A French - American Collaboration in Engineering and Technology Education

Wayne Hager, Richard Devon
The Pennsylvania State University

Jacques Lesenne, Dominique Saintive
The Université d'Artois at Bethune

Abstract:
With the globalization of the economy, it is becoming increasingly important for engineering and technology graduates to have international and cultural opportunities and experiences as part of their undergraduate curricula. This paper reports on the value of using a multi-faceted collaboration to generate relevant, diverse, and cost effective experiences for faculty and students. And, while many opportunities exist for engineering students, only a few are currently available for technology students and faculty. We have built a collaboration that provides opportunities for both. Further, we will even report on a project that was both international and between engineering and technology students.

Over the past five years, a collaboration has developed between the Penn State School of Engineering Technology and Commonwealth Engineering (SETCE) and the Institut Universitaire Technologie (IUT) on the Béthune campus of the Université d'Artois in northern France. It now includes faculty exchanges, student exchanges, short term student industrial placements, joint conferences, seminars and, most recently, joint team projects[1]. Many of these activities utilize videoconferencing and other electronic technologies, which are critical to the goal of having cost-effective programs. The symbiotic relationships among the different facets of the collaboration have proven very beneficial as each new activity is supported and enriched by elements of the previous activities.

Rationale for Internationalization of the Curricula: The world is changing in fundamental ways, and as educators we must be responsive to these changes. We are moving rapidly into a networked society, in which old and familiar institutions are losing their power, including the nation state itself[2]. Furthermore, the economy is more and more based on information[3] and services[4]. Almost all the major corporations have now dispersed their operations around the world.

The corporate organization is being flattened and powers dispersed. Employees at all levels are becoming more empowered. Relationships are increasingly functional and lateral rather than institutional and hierarchical, and they may involve employees located around the globe. In engineering, time to market is becoming the primary driving force and solutions to problems are

sought in a team environment that speeds this process through concurrent engineering practices. These teams and collaborations may be international while still intra-corporate. Competition, by contrast, is becoming primarily inter-corporate and intra-national.

At the local level, we are now urged to connect directly with the global economy[5]. This is true even in State College, a small rural Pennsylvania community. The largest industry, Corning Asahi, is an American-Japanese alliance that manufactures glass TV screens according to international ISO quality control. The workplace and the shopping mall are, like the financial world, now global[6]. And the best industrial practice, that must be met, now means the best anywhere in the world[7,8].

Our graduates must be prepared to work in multicultural teams in multinational corporations. Some of the education preparation that they need will come from international collaborative experiences that develop abilities and familiarity with information technology, teamwork, international collaboration and design methodologies and codes in a multinational and ISO environment. We believe these experiences should start early in the engineering and technology curricula.

Penn State, like most major universities, has a large variety of international initiatives in virtually all disciplines, including engineering. However, none of them involve engineering technology faculty, few have involved faculty in any discipline at locations other than the main campus, and only limited opportunities have existed for faculty involved in introductory engineering courses. For engineering technology undergraduates, international educational experiences are rare. In addition, the majority of international exchange opportunities center on gaining language competency in the traditional “semester abroad” model while those in engineering focus more on technical course equivalents with English speaking universities. The typical engineering exchange expects students to make normal progress toward their degree and simultaneously gain an international cultural experience. In practice, an international experience extends the time to graduation, and, until very recently, this deterred most engineering undergraduates. Only 3% of engineering majors gain an international experience that includes academic credit before graduation at Penn State.

However, over the last several years the authors have seen a growing interest among undergraduate engineers at Penn State to include an international experience in their education, particularly international co-ops. An additional indicator of the importance of international educational experience is reflected by the Penn State Schreyer Honors College, which, with considerable donor funding, recently established a goal of having half of its students have a significant international experience during their undergraduate education. About 30% of the students in the Honors College are engineering majors and there will now be financial support for them to gain international experience. Significantly, the Honors College policy is to avoid “academic ghetto” experiences where the American students would all stay together while overseas.

Of course, most engineering students are not in the Honors College, so new models for incorporating international experiences will be required to increase the number of international

experiences for all students. Our experience indicates that new instructional technologies, especially those involving electronic media, have the potential to change many of these traditional exchange program paradigms. They present new opportunities to internationalize the curriculum in innovative ways, often without leaving the home institution.

The d'Artois-Penn State Connection: the Institutions. The Université d'Artois is a new university in northern France, but with roots that go back to the 17th century. It is composed of four campuses that until the early 1990's were part of the University of Lille. Today, the Université d'Artois houses programs in engineering, engineering technology (2 year technician programs), and management at its Béthune location, in liberal arts and related disciplines at its campus in Arras, in natural and applied sciences in Lens, and in law programs in Douai[a]. As a new university in the French system, it has a strong commitment to internationalism that is being directed from the Béthune location, and which initially focused on engineering and engineering technology. In addition to the IUT, the Béthune location also includes an Institut Universitaire Professionele (IUP). The IUT programs are roughly equivalent to associate degree engineering technology programs and the IUP programs are roughly equivalent to baccalaureate engineering technology or applied engineering programs in the US. Graduates from both the IUT and the IUP must satisfy a foreign language proficiency requirement[b] and an industrial placement component in their curricula. English is one of the required foreign languages for both the IUT and the IUP.

At Penn State's main campus at University Park (UP), the baccalaureate engineering degree is offered in twelve undergraduate majors. However, annually more than 50% of the College's engineering majors begin their engineering education at one of eighteen other Penn State locations. Many of these locations also offer associate and selected baccalaureate degree programs in engineering technology[c]. Thus, the IUT and IUP programs more closely parallel the programs offered at these locations rather than those at the University Park campus.

The Université d'Artois is committed to building an international component and cultural awareness into all of their programs. For the IUT and the IUP, the specific motivation for involvement with Penn State is their desire to expand their faculty and student awareness of American pronunciation of English and of American culture, particularly with respect to education, technology, and industry. The institution is committing significant resources to the internationalization effort, to the support of their faculty for short-term exchanges to the US, and for the limited support of foreign faculty for short-term exchanges to Béthune. Because of the English language proficiency requirement in both their engineering and engineering technology curricula, they expect US faculty to teach modules of selected courses in English.

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[a] For purposes of this paper, US terminology for various disciplines and program areas are used; actual French terminology will differ;

[b] Most programs require two foreign languages.

[c] The distinction between engineering and engineering technology is formally defined be the Accreditation Board for Engineering and Technology (ABET). In simpliest terms the difference is in the focus on engineering theory in engineering and the focus on engineering practice in engineering technology. Few other countries make this distinction in the "engineering" profession or practice; however, applied engineering is an academic term frequently applied in UK and other English speaking countries.

The motivation of SETCE at Penn State is for developing international experiences for faculty and students in introductory engineering and design courses and in engineering technology. A major interest is also to experiment with innovative ways to provide an international experience in the curricula given limited resources. Co-op exchanges are also a small but growing activity in the collaboration.

The History of the Collaboration: The current exchange was initiated in 1994 with the exchange of one faculty member each. Several other exchanges of faculty followed. In early 1996, a Memorandum of Understanding was signed by both institutions outlining a broader range of interests and activities. These included the exchange of students, the development of common course components or modules, cooperative videoconferences, and the exploration of the use of new information technologies for teaching, learning and distance education.

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. Two Penn State students spent two months in industrial placements in Béthune and Lille. Both of these students were in our Engineeirng and French dual major program.

Additional exchanges of faculty subsequently occurred that resulted in the development of a design for society module that was delivered to the IUT during the spring of 1997 via videoconferencing. This was a direct follow-up to the two-day green engineering conference that was conducted during the previous May. Penn State faculty delivered eight sessions, and several discussion sessions were conducted involving students at both locations. Several sessions focused on different cultural perspectives of technology. The course was concluded with an on-site workshop in Béthune in May 1997. Again, in 1997, five Penn State faculty members traveled to Béthune to conduct lecture and laboratory sessions and to collaborate on a conference on technology and the pedagogical potential of videoconferencing and the World Wide Web. 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. These short-term co-ops will be repeated in 1998 with another small increase in numbers, belying a major increase in the number of Penn State students showing interest (25 initially, with 9 making full aplications).

Future objectives include the continued development of cooperative 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. In this latter category, we have most recently experimented with the use of collaborative design teams using electronic communications. The remainder of this paper focuses on those efforts and specifically our experience in an introductory design course taught during the fall semester 1997.

Collaborative Design Project

At the IUT, the use of the WWW, multi-media, and audiovideo conferencing in courses required the adoption of new instructional technologies and equipment. Faculty experience was primarily limited to that presented during the May 1997 workshop on videoconferencing and the WWW. In addition, an infrastructure had not been established to support these new technologies. For example, the IUT has had little experience in using undergraduate students as assistants, without which Penn State would be severely constrained. In this context, we entered the collaborative design project.

A collaborative design project, "Alliance by Design" was developed as a direct follow-up to the May 1997 faculty workshop on instructional technologies and the on-site student sessions of the Design for Society course. It was developed to test the feasibility of using information technology to internationalize the in-house curriculum at both institutions in a cost-effective way. The model employed here has the potential for widespread impact on the curriculum, because it uses information technology to bring the world into the resident curriculum.

In the fall semester of 1997, teams were formed from 33 Penn State students in one section of the Penn State first-year engineering design course, and 36 production management[a] students in an English class at the IUT. It was understood at the outset that we could take advantage of the mandatory English classes taught by Saintive and others to the students at Béthune. We chose the Department de Organisation et Gestion de Production (OGP) in which Saintive works. By chance, it could be arranged for each of the 10 teams formed to have an American student with 2-4 years of high school French. This turned out to be of small benefit, and interpretation as needed was provided by Saintive and two American students in a dual major French-Engineering program, both of whom had had internships in France arranged by the collaboration. The French oral abilities of the Penn State students were minimal, despite 2-5 years of high school French.

The design project was made especially relevant by offering travel scholarships to the members of the winning team. Friendships formed in the other teams allow the possibility for personal travel, also. At Penn State, the costs for 3 travel vouchers, one faculty trip, the student interpreters, and the ISDN line costs were approximately $5,000 for one class of 33 students. The same collaboration could work for two sections for a slight increase in budget. These costs are modest, and industry support is a real possibility since industry interest in this type of project is growing. Using the audio-video conferencing facility in Netscape Communicator would reduce the costs sharply, since there would be no ISDN line costs.

Because there is a 6-hour time difference, Penn State students in early morning classes must connect with Artois students in late afternoon classes. While the time difference created some constraints that could be overcome, a larger problem developed in trying to coordinate institutional calendars. In hindsight, more detailed preparation should have been done in the summer of 1997 to prepare for the collaboration. This must include an explicit and detailed sharing of the calendars, student schedules, laboratory availability, vacation and holiday dates, and so on. We initially overlooked most of this and simply made a verbal understanding that the students would be getting together on Tuesdays and Thursdays.

[a] Roughly the equivalent of US associate degree Industrial Engineeirng Technology students.

Initially, we had planned to have the students get to know each other through some general class discussions about technology. Although these took place, they were unsatisfactory because of technical difficulties in establishing the ISDN connection. In addition, due to class size whole class sessions devoted to open discussion proved difficult to run logistically. In an attempt to solve some of these difficulties, the IUT class was relocated from a video classroom to a computer laboratory where the students had access to desktop conferencing. This move from a centrally controlled classroom to a departmentally controlled laboratory provided increased flexibility at that site. In addition, this eliminated previously experienced transmission delays because this laboratory had newer equipment.

Initially Penn State was operating with a Pro-Share 200 software package by Intel and Béthune had installed CLI (VTEL). Both are supposed to be PictureTel compatible; however, this did not prove to be the case. The Pro-Share system was capable of receiving calls from the French site but could not place calls successfully. Thus, the IUT was billed for all the line charges in the beginning. Pro-Share is a desirable software package because it has file and application sharing, which CLI does not have. Originally, we had hoped that the IUT would also have a Pro-Share system. However, the manufacture does not wish to have it operated outside the US at this time.

By mid-October, the anticipated email accounts for the students at Artois had not yet been established. Only one central departmental email account was available. The students in this IUT class would be the first students at Béthune to have personal email accounts. The American students not only had email accounts but were learning a lot of Internet skills in their course. These email accounts for the French students were viewed as essential to the project since a single A-V connection would be inadequate for 10 teams.

One of the successes was the identification and assignment of an industry based design project including documentation and an in-house video illustrating the problem being addressed. The problem came from Corning Asahi in State College. At this site they manufacture glass screens for televisions sets. With the increased popularity of larger screen televisions the existing manual inspection process for the screens was not possible due to their increased weight. Because this was an assembly line problem, and real, it was very well received by the OGP faculty, as well as IUT faculty in other departments who were following this project. It will also serve as a good model for the IUT faculty when they search for future projects from the industries with which they work.

The students at both ends began developing ideas for the design, and things were just beginning to move when Halloween arrived in the US and the French took a week off for All Saints. On return, the French lab had been booked again and at Penn State another faculty member began using the computer lab on Tuesdays. Originally we had planned to have this phase of the project completed by this time.

At Béthune, security concerns led to a desire to install a firewall in the student lab. The policy prevented a solution to the communication problem: all the French students were given accounts on the American site, but they were not allowed to use them. Nor could the French students use Netscape after 6pm local time. Unfortunately, this firewall could not be accomplished in a timely

manner because the relevant technical person at the Arras campus, which houses the university administration, was on maternity leave. This policy had already caused some tension between the campuses and the project exacerbated this.

Following these difficulties, which threatened to terminate the project, the Director of the Béthune campus made the project a top priority. He intervened and arranged email availability for their students involved in this project. These accounts were on new computers in the OGP department, acquired ahead of schedule also to accommodate the project. And the head of the OGP mandated that the students would do the A-V conferences for this project from 8-10 each Tuesday. This schedule became 8-11 and was followed for the rest of the semester. The 8-9 hour was not a schedule time for the American students, but most could, and did, make it as needed.

In the meantime, Penn State installed a Swiftsite system in a faculty office to overcome the unavailability of their computer lab in November. The A-V conferences had been intermittent before this and one group still had not met at all. On Tuesday, November 18, A-V student team conferences for all 10 teams took place for the first time. This was at least six weeks behind our original schedule. Artois has a document camera and Penn State used a very high quality camera that doubled as a document camera. So the conferences were excellent, with very good exchanges of ideas using drawings and verbal descriptions. Mostly the exchanges were in English but some were in French, since some Penn State students spoke a little French and they had an interpreter as well. Throughout the semester Saintive interpreted, as necessary, at his end. During this week, the email and FAX traffic began to start and the students began to get very involved.

The choice of a design solution to develop for their project was a very critical moment. Students became concerned about competition between the ideas of French students and American students. This had been foreseen and the students were reminded of two things. The competition was between teams not within teams. They had to find the best collaborative design. Secondly, all designs have good and bad features, this is why design selection matrixes[10] are used. This technique requires a willingness to criticize your own design ideas and to praise the design ideas of others, with the desired result that agreement will be easier to reach. The use of the design selection matrix with an across the board weighing of tradeoffs is ideal for going past mental us/them blocks and worked well for this project.

Also, the complementarity of the skills of the students began to work at this point. On average, the French students were better at traditional graphics and they all had experience working in manufacturing which was rare among the American students. The American students were as strong in generating design ideas, and they had more training and better facilities in computing. There were exceptions to these generalizations at each end.

At Penn State, the students concentrated on creating a web site to document their designs. The French sent drawings and photos and started the translations into French. By the first of December, communications included the first posting on the WWW for viewing and downloading. Use of the WWW, FAXes, and email increased. The A-V team conferences were

very focused, and the lead student interpreter, Wendy Rentz, became very adept working opposite Saintive.

One new problem emerged. Although an effort had been made to put an "outgoing" personality in each American group, it was not foreseen that the American students would have a problem with English. In fact, they often spoke too quickly, mumbled self consciously, and used idioms and constructs that were inadvisable even for American ears. The bilingual A-V setting, then, is an opportunity to improve the use of English by the American students, and to apprise them of some basic principles in using English when speaking to people who have acquired a limited knowledge of English.

The 10 teams had to be judged. It was decided that the web sites were finished by midnight U.S. time (EST) on December 12th. By Monday, December 15 (noon U.S., 1800 hours France), all the students had logged on and reviewed all 10 design projects. They then submitted their scores for the 10 projects to Saintive and Devon. Their scores for their own team were discarded and the rest compiled with any suspiciously extreme scores discarded. Additional assessments were provided by faculty judges at each end.

The awards were made on December 16th. The winning team, happily identified universally as the best, has their project web-site at: http://www.ecsel.psu.edu/~rdevon/visual/inspection.html . We were very impressed at the accomplishments of these first and second year students under difficult circumstances and severely constrained by time.

Lessons Learned from the Design Collaboration

There were many lessons. The impact of such a project on the institutions involved will be bigger even than the impact on the students. Penn State made it first commitment to internationalizing the in-house engineering curriculum by using their existing computer resources. Artois made rapid strides in bringing computers into their curriculum while drawing on its existing commitment to internationalize their curriculum. The number of faculty at both institutions who want to be involved in the future has increased markedly. All the students in the classes, whether they won and went, or not, had their first experience in the global economy and made foreign friends.

The biggest problems had to do with scheduling: working around holidays, coordinating A-V meeting times, and arranging timely access to labs with key facilities. These things should be in place well before the classes start. Access to technologies and compatibility of technologies also caused problems. This sort of project needs email and WWW technology in order to work. However, the face-to-face team conferences using A-V conferencing technology are very helpful in establishing relationships. All the more so, since the winning team members will visit each other. An attempt to do a similar project in another Penn State engineering department among students at different US universities but only using email had problems getting the teams to bond well. Finally, a good project is essential. You can't get the necessary commitment of time and energy with an academic exercise that has relevance only on one side of the collaboration. Industry is now global and provides the best source of projects. The project we used was very motivational for both faculty and students.

Compared to scheduling and technological compatibility, language and cultural difficulties were negligible. Mixing the teams helped diffuse any cross-cultural tension and enriched the resources of each team. A key resource on both sides was time. Saintive and Devon both doubled the time they usually commit to their respective classes. This will get less as they get better at it, but it is not yet a casual enterprise. Technological progress will also reduce the time burden.

Despite the problems, the students, the faculty, and the administration on both sides viewed the collaboration as a great success. . Arrangements for the fall semester of 1998 have already begun for two projects involving two different departments and classes at each institution. And, of course, the winning students are making their travel plans.

A Developmental Model for International Collaborations

During initial discussions between the SETCE and the IUT, we recognized the following developmental stages of international educational partnerships. This model has been successfully followed to date to somewhere between stages 3 and 4:

1. Familarization with Institution
   This is a time period to exchange adminstrators, faculty, and key individuals associated with the anticipated development of the exchange program. The purpose of the exchange is to become familiar with the partner institution, its goals and mission, institutional facilitites, and level of commitment to the international partnership. The first friendships are also established.
2. Identification of Common Interests
   This is a period of more in-depth exchanges with specific focus on instruction and/or research activites where commonality exits and an interested faculty has been identified. Additional familiarization activities may take place simultaneously.
3. Development of Cooperative Projects & Activities
   This is a period during which previously identified projects and activities are conducted and evaluated. Additional activites may be identified as a result, or, conversely, actvities may be modified or cancelled.
4. Instruction of Common Courses
   This is a period involving the instruction or exchange of selected courses, modules of courses, or common classroom sessions, seminars or workshops
5. Institutionalization
   This is a period during which successful projects and activites are institutionalized within the home institution. The goal of which is the sustainability of these projects and activities.
6. Cooperative or Common Degree Programs
   This is a culmination period resulting in the development of common curricula and degree programs. In the most developed state this could result in a common or dual degree for the participating students.

The goal of this partnership was to move as far into these stages of development as possible within a five year time period. A realistic expectation was to have activites and projects at the

stage 3 and possibly stage 4 level. If achieved this would allow for assessment of activities and re-evaluation of our goals and objectives prior to institutionalizing these activities. We recognized that stage 6 would be unlikely to achieve given the different nature of our institutions, cultures, and educational systems.

Over the five-year time period the level of activities have grow from a very modest initial exchange of faculty to one which now includes five to six faculty per year for each insitution. In addition, our activities have grown to include the annual exchange of three to four students per year for short term industrial placements, the conduct of an annual cooperative workshop or seminar, the inclusion of compressed video lectures and student discussions in several courses, both engineering and non-engineering, and the conduct of common design projects using international student teams.

Conclusion: Symbiosis and Success

To date, only anecdotal evidence is available to support the success of these efforts from both faculty and student perspectives; however, more formal assessments are currently being developed. From the perspective of the authors, the success of this partnership has been a direct result of the synergistic nature of the activities and personnel involved in the various projects and activities.

As the collaboration has progressed, each activity has involved generating ideas and planning for the next activity. Also, the number of faculty and students has grown and these have become resources for each new development. The "Alliance by Design" student design project that is described above illustrates this well. The project grew out of the faculty workshop in 1997, and it includes the same department at the IUT, and even some of the same students, that were involved in the design for society mini-course. It used interpreters at Penn State who had had industry internships in France arranged by the collaboration. One of these interpreters has gone to work in the corporation from which the design project came, and we now expect to include her as an industry member of the collaboration. The design project used the information technology studied in the 1997 workshop and it has, in turn, led to the 1998 workshop on teamwork in education and industry, as well as supporting a bid for external funding. In 1998, a leading, and experienced, Penn State undergraduate assistant will spend two months on the Béthune campus assisting with developing its instructional computing facilities. This student was the TA for the Penn State class in the Alliance by Design project. One of the three IUT students who are coming to Penn State for internships in industry was also a participant in the design project. It is easy to conclude that this sort of comprehensive collaboration makes each new activity both easier to do, and more successful when it is done, than trying to start cold with a new partner.

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WAYNE HAGER is Professor and Head of The School of Engineering Technology and Commonwealth Engineering within the Penn State University College of Engineering. He holds degrees in Chemical Engineering, has industrial experience with the Dupont Company and has served as a Fulbright Senior Scholar to the University of Mauritius. For the last four years, he has helped build an international partnership with the University of Artois.

JACQUES LESENNE is University Professor and Vice-President for Academic affairs at the University of Artois. He was previously the Director of the Bethune campus. Lesenne has been extremely active in developing collaborative programs in Europe, Asia and the USA. His academic areas are power electronics and control engineering and he has a dual doctorate in electronics and physics.

RICHARD DEVON is an Associate Professor of Engineering Design & Graphics and Director of the Pennsylvania Space Grant Corsortium. He has twice been Acting Director of the Science, Technology, and Society Program. He publishes on design education, design ethics, international education, and spatial visualization.

DOMINIQUE SAINTIVE is a Professeur d'Anglais Certifie and in charge of international relations in the Department of Organization and Management of Producation at the Institut Universitaire Technologie (IUT) on the Bethune campus of the University of Artois. He also works in the Department of Continuing Education and has experience with international programs from high school students. He was educated at the University of Lille.