Global Engineering: Taking the Engineering Classroom to the Real World

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Professor Erikson is an Assistant Professor of Engineering. He obtained his BSEE degree from Rutgers University in 1969 and his MSEE degree from Purdue University in 1971. He had worked in industry for 18 years before coming to Messiah College to help start the new BSE program in 1989. He has authored many articles on microelectronic processing and components. He has given numerous presentations to industry, colleges, professional societies, and civic organizations. Since 1990 Mr. Erikson has been interested in and promoting the concept of Appropriate Technology in the Third World as well as in urban areas around the world. He has worked in Kenya, Bolivia, Venezuela, and Guatemala. As part of the Collaboratory, Professor Erikson is Energy Group Advisor. The Energy Group is responsible for solar photovoltaics, solar hot water, biofuels, and wind energy projects.

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Abstract

This paper includes an update on previous papers/presentations at the Mid-Atlantic Chapter of ASEE conferences given by the author on the Integrated Projects Curriculum (IPC) and the Collaboratory for Strategic Partnerships and Applied Research (Collab). The IPC is a service learning base course of study in the Department of Engineering at Messiah College while under the umbrella of the Collab, under the School of Science, Engineering, and Health at the college. IPC has been operating and evolving over its 4 or 5 year history. Over 100 engineering students are involvedin studying, researching, designing, prototyping, and implementing projects. Six major project areas include biomedical, communication, disability resources, energy, transportation, and water. Students have recently completed projects in Honduras, Nicaragua, Burkina Faso, Zimbabwe, and Zambia.
The study and use of Appropriate Technology principles in the classroom and laboratories allow the students to consider not only technology issues in the Third World but also non-technical issues of social, economic, cultural, and political concerns. The service learning pedagogical approach provides the content, engagement, and reflection components to achieve the successful educational goals of the Department.

Introduction

This paper is an update of two past Mid-Atlantic ASEE Conferences papers [1,2]
In addition several other papers on the Integrated Projects Curriculum (IPC) and the Collaboratory for Strategic Partnerships and Applied Research (Collab) have been written for other national organizations' conferences such as ASA [3] and AAC&U [4] as well as other regional conferences such as the St. Lawrence Chapter of ASEE [5]. These papers give most of the background leading up to the implementation of the Collab in 2004 and the IPC in 2007. In summary, the Collab is a student-run center on campus for all disciplines while the IPC is a Department of Engineering initiative for its students. Both the Collab and IPC "add value to classroom learning by enabling participants to apply academic knowledge and live out their Christian faith through imaginative, hands-on problem solving that meets needs brought to us by Christian mission and relief and development organizations and businesses"[6]. Some of the international clients have included World Vision, SIM(Serving in Missions), MCC(Mennonite Central Committee), CURE International, PACTEC(Partners in Technology International), and MAF(Missionary Aviation Fellowship). Local organizations and businesses are also an important source of projects for the students and include Project SHARE, Paxton Ministries, Joshua Farm, and Silence of Mary Home.

Classroom instruction

Traditional course work continues as the essential backbone of the engineering curriculum, i.e., engineering fundamentals in the five specific concentrations [Biomedical, Computer, Electrical, Environmental, and Mechanical] within the BSE program are taught in the classroom. In addition, for all concentrations the IPC requirements allow the faculty to integrate cognitive, affective and behavioral education through a two course seminar series and five project courses starting in the second semester of the sophomore year. The IPC curriculum builds on service-learning pedagogy including academic content, project engagement, and reflection. Essentials elements of this integration include the shared leadership concept, effective use of

documentation and logbooks, how to do meaningful research, working on teams, and many other skills needed for future professional work.

Throughout the students' four years in the engineering curriculum, the use of appropriate technology (AT) principles are taught and implemented. One useful definition of AT is as follows:

> Appropriate technologies are local, self-help, self-reliant technologies that local people themselves choose, which they can understand, maintain, and repair. They are generally simple, capital saving, labor enhancing, and culturally acceptable. Ecologically, appropriate technologies are environmentally sustainable, as much as possible using renewable energy, and limiting atmospheric, chemical, and solid waste pollution. [7]

Because most students are privileged living in the USA, non-technical issues such as the role of culture, religion, socio-economics, and worldviews are continually stressed as part of engineering solutions to the real needs of the world. Students research, design, build, and test prototypes in consultation with clients within a specific culture, using the resources and local skills of the indigenous artisans that they are working with. Some projects may take one academic year to complete while many take several years before implementation is completed in the field.

Presently there are six groups in IPC which include Biomedical, Communications, Disability Resources, Energy, Transportation, and Water. TheCollab has other groups to include Education, Micro-economic Development, Staff, and Sustainability. Each group's orientation includes the history of the group, training on specific equipment, what documentation procedures and requirements are necessary, how to become effective team members, etc.

Actual experiences

Several recently completed projects demonstrate the success of the IPC to educate the engineering students as well as meet the needs of various peoples groups around the world**.**

Water group

Potable water is an essential commodity for a healthy community any place around the world. One important fundamental that the students in the Water Group learn about is the use of different water purification techniques to fit the particular need of a community. Three specific water purification techniques have led to successful projects to include implementation of two ultra-violet systems in Guatemala, a reverse osmosis system in Honduras, and an ozonization system in Nicaragua.

Disability resources group

In Mahadaga, Burkina Faso, West Africa, students have developed improvements to both hand-powered and electric powered tricycles for the disabled. The local artisans are "taught" improved manufacturing techniques by students who have successfullydesigned, built, and tested prototypes in the USA before sharing the results with the artisans. Key manufacturing principles of minimizing welding by proper bending of structural components and strengthening weight bearing design have demonstrated to the local artisansways to improve the tricycles' manufacturability**.**

Energy group

The reliability of an electrical energy supply as well as the energy's cost are problematic in many communities around the world. Solar energy is readily available for both electrical needs as well as for delivering hot water. Several solar hot water systems have been implemented by IPC students for the Theological College of Zimbabwe for use in its students' dormatories. Three solar photovoltaic systems have been implemented in Madahaga, Burkina Faso, for lighting a maternity clinic, for pumping well water, and for powering several homes.

Several other IPC groups are working on projects under development but have not been implemented in the field as yet. They include the following:

Transportation group

The Light Sport Aircraft (LSA) has been under development for many years. The LSA is to be used for short take-offs and landings (less than 300 feet) for emergency use or in rugged terrain applications. Students have worked on frame/body design, engine design, landing gear design, and a folding wing design. The first prototype should be completed within the next year.

Communications group

Within the Communications Group, students have been developing an assistive communication technology project called the Wireless Enabled Remote Co-presence (WERC) project. Several prototypes of "WERCware" have been demonstrated allowing "people with Asperger Syndrome to work and live more independently by connecting them to an off-site social coach who can provide real-time support".[6]

Biomedical group

The Biomedical Group is the newest group in the IPC. Recently the students have started a project in developing a low cost oxygen concentration generator for use in hospitals in the Third World.

Conclusions

The service learning pedagogy of integrating projects into the engineering curriculum is both challenging and beneficial to students and faculty, providing both academic credit for students and load credit for faculty. Real world constraints and issues, both technical and non-technical, allow future engineers to know what to expect as they enter the job market, taking classroom theory into actual practice.

Time management skills, cost and resource allocations, client interface/communications, leadership development, and effective documentation are but a few learning/growing experiences that the students develop by working on these real world projects.

Even though IPC is still evolving, it is an innovative curriculum that integrates engineering knowledge, project engagement, and meaningful reflection on how and why one uses his/her talents for the "benefit of humankind".

Bibliography

1]"Integrated Projects Curriculum: Opportunities for Hands-On Alternative Energy Projects", given at the Mid-Atlantic Chapter ASEE Fall Conference, October 2009.

2]"Project Team and Advisor Characteristics", given at the Mid-Atlantic Chapter ASEE Fall Conference, November 2007.

3] "Appropriate Technology in the Department of Engineering at Messiah College", ASA National Conference, Messiah College, August 2005.

4] "Integrated Projects Curriculum", AAC&U Conference, Denver, October 2005.

5]"Service Learning Projects "For the Benefit of Humankind": The Societal, Global, and Professional Impacts of the 21st Century Engineer", 2005 ASEE St. Lawrence Section Conference, 2005.

6] taken from a Collaboratory pamphlet produced in 2010.

7] taken from Appropriate Technology:A Focus for the Nineties edited by Robert W. Stevens, page ix, ITDG of North America, 1991.