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1-1-2001

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Richard Devon
Pennsylvania State University

Pierre Buvat
Institut Universitaire De Technologie

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Devon, Richard and Buvat, Pierre, "LEAVING HOME WITH IT: USING INFORMATION TECHNOLOGY TO CREATE CROSSNATIONAL DESIGN TEAMS" (2001). *Innovations in Undergraduate Research and Honors Education: Proceedings of the Second Schreyer National Conference 2001*. Paper 7.
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LEAVING HOME WITH IT: USING INFORMATION TECHNOLOGY TO CREATE CROSS- NATIONAL DESIGN TEAMS

**RICHARD DEVON
THE PENNSYLVANIA STATE UNIVERSITY**

**PIERRE BUVAT
INSTITUT UNIVERSITAIRE DE TECHNOLOGIE**

ABSTRACT

This paper describes a five-year use of information technology to create cross-national design teams in an engineering design class. The program features robust, interdisciplinary, industry-sponsored projects that are presented and solved using a wide array of inexpensive, readily available technology. The structure should not be viewed simply as providing an alternative to actual travel. On the contrary, it raises the likelihood that the exposed students actually will travel.

INTRODUCTION

The main issue in internationalizing the curriculum is that study abroad means going abroad. This triggers the constraints of cost, time, foreign language competence, and the schedule for completing the degree.

However, it is quite feasible now to expose *all* students to the world using information technology. Lectures, discussion, and projects may be done with faculty and students from any university in any country that has the technology available. Some types of technology, like MSN Messenger and NetMeeting are now available free. Adding camera, microphone, and speakers to a microcomputer can cost less than \$100; therefore, expensive satellite or PictureTel room systems are no longer required. There are many other collaborative tools that may cost money, such as the PictureTel 550, which is a nicer version of NetMeeting for about \$1300, but you don't need to buy it. And MSN Messenger, like NetMeeting, lets you save money by having voice conversation free without the telephone charges unless you use a modem and pay a local fee. In engineering, there are commercial collaborative tools like Alibre Design, Groove Net, and CoCreate, but, again, there are also collaborative tools built into most of the CAD software that engineers already use. Some of these companies are making generous offers to universities to spur adoption of their software.

Our foreign students are quite familiar with some of these tools for staying in touch with their friends and relatives, and most American students are using MSN Messenger or AOL Instant Messenger. So it is becoming more and more curious as to why information technology is not being used more to internationalize the curriculum.

HISTORY

The cross-national design teams are a project of the honors section of the first-year engineering design course and students in a second-year English course of a two-year program in industrial engineering (OGP) in the Institut Universitaire de Technologie (IUT) of the Bethune campus of the University of Artois in Northern France (Devon et al., 1998a). They have been run each fall from 1997-2001, although in the first year it was not in the honors section. The project has taken place within a collaboration begun in 1994 that also features faculty-industry workshops and student internship placements both ways (Devon et al., 1998b, 1998d). The first trial in 1997 was a direct result of a faculty workshop earlier that year.

In 1998, the project received funding from Alcoa under the name Alliance by Design that was also used to start a formal global Internship and Coop Program in the Penn State College of Engineering. Students from the winning team at Penn State have always visited France, but since the fall class of 1999, the top ten students, as ranked by their design project scores, have gone to France for a weeklong tour of French industries. This score includes a rating of how well they collaborate with their French partners. The tour is financed by the Schreyer Honors College and the IUT. The placing of students overseas and sending them for the tour led to the creation of a 1-credit international orientation class. That has now run for several years. The Alliance by Design website has information about this class, the industry tours, and all the student projects done each year: <http://www.ecsel.psu.edu/alliance/>.

A collaborative design project was first run in the fall of 1997. Ten teams of three Penn State and three 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, the students collaborated by email, FAX, the WWW, and audio-video conferencing. The documentation for the design solutions was placed in bilingual sites on the WWW. Students on the winning teams were given travel vouchers to visit each other. This has been documented elsewhere (Devon et al., 1998a). There were considerable problems of scheduling and technology, but the collaborative project was so successful that it was continued. Over the next four years, we became more sensitive to each other's calendars. In fact, sharing calendars is the first step in any such collaboration.

THE PROGRAM

The Collaborative Design Projects

All projects are provided by industry either in France or in the USA. In fall 2000, there was one of each, which we decided was too much work, and the quality suffered. In the fall of 2001, we had a representative of the sponsoring industry in France visit the IUT and engage in an audio-visual consultation with the Penn State students. This was an objective we had had for a long time but have only achieved with this project from the French side. At least one industry tour in France has included the site of the sponsoring industry for the design project.

Almost all the cross-national interaction takes place within weekly student team meetings. There are only a few plenary sessions.

Objectives

Why have we been doing this? (See Devon et al., 1998c.) The Alliance by Design objectives are

- To teach students about the world to better prepare them for careers and lives that will be far more international than before, because;
 - Our graduates will work for multi-cultural teams in multinational organizations,
 - It promotes advances in knowledge, culture, justice, and peace.
- To use information technology to internationalize the curriculum in real time without travel. Theoretically, it has excellent possibilities for scale-up and would allow us to bring the world to all the students.

The Technology

We soon found ourselves using everything we could for communication. The IUT has poor TCP-IP bandwidth, so we have used ISDN lines for audio-visual (A-V) conferencing using PicTel room systems on the Penn State side. We also used a number of Internet technologies, such as WWW, Telnet, FTP, although downloading was slow sometimes at the IUT. Whereas the British like phone calls and the Americans like email, the French are fond of the FAX, so we put one in our computer lab. We also use low-tech items like sketch pads using dark b or 2b leads for showing design sketches in front of the camera, FAXing them, or scanning them into the computer. We have still had trouble with the sound quality on the A-V conferencing, so we will supplement it in 2002 with a speaker telephone and possibly MSN Instant Messenger. Although we have used ProShare and now PicTel 550 at Penn State, the IUT has used a different package and it is only compatible at the A-V level and not for application sharing.

The Languages

All designs are documented in bi-lingual websites and all A-V conferencing is bilingual. All Penn State students must have at least two years of a foreign language prior to admission, but in practice students seem to need four-plus years to speak with sufficient proficiency. If we use eight teams, three to five will have a Penn State student with reasonably good French skills, and about the same will have an IUT student with good English skills. Penn State provides bilingual, wage-payroll student interpreters for the conferencing and on-line translators. The IUT hires a translator to help. The participating faculty are both somewhat bi-lingual. In addition, all the students are aware of the on-line translation tools available and many use them. They are imperfect, but, with good editing, they can provide a fast way to a passable translation.

Language, then, is not a major impediment. Getting the students together so they can learn about each other and, in so doing, to learn more about themselves is one of the success stories. 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 cultural differences, including studying different engineering codes and different design and manufacturing practices.

A key to collaboration requires clearly conveying basic design concepts in various graphical language systems, and the use of sketches and CAD drawings have been very important. We hope to use Alibre Design next year, which allows both sides to import their CAD drawings into a common CAD environment for viewing and discussing.

Design Teams: Interpersonal Skills

The curriculum that has been developed at Penn State for teamwork skills has not generally been shared with the French partners, although this is an obvious area for future development. The main features of this curriculum are

- Training in conflict resolution and listening skills. The materials include a video on active listening that is both humorous and effective: "Getting from No to Yes" [Video Arts] and the Thomas-Kilman self-knowledge test about the five basic approaches to conflict.
- Penn State students' learning to speak *English* well; slowly, clearly, in complete sentences, in simple words; no jargon, idioms, or metaphors. This is one of the valuable lessons learned from the first collaboration and followed ever since.
- Learning that other teams, not the French on your team, are the competition. This important and humorous lesson is learned anew by each new class of students.

THE RESULTS

Cross-Cultural Learning: Anecdotes of Student Reactions

A major goal is to teach students about the world to better prepare them for careers and lives that will be far more international than before. These graduates will work for multi-cultural teams in multinational organizations, which require many collaboration skills as well as a moral sense of global ethics.

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. An assessment of different conceptions of what it takes to be a good team player was carried out during one of the collaborative design projects. 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 between Penn State students and the Artois students in a different course on design ethics 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 weapons 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 rather than Saddam Hussein (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. Thus we were able to expose students to different perspectives and show how they could learn from each other. Hopefully, this experience provides some antidote to the influence of the media in both countries.

Apparently we have been getting better at what we do. In the fall of 2001, we ran a project developed by Professor Buvat for an industry in France. We knew it was working very

well, but, even so, the student assessments of the course at Penn State were extremely positive about the collaborative project and some even suggested continuing it for another semester. This is a very rare comment in the student assessments of our introductory design course even though it is typically well reviewed.

Logistics

The heart of the collaboration, why it works when it works, and why it does not when it does not, rests on the logistics. Achieving quality requires planning. You begin with two professors who want to do it and who have a course in which it can be a required element. We find modular approaches with projects and curricular modules are far easier to do than shared courses and degree programs even though university administrators may prefer the latter.

The next step is to share the calendars. We share information concerning when the classes meet, when the classes are in session, and when there are holidays or other disruptions in the sequence of the course. The time difference is important; the Penn State course runs from 8-10 am on Tuesdays and Thursdays and also on Thursday afternoons. We always use the Tuesday morning time for communications, which is 2-4 pm (1400-1600) in France. Penn State has Labor Day, Thanksgiving, and a Fall Break of two days. The IUT has an orientation week in early September, a holiday week (Toussaints) at the beginning of November, and Armistice Day shortly thereafter. The semester calendars are fairly close, with Penn State starting in the last week of August about ten days before the IUT and finishing classes in the second week of December about one week before the IUT, although we schedule the awards ceremony during the finals week at Penn State, which ends in the third week of December.

Follow-on Effects

This project directly led to the Alcoa funding at Penn State that has been used to start a Global Internship and Coop Program in the College of Engineering. We now target sending and receiving twenty students each year. In particular, the collaboration with the IUT has led to an increasing number of students going both ways to engage in internships (stages) for eight to ten weeks. We are exchanging about five each way now. The IUT pays for the lodging of the Penn State students and Penn State finds a position that pays at least \$600 a month for the French students and a place to stay that costs almost that much. A domestic or international internship (stage) is required each year for the French students. At Penn State, students are strongly encouraged to take a co-op after completing their sophomore year. We have been encouraging students even after the first year to take summer internships. In fact, a few students from the introductory honors class have pursued an internship in a foreign language environment (France or Germany) for the last three years, after completing only one year of college.

In addition to the internship program, this project has allowed us to develop the orientation course and also the industry tour. We also have under development a website that explores technology around the world. Alliance by Design was also very strongly featured in the site visit by Boeing that led to Penn State's being awarded the Boeing National Engineering Educators Award in 1998 [<http://www.ecsel.psu.edu/edg/>]. Future plans include expanding the project to other courses at Penn State, and we are creating a multi-national consortium that will feature such projects. At the IUT, the project is featured each year in its open house for recruitment.

Alliance by Design Obstacles

The obstacles are mundane and have little to do with culture or language. Projects like this start with a collaboration between faculty at universities in two different countries. To date, universities typically do not have incentive systems in place to make this happen, so it has been relatively rare. (The FIPSE program at the Department of Education in the United States has been extremely successful in starting international collaborations with modest funding, but it has concentrated on funding actual travel.)

A survey at Penn State in the fall of 2001 found about 100 engineering faculty (25%) expressing interest in international engineering education. This seems like almost an order of magnitude increase over the last five to ten years, so perhaps it will translate into rapid growth in such programs as the one described here, thus overcoming one obstacle, faculty hesitation.

As noted earlier, other logistic issues such as the calendar, the time difference, curricular institutionalization, and compatible technology are all important factors. Cost is not an obstacle. This is not expensive to do. On the contrary, cost effectiveness is one of the two main attractions of such a project--the other being its universal potential.

One other obstacle is time. Resolving the logistics for a cross-national project like this adds considerably to the time needed for teaching any course. It should get easier over time, and the technology should help this, but some "slack" should be built into the planning. Hiring a few student assistants to help with the technology and the translations is a very good idea.

Alliance by Design: Assessment

Assessment is known only in terms of the ancillary effects on behavior such as the new programs and the subsequent behavior of students. In this regard, the program has been extremely successful, driving the creation and development of many other programs. Still, it is time to track each cohort and see how they feel about the program in hindsight and whether it has spurred more activities of an international nature. Anecdotally, the answers here appear to be very positive.

Of the twenty-four students in EDG 100H in Fall 2000, ten went on a 2001 industry tour in France and two others for a summer internship in Germany. In Fall 2001, fifteen of twenty-four wanted to go on the industry tour and ten will. One other student will take an internship in France. We feel it is important to get the students involved starting in their first year to develop their interest, language skills, and experience. Waiting until their junior year reduces the likelihood of their getting involved in international programs.

The Future

This project has been very successful, and all our plans involve replications and expansion of this project and the ancillary activities that it has spawned. There are a few other such cross-national design teams,¹ and we have started working with the one between Leeds University and Arizona State University.

¹ Other design collaborations include the University of Michigan, Oxford University, and Seoul National University (http://www.indec.or.kr/gpd_main.htm), and one between Leeds University and Arizona State University, (<http://www.mech-eng.leeds.ac.uk/GEDT>).

CREDIT

This paper benefited considerably from the editing skills of Julia Liu, an engineering honors student at Penn State.

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AUTHOR BIOGRAPHIES

Richard Devon is Associate Professor of Engineering Design at Penn State University. His interests are design, design education, ethics and technology, and global engineering education.

Pierre Buvat is the Head of the Department of Organisation et Génie de la Production (Production Management Department) at the Institut Universitaire de Technologie (I.U.T.) in Béthune, France. He teaches mechanics, production management, and maintenance. He has degrees from the Ecole Nationale d'Ingénieurs de Saint-Etienne and started his career as a production engineer in a wood factory. Later he worked as a maintenance engineer in a food factory and also as a quality engineer in a mechanical firm.