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ABSTRACT

Establishing international collaborations between engineering education programs often entails a number of different activities, none of which are easy to establish or maintain. It is easy to lose sight of the goals. This paper suggests using student outcomes as a way of assessing and focusing these collaborations. The topic will be addressed using the experiences and data from a 5-year collaboration between the Universite d'Artois in France and Penn Sate University in the USA. Anecdotal data will be used from students who have engaged in collaborative design projects, in discussions of ethics, and who have had cross-national co-operative experiences. Key issues studied will be the positive role of cross-cultural differences, the preparatory role of such student experiences for working in the global economy, and the ability of information technology to internalize the in-house engineering curriculum. (Author)

Student Outcomes of International Collaborations

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Abstract

Establishing international collaborations between engineering education programs often entails a number of different activities, none of which are easy to establish or maintain. It is easy to lose sight of the goals. This paper suggests using student outcomes as a way of assessing and focusing these collaborations. The topic will be addressed using the experiences and data from a 5-year collaboration between the Université d'Artois in France and Penn State University in the USA. Anecdotal data will be used from students who have engaged in collaborative design projects, in discussions of ethics, and who have had cross-national co-operative experiences.

Key issues studied will be the positive role of cross-cultural differences, the preparatory role of such student experiences for working in the global economy, and the ability of information technology to internationalize the in-house engineering curriculum.

Background

Penn State and the Université d'Artois have built a collaboration over the last 5 years. [1] The force behind this collaboration has been Jacques Lesenne, the Director of the Béthune campus of Artois over this period, who long ago foresaw both the emerging power of the global economy, the opportunities to learn from the way engineering and engineering education was practiced in different countries, and the need to pursue such opportunities to prepare students to work in the global economy.

This paper is a reassessment of what has been done so far in the collaboration by focusing on the desired product of international engineering education: engineering and technology graduates who are prepared to work in the global economy. To begin the reassessment we will review the original assumption that we need to emphasize international engineering education (IEE) because the global economy demands it. In our view, the last few years in particular have confirmed the original assumption. We now expand our assumption with the following synopsis of the social and economic context for IEE.

1. Industry is increasingly interested in IEE. Penn State has extensive contacts with industry and over the last few years the industry contacts of Penn State's College of Engineering and of the University's Honors College have been almost unanimous in raising this issue. One donor is opposed, however. In 1998, ALCOA actually asked Penn State for ways to support IEE.
2. The National Science Foundation has begun to support IEE. (ICEE-97, 98, 99)
3. In the last few years, the number of IEE conferences per year has gone from 1 or 2 to perhaps 5-10. Many of these are supported around the world by the UNESCO International Centre for Engineering Education (UICEE) at Monash University in Australia. (http://www.eng.monash.edu.au/uicee)
4. The global economy is increasingly powerful, and the major corporations are now multinational and decreasingly dominated by the US.
5. Global migration patterns are very strong in technical fields. Colleges of engineering have 50%, or more, foreign-born faculty on their staff, graduate student populations are over 50% foreign born, and the presence of foreign students in the undergraduate body is growing steadily.
6. American engineering students have begun to show an increased interest in foreign education and coop experiences.
7. Engineering graduates are increasingly likely to work in multicultural teams for multinational corporations when they graduate.
8. IEE offers opportunities for the engineering education community to advance their knowledge of engineering by studying it around the world.

9. The advances in information technology technology that accelerate the growth of the global economy also offer cost-effective means of pursuing IEE.

Policy Implications

If the above assumptions are correct, then colleges of engineering and technology face some obvious policy considerations.

1. Most trends indicated above will continue whether the colleges of engineering and technology do anything about IEE ,or not, but successful colleges will not behave passively.
2. Some involvement by the colleges of engineering and technology in IEE is necessary to maintain good relationships with their industry partners, to stay relevant to the global economy, and to be competitive in attracting good students.
3. Some involvement with IEE is necessary because of the economic principle of comparative advantage. The best research, the best information, the best design, the best teaching of a subject may be somewhere else in the world. Benchmarking can be global, the available pool of ideas and information can be expanded, and the quality of collaborations can be improved. Further, it may be economically advantageous to give or to receive specialized education rather than for the client institution to develop its own capacity.
4. The ability to market and buy curricula services in the global economy will become increasingly important. For example, PennState has recently created a World Campus. http://www.worldcampus.psu.edu/
5. While somewhat outside the purview of this paper, the R&D scene may globalize to the extent that colleges of engineering may need to support faculty and graduate students' involvement in strategic ways. Integrated collaborations involving faculty, graduate, and undergraduate students may be an attractive mode.
6. Modular, flexible modes of IEE may be particularly attractive at the outset of a collaboration. For example, project-based learning in research and design has several benefits. It is known to be an effective learning environment, and it would integrate the nationalities and would avoid the ghetto problem of many study abroad programs. And it is far easier to collaborate for a design project than it is for the entire course. Another example would be mini-lecture series on national design practices or the national regulatory environment.
7. The investment already made in information technology in colleges of engineering and technology can, with small additions for audio-video conferencing / virtual desktop technology, be used to pursue IEE objectives.

Implementation

Behind this move to develop IEE lies a vision of a global community of faculty, graduate and undergraduate students who study in ways that are increasingly independent of the constraints of time and place, and who engage in collaborations with domestic and multinational corporations and domestic and foreign universities.

To realize this vision, colleges of education will need to promote international experiences in IEE through foreign education and co-op experiences, foreign course offerings and foreign course recognition, and through internationalizing the in-house curriculum. Information technology, foreign travel, and hosting will characterize these activities. Co-op exhcange programs will require a lot of work and will need the involvement of existing co-op offices.

The practice of IEE needs to be guided by the desired outcomes, which, for undergraduate education, we take to be the following:

Outcomes

1. Increasing numbers of engineering and technology graduates will understand the global diversity in engineering practices and codes, and the emergence of international codes and practices.
2. Increasing numbers of engineering and technology graduates will have the ability to work in multi-cultural / multi-national teams.
3. Increasing numbers of engineering and technology graduates will have had foreign co-ops.
4. Increasing numbers of engineering and technology graduates will have developed their foreign language skills, particularly their oral and technical foreign language skills, while in college - including getting a dual degree or a minor in a foreign language.
5. The quality of engineering and technology graduates may be increased by using the principle of comparative advantage.

Colleges of engineering and technology need clear statements of what the options are in IEE, what the costs and benefits are of the various options, what IEE they want, and how they plan to get it. Before doing this, they should identify the stakeholders, (faculty, students, industry partners, and representatives of foreign universities) and get them involved in defining the future of IEE in their institutions.

A Case Study: Penn State and d'Artois

The story of the first five years of this collaboration has already been told. [1] Here, we will review what has been done in the light of the desired outcomes listed

above. To some extent, we will see that the focus on the students at the beginning weakened as the collaboration matured, but it has returned again over the last year. The process of involving faculty, identifying common interests, and developing missing resources were critical to establishing the collaboration, and this meant that, for several years, the students were not the primary focus of the collaboration.

The current exchange was initiated in 1994 with the exchange of one faculty member each. The first Penn State faculty member to visit Artois taught classes there in pursuit of the Artois policy to expose their students to foreign faculty talking about engineering in their own language (usually English). [Outcomes 1,4 & 5.] Several other exchanges of faculty followed in 1995 and 1996, but not always for teaching purposes. In early 1996, a Memorandum of Understanding was signed by both institutions outlining a broader range of interests and activities.

In 1996, five Penn State faculty members traveled to Béthune to teach and observe in several departments. Two were involved in the development and conduct of a two day conference on green engineering, "L'Ingenierie Verte," in collaboration with the Béthune campus and local industry. Additional Penn State faculty from the University Park and Harrisburg campuses participated as presenters in the conference via compressed video technology (PictureTel). Two Penn State students spent two months in industrial placements in Béthune and Lille. However, by this time, the teaching component was overshadowed by two other activities: an annual joint conference involving faculty and occasionally industry representatives, and by exchange visits of faculty and staff to observe and to learn. There was some student incolvement in the joint conferences. This characterized the years 1995 and 1996, and it represented an increase in the number of faculty involved and a deepening of the personal relationships. In 1997 and 1998, there was more teaching again, and the exchange of students for internships in industry became established and began to grow. [Outcomes 1-5.]

The student focused activities often followed some of the faculty activities. For example, the development of a design for society module that was delivered during the spring of 1997 via videoconferencing was, to some extent, a follow-up to the two day green engineering conference that was conducted the preceding May. Penn State faculty delivered eight sessions in this module, and several discussion sessions were conducted involving students at both locations. The course was concluded with an on-site workshop in Béthune in May, 1997. Two Penn State students had industrial placements in northern France arranged by the IUT and three Béthune IUT students had industrial placements with central Pennsylvania industries arranged by the Penn State Altoona College. The co-ops will be repeated in 1998 with a further small increase in numbers.

In another student focused development, a collaborative design project, Alliance by Design, was run in the fall of 1997. Ten teams of 3 Penn State and 3 Artois students were each given the same design problem drawn from an industry near Penn State. Taking advantage of information technology to deliver a cost effective IEEE program, they students collaborated by email, FAX, the WWW, and audio-video conferencing. The documentation for the design solutions were placed in bilingual sites on the WWW. Students who were on the winning team (http://www.ecsel.psu.edu/~nkleno/visual.html) were given travel vouchers to visit each other. This has been documented elsewhere. [2] There were considerable problems of scheduling and technology, but it was so successful that it will be expanded for the fall of 1998 to involve two classes at each institution in two separate design projects. This project was a direct outgrowth of the joint conference in May, 1997, when five Penn State faculty traveled to Béthune to teach lecture and laboratory sessions and to collaborate on a conference on technology and pedagogy of videoconferencing and the World Wide Web.

This design collaboration had other dividends. It was featured prominently in a site visit by Boeing which led to a group of 8 faculty at Penn State getting the 1998 Boeing Engineering Educator Award. And the Penn State College of Engineering used it to submit a proposal to ALCOA for IEE in response to a request from ALCOA. The funds would support the expansion of the Alliance by Design project to more courses, create ALCOA IEE undergraduate scholarships for travel, co-ops and design team interpreters, and help Penn State get an IEE co-op program started. And the 1998 joint conference was on Teamwork in Education and Industry, an obvious outgrowth of the project. Continuing the theme, the 1999 joint conference will be on cross cultural dynamics in teamwork in education and in industrial placements.

Future objectives of the collaboration include the continued development of cooperatives, courses and projects, the short term exchange of larger groups of students for intensive seminars, workshops and cultural experiences, and the expanded use of new instructional technologies to supplement other courses. So the collaboration has now returned to its original objectives. However, a lot of what transpired in the meantime was also critical to achieving those objectives.

At the IUT, using computer, multi-media, and www technologies in the curriculum required new equipment and new pedagogies. Faculty experience was very limited prior to the May 1997 conference which focused on the use of these technologies in the curriculum. By the fall of 1997, the new, on-line computer lab was used heavily by faculty in a number of different departments, showing a very rapid learning curve that will support any future collaboration based on information technologies. Every year the collaboration

triggers an acceleration in the acquisition of computer technology at the IUT and an acceleration in IEE at Penn State.

At Penn State, there has been uncertainty in recent years about how to institutionalize IEE. The successes of the collaboration with Artois have helped draw attention to the value of IEE and to illustrate some of the opportunities. Three of eight members on the international education committee of the College of Engineering are involved in the collaboration. And one of the faculty members in the collaboration was a finalist for the university wide award for faculty international achievement (there were over two thousand eligible faculty).

In addition to these necessary institutional changes, there are now friendships that are several years old and renewed 2 or 3 times a year. These make communications easy and trust automatic. And there is also now a community that provides resources for new activities. For example, the collaborative design project used two student interpreters who had had internships in France arranged by the collaboration, and a French student on one of the teams has come to Penn State for an internship in industry. Several Penn State students in the design project have expressed interest in doing an internship in France in the near future.

This interplay between building infrastructure and delivering programs that meet the five objectives listed above will continue, but the infrastructure activities will be come even more focused on developing what is necessary to deliver student-focused programs. As noted above, the 1998, Ind 1999 joint conferences have student focused themes. These will directly support the collaborative design projects for the Fall of 1998. Some of our earlier activities did not do this directly. There were very interesting joint conferences with industry on continuous quality improvement (1995) and on green industry (1996) that did not lead to student programs, although they helped to build faculty involvement and some students attended the conferences.

Anecdotes of Student Reactions

Experiences of Penn State faculty teaching students in France directly have been positive. There have been some difficulties in guaranteeing student attendance, because it has not always involved a graded exercise that affected the academic progress of the students. But most students have attended and were enthusiastic. Tightening the integration of teaching these modules with the required courses has occurred and was quite effective in both institutions for the latest program, the collaborative design project.

Uni-directional instruction from Penn State to students at Artois led to the French students asking for joint sessions with Penn State students. The subsequent student to student experiences were appreciated at both institutions and it is definitely a good thing to do, particularly in small groups such as project teams. When Penn State students had to meet during out-of-class hours, a few grumbled, but most did not. At Artois, some of the usually uninvolved students became enthusiastic during the collaborative design project to the surprise and pleasure of their professor. Others bought their own computers to get on the Internet as a result of the project.

Language is an issue, but its effect is mainly one of slowing the exchanges rather than preventing them. Cultural differences have been noticed but are not major, and this diversity can be contributive rather than an obstacle. An assessment of different conceptions of what it takes to be a good team player was carried out during the collaborative design project. This found that work had rather more influence than culture, and that the concerns of the French and American students were quite similar. One clear difference seemed to reflect what was in vogue in both countries rather than a deep cultural difference. The French stressed being "impliqué" (involved) in the project while the Americans stressed being a "good team player" (cooperative, helpful).

The same thing was found in an exchange in between Penn State students in a design ethics course and Artois students that took place in the Spring of 1998. The students were discussing the relative worth of right action ethics (deontological approach) and right outcomes ethics (consequentialist approach). At the time, there was an international debate about using military action against Iraq to force compliance with the deployment of UN inspectors. The American students were very prone to advocate taking the right (military) action against the "monster." The French students usually stressed that innocent Iraqi citizens would suffer (a consequentialist argument),and that it was a UN decision not just an American decision (this is a social ethics argument that stresses the social arrangements for how a decision is to be made). The positions taken by the students reflected the way the issue was presented in their respective countries by their governments and their media.

Getting the students together, then, will allow them to learn about each other and, in so doing, to learn more about themselves. As we get past the trial and error stage of creating these collaborative experiences, we intend to be more systematic about the students learning from the cultural differences, including studying different engineering codes and different design and manufacturing practices.

Conclusion

While industry seems to be very supportive of IEE, the faculty and administration in colleges of engineering and technology may not yet be fully convinced of its significance. It is important, therefore, to keep the rationale for IEE very focused and very visible. We have suggested that focusing on student outcomes is the

best way to do this. We recognize that there is also an argument to be made for (further) internationalizing R&D and that there can be a symbiotic relationship between IEE and international R&D in engineering education. But we have found a focus on student outcomes helpful for focusing the efforts of the 5-year collaboration between Penn State University and the Université d'Artois that has been used to illustrate our approach. Formal assessments of these outcomes would be valuable.

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