International Collaboration in an Engineering Design Course

P. Ferro¹, M. Matsuishi¹, T. Furukawa¹, T. Yamakawa¹, R. Stamper², L. Sanders³

1. Rose-Hulman Institute of Technology, Terre Haute, IN, USA, ferro@rose-hulman.edu
2. Kanazawa Institute of Technology, Nonoiichi, Ishikawa, Japan
3. Rose-Hulman Institute of Technology, Terre Haute, IN, USA

Abstract

International collaboration in an Engineering Design Education between two universities, Kanazawa Institute of Technology, Japan and Rose-Hulman Institute of Technology, USA, was started in 2004. Three academic years of experience in conducting the joint course are summarized. The collaboration involves an Engineering Design course that is required for first- and second-year engineering undergraduates at Kanazawa Institute of Technology, and an elective course for engineering undergraduates at Rose-Hulman Institute of Technology. Students from each institution, who stay in their own institution, form one independent team, select one project theme, and practice design activities separately. “Establishing Sustainable/Ecological Society” was selected as the main theme of the collaborative design project in 2006. Progress reports and final achievements were exchanged between the two institutions. This collaborative design project provided a positive experience for students and also benefited the faculty members. The paper summarizes the achievements gained from an international collaborative project and offers ideas for future improvements.

Keywords: Engineering design, International collaboration project, Main theme, Information exchange

1. Introduction

International design projects have been used at universities in many countries to develop communication skills, and to expose students to other cultures [1]. Students that are familiar with engineering and design methods used in other countries will be demand by the multinational employers. With increasing recognition that globalization will be the dominant paradigm in manufacturing for at least the next generation, technical universities are continuing to increase efforts in developing students' foreign language and foreign culture skills.

The collaboration project between Kanazawa Institute of Technology (KIT) and Rose-Hulman Institute of Technology (RHIT) started in 2004, and has been supported at the highest levels at each respective institute. Administration officials at both KIT and RHIT regularly attend collaboration events specific to the KIT/RHIT joint project and encourage the continuation of the project.

One of the hallmarks of the KIT/RHIT collaboration project has been the selection of a main theme each academic year. For example, the main theme for academic year 2006 was green materials and sustainability. The purpose of the main theme is to provide a common anchor point for all of the student projects. At KIT and to a lesser degree, at RHIT, students from many different disciplines are involved in the creation and presentation of ideas that are generated in the project course. Even if the student teams are from as varying disciplines as Communication Arts or Mechanical Engineering, the main theme provides a common link.

The paper summarizes experiences in project selection, communication format, language, software and assessment. The paper offers ideas for future improvements in each of these areas.

2. Engineering Design Project

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

- Program 1: Students from different institutions gather at a certain place, form one team, select a project theme, and practice design activities jointly.
- Program 2: Students from different institutions, who stay in their own institutions, form one common team, select a project theme, and practice design activities jointly using ITC technology.
- Program 3: Students from each institution, who stay in their own institution, form one independent team, select one project theme which is related to the main theme, and practice design activities separately. Each team independently works on their project theme focusing on their themes of interest. Progress reports and final achievements are exchanged among participating institutions through e-mail, website and/or video conference, and are exhibited in each class.
Due to the differences in time, academic calendar and grading system among participating institutions, Program 3 was selected.

After selecting the method for carrying out the project, the main theme for the collaborative design project was selected. Main theme defines a broad problem area where many specific problems and needs exist. The main theme provides a unifying element for the class. "Establishing Sustainable/Ecological Society" was selected as the main theme of the collaborative design project in 2006. The key to a sustainable future lies in finding a way to satisfy our current society's lifestyle in a more constructive manner by suppressing climate change, adopting energy conservation measures, achieving sustainable resource use with minimal environmental impact, and achieving higher recycling rates, etc. Once the main theme for the academic year is selected, a list of possible group projects is generated.

Engineering Design Education at KIT consists of two courses: ED I and ED II. ED I is taught in the Fall term of the freshman year, and ED II in the Winter term of the sophomore year, respectively. The course objectives of ED I and ED II are distinct and properly coupled in order to achieve a seamless transition as shown in Figure 1. Based on the main theme, each design team of ED I identifies a project theme, applies the Engineering Design Process up through Stage 3. The list of possible projects generated in brainstorming exercise of ED I at KIT, which fit within the main theme of the international design project, may number more than one hundred. One of the proposals under consideration is to generate a similar list during a brainstorming exercise during a required module for Engineering Introduction to Design course at RHIT. The Introduction to Design course is a required course for first-year students at RHIT.

At KIT, with more than 1700 sophomore students involved each year, all of the projects will be selected by at least one team of ED II. At RHIT, with approximately 20 students involved (all taking the course as an elective), only a small number of projects from the list will be selected. During the three years that the project has been running, the students at KIT and RHIT that have the same project make an effort to introduce themselves. Usually an email is sent from one project team to the other, with a PowerPoint file attached that may include brief ideas about the project and pictures of the individuals involved. Future academic years may include live communication with audio and video.

1. Identification of Design Opportunity
2. Project Characterization
3. Design Concept Generation
4. Design Concept Evaluation and Selection
5. Detailed Design

ED I

ED II

Review

Figure 1. Flow of ED I and ED II

The initial communication usually happens within a week of the RHIT team selecting a project, which occurs in early December. At RHIT, the Winter Quarter begins in early December. At KIT, the possible project list is generated earlier in the academic year, and project teams of ED II have been working on project ideas before the teams at RHIT select. One idea for increasing the collaborative experience is to have RHIT teams select their project after listening to short presentations from a small number of teams at KIT. For example, the teams at RHIT could send a request for an interview and could be responsible for generating the necessary communication method. The teams at KIT could be responsible for delivering a short (approximately five minutes maximum) presentation that captures the essence of the project. RHIT 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 KIT groups could give feedback to RHIT groups. If the RHIT group selects a certain project, the RHIT group could be 'invited' to join the KIT group in working on the project, thereby increasing the energy of the KIT group and increasing the collaborative atmosphere.

It is worthwhile to consider what constitutes a good design project as well as what are the characteristics of design projects that should be avoided. In general, a good design project is one that has an altruistic merit, is contemporary, is easy to understand, crosses cultures, is fun to work on and is a fertile area for idea generation. One example of a good design project that meets each of these criteria is a project that was worked on by at least one group at KIT in 2006. The group looked at ways of increasing the ridership of a small bus line around Kanazawa. Reasons why this was important were related to the main theme of green materials and sustainability. The group of Japanese students explained their ideas to a RHIT professor during a joint session at KIT. 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 project appeared to meet all of the criteria listed above.

As well as considering what constitutes a good project, it is worthwhile to consider the project types to avoid. The project types to avoid may be those which are not applicable and/or possibly offensive in one of the cultures.

3. Project Themes of EDI and EDII in 2006

Examples of possible project lists generated at KIT and project themes selected for the international collaborative
project are shown in Tables 1 and 2, respectively.

Table 1 Examples of Possible Project Themes generated in ED I at KIT

<table>
<thead>
<tr>
<th>Project Theme</th>
<th>Purpose of design</th>
</tr>
</thead>
<tbody>
<tr>
<td>A reusable shopping bag to reduce</td>
<td>To depress consumption of fossil fuels in order to</td>
</tr>
<tr>
<td>grocery bags</td>
<td>produce grocery bags</td>
</tr>
<tr>
<td>An energy-saving streetlamp</td>
<td>To conserve electricity generated by fossil fuels</td>
</tr>
<tr>
<td>An easy-to-use electronic book</td>
<td>To depress consumption of paper and not to destroy</td>
</tr>
<tr>
<td></td>
<td>the woods</td>
</tr>
<tr>
<td>A convenient public transportation</td>
<td>To control exhaust gas from private cars and to</td>
</tr>
<tr>
<td>system</td>
<td>depress consumption of fossil fuels</td>
</tr>
</tbody>
</table>

Table 2 Examples of Project Themes for International Collaborative Project

<table>
<thead>
<tr>
<th>Project Theme</th>
<th>Purpose of design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design of a New LED Light</td>
<td>Develop a new LED light of which color can be changed so that it can affect users</td>
</tr>
<tr>
<td>Energy-Saving Streetlamp</td>
<td>Design an energy-saving streetlamp equipped with infrared-ray-sensors to detect</td>
</tr>
<tr>
<td>Design of an Electro-Hybrid Bicycle with</td>
<td>motivating the approaching pedestrian and with a wind power generator/solar cells</td>
</tr>
<tr>
<td>a Power Assist System for Long Distance Ride</td>
<td>to reduce the consumption of fossil fuel.</td>
</tr>
<tr>
<td></td>
<td>To enlarge the power assisted distance of an electro-hybrid bicycle by recovering</td>
</tr>
<tr>
<td></td>
<td>energy and charging its battery</td>
</tr>
</tbody>
</table>

4. 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 has advantages and disadvantages.

Table 3 Considerations for the optimal software package

<table>
<thead>
<tr>
<th>Priority</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Students and instructors can easily register for accounts of the website and</td>
</tr>
<tr>
<td></td>
<td>exchange information/question/answer (Accessibility)</td>
</tr>
<tr>
<td>2</td>
<td>Files of Word, Excel, PowerPoint, pictures (JPEG), video (MPEG) can be</td>
</tr>
<tr>
<td></td>
<td>posted (Versatility)</td>
</tr>
<tr>
<td>3</td>
<td>Files in English and Japanese can be posted and represented correctly (Multi-</td>
</tr>
<tr>
<td></td>
<td>Linguistic)</td>
</tr>
<tr>
<td>4</td>
<td>Posted threads can be classified/identified according to e.g. project theme,</td>
</tr>
<tr>
<td></td>
<td>Q&amp;A, (Identifiable)</td>
</tr>
<tr>
<td>5</td>
<td>Those, who registered for specific topic(s), can get a notice when a target/</td>
</tr>
<tr>
<td></td>
<td>specified topic is posted (Notability)</td>
</tr>
</tbody>
</table>

There are exchange websites available for free on the Internet, which requires 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 works by having students register as a user, which 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 site 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 (CMS) package. The CMS package used at Rose-Hulman is ANGEL, and it has shown a reasonable ability to exchange data and files (including pictures) in courses at Rose-Hulman since 2004. ANGEL appears to be a good choice for the International Design Project course because it allows for allocating disk space to groups. ANGEL would also enable the posting of large files that would be accessible to anyone in the course. A further advantage of ANGEL is that it is password protected. One disadvantage of selecting ANGEL for the International Design Project communications method is that the format of the software is English only, although the content and language style of posted files in ANGEL is unlimited. Another listed drawback of ANGEL for the International Design Project is that the software is relatively new, and does not have the ease of use of more developed products such as those in the Microsoft suite of products.

A third software possibility is to consider using a software package such as 'Breeze'. Breeze is a collaboration software that is used by large multinational companies such as General Electric. 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.

5. 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. One of the challenges for the upcoming academic year is to clearly identify course outcomes, and assess the course's ability to meet the outcomes.

   The first step in creating a meaningful assessment of the course is the establishment of learning objectives. Each of the two institutions involved lists the course by a different name and course description, and thus has a different syllabus. However, common learning objectives may be established to allow for an assessment. Possible common learning objectives with measurable criteria may include:

   (1) Students will be able to identify the basic steps in a Design Process (e.g. problem identification, brainstorming, design refinement, analysis, optimization, documentation),
   (2) Students will be able to identify design problems and solutions that are applicable internationally,
   (3) Students will have experience communicating and performing the steps in a design process in a non-native language and culture,
   (4) Students will be able to identify differences between design processes for different cultures.

6. Conclusion
   Important information obtained is listed as follows:

   (1) The method for carrying out the international design project was selected based upon the differences in time zone, academic calendar and grading system of each institution:
      Students from each institution, who stay in their own institution, form one independent team, select one project theme which is related to the main theme, and practice design activities separately. Each team independently works on their project theme focusing on their themes of interest. Progress reports and final achievements are exchanged among participating institutions through e-mail, website and/or video conference, and are exhibited in each class.

   (2) “Establishing Ecological/Sustainable Society” was selected as the main theme of the collaborative design project, because the key to a sustainable future lies in finding a way to satisfy our current society's lifestyle in a more constructive manner by suppressing climate change, adopting energy conservation measures, achieving sustainable resource use with minimal environmental impact, and achieving higher recycling rates, etc. Varieties of design solutions were deployed based upon the circumstances and needs of each country. Therefore, students of the two institutions were very much interested in working with this international collaborative project.

   (3) Plans of future improvements in project selection, communication format, language, software and assessment were offered.

References

Biography
Patrick D. Ferro is an Assistant Professor of Mechanical Engineering at Rose-Hulman Institute of Technology
Masakatsu Matsuishi is a Dean of Engineering Practice Education and a Professor at Kanazawa Institute of Technology
Tetsuro Furukawa is a Lecturer at Kanazawa Institute of Technology
Taketo Yamakawa is a Professor at Kanazawa Institute of Technology
Richard E. Stamper is an Associate Professor of Mechanical Engineering at Rose-Hulman Institute of Technology
Wayne Sanders is a Professor of Mechanical Engineering at Rose-Hulman Institute of Technology

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