of many international universities having different bases for tuition. Given such a

system network, it will also be possible to offer courses in other languages where the desire is to learn in another language as well. Consequently, we look at this as a growth opportunity to further develop an even broader and different international aspect.

Conclusion

Overall, in terms of the future, we look at an increasing diversity of student base coupled with an almost international standard and practice in terms of the process of the educational system. This will evolve to make it easier for students to be exchanged and learn in an international framework. The issues of safety will be both short-term and long-term, and we need to develop mechanisms to properly deal with these so as not to overly discourage the opportunities for exchange. We have learned to accommodate to longer waiting time at airports and in a similar way, we need to learn to accommodate to longer times in visa processing. The opportunities offered by Global E^3 to increase women in the science and engineering workforce using the opportunity of international exchange as a leveraged opportunity, should be taken up by more of the member institutions as well as others. In terms of the changing world of competition, some universities may look to expand to be able to offer courses and degrees between internationally based institutions in the future as another leveraged opportunity. Finally, the ability of the traditional campus based universities to offer such an exchange program as a component of their educational framework, should bode well when comparing this type of opportunity to a pure distance learning educational program or one that is extremely focused on the industrial sector from which it developed. In the end we feel that the Global E^3 Program will continue to grow and prosper although still faces some hurdles to be overcome. And they will be overcome.

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