
An International Collaboration in Engineering and Technology Education

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The Béthune campus of the Université d'Artois in northern France contains the Institut Universitaire de Technologie (IUT) and the newer Institut Universitaire Professionnel (IUP). The former grants degrees in technology, the latter in engineering. The Penn State College of Engineering at University Park is home to the School of Engineering Technology and Commonwealth Engineering (SETCE). This academic department is responsible for the delivery of associate and baccalaureate engineering technology programmes and lower division core baccalaureate engineering courses in a multi-campus environment, 18 Penn State locations in fact. A collaboration between IUT/IUP and SETCE was begun in 1994. It now embraces faculty exchanges, joint conferences, short-term student industrial placements, distance education and teleconferencing, and research collaboration. These efforts have also expanded to include interdisciplinary Science Technology and Society (STS) courses, the College of Liberal Arts languages courses, and several branch campuses in the Penn State system. This paper identifies what the critical inputs were, what the enduring obstacles are, and what the present success and future promises are. As the exchange has developed, personal ties and information technology have emerged as more significant than money and formal agreements between the universities.

INTRODUCTION

In his prophetic book, *The End of the Nation-State (Le Fin de la Démocratie)*, Jean-Marie Guéhenno notes the increasing mobility of capital, ideas, information and people, with the concomitant weakening of the significance of territory and nation states [1]. An OECD Centre for Educational Research and Innovation study, *Internationalisation of Higher Education*, contains similar conclusions. Internationalising higher education, in this view, means internationalising the curriculum to support the global economy, including local and shared curricula, and the increasing international movement of faculty and students [2].

The OECD document reports different histories in different countries for internationalising the curriculum. Australia, in 1985, decided to treat education as an international trade industry, and by 1994 it was

earning over a billion dollars (US) a year from foreign students. They have since pursued the economic route more by focusing on their Asia/Pacific trading region. Japan has been acting to overcome isolation since the late 1970s, and about 90% of their more than 500 universities now have international agreements. Countries such as Denmark and the Netherlands, who have long compensated for their minority language status at the faculty level, also now embrace international experiences for their students. Even countries with strong research and industry, Germany and France for instance, have similarly moved assertively to internationalise their curricula in the last decade. Despite such very different histories and characteristics, all these countries are taking the same path.

The United States has internationalised in a rather passive mode by being host to very large numbers of foreign students from developing countries, particularly at the graduate level. Foreign students are typi-

cally from Asian countries, whereas American students tend to go to Western Europe for foreign study [3]. Nevertheless, US policy has always been actively articulated with the domestic job market, the needs of US universities, and extant immigration policy. (An exceptional situation might be the present conjunction of a strong job market and a very restrictive immigration policy.) In a new proactive development the National Science Foundation sponsored the first *International Conference on Engineering Education* (ICEE-97) in Chicago in 1997. This conference clearly met an emergent need and drew far greater attendance than anticipated. Plans are underway for follow-on conferences in Brazil in 1998 (ICEE-98), and the Czech Republic in 1999 [4].

The trend to internationalise higher education appears to be moving steadily in the direction predicted by Guéhenno. For example, the OECD document provides a comparison of activities in the Netherlands and Australia. Rather surprisingly, both countries had the same three categories comprising 50% of all types of international curricula. These were: curricula with an international subject; traditional curricula augmented with an international component; and curricula which prepare students for defined international professions. The collaboration described in this paper falls into this third category. The main differences noted in the study were that the Australians reported a strong emphasis on area specific studies and the top category for the Dutch was curricula designed for foreign students [2].

COMPARISON, COLLABORATION OR MARKET SHARE

Collaboration is not the only way to go. There were 39 panels over two days in ICEE-97, and only two panels were dedicated to papers on international collaborations, although almost 60% of the sessions had one or more speakers reporting on engineering education in countries other than the United States [5].

The ICEE-97 conference illustrated the comparative method of learning through the sharing of ideas and experiences from various countries. This is similar to the benefits of visiting universities in other countries, although the collaborative method, while harder to do, probably does the same thing better by providing for joint experiences and participant observation, and furthermore it promotes the sharing of resources that may be complementary. Better still, collaborations which include direct experiences for the students prepare them for working in multicultural teams for multinational corporations, which is an experience awaiting most of them. This is the reasoning behind the

Penn State-d'Artois collaboration.

Another view entirely however is that of higher education as an economic enterprise in which it too will scale up to the global economy. There is much discussion now about the *Virtual University* and the *World Campus*. While the responsibilities of the university towards the development, verification, maintenance, and dissemination of knowledge are hardly yet being performed on the WWW, learning is increasingly freed from the constraints of location, occupation, or disability. Distance education is rapidly gaining respectability. While many universities have established overseas campuses, one stands out in particular. The Open University in Britain, which primarily uses distance learning, was chartered in 1969. By the mid 1990s it had 200,000 students utilising 306 study centres. Newberry notes that:

The formation and the development of the European Economic community and the lowering of trade barriers and educational interchange among the members has been very productive for the [Open] University. We currently have in excess of 10,000 undergraduates studying through 46 study centres in Europe [6].

Not only is it taking on increasing numbers of foreign students and looking far beyond Europe for them, the Open University is developing courses to be delivered in foreign languages such as French and German. Ironically, this egalitarian institution that sets no academic qualification barriers for its applicants and that has been essentially free, will be charging significant tuition fees in 1998 for the first time, and it may well set an initial standard for the international corporate university. In part the fees were unavoidable because they cannot charge students from countries in the European Community more than they do the British students. So either they charge, they subsidise foreign students, or they drop the expansion into Europe. Their competitive disadvantage is their enormous costs for new course development (in excess of one million US\$/course), which will be easily undercut in cost and time to market by universities delivering existing courses using information technology.

THE D'ARTOIS-PENN STATE CONNECTION

The University d'Artois is a new university in northern France. It comprises four campuses which were part of the University of Lille until the early 1990s. Today the University d'Artois houses programmes in applied engineering, engineering technology, and man-

agement at its Béthune location, liberal arts and related disciplines at its campus in Arras, natural and applied sciences in Lens, and law programmes in Douai¹. As a new university in the French system it has a strong commitment to internationalism, which is being directed from the Béthune location and which initially focused on engineering and engineering technology. Graduates from both the Institut Universitaire de Technologie (IUT) and the Institut Universitaire Professionnel (IUP) must satisfy a foreign language proficiency requirement (for two foreign languages in the case of the IUP) and an industrial placement component in their curricula each year.

At Penn State's main campus at University Park (UP), a baccalaureate engineering degree in twelve undergraduate majors is offered. Annually, however, more than 50% of the College's engineering majors begin their engineering education at one of 18 non-UP locations and, furthermore, approximately 40% of the college's baccalaureate engineering graduates experience one or more semesters at a non-UP location each year. Many of these non-UP locations also offer associate and selected baccalaureate degree programmes in engineering technology². The faculty at these non-UP locations are members of UP's School of Engineering Technology and Commonwealth Engineering (SETCE) Faculty, and the curricula are the responsibility of SETCE and the College of Engineering. While Penn State has no foreign language requirements for graduation, it is currently moving towards a requirement for all entering students to have had two years of coursework in a foreign language. It is also pursuing, with Sloan Foundation support, an embryonic plan using distance education to create a *World Campus*.

Although Penn State has a large variety of international initiatives in virtually all disciplines, including engineering, none of these have involved engineering technology faculty, few have involved faculty in any discipline at non-UP locations, and only limited opportunities have existed for faculty involved in lower division (freshman and sophomore) and introductory engineering courses. In addition, while the majority of international exchange opportunities centre on gaining language competency, those in engineering focus

¹ For purposes of this paper, equivalent US terminology of disciplines and programme areas are used; actual French terminology will differ.

² The distinction between engineering and engineering technology is formally defined by the Accreditation Board for Engineering and Technology (ABET); for the benefit of the reader the major difference is in the focus on engineering theory in engineering and the focus on engineering practice in engineering technology [10]. Few other countries make this distinction in the *engineering* profession or practice.

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. The typical foreign language exchange is in the *semester abroad* model.

New instructional technologies, especially those involving electronic media, are rapidly changing and simultaneously challenging many of these traditional exchange programme paradigms. The new activities of IUT/IUP and SETCE increasingly involve new instructional technologies and electronic media. At ICEE-97, of 39 panel sessions, six were focused on the use of multimedia, Internet and related computer-based technologies in education [5].

The primary motivation of the IUT/IUP is to expand their faculty and student awareness of American English and American culture. They believe that their students will end up working in multicultural teams for multinational corporations. In the European Community this is inevitable. They are also in a position to commit significant financial resources to the support of their faculty for short term exchanges to the US and for the limited support of SETCE 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 courses (more accurately these should be referred to as modules of selected courses) in English.

The primary motivation of the Penn State SETCE is to develop international experiences for faculty in first and second year introductory and design courses, in engineering technology at the associate (two year degree) and baccalaureate (four year) level, and for engineering and engineering technology faculty at non-UP locations. They too know their students will end up in the global economy, although this is less obvious in the United States than it is in the European Community. Less direct financial support has been available from Penn State and the SETCE than from IUT/IUP for this initiative. Significant resources have been committed in time and support by faculty, staff, and administrators however.

Historical overview of exchange development

The current exchange was initiated in 1994 by an invitation from the IUT for one to three Penn State instructors to teach a 24 hour course module in a variety of engineering topics at Béthune. Instruction was required to be in English. Initially only one faculty member took advantage of this opportunity and taught classes in solid modelling and technology assessment.

The initial exchange was also to a more limited degree motivated by the faculty member's desire to experience French culture, particularly the wine, cheese, and cuisine.

Six months later, following a short term visit by the SETCE head to assess programmatic levels, facilities, and the local environment, three faculty accepted opportunities to teach in May of 1995. Some had good French language skills and consequently began to develop personal as well as professional linkages with the Université d'Artois faculty and staff. These personal ties have subsequently contributed as significantly to the development of the exchange as the professional ties.

Five Penn State faculty travelled to Béthune to teach and observe in several departments in 1995. Two were involved in the development and conduct of a two day conference on green engineering, *L'Ingénierie Verte*, in collaboration with the Béthune campus faculty and local industry. Additional Penn State faculty from the University Park and Harrisburg campuses participated as presenters in the conference via compressed video, PictureTel. Two Penn State students spent two months in industrial placements in Béthune and Lille.

In the fall semester of 1996, faculty from Béthune visited to discuss the development of a co-operative green design course for delivery during the spring of 1997. This was a direct follow up to the two day conference organised the preceding May. Early in the 1997 spring semester, seven sessions of the course *Design for Society* were delivered from Penn State to the IUT via PictureTel. This was followed with on-site sessions in May. Also in early 1997 another faculty member from Béthune visited Penn State to discuss a possible research collaboration.

A total of five Penn State faculty from two campuses went to Béthune in May 1997 to teach and to collaborate on a conference on the use of information technology in engineering and higher education. Two Penn State students had industrial placements in northern France through the IUT. In addition, three Béthune students came to Penn State and had industrial placements in central Pennsylvania.

Future objectives include: the continued development of co-operative courses and projects; a collaborative design project in the Fall of 1997 using teams of French and American students; 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. With the background that has been established it is hoped that some external support can be obtained to back some of these expanded

activities.

Penn State has developed a new model for international collaborations which stresses a comprehensive approach, involving teaching, research and service, with many activities and a designated administrator at each university. While this effort is coming from the top with funding difficulties, the Penn State-d'Artois collaboration is building such a model from the ground up, relying on enthusiasm and modest budgets. Collaborations in engineering education have been established at Virginia Polytechnic Institute and Clemson University, who have achieved more to date, but they also enjoy significant external support [7][8]. The impressive international programme at Worcester Polytechnic Institute has been achieved with major internal support [9]. Further expansion of the Penn State-d'Artois model without major external funding may be possible by relying on information technology. If we are ever to involve large numbers of students, this type of low budget approach is essential. We plan to supplement the modest information technology costs with some expenditures on faculty travel, and partial travel scholarships to students on winning design teams.

SIGNIFICANT FACTORS IN ASSESSMENT

The 1996 OECD study lists ten general factors that they found contributed to successful efforts to internationalise higher education in OECD countries [2]. We will follow their categories even though our focus is on international collaboration, while theirs was on internationalising higher education more generally. The factors seem very relevant since all new activities in a university run into similar problems.

Sufficient institutional autonomy

Autonomy in France has been a major issue as the government exercises considerable control over all levels of education. Since 1989, however, there has been a four year contract between the State and institutions and through this mechanism the institutions can now bargain for their own goals. International co-operation has increasingly been encouraged by the State in these contracts, a contractual opportunity that has allowed the Béthune campus to pursue international agreements aggressively. At Penn State, itself largely autonomous, it was individual autonomy within the university that allowed the faculty to engage in the collaborations. While university policy at Penn State has increasingly stressed the importance of such activities, the incentive system has not. Nevertheless,

there are various modest support mechanisms and freedoms that allow faculty and departments to develop their involvement in international activities. In addition, the semester at Penn State ends six weeks before d'Artois, which creates the most actively exploited time interval.

Sufficient flexibility in curriculum regulations and restrictions

This adjustment was largely made by the Béthune campus and it required significant efforts by the Director to open up an already full curriculum to allow for foreign faculty from various countries to come and teach there. The curriculum at Penn State has not yet been affected beyond a joint PictureTel class session. However, it is clear that modular collaboration using conferences, co-ops and curricula modules, such as collaborative design projects, are much easier to achieve than activities that require common courses or common degrees, although these may come later when the collaboration is at a more mature stage. During 1997-98 there will be joint student discussions using video-conferencing technology in the classroom, and a collaborative design project for teams composed of both French and American students.

The idea represents an academic challenge

The OECD study suggests that universities can support something if it is a new idea. In our experience this is not necessarily true on the US side of the collaboration. If the new idea leads to refereed publications, external funding or, in the case of engineering education, it is supported by industry, then it will be supported by the university. International collaborations do not necessarily meet any of these *requirements*, but it helps to say that our graduates will work in multicultural teams in multinational corporations, because it implies industry support. In general, internationalising higher education is a widely accepted goal in higher education, but it is seen as expensive without a sufficient return on the investment and, furthermore, it is not usually a factor in promotion and tenure decisions. On the French side, however, programmatic and administrative achievements are rewarded in the promotion process, and this is one reason why the French drove the collaboration at the beginning.

A strong innovator leads the process

This has been the most important factor. The main driver of the collaboration has been Professor Jacques Lesenne, the Director of the Béthune campus. His

commitment to innovation at his own campus rests on adding mandatory industry experience each year for his students and internationalising the curriculum - including a requirement for students to gain a working knowledge of foreign languages. The latter he supplements by bringing in faculty from other countries to teach their speciality in a foreign language, often English. The countries are typically European and North American, but Asian collaborations are also being pursued. At Penn State, Lesenne's counterpart has been Professor Wayne Hager, the Head of SETCE, who has managed his autonomy successfully to bring Penn State resources into collaborations. While their efforts were essential, they have also been successful to the point that activities would now continue without them, as noted in the next section.

A broad involvement and commitment of staff

Building the pyramid of involved personnel at each end is both cause and effect in the development of an international relationship. D'Artois is much smaller and the faculty and international programmes staff alike both report directly to the Director, who knows them well personally and professionally. The Penn State involvement has been at the department level with modest support from the international programmes office of the university and, in 1997, support for the first time from the College of Engineering and one of the system campuses.

In this category the most important development is establishing relationships between faculty that enable activities to occur without the prodding of the lead actors on each side. To date, there has been some tendency for d'Artois to send staff to Penn State and for Penn State to send faculty to d'Artois. That has begun to change however, and faculty, and some spouses, are now going both ways. This is reflected in communications which are now often lateral at sub-leadership levels. This occurs easily because of new information technology. There are now sufficient people and programmes involved that the collaboration is sustainable without the leadership. Any threat to the collaboration would most likely come from competition from potential new partners, not from personnel shifts.

Endorsement from the management

This is in place. At d'Artois the collaboration was initiated and carried forward by the management. At Penn State the Head of SETCE has had sufficient autonomy to enter into the collaboration. Further, Penn State and the French Government recognise the im-

portance of international collaborations. Unfortunately, SETCE is not given the chance to negotiate international activities into a contract. The contractual model for departments within a large university would be an interesting concept to consider.

Combined top-down and bottom-up strategy

At d'Artois this has occurred naturally as the result of scale. This has been mirrored at the department level at Penn State whereas the department's articulation with the larger university consists of congruent goals, information exchanges, and occasional very modest support. The collaboration began with a visit or two by administrators followed by first one and then more faculty, students and staff. It was complemented by information technology, which tends to sweep away such distinctions as top-down and bottom-up [1].

Consistence with institutional mission and policy

At d'Artois the institutional policy and the collaboration are established and pursued by the Director. There is a very high degree of consistency, including time, money and curricula. At Penn State the collaboration is well supported, and increasingly so, by stated institutional policies, but here, at least, the top/bottom distinction still has some meaning. The bottom is doing what the top wants, but for which it has not yet allocated commensurate funds. Fortunately there is sufficient autonomy and resources at the department and faculty level at Penn State to pursue the collaboration.

Continuous evaluations

Assessments are done immediately after each event, and planning for the next events commences while the lessons are still fresh in everyone's mind. The immediacy is important. So too is the wide open nature of the assessments. Candour in the evaluative process follows from the personal relationships, the trust, that has been established over the years.

Budget for development costs

The budget allocation for the collaboration has occurred primarily in France. Penn State has used a collection methodology for participation: a little from here, a little from there. Penn State has yet to make a formal budget allocation for the collaboration, and there has been no attempt yet to get third party funding. Nonetheless, the collaboration has been developing well,

mainly due to the commitment of d'Artois and because it is a ground-up activity at Penn State, that is, where they decide on the activity and then find the cheapest way to do it well. The programme has been very cost effective to date. Personal commitments, information technology, and cheap airfares will probably keep it that way.

Other factors

Developed by the OECD, the list of important factors for internationalising the curriculum provides a helpful starting point for understanding an international collaboration. We would like to build on it, understanding that we are explicitly looking at collaborative activities, whereas they also considered change at a single institution, so that our approaches reflect slightly different agendas.

Complementarity

Although both institutions are in rural, transitional economies, Penn State and d'Artois are quite different. Penn State is old, very large, and a research university. The Université d'Artois is new, small, and with an embryonic research programme. The Béthune campus holds the IUT, which provides strong ties with industry for the undergraduate curriculum and employment. Penn State has strong ties to industry for research and employment, but not as strong at the undergraduate level - although its co-op programme is now 10 years old. There is much industry near Béthune, but not much near Penn State. Penn State wants to internationalise its curriculum; d'Artois is doing it.

From the beginning the differences attracted and helped make things work. Penn State ends its school year six weeks before d'Artois, allowing an ample window for collaborative activities. Faculty who go to d'Artois always get visits to major industries, which is hard to do in a rural institution like Penn State. The industry ties at Béthune also made industry co-ops easy to arrange for Penn State students. The d'Artois faculty and staff are interested in learning about the administrative procedures and faculty activities at Penn State.

Differences that impede

American students pay for their education; French students do not. American students therefore get paid for working in industry; French students do it as an unpaid learning experience. This is a major problem for student exchange programmes for coursework or co-ops. Obviously, American students like free edu-

cation and French students like being paid for co-ops. It is the two converse situations that present difficulties. French industry to date has been willing to pay something to the Penn State students, and Penn State has provided some support for their own students. To date, no students have taken courses at the other institution. In the Spring of 1997 an experimental PictureTel course was run from Penn State for a full class of students at d'Artois. This indicates a way for keeping costs very low if shared course work emerges.

Language is an issue, and again it is the French who have taken the lead. They require all their students to gain a working knowledge of two foreign languages for the IUP students, and English for the IUT students. In the Penn State student-choice approach, a dual major of Engineering and French has been set up (there is one for German, also). Of course only a few students wish to add a year to their degree programme to do this. Penn State too tends not to recognise either the utility of working knowledge or profession specific language skills. Both principles prevail at d'Artois. The language skills of Penn State faculty is also a problem. The first faculty member spoke little French and even after three visits his French is not good enough for teaching. Of the five currently active Penn State faculty, one is expert, two have rudimentary skills in French, and two have none. The few Penn State students involved have good French skills. Unquestionably, language skills improve the quality of the collaboration. The many French faculty, staff, and students involved have English skills that range from none to expert. It is noteworthy that faculty with the best English, such as those that teach it, have played a very significant role in the programme to compensate for language weaknesses on the American side.

Information technology has also been an issue. The telephone and FAX is the preferred mode at d'Artois, but by 11:00 am EST they are leaving their offices. At Penn State, email is the primary means for even slightly remote communication. The Internet was resisted in France for a long time and it was not possible for d'Artois to get connected. This is now changing and the Béthune campus installed its first student Internet and multimedia computer lab in the Spring of 1997. PictureTel and multimedia technologies are at both campuses and used thoroughly. In 1997 both Penn State and Bethune installed an ISDN, computer-based video conferencing system that is being actively used for general communications and for a collaborative design project.

Personal relationships

There are two dimensions to this topic. First, the de-

velopment of friendships has been a great benefit. When extrinsic rewards are modest, nonexistent or negative (publishing time foregone), then it is the intrinsic values that motivate. Lesenne, from the outset, wished to cultivate relationships rather than use new people each year. This has worked, and there are at least four institutional visits each year, counting both directions. These visits always include strong social components. If there is a disadvantage it is that the collaboration may be seriously weakened by the departure of key players, although this has not yet happened.

Secondly, the role of information technology is very important. As the use of the Internet between the two universities has emerged, the quantity, quality and speed of the exchanges has improved. But more than that, as Guehenno predicts, there has been a flattening of hierarchy and direct (lateral) functional relationships have become prevalent with leaders operating more and more as resources rather than engaging in command and control behaviour.

Interestingly, Guéhenno is very concerned with the loss of public life (political sphere) that occurs with the decline of the nation state. He sees this globalisation and functionalisation of relationships in this networked world as being accompanied by no higher purpose, no larger human meaning, no cultural memory. He worries about a world:

... that is no longer defined by the human groupings (national or corporate) that it is composed of, but only by the problems with which it must deal [1].

In the present context we might quip - it is a world in which we are all becoming engineers. In our experience, however, he may be partly wrong. Any weakening of national sovereignty is accompanied by both friendships and empowerment, and it promotes peace. We can correctly point to the economic benefits for our students when they are prepared to work for an increasingly global economy; and we can be aware of the benefits of learning of other technologies and other institutional policies. But, when we explain our own involvement, we should also remember the role of friendships and the attractions of cultural diversity and foreign travels.

ENDNOTE

An earlier version of this paper was given at ICEE-97. Devon, R., Hager, W., Lesenne, J. and Pauwels, J.F., Building an International Collaboration in Engineering and Technology Education. *Proceedings of the International Conference on Engineering Edu-*

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BIOGRAPHIES



Richard Devon is Associate Professor of Engineering Design and Graphics, and Director of the Pennsylvania Space Grant Consortium. He is active in developing new initiatives and courses in design, ethics, and international programmes. His recent re-

search focuses on the impact of learning environments on cognitive development (spatial visualisation), attitude change (group dynamics) and retention. He has industry experience in civil engineering and has also worked for the National Aeronautics and Space Administration.



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. He has been involved for the last four years in building an international partnership with the University of Artois.



Professor J.F. Pauwels holds the Chair of Physical Chemistry at the University of Artois, IUT Bethune. He is the Head of the Laboratory of Applied Physical Chemistry (LCPA - URA CNRS). His research interests focus on gas phase chemical processes in the area of combustion chem-

istry (environment, waste incineration, thermal degradation of volatile organic compounds and flame kinetics). He has served as a visiting scientist at the Combustion Research Facility of the Sandia National Laboratories (CA, Livermore).



Professor Jacques Lesenne is the Vice President for Academic Affairs of the University of Artois. He was previously the Director of the Bethune campus. Professor Lesenne has been extremely active in developing collaborative programmes in Europe and the USA. His academic

areas are power electronics and control engineering and he has a dual doctorate in electronics and physics.