Succeeding in a Cross-Disciplinary, international, Student Design-Team Project: Auburn University/University of Plymouth Experience

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Abstract

Globalization has turned product design upside down. Members of a single design team in multinational firms may be located in several countries such as the USA, UK, Italy, India and so on. It is a challenge to give engineering and business students a taste of this experience. Auburn University’s Business-Engineering-Technology (B-E-T) program, and the College of Engineering, University of Plymouth, participated in a joint effort to replicate real-life product design process with a mixture of engineering and business students. This paper describes the experience, its lessons and compares it with other attempts at multinational student design-team projects.

Introduction

In the last ten years, an important change is occurring in new product development in large technology-intensive American manufacturing firms. They are tapping into engineering talent in countries around the world without actually bringing internationally trained engineers to the US. Consequently, complex product/process design is undertaken by teams made of professionals located in more than one continent. The challenge, assumed by program at Auburn University, addressed the issue of giving engineering and business undergraduates a hands-on experience in new product design in teams spread across two continents (North American and Europe).

During the spring semester, 2004, Auburn University, USA and the University of Plymouth, UK, engaged in a pioneering experiment to give student teams in the respective universities an experience in product design in a team composed of undergraduate in both universities campuses. A team of four students from the Auburn University’s Business-Engineering-Technology (B-E-T) program (a lock-step, two-year minor for selected engineering and business students), and four students from the University of Plymouth worked in a joint team for one semester to develop a tail-gate opening mechanism that could be used in a commercially sold sports utility vehicle (SUV) manufactured in Alabama, USA; the project was selected by the student team. This team of four students from Auburn was part of a larger class of 19 cohorts in the BET program.

************ Insert Table 1 about here************
A comparison of overseas collaborative team programs (Table 1)

There have been a few attempts by US universities in the last six years to try overseas collaborative experience for undergraduates. Table 1 compares the experiences of other universities with the Auburn experience, and the following paragraphs review the various publications describing the experiences in Table 1.

Swigger, et al.\(^1\) have investigated the various cultural factors by a questionnaire, which affect the performance of the student learning teams between University of North Texas (USA) and Middle East Technical University in Ankara, Turkey. They found several cultural attributes that were most strongly correlated with group performance. There are organizational hierarchy, organizational harmony, trade-offs between future and current needs, and beliefs about one’s influence over their fate. Their study also demonstrates that cultural attributes of the group, technology factors such as adequate information and scheduling infrastructure, and human resources such as training, on-site coordination and administrative support are critical to the success of these projects.

Van Ryssen, et al.\(^2\) strongly believe that setting up intercultural overseas collaboration under imperfect circumstances and limited access to technological resources is a valuable complement to traditional text book learning. Collaborations have a problem-solving aspect that guarantees that new skills are learned and attitudes are changed.

Pollard, et al.\(^4\) have encountered many logistical problems in overseas collaborations including teaching schedules, computing facilities, team sizes, and assessment criteria. They recommended more and longer virtual team meetings, which must be well planned and well prepared so that the efficiency of the team members is optimal.

Devon, et al.\(^3\) have developed a collaborative design student projects to internationalize the in-house curriculum at Penn State University, USA and d’Artois University, France, in a cost-effective way by relying heavily on information technology. The problems they faced were scheduling conflicts, working around holidays, coordinating A-V meeting times, and arranging timely access to labs with critical facilities. They found that the virtual face-to-face team conferencing using A-V conferencing technologies are very helpful in establishing relationships.

Cardozo, et al.\(^5\) describe a program that has no overseas component but its novelty lies in the collaboration between the colleges of business and engineering at the University of Minnesota. The Auburn Business-Engineering-Technology (BET) program has routinely done this since fall 2001 through a joint minor, and has now taken on the challenge of product development in overseas teams. The motto of the BET program is, “Launching new products through teamwork.”

To summarize, all previous reports on overseas collaborative student projects reveal problems in bringing about successful collaboration. It is evident that overseas collaboration is still in its infancy. Table 1 reveals that there is not one accepted approach. Auburn University and the University of Plymouth began with the understanding that no clear method for overseas collaboration for product design has emerged. We embarked on this project in the hope of...
plowing new ground. We have presented the project from the start until completion including qualitative assessment. It is hoped that more quantitative assessment of similar projects would emerge in future trials of this project.

The Need

The trend towards collaborative design and manufacturing performed by global engineering teams from the USA and other countries has been gaining momentum. For example, Ford India supplies parts to Ford plants in Mexico, Brazil and China. GE Medical in Bangalore, India has developed a high resolution-imaging machine for angiography to meet GE’s entire global requirement. Two-thirds of GE Plastics’ 300-member research team in India is doing fundamental research on molecules. GE Motors India has developed an almost noiseless motor for GE’s most sophisticated washing machine lines in the US; it is the sole sourcing point for a million of these motors every year. Engardio states, “By mobilizing global R&D teams around the clock, nimble companies can accelerate development cycles, bringing new technologies to consumers, and industry faster, cheaper, and in more varieties. Worldwide innovation networks are the new keys to R&D vitality and competitiveness.” At Auburn, we believe that it is critical that engineering as well as business students in the U.S. understand how to work closely with foreign business teams in designing products and processes.

Auburn University Initiative

Auburn University’s colleges of business and engineering have an on-going joint program for undergraduates called the Business-Engineering-Technology minor since fall 2001. One of the goals of this program from its inception was to engage student teams at Auburn University with students in universities around the world. The dean of the COE is a major supporter of the implementation of this ideas. University of Plymouth (UP) faculty have worked with Auburn faculty from the colleges of business and engineering on joint research and educational projects in the nineties. Therefore, UP was tapped for the initial experiment in conducting an overseas design team project.

Project Description

Students from Auburn University (two from engineering and two from business) worked with their colleagues in UP in designing a tail-gate opening mechanism for an SUV. The details of the project are:

1. At Auburn, the students were enrolled in fall 2003 in a two-course sequence of courses called the BUSI/ENGR 4970 and BUSI/ENGR 4980: Capstone Design Projects I and II. University of Plymouth students were enrolled in their senior-year design sequence. All students were seniors.

2. One of the four teams in the course sequence volunteered to work with a team in Plymouth. Auburn and Plymouth teams had four members each. Auburn team had two business and two engineering students. Plymouth team was all mechanical engineers. They did not have a joint program with their College of Business as Auburn University does. A role for the COB is contemplated for the future. This is
understandable because active collaborations between and engineering and business colleges are rare in the US and UK.

3. Students in both universities began independently to start preliminary class work on their design projects in fall 2003. Auburn University stressed the design process but UP students moved forward with the design project selection.

4. The overseas teams began contacts in January through video conferencing to select a common product for design with inputs from both teams. We found that the UK team had more influence in the final choice of the product perhaps because they had moved farther ahead with the idea.

5. They held weekly video-conferences and uploaded all their meeting minutes and notes to a website specially created for sharing information. An engineering faculty member from Auburn University and another from UP served as moderators/facilitators. The students were able to form a team using the video-conferencing technology, e-mails and a website.

6. During March 2004, the four students from Auburn University along with a faculty member from the B-E-T program traveled to Plymouth, UK, in order for Auburn team members to work face-to-face with their colleagues at the UP. This was a new experience for the students; three of the four students did not have a US passport and had never traveled outside the country. One of them, who had traveled to London earlier, became the leader of the group.

7. The UP team visited Auburn in late April 2004 and worked with the AU team to complete their joint report and make a presentation to all the B-E-T students and faculty members. The joint report and joint presentations were judged as successful and effective. During the three-day visit to Auburn, the student teams worked very closely to bring the project to completion which included an extensive project report of about 170 pages. Auburn team was graded by Auburn teacher and vice versa.

The University of Plymouth’s interest in the project

Students from Mechanical Engineering and related fields at the University of Plymouth (UP), UK, have for many years done team-based design projects in their final stage (years 3-4) design module in order to:

- Develop group working skills (team sizes are normally 6-8 students)
- Gain an understanding of how graduate engineers work and to gain this experience; team chairperson and secretary are elected
- Enable students integrate different fields of their undergraduate studies e.g., fluids, manufacturing, business etc. This is a requirement of the British accrediting professional body-I MECH E

However, increasingly, engineering profession is becoming multinational, and it made sense to incorporate an international aspect to this activity. The Auburn University link offered the UP a chance to implement this ahead of other universities in the UK and perhaps the EU.

Building the link between the two overseas universities
The teacher responsible for the design course (one of the coauthors) and the Dean of Engineering at UP visited Auburn University in September 2003 to meet teachers of the Business-Engineering-Technology program at AU, the program administrators, the deans of the colleges of Business and Engineering, and students enrolled in the B-E-T program. During this visit, the rough details of a pilot to be launched in Jan 2004 with one team each from both universities were developed. The two deans agreed during this visit to fund the cost of exchanging one student team and a professor from each college in spring semester 2004 to enable the teams complete the project. Team size was tentatively set at four students from Auburn and four from Plymouth.

The visiting team from UP was made familiar with AU Video conferencing facility, which uses a large screen in excess of 60” diagonal.

**Executing the design project at UP**

This pilot scheme was promoted to students during autumn of 2003 and students were selected at UP. Student teamwork across the Atlantic started in the middle of January 2004 with introductions during the first video conference with AU student team. Students setup a project web page, and maintained correspondence and learning via e-mail. The joint AU-UP team held regular video conferences; initially only one video conference for 2 weeks was planned but the students progressed to two conferences per week. Conferences lasted for 20- to 60-minutes duration. A web page was set up by the faculty advising the joint student team describing:

- What was required of Students
- Plan of Work/Video conference dates etc.
- Advisor Reports, and team work

**Student Role in the Team**

Student contributions were not identical. The UP team, made of all engineers, took the lead on the engineering side of product design and development, and the AU team took the lead on the business-engineering interface issues. Overall, the experiment provided an opportunity to experience and overcome cross cultural barriers, and open students to inter-continental design experience. Through this experience, students learned to depend on each other to complete a common project which included, extensive engineering, business issues and business-engineering interface.

**Program evaluation**

Table 1 compares the experiences of other universities with the Auburn experience to highlight how each program is different. According to the table, Auburn University experience is the only one where the team members from the US university get to meet team members from another nation for consultation before their project is completed. Further, the Auburn University experience requires the teams to make a joint appearance and presentation at the end of the semester.
Program evaluation after the first iteration of this project is based on subjective measures such as observations of the process and outcome, evaluation of the project report, and written student comments to the question, “What I learned from this project.” The evaluation is summarized in subheadings A, B and C below. Item C: Student comments are an important piece of the evaluation at this stage. They bring out many issues that were beyond expectations and plans laid out at the outset.

A. Benefits to students:

Students at both campuses benefited from the experience. Their benefits included but were not limited to the following:

- Gained an understanding of US vs. UK culture and education
- Gained the experience of writing technical report to document the project. The joint written report of about 170 pages was judged as very good.
- Gained an understanding of business + engineering aspects of a product development project
- Strengthened their appeal to potential employers.

B. Students learned

- The difficulties of long distance and international communications, and how they may be overcome
- The importance of cultural factors in product development teams
- How to incorporate business issues in product design
- How to depend on people from other disciplines to complete a complex design project.

C. Student Comments

The students from the two universities included extensive remarks about their design project experience in their final report. We asked for this input as part of our qualitative assessment of the project. Original comments are not paraphrased or summarized to deliver the full impact of student conclusions about their experience. Here is a sample of their comments:

University of Plymouth Students:

1. “It wasn’t until the halfway stage of the assignment, when the two groups physically met for the first time, the [joint] team really bonded and the communication barrier dismantled. This was the turning point of the project….”
   S.D.
2. “It was clear in the first two video conferences it was clear that the American team members were being expected to follow a strict design process, as a result the decision to follow the process guidelines set by the US members was taken.”
   R.B.
3. “It is felt that the business aspects brought to the project by the US team significantly broadened the project scope compared with standard design projects completed in the past by the UK team members and vice versa....” R.B.

4. “…it is definitely the highlight of my time at the University of Plymouth.” J.P.

Auburn University Students:

1. “…the most beneficial experience I’ve had in my four years of college...At times it was difficult for the Plymouth contingent to convey complex engineering issues to the Auburn side and vice versa with business concerns. But that’s exactly why this group design project was such a tremendous experience...” B.G.

2. “Once the two sides got familiar with their respective members and their work styles, the project developed in a cohesive manner throughout its duration.” B.G.

3. “Teamwork is the biggest intangible factor that contributed to the success of this project.” D.F.

4. “The Auburn branch, consisting of both business and engineering students, was accustomed to taking product development in doses of well-defined steps. Conversely, the Plymouth branch was accustomed to jumping quickly into design...both branches began to recognize each other’s traditional design approaches and hence began to adjust.” D.F.

5. “The first difference that we had to deal with was time. There is six hour difference between us and Plymouth...have to wait sometimes 14 hours for a response...I would check my email every night before going to sleep.” K.W.

Additionally, the value of this experience is evident from a few e-mails received about the quality of this experience from the students:

- “…we are very grateful for the opportunity to visit you guys, and definitely had a great time. To date, it has been the best part of this degree.” (UP student)
- “…thank you for your visit, it was most educational on all fronts. I hope we were good hosts, and you found your trip equally educational and pleasant.” (UP student)
- “It was definitely the best experience I've had in my four years of college.” (AU student)

Conclusions

The experimental project described here met Auburn University’s B-E-T program’s goal of giving to students the experience of working and learning in an international design team was accomplished with a number of benefits mentioned earlier. The student comments quoted above captures unplanned and unexpected benefits as well as the richness of the experience.

At the end of the semester, when the UP team was taking leave of the dean of the COE, it was tentatively agreed that two teams from each college will engage in common design projects across the ocean next year. This was our acknowledgement of the fact that the two colleges had succeeded in their first attempt to offer and manage student project teams across the continent.
The mission of this project fits well with the mission statements of the Faculty of Engineering, Plymouth University; whose objective is to produce high quality graduates well prepared for careers in engineering through high quality student experience. The experience that the student gained through this project is unique and unparalleled for working in the increasingly global economy, where product development teams are scattered all over the globe.

Being a well-received program, all applicants to this design course at UP in fall 2004 are being told about the overseas design team experience. It is viewed by students as a very positive feature because of its potential value to recruiters.

What could we do differently to improve the project?

The following list is based on inputs from students and teachers.

- One visit may be done late January and the return visit done in March in the spring semester to help students to get to know each other and their projects, and reduce student workload towards the end of the spring semester/term.
- If possible, the project may stretch over two terms/semesters; fall and spring semesters.
- “…either a simpler task /project should have been chosen or more time allowed.” J.P.
- “It was noticed that the Auburn group was required to perform an interim presentation, which I think would be a good idea for the Plymouth group…..” J.P.
- “…I think an ‘ice breaker’ exercise would have been very beneficial as the first exercise for the groups to perform….it would have helped to improve communication and would have promoted a less formal atmosphere within the group.” J.P.

Some of the more challenging ideas for the future:

- Start the project during the junior year of the students and conclude the project in their senior year
- Work directly with companies so that students could be involved in new innovations that are needed by the marketplace
- Extend the concept to include students from more than two countries in the team.

Next step

In the second year of the program, two teams each from both universities are collaborating since fall 2004. At Auburn, eight students in two teams are participating in the overseas design project. They work with two teams of three members each at U. of Plymouth. Plymouth teams made their visit earlier than last year; they visited Auburn in January as result of the improvements to the program contemplated after the first cycle. As of this writing, project is in progress.

REFERENCES

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**BIOGRAPHICAL INFORMATION**

Dr. PAUL M. SWAMIDASS: Professor of Operations Management and Director of the Thomas Walter Center for Technology Management, Auburn University, USA. Directs the Business-Engineering-Technology program.

Dr. BOB BULFIN: Professor of Industrial Systems Engineering, and TWC Professor of Technology Management, Auburn University. Teaches the above-mentioned Capstone Design courses I and II as part of the Business-Engineering-Technology Program at Auburn University.

Dr. DAVID GRIEVE: Professor of Mechanical Engineering, University of Plymouth, UK. His students in the course mentioned above participate with Auburn University students.

Dr. CHETAN SANKAR: Professor of Management Information Systems, and TWC Professor of Technology Management, Auburn University. He teaches in the Business-Engineering-Technology program.

Mr. VENUBABU VULASA: Doctoral student, Industrial Systems Engineering, Auburn University.
Table 1: Other reported experience review

<table>
<thead>
<tr>
<th>Author</th>
<th>Collaborating Universities</th>
<th>When</th>
<th>Exchange of Visits</th>
<th>Common Report</th>
<th>Common Project</th>
<th>Web, Collaboration Software</th>
<th>E-mail</th>
<th>Video Conference</th>
<th>Students</th>
<th>Nature of the Project</th>
<th>No. of Teams</th>
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<td>Video conference and two face-to-face meeting</td>
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* ? – Not Available