Development of Capstone Design Projects with International Collaboration

Mahbub Uddin
Department of Engineering Science, Trinity University,
San Antonio, TX 78212 mahbub@rex.engr.trinity.edu

A. Raj Chowdhury
School of Technology, Kent State University,
Kent, OH 44242 raj1@kent.edu

Abstract – Development of global capstone design projects with international collaboration incorporating realistic design constraints can satisfy several ABET outcomes of Criterion 3. Global design projects should have an overall objective to develop affordable tools for the people of the developing world which can provide the first step out of poverty and improve health and living conditions. Global design projects can provide opportunities to students to learn and understand other cultures, values, religion, societies and politics.

Index Terms – Developing world, Global capstone design project, International collaboration, Sustainable design.

INTRODUCTION

Capstone design experience is an integral part of all the undergraduate engineering curriculum in the United States. A traditional capstone design course involves design, build and test a device, equipment, system or process. ABET Criterion 3c states that engineering programs must demonstrate that their graduates have an ability to design a system, component or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability and sustainability. Also, ABET Criterion 3h states that the graduates must have the broad education necessary to understand the impact of engineering solutions in a global and societal context [1].

The National Academy of Engineering in its report “The Engineer of 2020: Visions of Engineering in the New Century” on Societal, Global and Professional Contexts of Engineering Practice states that “The future is uncertain. However, one thing is clear: engineering will not operate in a vacuum separate from society in 2020 any more than it does now. Both on a macro scale, where the world’s natural resources will be stressed by population increases, to the micro scale, where engineers need to work in teams to be effective, consideration of social issues is central to engineering. Political and economic relations between nations and their peoples will impact engineering practice in the future, probably to a greater extent than now. Attention to intellectual property, project management, multilingual influences and cultural diversity, moral/religious repercussions, global/international impacts, national security, and cost-benefit constraints will continue to drive engineering practice.” [2]

Our challenge is to provide engineering design education incorporating realistic constraints and analyzing the impact of design decisions on the society and environment from national and global viewpoints.

Development of capstone design projects with international collaboration has tremendous potential to satisfy the needs of ABET Criteria (3c & 3h) and the visions of engineering practice in the new century.

In this paper we discuss the development of capstone senior design projects with international collaboration. We explore various strategies to foster sponsorship/partnership with international and national organizations, and Non-Government Organizations (NGO) for development of capstone design projects. We provide examples of global capstone design projects and also discuss the criteria for development of global design project teams.

CRITERIA FOR GLOBAL CAPSTONE PROJECTS

Global capstone design projects should have the following design criteria:

- The project should involve design, build, test and analysis of a system, process or components to satisfy global or society needs
- The design should include economical, ethical, social and political consideration
- The design should be sustainable
- The design should identify its potential impacts on society and the environment from a global viewpoint

The above four design criteria can be easily mapped into ABET’s Criteria 3c and 3h. The primary objective is to develop capstone projects for engineering students in the United States of America which will satisfy the above design criteria; however, the goal is that the design solution would be applied and implemented in the developing world.
INTERNATIONAL COLLABORATION

International collaboration is extremely important to develop a successful global capstone design project. International partnership can be achieved through developing relationships of various organizations such as Non-Government Organizations (NGO), Association of International Educators (NAFSA), Multi-National Companies (MNC), Engineering Without Borders, Engineering World Health, Global Education Associates (GEA), World Safety Organization (WSO), Engineers for a Sustainable World (ESW), International Development Enterprises (IDE), Engineering Projects in Community Services, etc.

I. Non-Government Organizations (NGO)

NGOs in the targeted country can play a vital role in the development and implementation of global capstone projects. The first step is to identify a design need for a society in a particular country. A Google search for that country’s NGO will provide initial lists of NGOs, their websites, and addresses. A faculty advisor then establishes contact with the appropriate NGO and then develops a global capstone project in collaboration with the local NGO. NGO global network (non-government organizations associated with the United Nations, www.ngo.org) can also provide assistance to develop a relationship with the local NGO.

II. Association of International Educators (NAFSA)

Association of International Educators is a member organization promoting international education and providing professional development opportunities to the field [3]. NAFSA’s Global Partnership Program (GPP) offers opportunities to coordinate with 9000 members of international education professionals on various educational projects. NAFSA offers assistance in the form of Global Advisor, Global Advocate, and Global Associate. Please visit NAFSA’s website (www.nafsa.org) for more detailed information.

III. Engineers Without Borders (EWB-USA)

Engineers Without Borders-USA is a non-profit organization partnered with developing communities worldwide. The primary objective of this organization is to improve the quality of life through implementation of sustainable engineering projects and training internationally responsible engineers and engineering students [4].

EWB-USA provides excellent opportunities and resources for global capstone projects. EWB-USA projects often require the development of systems and solutions that could be implemented in small developing communities worldwide [4]. Detailed information about EWB-USA and opportunities for global capstone design projects can be found in their website (www.ewb-usa.com).

IV. Engineers for Sustainable World (ESW)

Engineers for a Sustainable World is a non-profit organization with a network of more than 3,000 professionals and students working to reduce poverty and improve global sustainability. Established in 2002, ESW engages engineers in addressing some of the world’s most critical challenges: increased access to clean water, energy, sanitation and food security [5]. Currently, there are 30 ESW chapters across the USA. For more information please visit ESW’s website (www.esustainableworld.org).

V. International Development Enterprises (IDE)

International Development Enterprises (IDE) is a non-profit organization that employs market principles to strike at the roots of rural poverty in the world’s least developed countries [6]. Founded in 1981 by Dr. Paul Polak, IDE has worked for decades helping rural farm facilities increase their agricultural productivity, providing them a basis for food security, income generation, integration with markets, and the beginnings of an upward spiral out of poverty. IDE has program offices in UK, Canada, Bangladesh, Cambodia, Ethiopia, Myanmar, Nepal, Niger, Vietnam, Zambia and Zimbabwe. IDE can provide valuable guidance in the development of global design projects. For more information please visit IDE website at www.ide-international.org.

VI. Engineering Projects in Community Services (EPICS)

Founded in 1995 at Purdue University, the EPICS program offers a unique opportunity for undergraduate students to design, build and solve engineering-based problems for the local community [7]. EPICS projects are broad based: human services, access and abilities, education and outreach, and the environment. Recently several international universities formed National EPICS. The National EPICS is a consortium of universities across the country committed to and successfully practicing the EPICS model founded at Purdue University. For more information please visit EPICS website: www.epics.ecn.purdue.edu. Collaboration with EPICS can lead to successful global design projects.

VII. Multi-National Corporations (MNC)

Many multi-national corporations (Dell, Microsoft, Intel, Nike, Procter & Gamble, Samsung, etc.) are transporting their manufacturing and product design and development work to developing countries such as India, China, Malaysia, Vietnam, Brazil, etc. MNC are also interested in product developments for their host countries. Contacting MNC to explore the possibility of sponsorship for global design project can lead to a very successful venture.
EXAMPLES OF GLOBAL DESIGN PROJECTS

Several universities in the USA have already started incorporating global capstone design projects. Brief descriptions of a few of these projects are given below:

I. Arsenic Removal from Drinking Water in Bangladesh

Due to the abundance of arseniferous compounds, groundwater across the world, including the United States, Mexico, India, Mongolia, Chile, Thailand, China, Nepal, and Bangladesh has become contaminated with arsenic. Bangladesh is the most vulnerable of these countries, with at least 21 million people now exposed to the arsenic contamination. Over 60% of the groundwater in Bangladesh, from which 90% of Bangladeshis draw their water daily, is contaminated by natural, inorganic arsenic at concentrations up to 50 times the World Health Organization’s guideline value of 10 parts per billion [8].

This project was adopted in Fall 2005 for a year long senior design project in the Department of Engineering Science at Trinity University, San Antonio, Texas [8]. The fundamental objective of this project is to design, build and test a reliable, safe, low cost, easily operated sustainable prototype device for use in the villages of Bangladesh. The design performance characteristics and project specifications were set by the National Academy of Engineering (NAE). The overall concentration of arsenic must be reduced to 50 milligrams per liter or less without damaging the quality of water. The systems must be cost effective, as well as easy to manufacture and maintain in order to ensure consistent long-term operation [8].

II. Solar Powered Electricity in San Pablo

A team of six students of Colorado School of Mines adopted a senior design project in 2003 to work with the villagers of San Pablo to install two 150 watt solar panels. They built a small building to house the electronics and wired up the village elementary school, church, store, community pavilion, and women’s center. The villagers now enjoy the electric lights which they did not have before. This project was sponsored by the Engineers Without Borders-USA [4].

III. Low Cost Electrocardiogram (ECG) Tester for Developing World

Two biomedical engineering students at Duke University designed, built and tested a low cost electrocardiogram (ECG) tester for developing countries. This machine offers a low cost alternative to current ECG simulators and is capable of integrating with different ECG machines. Through this device engineers in developing countries will be able to identify problems with ECG machines and subsequently test repairs made to malfunctioning ECG machines. This project was completed in May 2005 and was sponsored by the Engineering World Health program [5].

In the March 2006 issue of ASEE Prism, Anna Mulrine wrote an excellent article titled “To the Rescue: Engineers Use Their Skills to Help Solve the Problems of the Developing World” [9]. In this article she mentioned several program initiatives undertaken by various universities and organizations such as MIT, Duke, Engineers for a Sustainable World (ESW) and Engineering World Health (EWH) to provide opportunities to engineering students to apply their skills to help the developing world. Many problems the developing countries mentioned in her article can be excellent candidates for global capstone design projects.

We believe that the overall objective of the global capstone design projects should be to develop affordable tools that can provide the first step out of poverty and improve health and living conditions for the people in the developing countries.

DEVELOPMENT OF GLOBAL DESIGN PROJECT TEAMS

The faculty member who has a desire to gain experience in international projects or has a passion to help the people of the developing world is an excellent candidate to take the leadership role in the development of a global design project. A faculty advisor solicits ideas for global design projects from international/national organizations through personal contacts and web solicitation. Project and team development should begin in the second semester junior year. In the selection of student teams members the following criteria can be used:

- Student should have a strong motivation and interest in global issues
- Student should have a desire and curiosity to know other people, language, culture and value systems
- Student should have a passion to participate in a design project that matters
- Student should have a willingness to help people and communities in the developing world through innovative, low cost, affordable and sustainable design solutions.

In addition to the above criteria, the team members should also possess strong communication and interpersonal skills.

Four to five student members is the ideal size of a global project team. The project should be a year-long capstone course. Typically the project will start at the beginning of the Fall semester of the senior year and should be completed by the end of the following Spring semester. The project grade should be tied to the degree of completion of the stated goals.

To avoid potential delays and unexpected setbacks the project members in collaboration with the faculty advisor and international sponsors should work out a detailed five-phase project management plan of action: Initiating, Planning, Executing, Monitoring and Controlling, and Closing. Common project management tools, such as Gantt Chart or MS (Microsoft) Project should be used to create a “Critical Path and Float” and monitor project milestones.

Successful completion of a global design project largely depends on the careful selection of the project team members and effective project management.
CONCLUSIONS

Global capstone design projects offer engineering students opportunities to engage in design and development activities that can make a difference in people’s lives and livelihoods. Global capstone design projects will help our students learn and understand other cultures, values, religion, societies and politics. It can provide students an opportunity to practice service learning and develop an entrepreneurial mind set. Global design projects will also provide our students opportunities to analyze and assess the impact of their design solutions from global viewpoints.

REFERENCES


