

AC 2008-1522: A PROJECT-BASED INTERNATIONAL COLLABORATION IN ENGINEERING EDUCATION

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A Project-Based International Collaboration in Engineering Education

Abstract

This manuscript describes a project-based international collaboration in engineering education. The collaborators include Penn State University, Altoona College, USA; IUT Bethune, France; Dublin Institute of Technology, Ireland; Warsaw University of Technology, Warsaw; Cluj Napoca University, Romania; and Kando Kalman Faculty, Hungary. The collaboration emphasizes a team-based engineering design project to be completed by undergraduate engineering/engineering technology students at the above mentioned universities. What is innovative about this international academic collaboration is that although the student teams in the above mentioned educational institutions work on a common engineering design project, each participating institution is responsible for designing a specific subsystem of the entire engineering system. Therefore, the student teams in USA are responsible for designing and implementing a subsystem different from the teams in France. Eventually, all the subsystems are integrated into a single functional engineering system. Throughout the duration of this project, student teams in USA, France, Ireland, Poland, Hungary, and Romania are expected to communicate with each other through e-mail and web.

This manuscript describes the above mentioned on-going international academic collaboration and provides details regarding the implementation of this collaborative project.

Introduction

Engineers are increasingly asked to work with international suppliers, co-workers, and clients. Global assignments for companies in industry sectors such as communications, information technology, and automotive manufacturing, require engineers to integrate technical knowledge with global competencies. In response to the need for globally competent engineers, the Accreditation Board for Engineering and Technology (ABET) requires all the ABET-accreditable engineering technology programs to demonstrate that the program graduates have a respect for diversity and a knowledge of contemporary professional, societal, and global issues (Criterion 2j of TAC of ABET). In addition, the ABET requires all the ABET-accreditable baccalaureate engineering programs to demonstrate that the program graduates have the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context (criterion 3 of ABET).

The engineering and engineering technology graduates of The US educational institutions must be prepared to work in multicultural teams in multinational corporations, some of

the education preparation they need will come from international collaborative experiences that develop abilities and familiarity with information technology, team work, international collaboration, and design methodologies in a global environment [1]. International engineering design collaboration can occur in several different forms. It can range from a parallel design program in which students at two collaborating institutions in different countries work on the same design problem, to a program in which students work together on a single international design team and visit each other during the academic year. Examples of all these forms of international design collaboration are provided in several papers [3-5].

In the first form of international collaboration, each educational institution pursues its own engineering design itinerary but both partner institutions would use the same problem and design objectives. Such a collaboration would involve the project mentors developing common project goals and design procedures and the participating students exchanging information on a regular basis through internet.

The international collaboration between Penn State University, Altoona College and several educational institutions in Western and Eastern Europe is a unique initiative to create an early awareness of the global implications of engineering education. The partners in this international engineering design collaborative project are:

- The Pennsylvania State University, Altoona College, USA
- IUT Bethune, Universite d', Artois, France
- Dublin Institute of Technology, Dublin, Ireland
- Warsaw University of Technology, Warsaw, Poland
- Cluj Napoca University, Cluj, Romania
- Kando Kalman Faculty, Budapest, Hungary

International Collaboration Goals

- Undergraduate engineering students enrolled in different educational institutions in France, USA, Ireland, Poland, Romania, and Hungary will design and implement a common engineering design project.
- Students will gain valuable experience in teamwork and project management.
- Students will gain valuable experience in communication through electronic media.
- Participating engineering students will gain experience regarding the modern reality that many times one subsystem of an engineering application is developed in one country and the other one is developed in another country.
- The proposed collaborative team-based design project will link multiple engineering students' teams over international borders.

The Partners and the Project Timeline

The common engineering design project, conducted by the undergraduate engineering students enrolled in different educational institutions in USA and Europe, is termed "A Renewable Energy System for an Agricultural Farm". This engineering design project

was started during the Fall 2007 semester. It will be completed in June 2008. The timeline for this project is provided in TABLE 1.

Project Methodology

As mentioned earlier, the international engineering design project was started in the Fall 2007 Semester. The participating students will complete the project in June 2008. The implementation of this project involves several steps listed below:

Step 1 – Identification of an Engineering Design Project

The engineering system to be designed and implemented is titled “A RENEWABLE ENERGY SYSTEM FOR AN AGRICULTURAL FARM”. Technical details regarding this common engineering design project are provided in a separate section of this manuscript.

Step 2 – Team Formation and Development of Project Specifications

Teams consisting of 2-3 students each will be formed at IUT Bethune, Penn State University, Dublin Institute of Technology, Warsaw University of Technology, Cluj-Napoca University, and Budapest Faculty. Preliminary technical specifications regarding the proposed engineering system will be provided to the student teams. Each of the student teams will be assigned a faculty coach/mentor. The faculty mentors will guide their respective students teams throughout the duration of this project.

Step 3 – Preliminary Design Review (PDR)

Each student team will propose a design solution for the subsystem to be designed and implemented by that team. This design solution will undergo a preliminary design review by the faculty mentor assigned to the student team. The subsystem design solution proposed by each team will be posted on a website to be developed by the Electrical Engineering Department of the IUT Bethune, France. The website will be permanently maintained to showcase all the collaborative undergraduate engineering design projects (current and future) to be conducted through this proposed collaboration among France, USA, Ireland, Poland, Romania and Hungary.

TABLE 1: Common Engineering Design Project Timeline

<u>Institution</u>	<u>Project Component</u>	<u>When to be Conducted by the Students</u>	<u>Level of Students</u>	<u>Date of Completion</u>
IUT Bethune, France	Assemble a new system with solar panels and special inverters to send the electrical energy to the power grid	December 2007 – April 2008	Second year Electrical Engineering Students	April 2008
Warsaw Univ. of Technology, Poland	TBA	April 2008 – June 2008	Third year Electrical Engineering Students	June 30, 2008
Penn State Univ., Altoona College, USA	Using a Motorola 68HC11 Microcontroller, write a program to control a sump pump which is connected to the power grid of the Renewable Energy System.	October – December 2007	Second year Students Enrolled in the BSEMET (BS Electromechanical Engineering Technology) Program	December 2007
Kando Kalman Faculty, Budapest, Hungary	Charge Regulator	Academic Year 2007-2008	Second and Third Year Electrical Engineering	June 2008
Dublin Institute of Technology, Ireland	TBA	February 2008 – May 2008	Final year of a 3-year degree in the Electrical Engineering	May 2008

Step 4 – Project Work

Once the preliminary design review for each student team has been conducted by the faculty mentor assigned to that team, student teams will start working on the design and implementation of the proposed engineering system. Student team will be using appropriate project management tools to make sure that all the tasks associated with the project are completed effectively within the allocated time. Faculty mentors will be available to guide students as they work in teams to attain the goals of the proposed project. In addition, student teams will communicate with each other regarding their work using internet.

Step 5 – Project Report & the Realized Project

When the project is completed by the student teams, each team will submit a project report and the realized subsystem to the faculty mentor assigned to the team. The project report will consist of the following components:

- Problem Description
- Literature Search
- Description of the Solution
- Test Results
- Conclusions
- Appendix I to consist of the chronicle of project activities
- Appendix II to consist of students' perceptions regarding the above mentioned collaborative engineering project.

Step 6 – Project Evaluation

The work done by student teams will be assessed by their respective faculty mentors. The project report and the subsystem developed by each student team will be evaluated. All the project reports will be made available through the above mentioned website maintained by the Electrical Engineering Department of the IUT Bethune, France.

Step 7 – Faculty Collaboration

Throughout this project, all the faculty mentors will collaborate with each other to make sure that the student teams are progressing towards the attainment of the project goals. The faculty mentors will jointly develop the instruments to be used to assess students' teamwork. A faculty seminar will be conducted in Bethune, France in June 2008 to sum up the conclusions of this project. Faculty members will discuss the instruments used for the assessment of students' team work. The participating faculty members will also perform an analysis of the project management skills demonstrated by the student teams. Also, an analysis of students' perceptions will be conducted. Finally, plans for publishing manuscripts (regarding the above mentioned collaborative international engineering design project will be finalized.

Technical Details

Each partner institution is required to work on a component of this international engineering design project. At the completion of this project, all the components will be put together to produce a functional engineering application.

The complete engineering design project consists of designing the electrical supply system of an agricultural farm using different renewable energy sources, photovoltaic panels, a wind turbine, and a small hydro-electric station. This farm is connected to the national power grid, so we have the possibility of sending back the energy to the national supplier.

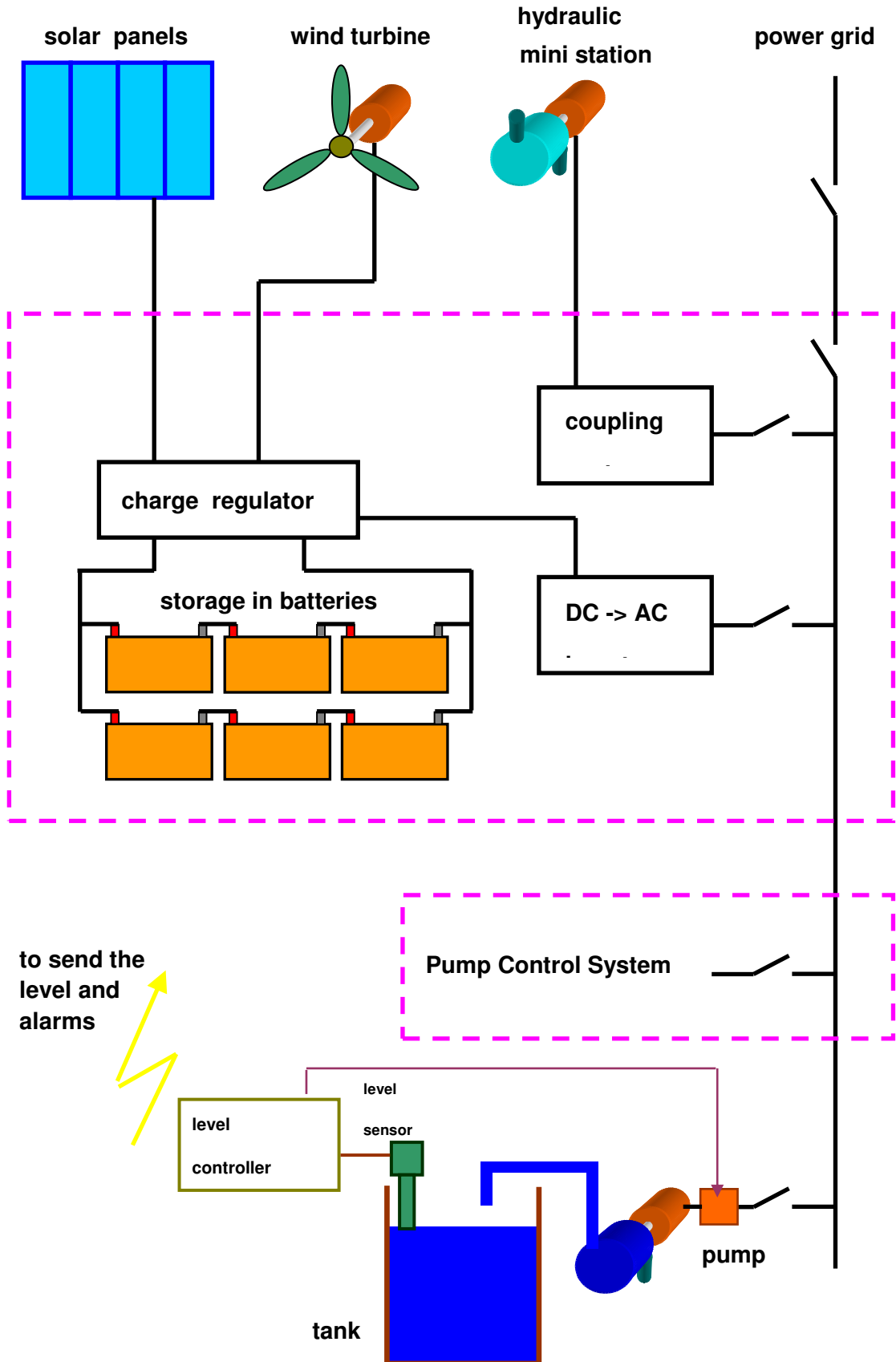
Different subsystems in this renewable energy application consume the electrical energy. The subsystem to be designed and implemented by the Dublin Institute of Technology undergraduate EE students consists of a water tank filled up by an electrical pump. Students will take the measurement of this water level and send this data to the central system to control the pump. The Penn State University, Altoona College electromechanical engineering technology (BSEMET) students will write a Motorola 68HC11 assembly language program to control a sump pump which is connected to the power grid of the Renewable Energy System.

The IUT Bethune electrical engineering students are asked to assemble a system with solar panels and special inverters to send the electrical energy to the power grid. The Kando Kalman Faculty electrical engineering students will design the charge regulator for this energy system. A diagram showing the outlines of this renewable energy system is presented in Figure 1.

Driving Factors for this Project

1. *Committed Faculty Mentors* – The principal drivers of this international collaboration are the faculty mentors at the partner institutions. At least one faculty member has been identified at each of the participating institution. This faculty member will serve as the institution's contact for this project. He/she will be responsible for mentoring the undergraduate students' teams at his/her respective institution.
2. *Endorsement from the Management at the Partner Institutions* – The academic administration at each of the partner institutions has endorsed the above mentioned international collaboration. Funds have been committed by the partner institutions to allow the above mentioned project faculty mentors to attend a meeting in France during June/July 2008. The purpose of the meeting will be to conduct a formal assessment of this international collaboration and to plan for the following year.
3. *Assessment* – Assessment will be conducted immediately after the completion of this project and the planning for next year will be carried out while the results of the previous design project are still fresh in everyone's mind.

Figure 1: Renewable Energy System



Obstacles

1. *Language* – It is stipulated that the participating students from Europe and USA will exchange information on a regular basis through internet. Although, most of the European students communicate in English, there may be several individuals with poor English language skills.
2. *Compatibility of Academic Calendar* – The partner institutions do not use the same academic calendar. Penn State University, Altoona College is the only one that uses a semester system. The other institutions run their academic calendars on a yearly basis starting in September and ending in June. Due to this incompatibility of the academic calendar, students at the partner institutions will be working on the project during different time frames as indicated in TABLE 1.

Conclusion

International engineering design collaboration between Penn State University, Altoona College and several European educational institutions was described in this manuscript. The unique aspect of the above mentioned international academic collaboration is that although the students teams in the partner institutions work on a common engineering design project, each participating institution is responsible for designing and implementing a specific subsystem of the complete engineering system. Eventually, all the subsystems will be integrated into a single functional engineering system.

The international engineering design project will help the participating students understand the impact of engineering solutions in a global context. More importantly, it will expose students to the modern reality that many times one subsystem of an engineering application is developed in one country and the other one is developed in a different country.

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