

## **AC 2008-357: INTERNATIONAL DESIGN COURSE EXPERIENCES**

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# International Design Course Experiences

## Abstract

International design course experiences between two engineering institutes are reviewed. The international collaboration, between a Japanese- and US-based engineering institute, has been ongoing since 2004. In the past four years, each institute has conducted a design course that relies upon student interaction with the other institute<sup>1</sup>.

The collaboration involves an Engineering Design course that is required for first- and second-year engineering undergraduates at one of the institutes, and an elective course for engineering undergraduates at the other institute. Engineering design projects are assigned to groups of four to six students at each university, and instructors help facilitate international collaboration.

The paper discusses methods and challenges for conducting an international engineering design course. Experiences in project selection, communication format, language, software and assessment are summarized. The paper offers ideas for future improvements in each of these areas.

## Introduction

Before starting the collaboration, discussions were held to determine the optimal method for carrying out the project. Options included:

Option 1: Students from different institutions gather at one location and form teams. Each team selects a project and design activities are practiced and presented throughout the academic term,

Option 2: Students from different institutions stay at home institutes but form interinstitute teams. Teams practice design activities using the internet,

Option 3: Students from each institution stay at home institute and form independent teams. Teams conduct design activities and communicate their results to counterpart teams at the other institute using the internet.

The third option was selected, and has been used as the means of carrying out the international collaboration. Each team independently works on their selected project. Progress reports and achievements are exchanged through email, websites and web conferencing. All of the teams select projects from a list that includes project topics related to the instructor-determined main theme. Since 2004, the main theme has been sustainability, green engineering and the environment.

The main theme defines a broad problem area where many specific problems and needs exist. The main theme provides a unifying element for the class. Each design team chooses a project topic, related to the main theme, based upon respective majors and interests of each team member.

“Establishing a Sustainable and Ecological Society” has been selected as the main theme title of the current collaborative design project. The abstract for the main theme describes a sustainable future as one in which demands from society are satisfied in a way that suppresses climate change, adopts energy conservation measures, and achieves sustainable resource use with minimal environmental impact. Examples of project topics include “Energy Efficient Street Lighting”, “Bicycle-Powered Electrical Generating System”, “Bicycle for Long Distance Ride”, and “Bio-Mass Fuel to Run a Scooter/Automobile”.

Some of the goals of the international design collaboration project include developing communication skills in students, and exposing students to other cultures. The intention is to respond to increased demand for graduates that are familiar with engineering and design methods used in other countries. Recognizing that globalization may be the dominant paradigm in manufacturing for at least the next generation, technical universities are encouraged to increase students' foreign language and foreign culture skills<sup>2</sup>.

The collaboration project between a Japanese- and US-based engineering institute is supported at the highest levels of each respective institute. Administration officials at each institute regularly attend collaboration events and encourage the continuation of the project.

One of the hallmarks of the collaboration project has been the selection of a main theme each academic year. The main theme that has been selected for the current academic year is related to green materials and sustainability. The purpose of the main theme is to provide a common anchor point for all of the student projects. Since students with diverse majors and interests may be involved in the course, the main theme provides a common platform and discussion point for all ideas generated. For example, if a team has individual members with majors that include each of Electrical Engineering and Communication Arts, the project can be related to a larger theme in which both disciplines have nominal involvement. Majors can include Architecture, Robotics, Communication as well as traditional Engineering disciplines.

## **Design Projects**

Once the main theme for the academic year is selected, a list of possible group projects is generated. In the collaborative effort described, the list of possible group projects is generated in a brainstorming exercise in a first-year course at the Japanese-based engineering institute. One of the proposals under consideration is to generate a similar list during a brainstorming exercise during a required module for the Introduction to Engineering Design course at the US-based engineering institute. The Introduction to Design course is a required course for first-year students at many US engineering schools.

The list of possible projects (that fit within the main theme) may number more than one hundred possible projects. A typical offering of the project may involve more than 1700 students at the Japanese-based school (each taking the course as a required course), and approximately twenty students at the US-based school (each taking it as an elective). The four or five teams that are formed at the US-based school have selected projects that at least one team in Japan is working on. The instructors at each school facilitate the collaborative interaction between the teams of students.

During the three years that the project has been running, the counterpart teams at each of the two schools send emails to introduce themselves. Sometimes the instructors are copied on the email, but not always. Often a PowerPoint file is attached to an email message to communicate brief ideas and pictures about the project. An important exchange that is encouraged is to include pictures of the individuals involved on the exchanged PowerPoint files. For the present academic year, the instructors are attempting to encourage and facilitate web conferencing. Adobe Breeze Connect software is being tried to aid communication. Using live video and audio has been highly interactive and challenging.

The calendar of the course is outlined in Table 1.

Table 1. Calendar for the collaborative design course

MONTH	MAJOR ACTIVITY
September	Project list generated in Engineering Design 1 course at Japanese school
November	Project teams in Engineering Design 2 course (in Japan) begin working
November	Teams at US school formed; projects selected
December	First communication between counterpart teams
January	Development of design solution by teams; communication exchanged
February	Collaboration Design Conference held in Japan; US students and faculty encouraged to attend
March	Main theme for the next year is determined by faculty

The initial communication between counterpart teams happens within a week of the US-based groups forming into teams and selecting a projects, which occurs in early December. At the Japanese school, the possible project list is generated (based on the Main Theme) in September. The list is generated during an first-year course in Engineering Design 1.

At the Japanese school, project teams are formed in a second-year course, Engineering Design 2. Initial study of selected projects commences for teams in the Engineering Design 2 course in November and December. One idea for increasing the collaborative experience is to have the US-based teams select their project after listening to short presentations from a small number of teams at the Japanese school. For example, US-based teams could send a request for an interview and could be responsible for generating the necessary communication method. The teams at the Japanese school could be responsible for delivering a short (approximately five minutes maximum) presentation that captures the essence of the project. The US-based teams could be responsible for selecting a project based on the presentations, and giving feedback to all the teams that gave short presentations. Additionally, the Japanese teams could give feedback to the US teams. If a US-based group selects a certain project, they could be 'invited' to join the Japanese group in working on the project, thereby increasing the collaborative atmosphere.

The characteristics of an acceptable design project topic is one that has altruistic merit, is contemporary, is easy to understand, crosses cultures, is fun to work on and is a fertile area for idea generation. An example of a good design project was one that was studied by a group at the Japanese school during the previous academic year. The group studied ways of increasing the ridership of a small bus line around their university home town. The group's solution was within the main scope of green materials and sustainability. The ideas for increasing ridership included adding massage machines on the side of the bus seats that would massage the riders' calves during transportation. The solution was practical, interesting, unusual and fun to work on.

Tables 2 and 3 list some of the projects that were selected for design-solution creation during the previous academic year. Table 2 is an example list of project ideas that were created in the first-year design course at the Japanese university. Table 3 is an example list of projects that were selected for development by teams in the Engineering Design 2 course at the Japanese university.

Table 2. Examples of Projects generated in Engineering Design 1

	Project Theme	Purpose of design
1	A reusable shopping bag to reduce grocery bags	To depress consumption of fossil fuels in order to produce grocery bags
2	An energy-saving streetlamp	To conserve electricity generated by fossil fuels
3	Water-conserving faucet	To conserve water
4	A durable umbrella	To conserve natural resources by designing a durable umbrella because a vinyl umbrella used by students is not durable
5	An easy-to-use electronic book	To depress consumption of paper and not to destroy the woods
6	An energy-saving lamp	To conserve electricity generated by fossil fuels
7	An information system of a streetcar	To control exhaust gas from private cars and to depress consumption of fossil fuels
8	An air conditioner utilizing snow stored in winter	To conserve electricity generated by fossil fuels
9	An electronic textbook	To depress consumption of paper and not to destroy the woods
10	A refrigerator which prevents the escape of cooled air	To conserve electricity generated by fossil fuels
11	A convenient public transportation system	To control exhaust gas from private cars and to depress consumption of fossil fuels

Table 3. Examples of Projects Selected by Engineering Design 2 Project Teams

	Project Theme	Purpose of design
1	Design of a New LED Light	Develop a new LED light of which color can be changed by controlling intensities of Red, Green, and Blue lights. The new LED light can affect users psychologically by controlling the combination of the three colors.
2	Energy-Saving Streetlamp	Design an energy-saving streetlamp equipped with infrared-ray-sensors to detect an approaching pedestrian and turn-on the metal halide lamp. The streetlamp is equipped with a wind power generator/solar cells to reduce the consumption of fossil fuel.
3	Energy-Saving Streetlamp	
4	Energy-Saving Streetlamp	
5	Design of an Electro-Hybrid Bicycle with a Power Assist System for Long Distance Ride	To enlarge the power assisted distance of an electro-hybrid bicycle by recovering energy when its brake works and charging its battery
6	Recycling wasted woods	Improve a recycling rate of wasted wood by developing a new technology to produce cloth from wasted wood

### Requirements for Information Exchange Website

One of the challenges of the International Design Project has been to identify, use and improve a software program that allows for easy interaction between design groups in Japan and the US. Three general possibilities have been identified and tested, and each have advantages and disadvantages.

There are exchange websites available for free on the internet. The exchange websites require little information from potential users and only minimal administration from a course instructor. One of these sites has been used during the past three years of the project and has given only marginal levels of interactivity. The exchange website has students register as a user, and then allows them to post comments and files. Several users have reported problems in posting large files, and most users do not find the site to be interesting or attractive. The language requirement of the website that was used is English-only, which possibly was a disincentive to students who are self-conscious about their written English ability.

Another communications software that has been proposed for the International Design Project course is a course-management software package. Course management software packages may have a reasonable ability to exchange data and files (including pictures) since that is the main function of using a course management software package in academic courses. Course management software allows for the posting of large files that would be accessible to anyone in the course. One disadvantage of a course management software package for an International Design Project course is that the format is often English only.

A third software possibility is to consider using a collaboration program used by large multinational companies. The main advantage of using a collaborative software package is that it is designed for international collaborations, and takes into consideration the need for maintaining one active file as well as multilanguage considerations. The major disadvantage of this option is often high cost.

Table 4 lists the main considerations for the optimal software package for the International Design Project.

Table 4. Considerations for the optimal software package

	Priority	Requirements
1	highest	Students and instructors can easily register for accounts of the website and exchange information/question/answer
2	highest	Files of Word, Excel, PowerPoint, pictures (JPEG), video (MPEG) can be posted
3	highest	Files in English and Japanese can be posted and represented correctly (non-garbled)
4	highest	Posted threads can be classified/identified according to , for example, project theme, Q&A.
5	second	Those, who registered for specific topic(s), can get a notice when a target/specified topic is posted

During the current academic year, the collaboration software has been used to foster interaction. At the US-based school, teams of students practice international videoconferencing by holding meetings with students and faculty at different locations on campus. Additionally, videoconferences with Japanese counterparts have been used to discuss projects. One challenge in scheduling the meetings is the fourteen hour difference in time zones between the two locations.

### Assessment

The topic of assessment has been discussed among the educators involved in the project. Possible methods for assessing the effectiveness of the joint project include surveys, and study of course evaluations.

Course outcomes for the US-based school are as follows:

- students will be able to identify the basic steps in a Design Process e.g. problem identification, brainstorming, design refinement, analysis, optimization, documentation
- students will have experience communicating and performing the steps in a design process in a non-native language and culture

- students will be able to set up international meetings, conduct the meetings through webcams and software, and disseminate the notes to attendees and principals after the meeting

Using the measurable outcomes listed above, an assessment plan is being developed.

The course primarily addresses ABET Criteria c, d, e, g, h and j. The criteria<sup>3</sup> are summarized in Table 5. The table shows how the course specifically addresses the listed ABET criteria.

Table 5. Summary of ABET criteria addressed by the International Collaboration course

ABET criteria letter	Description	How the course addresses the ABET description
Criterion c	Ability to design a system, component or process to meet desired needs	Groups must design a solution to a given problem
Criterion d	Ability to function on multidisciplinary teams	Groups include students from several majors
Criterion e	Ability to identify, formulate and solve engineering problems	Understanding the design process and problem solving is one of the course objectives
Criterion g	Ability to communicate effectively	Since international communication is required, effective and ineffective communication are readily apparent
Criterion h	Ability to understand the implication of engineering solutions in a global context	Students are required to communicate their solutions in an international forum
Criterion j	Ability to know of contemporary issues	Sustainability and green engineering are contemporary issues

## Conclusions

The International Design Collaboration course has been ongoing between two schools for four years. The course continues to evolve and improve at each of the schools. Collaboration software has been tried to determine if interaction can be improved between groups of students. An assessment program has been started at the US-based school to determine if program outcomes



are being addressed as a result of offering the course.

## **References**

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