

ACHIEVING A GLOBAL ACADEMIC INDUSTRIAL NETWORK FOR STUDENTS AND FACULTY

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Abstract

It is clear that the engineer of the 21st century will be required to spend an appreciable portion of his or her career in an environment rich with a variety of global connections. Colleges of engineering must develop ways to prepare their students for this world. Students, of course, will only fully understand global concepts through the role models that their colleges provide.

The Global Academic Industrial Network (GAIN) is an attempt to create multi-organizational, international partnerships of academic and industrial organizations that emphasize collaborative educational programs and research that meets the global needs of faculty, students, and industry.

Introduction

The need for a global perspective in engineering education is, perhaps, best understood from a quote by Peter Drucker¹, "In the new mental geography created by the railroad, humanity mastered distance. In the mental geography of e-commerce, distance has been eliminated. There is only one economy and only one market." For example, when using the Internet to purchase an item, a consumer has no idea of the locations of the server on which the transaction is taking place or the warehouse from which the product will be shipped. In fact, little or no attention is given to location when one transacts business on the Internet.

We in engineering education must begin to understand the reality of one economy and one market. We must learn to think globally but act locally; that is, we must understand the importance of a global perspective for our students and take action to ensure that our local environment satisfies this need and that our efforts at globalization fit the local culture.

For educational programs to have a real impact on global perspective, the vast majority of students and faculty must be exposed to international engineering educational and work experiences. To date, colleges of engineering have made little progress towards international goals because the approaches used by most programs are fragmented and individual. At the same time, most universities have not involved industrial organizations in helping them to achieve their international goals. It is clear that a different approach is needed if meaningful improvement is to be made in the global skills of engineering students and hence early career practitioners.

In forming an international experience for students, it is important not to get too involved with defining the concept. After all, any experience is better than none. It is equally important not to get bogged down in a search for the ideal or perfect experience; six weeks in a structured summer program is a beginning. There are many forms of international experience, and no single

¹ *Managing in the Next Society*, Peter Drucker, 2002

experience will be best for all situations. It is important to start early to create interest and facilitate continuing opportunities at later points in the students' educational career.

This paper presents the results of a recent Global Academic Industrial Network (GAIN) Workshop in Mannheim, Germany, that brought together engineering educators from universities in the United States, Mexico, South America, and Europe along with representatives from several multinational industrial corporations. The goal of the workshop was to develop an action agenda to improve the global perspectives and experiences of students through academic and industrial partnerships. The action agenda was to be built on extensions of existing successful models of international collaboration.

For purposes of simplifying discussions, examples of successful collaborations were divided into academic models where the primary collaborators were two or more universities, and industrial models, which involved one or more universities and one or more industrial organizations. Of course, it is possible to have many combinations and variations on these models. Each of these models has been successfully deployed in one or more cases as reported at the 2002 GAIN Workshop.

General Issues

All of the following models for providing international experiences share several common needs and issues. First, it is important to match experiences to students' future job requirements. This will make the international experience more meaningful for students and will help engage their interest. It is helpful if one can show that obtaining an international experience will provide an advantage in future job opportunities.

Faculty members are critical elements of all international exchange programs. Institutions must work on ways to engage their faculty members in international experiences, including extended stays at a foreign institution. Programs built around a single faculty member and his or her international connection are very fragile and will likely fail if the faculty member changes jobs or loses interest. The best and most sustainable programs will be based on a wide variety of research and educational relationships.

Funding is certainly an issue for any of these programs. However, international programs will not happen if we let funding become a limiting factor. While many programs can be started with ad hoc funding, sustainability depends on creating a systematic funding model. Sustainability is also enhanced if the exchanges are multi-dimensional and involve several faculty members from each institution. Since it is often necessary to innovate and stretch the rules to make these programs work, institutional support at the highest levels is essential.

Students who are involved with international programs will be asked to study and learn under challenging conditions, which might include a foreign language and many distractions. In addition, students will generally encounter living and learning environments that may differ greatly from their previous experiences. As a result, students selected for international programs must be of high quality and possess a great deal of flexibility.

There is significant paperwork associated with international travel, including passports, visas, entrance requirements, and perhaps work permits. Much of this is unavoidable. However, it is wise to work on ways to streamline and systematize paperwork. Timely communication in both directions is critical to ensure that all necessary paperwork is completed at the appropriate time and that students are comfortable with their situations.

The different academic calendars of the host and home institutions can also cause problems, especially when two universities are in different hemispheres, such as an exchange between the United States and Australia.

Housing is an issue to be addressed in every exchange. Student dormitories, if available, can provide an excellent solution since the visiting students are placed into a good social environment.

In many institutions, however, students live at home during their university education. In these cases, the cost of room and board can be a significant new expense for the exchange student.

An additional issue arises for students involved in international work experiences: Pay scales vary widely among different countries. The problem can be acute when students from the United States work in foreign countries where the pay scale for junior practicing engineers may be less than that of a student intern in the United States. Early discussion of this issue and clear understandings by all parties offer the only possible solution.

In general, too few students are involved in international experiences. If we truly believe that the majority of students need this experience we must address the problem differently. The “classical” profile of engineers and their rigid educational format with its need to arrive at a single, correct answer may be counter to the flexibility and openness that is required to successfully engage more students in international experiences.

It is important that all international programs attempt to include opportunities for students to establish appropriate social contacts and obtain cultural knowledge of the host country. It is clear that language is a critical part of the culture because people think in the ways in which they communicate. As a result, students involved in international programs should have opportunities to become familiar with the language of the host country.

The lack of foreign language skills by U.S. students is a complicating factor in many international programs. The solution to this problem is long-term and will be effectively addressed only by looking at earlier language education. Compared to their European counterparts, U.S. students also have little or no opportunity for international experience. European students can get an international experience by crossing borders within their own continent; U.S. students must travel more extensively.

Academic Models

Academic models deal with international experiences between two or more universities located in different countries and their associated faculty and students. Examples of several different models follow.

Standard international exchanges

This is probably the most widely used form of international experience for students. It involves a student of one university (the home university) matriculating at a university (the host university) in another country. This model assumes that the student is not seeking a degree from the host university but simply wishes to take certain courses or to have a language and cultural experience there. The transferring of credit from one institution or another is the biggest challenge of this form of exchange; it often necessitates a careful evaluation of courses and the grading systems used by the universities.

In the simplest form, the student applies for admission to a host university. Upon acceptance, the student studies at the host university for a period of one or two semesters, paying tuition as appropriate to the host university as well as any travel and living expenses. In this model, the student is responsible for making arrangements at his or her home university to receive credit for the courses taken at the host university.

This type of exchange can also be facilitated through a formal agreement between the host and home institutions. In such cases, the goal is an approximately equal number of students moving in each direction. The host university agrees not to charge tuition to the home university's student/students. However, the host university does facilitate paperwork and housing. Students pay tuition, as appropriate, to their home university since they will eventually receive credit for their programs there. One or more faculty members from each university are involved and can help with

evaluating the equivalency of course content and grading systems. Maintaining the balance of student flow can become a challenge.

International learning communities

An international learning community is a team of students from two or more countries enrolled in a common set of courses. The community has an academic thread because the students study together, teach each other, and learn from one another. It also has a social thread because the students have fun together and develop a commitment to the success of the community. An upper division student provides mentorship, leadership, and team building to the learning community.

The version of this model implemented by Iowa State University and Monterrey Technical Institute (Mexico) involves a group of six to eight students from Monterrey Tech who study for a semester at Iowa State with a group of six to eight Iowa State students. The entire group then moves to Monterrey Tech for the second semester.

The experience to date has shown that students in learning communities have an easier acclimation to a foreign culture. Peer acknowledgement, support, and respect generally lead to improved academic performance as well.

Bi-national, dual-degree programs

In this model, exchange students follow a formally designed program of course work at two universities. The exchange portion of the program usually begins after the second or third year of study. Upon completion of the program, the student receives degrees from both institutions. These programs can also involve awarding a bachelor's degree from one institution and a master's from the other. In his keynote talk at the GAIN workshop, Dr. Director Dietmar v. Hoyningen-Huene discussed an excellent example of this type of program developed by Fachhochschule Mannheim and Tongji University in Shanghai.

The establishment of dual-degree programs can take considerable time since the faculties at both institutions must approve of the curriculum and possible substitute courses.

International summer programs

In their generic form, international summer programs involve a group of students traveling from one country to another for a period of four to eight weeks. The programs can be focused on a laboratory experience, one or more lecture courses, or a combination of lab and lecture. To date these programs have largely focused on taking students from the United States to other countries. Students from outside of the United States seem to have less need for such an introductory international experience. This may be because they are more likely to go abroad or to other countries for a year; this is especially true for European students who do not have to go far from home to have an international experience. Summer programs are a good way to introduce large numbers of students to an international experience. While students naturally have some fear of the unknown, they become more confident when they are with a group of friends with similar backgrounds. Their comfort levels are also enhanced by the fact that a faculty member from their home university normally accompanies them. The short duration of a summer program appears less risky. Generally, the total cost of a summer program is low compared to longer programs; however the cost per week of international exposure is higher.

The program need not be located in an English-speaking country if the host faculty member speaks English well. It is desirable that the faculty member from the host institution teaches most of the material. There should be an adequate number of computers for report writing and e-mail; inadequate availability of computers can become a real frustration for the students.

These programs will not be cost effective if both the host and home universities charge normal fees. Creativity will be required to overcome this problem. It may be possible to combine the

program with other international exchanges or perhaps the home institution will subsidize some of the expenses on the basis of addressing an important student need.

If possible, visiting faculty should be housed near—but not with—their students. It is important to note that the visiting faculty will probably have a greater role in the students' lives than they would have when the students are resident at their home institution. The visiting faculty may also be called on to play a greater disciplinary role than at home.

It is important to leave time for cultural experiences or to specifically schedule them into the program. Industry visits in the host country are an excellent way to introduce the students to work processes in other countries and therefore should be an integral part of summer programs.

International project experiences

In this model, students are sent to another country to conduct project work under the supervision of faculty members at the host university. The Fachhochschule Mannheim and the University of Maryland, College Park, have engaged in a program of this nature since 1990. The Mannheim students go to the University of Maryland for a six-month diploma theses, master theses, or practical semester. Because the students are working on funded projects, they are paid a stipend; housing is provided in apartments or homes.

The German students work on degrees in areas such as process, mechanical, electrical, and communication engineering, as well as computer science. They participate in projects at the research centers in the Mechanical Engineering Department on topics such as environmental energy engineering, electronic packaging, smart materials, energetic concepts, smart small systems, automotive systems, micro-engineering. The students expect that they will be involved in engineering-related work on a level that fits the demands of their profession, and that they will have social contacts with people from the United States.

International design projects

This model involves a team of students drawn from two or more universities who are assigned a collaborative design project. The projects normally run for one semester. The team members communicate using tools such as video conferencing, websites, email, chat rooms, and Internet-based meetings. Each institution provides one or more faculty members to serve as mentors to the students. Faculty members from the home institution assess the work.

In many cases, the students never have a face-to-face meeting. For this reason, this approach is sometimes referred to as a virtual collaboration. In other instances, the program may include face-to-face meetings at the beginning and end of the project. While such face-to-face meetings are advantageous with regard to several internationalization objectives, they do significantly increase the complexity of running such a program as well as the costs.

These design projects help students understand how culture can affect what would otherwise appear to be standard engineering problems. For example, Bruno Ramond of Universite de Techologie de Compiegne in France, who reported on his experience with this model, showed dramatically different design results based on the culture (American or French) of the team leader. He also noted that although the students were using the same design tools, the methods of using them differed considerably.

The students involved in international design projects learn several things. They gain an understanding and appreciation of engineering standards and common practices in other countries. They also develop the personal skills necessary to work on a common problem with a team of students from another country. The students also understand and master the difficulties of communicating clearly and concisely by electronic means.

In-country resident programs

To address international experience opportunities for their students, some universities have established resident programs in foreign countries. Instructors from the home university provide most or all of the instruction for these programs, and the courses follow the home university's syllabi. The students normally attend for one or two semesters. The calendar for the program can follow the calendar for the home institution.

This model provides an excellent chance for students to experience a foreign culture with minimal disruption in their academic progress. These programs require a great deal of work since the home university must schedule a steady supply of instructors willing to spend a lengthy period in a foreign country as well as a sufficient supply of students to make the program economically viable. In some cases, these programs are done in conjunction with a foreign university, which provides classroom space, housing for students, and some instructors.

Industrial Models

Many of the industrial models involve some of the elements of the academic models but extend them through some form of industrial experience.

Industry-sponsored academic and work experiences

These programs involve a three-way partnership between two universities and a global industrial partner of both universities. The students combine an education experience with the partner university and a work experience in another country with the industrial partner.

Ingolf Pruefer of John Deere, Mannheim Works, reported on an exchange program sponsored by John Deere that has operated since the summer 2000. To date, 11 German students from the Fachhochschule Mannheim have attended classes at Iowa State and made an internship with John Deere, Waterloo Works or PEC, and five U.S. students from Iowa State have attended classes at the Fachhochschule Mannheim and made an internship with John Deere in Mannheim.

John Deere provides round-trip airfare for participants as well as the cost for accommodations and transportation within the U.S. The students receive a monthly stipend during both the study and work periods; the German students also receive a book allowance. Participants are guaranteed an internship at a John Deere facility. As a part of the agreement between the two universities, the host institution charges no fees to the students although all fees at the home university remain unchanged.

The German students stay in the U.S. for approximately 12 months. They attend lectures for two semesters at Iowa State and get practical training afterwards at John Deere or PEC, Waterloo. The U.S. students begin their experience with practical training at John Deere Mannheim followed by a semester of lectures at the Fachhochschule and a second practical training experience.

Industrial design projects

This approach shares most of the elements of the international design projects, which were previously discussed. However, in this case, there is an industrial sponsor for the activity who normally specifies the design project to be undertaken. Industrial sponsorship provides several advantages to the program, including more realistic design problems, support of practicing engineers from the company, and resources for communication, travel, and prototypes.

Barry Butler, dean of engineering at the University of Iowa, reported on his experiences with a program of this type that he has run since 1998. The program involves University of Iowa students (U.S.) and students from Universite de Provence (France). The industrial sponsor is the HON Company of Muscatine, Iowa.

This program now includes face-to-face meetings and a period of time during which the French students reside in Iowa and serve as interns at HON. When the program was initiated, however, it did not involve face-to-face meetings. According to Dean Butler, the face-to-face interaction has added appreciable value and improved subsequent electronic communication. The related team social activities also decreased student anxiety. Butler also noted that financial support from industry has been very valuable because these programs are highly labor intensive (of faculty time).

Industry-sponsored master's programs

In one form of this model, students travel to a host university to complete an industrially sponsored master's program. This program is similar in nature to the dual-degree program discussed above, except that it includes industrial sponsorship.

The University of Iowa and Iowa State University participate in a program of this nature with Rockwell Collins of Cedar Rapids, Iowa. Their home institutions under guidelines defined by Rockwell Collins nominate Chinese students from either Beijing University of Aeronautics and Astronautics or the Northwest Polytechnic University of Xian. Students must satisfy the admissions requirements of the intended university and be approved by Rockwell Collins. They spend one academic year taking classes at one of the two universities and then move to Rockwell Collins, where they work on their thesis for six to nine months. Rockwell Collins provides funds for a stipend and other costs during their studies.

International faculty-industry collaborations

All of the aforementioned programs involve faculty members who support student exchanges. This model, however, involves a direct international experience for faculty, who take a leave at a foreign industrial organization to carry out one of a variety of engineering jobs.

Dr. Scott Chumbley of Iowa State University reported on his experiences at Perkins Engines in Peterborough, UK. During his six-month leave, Dr. Chumbley engaged in failure analysis, product development, and production support activities. The opportunity enhanced him personally and professionally. He experienced living in another country, received an industrial perspective of engineering activity, and gained a better understanding of personal ethics when challenged with the fact that his decisions might stop the production line. The experience also helped him shape his research agenda to benefit industry. He suggested that six months is a minimum period for a visit of this nature.

Dr. Chumbley suggested companies planning such an exchange experience for faculty members arrange for housing, transportation, and an appropriate stipend. He also encouraged them to provide assistance and information regarding such topics as banking, the locale, culture, history, and so forth to the faculty member. The faculty member should also plan to share his or her background, expectations of the visit, and possible family needs with the host site. It is helpful if the faculty member can make a preliminary visit to the site before the longer visit begins.

Finally, Dr. Chumbley suggested that companies think proactively about bringing faculty members to their sites. Faculty can provide help for new product development, strengthen university relations, and help to develop students as future employees.

Proposed New Forms of Collaboration – Action Agenda

The participants in the GAIN Workshop were asked to define an action agenda for the next year focused on real, meaningful actions. The goal was to be able to demonstrate measurable success by the 2003 GAIN Workshop in Monterrey, Mexico. In selecting actions, the participants were asked to look carefully at the related benefits, barriers, and metrics for judging success. They were asked to assign actions to specific responsible parties and to set a timeline for achieving the desired results. The following action items were identified.

International co-operative education

The attendees agreed that it would be important to benchmark industrial co-operative education models in both the United States and other countries. This would help to identify the important aspects of successful programs so that others could replicate them as they implemented new programs.

A portfolio for international cooperative experiences will be developed, beginning with information from GAIN 2002. Once again this will be helpful in the institution of new activities.

Virtual collaborations

In order to facilitate virtual collaborations on design problems, it was suggested that academic-industry working groups be formed to identify real-world, global projects. This will ensure that the problems being addressed by students are relevant and interdisciplinary. Investigation should also be undertaken regarding the use of new media-based tools to communicate.

An international team will be formed to develop new media content to assist in the instruction of mathematics and physics.

Summer programs

A multi-university, multi-cultural summer program of four to six weeks duration will be established between partner universities. The program will rotate among the members. A small number of students will be located at a partner institution for six weeks to complete a project under the direction of the host institution. German students will be placed on research teams in the U.S. for four months to complete their senior theses.

Research programs and technology transfer

International M.S. students will be recruited and funded to study abroad. The goal will be to obtain this funding from a single company. An industry mentor will be recruited to participate in a virtual, international design project or research program

Summary

Global perspective will be a critical skill for 21st century engineers. Colleges of engineering must ensure that the educational environment offers a variety of challenging and rewarding international experiences.

It is important to remember that industrial partners have much to add to this dialog. They are not just potential sources of funding but also sources of ideas and solutions. They have faced many of the challenges now confronting the academic world as universities seek to embrace a global perspective.