

## **International Experience for Engineering Students through Distance Learning Techniques**

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### **Abstract**

A new mechanism is being developed for expanding international exposure for undergraduate engineering and computer science students in the United States, using information technology and distance learning techniques. Technical students in the United States, in a few instances, have begun working on projects with similar students in other countries via electronic communications. This paper provides a rationale for having engineering students gain some international experience during their undergraduate educational periods, and points out barriers to getting such experience in traditional study abroad periods. It then cites several academic programs that are providing such experience via electronic means. Finally, the authors present a proposed direction to increase the use of distance learning techniques to provide international experience for American engineering students.

### **Introduction**

Russel Jones did a major study a few years ago entitled “Educating Engineers for International Practice”. That study, which was published in *Liberal Education* in the fall 1995 issue (1) argues for the need for extensive international exposure for United States technology students to adequately prepare them for international practice. It is the conviction of the authors of the current paper that such exposure is needed to keep the United States engineering base competitive in an increasingly global marketplace. That need has only increased since Jones’ earlier study was completed – yet we see too little movement toward better preparing college graduates for the international challenge.

Constraints such as the intensity of the undergraduate program for engineers and the lock-step progression through the four or more years of study weigh heavily against engineering students taking advantage of traditional study abroad experiences. Traditional study abroad or internship programs also tend to be quite expensive, again limiting the number of engineering students who can or will participate. It should be noted, though, that several engineering schools are conducting exemplary programs based on the studies abroad model of sending students overseas. Examples of these programs will be described later in this paper. But such effective programs currently have much too little impact when the 300+ engineering schools in the United States are taken as a whole. In its annual survey of student mobility, published in *Open Doors 1997-98* (2), the Institute of International Education reported that only 1893 United States engineering students had an international dimension in their education – representing less than 2% of the U.S. study abroad students, and an even smaller percentage of the current number of engineering students in the undergraduate pipeline.

It is also relevant other developed countries – such as those in Europe – prepare their engineering and computer science students for international practice very effectively. As pointed out by Simpson in 1997 (3): “Russel C. Jones article entitled ‘The World as Workplace’ in the November 1996 edition of the ASEE journal presents a policy which is being tried in Europe for a decade now”.

Knowing that engineering and computer science students need more international experiences, and aware of the barriers usually present in traditional study abroad programs, a few engineering schools have begun using information technology and distance learning techniques to provide some international exposure for their students. Such efforts are aimed at overcoming some of the major barriers of study abroad such as high cost, the constraints of a highly sequenced curriculum, and the concern of faculty that their control of the educational process may be lost.

### **Driving Forces for International Exposure for Engineers**

Many educators and practitioners have stated the need for international exposure for engineering students. In 1980 at a conference on New Directions in International Education, Burn and Perkin (4) argued that “Expertise on the rest of the world is needed as never before in government, business, and especially in the universities. ... Increasingly needed are specialists who combine foreign language training and international studies expertise with training in professional fields ...”.

More recently, Condit and Pipes (5) have stated “The changing needs of an industrial world create a corresponding need to improve and restructure higher instructions, Particularly that of engineering education”. And Pelkie (6) has written “Global competition has become a business reality. To become competitive, we must improve the rate at which new technical concepts are incorporated into our products and processes. ... Managers must recognize the impact that the technical education system has on future innovative productivity and take the initiative to improve it”. Fiedler et al (7) have argued that “Computer based information systems have altered the meaning of traditional communication and coordination, making global opportunities possible and global competition inevitable”.

### **Study Abroad Programs**

Engineering schools at several U.S. universities are conducting exemplary programs based on the traditional studies abroad model of sending students overseas. Worcester Polytechnic Institute, which requires a major project of each student prior to graduation, has an increasing number of such students fulfilling that requirement with an international educational experience. Massie and Zwiep (8) point out that “Project work in a foreign country provides a reasonably pragmatic way for students to gain international experience”.

The University of Rhode Island offers an even more intense international program for its engineering students, combining language study in a foreign language, courses on the home campus in that foreign language, and a work period abroad for an integrated international experience. Grandin (9) describes the URI program, which culminates in joint degrees in engineering and a foreign language.

Van Gulick and Paolino (10) have described two key features which serve to internationalize the Lafayette College undergraduate engineering curriculum: semester-long abroad study opportunities in all B.S. engineering degree programs; and a five year, two-degree program in which B.S. engineering students acquire in-depth knowledge of a foreign language and culture and complete a semester-long capstone experience working abroad as an engineer during their fifth year. A unique feature of the Lafayette programs is the use of two-way video conferencing to offer necessary technical courses to students abroad.

In 1983, the University of the Pacific started sending its students to Japan for their Co-op placements. Based on the experience and a similar program in Germany, a structured program for preparing students for such international Co-op experiences has been instituted. Martin (11) describes how the University has made available a plan whereby students can take internationally oriented courses prior to their Co-op periods abroad, and receive an 'International Engineering Minor' degree upon completion.

One of the most encouraging developments in educating U.S. engineers for international practice is the Global Engineering Exchange (Global E3), administered in the U.S. by the Institute of International Education and in the European Union (EU) by GE4. Global E3 focuses mainly on U.S. undergraduate engineering students, but graduate students from other countries may participate. As of April 1999, participants included 29 U.S. institutions, 39 institutions from the EU, and six institutions from non-EU countries. Students in the Global E3 program spend one or two semesters studying at a member institution overseas, paying tuition at their home institution only. The host institution provides students with intensive language and culture training. In addition to formal study, Global E3 encourages overseas internships as part of its program. Beginning in 1995-96, eleven U.S. engineering students studied overseas under the Global E3. That number has grown to 52 in 1998-99, and is expected to reach 70 in 1999-2000. In describing the Global E3 program, Gerhart and Blumenthal (12) have written "As other countries here recognize the value of a U.S. education, we must recognize that globalization is part of our very humanity, and that 96% of the global population lives outside of the U.S."

Many other engineering programs offer variations on the type of traditional study abroad programs described above. It must be kept in mind, though, that in the aggregate less than 2% of engineering students in the United States currently partake of such programs.

## **European Competition**

As noted earlier, some of the economic competitors of the United States in the global marketplace are currently more effective in preparing their engineering graduates for international practice. In the EU, the European Commission's SOCRATES program provides mechanisms for the cross-border study of a large number of students, including engineering students. In describing such programs, Mulhall (13) notes that the SOCRATES program includes groups of universities which have agreed to cooperate in a program of educational development in a particular area such as engineering, called Thematic Networks. A body called Higher Engineering Education for Europe (H3E) was created to manage the Thematic Network in engineering. One of the projects of H3E is the development of a European dimension in higher engineering education.

Weber (14) describes how engineering schools in Europe are co-operating to develop a common definition of qualifications needed by an engineer today. He notes that there is a growing convergence in adopting English as the language of engineering instruction.

Augusti (15) writes that the rapid globalization of the professional job market has created the need for an international system of recognition of degrees.

The European model for international experience for engineering students is based on the traditional study abroad movement of students. That approach appears to be highly successful there due to the relatively short distances between countries, and the overarching framework provided by the European Union.

### **Distance Education**

Mechanisms for student to student interaction across U.S. institutions have been developed and utilized by some of the Coalitions funded by the National Science Foundation. The Synthesis Coalition in particular has featured the development of electronic tools to facilitate joint work by student groups on campuses thousands of miles apart. Hsi and Agogino (16) describe the use of such advanced multimedia communication mechanisms to teach engineering design across campus borders, utilizing well-developed case studies. Gay and Lentini (17) further describe the advanced communication resources used by students engaged in collaborative design activity.

The use of the Internet has enabled both teachers and students to lessen the burden of disseminating and acquiring knowledge, according to Young (18). Even laboratory experiences can be enhanced through electronic media. Karweit (19) has created a virtual engineering laboratory on the World Wide Web for the students in his introductory engineering class and others. Experiments in this simulated laboratory include one that measures the rate of a hot object's heat radiation, and one that enables students to design bridges that will bear a specific weight. Fruchter (20) has used information technology augmented distance learning to teach a multi-site, project centered, team oriented course.

It is clear that information technology and distance learning techniques are available to facilitate in-depth interactions among students at distant campuses, including those across national boundaries.

### **Pilot International Exchanges via Distance Learning Techniques**

A small number of campus-based programs in the U.S. are currently using distance learning techniques to provide international experiences for their students. Programs of this sort are currently in operation at such engineering schools as Union College, the University of Washington, Texas A&M University, and the University of Pittsburgh, for example.

At Union College, beginning with the class of 2000, all engineering students are required to fulfill an "engineering experience" requirement. As described by Bucinell et al (21), "The ever increasing globalization of engineering practice has led to the realization that undergraduate students must be made aware of the global nature of the profession and the technologies that allow engineers the world over to collaborate on projects". Union College engineering students can fulfill the international experience requirement by a traditional term abroad, an international exchange to take courses at foreign universities, an international term in industry, the virtual term abroad, or an international project. The Bucinell et al paper describes the development of an International Virtual Design Studio, wherein students from Union College and the Middle East Technical University (METU) in Turkey were joined as a team to pursue their senior design projects across international boundaries and culture differences. Using a combination of interactive video and Internet

connections, the two parts of the team undertook a single design and build project, sharing data bases and designs electronically. The team members met each other in person at the end of the project when they came together in Ankara to assemble the final design and participate in the design competition with additional teams from METU.

At the University of Pittsburgh, a novel format for an engineering design capstone course combines industrial experience with international collaboration, and uses distance learning as a pedagogical tool. As described by Rajgopal et al (22), the course links programs in the Industrial Engineering Departments of the University of Pittsburgh and the Instituto Tecnológico y de Estudios Superiores de Monterrey in Mexico. The team of students from the two institutions conducts their design at an industrial location that alternates between Mexico and the U.S. each year. The two groups of students, and their faculty advisors, stay in touch by electronic mail, the Internet, and distance learning technologies. During the last week of the term, the full team comes together at the industrial location to present their work to the faculty and the industrial client.

At the University of Washington, various collaborations are being undertaken with engineering educators from the U.S. and Japan. Kalonji (23) describes how engineering educators from these two countries are working together to bring about a successful reform of engineering education in the two countries, and to enable engineers to play a more pivotal role in the shaping of the global economy. Student interactions between students in the U.S. and Japan have resulted from this effort, using distance learning techniques.

Texas A&M University is employing reciprocal distance education to promote internationalization of its undergraduate engineering program. As described by Holland and Vasquez (24), the Architectural and Construction Science Program at Texas A&M uses a model containing three distinct components for adding an international dimension for its students: insertion of an international dimension at the syllabus level; integration of an international dimension at the curricular level; and immersion in a foreign instructional environment. The first two components rely on the Internet and videoconferencing technologies. The third component is a blend of traditional study abroad programs with international internships and reciprocal student exchange programs.

The North American Design Institute (NADI) is a partnership of governments, universities and industries across North America. As described by White (25), it involves two universities in each North American country – Mexico, the United States, and Canada. These institutions collaborate on a unique exchange program in engineering design to prepare engineering students to better understand design in the context of cultural, health, safety, environmental, and other international regulatory policies throughout North America. A combination of students traveling to partner schools for a semester, industrial work assignments, and interactions via the Internet and the World Wide Web are utilized.

## **Conclusions**

The driving forces for international experiences for U.S. engineering students are substantial, and traditional study abroad programs – while generally of desirable high quality – are having too little quantitative impact to meet the needs of the bulk of such students. Distance education methodologies offer the opportunity for engineering students to get international experience in a cost-effective yet highly useful way. Several engineering schools have developed pilot programs utilizing information technologies

and distance learning methodologies to offer international experiences to students who are not readily able to travel abroad from their home campuses.

It appears that the time to begin scale up of the use of distance learning technologies to provide international exposure for larger numbers of engineering students is at hand. The authors (26) propose that a consortium of engineering schools be formed for this purpose. The activities of such a consortium would include:

    Illumination of the current state of the art in the use of distance learning for international programs in engineering

    Development of central mechanisms for developing case studies which can be utilized by teams of international students

    Establishment of an electronic database to facilitate international matching of engineering schools with similar interests

    Seeking funds to develop the central mechanisms described above, and for demonstration projects at several U.S. universities

It is anticipated that after such demonstration projects, the central mechanisms developed would become self-sustaining.

Such a project would overcome some of the major barriers to study abroad, such as high cost, the constraints of a highly sequenced curriculum, and the concern of faculty members that their control of the educational process may be lost. It should, at steady state, provide international exposure to significantly more than the 2% or so of U.S. engineering students

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