Appropriate Technology and Technical Service in Developing Countries (ETHOS) Elective Course

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Abstract:

EGR 330, Engineering Design and Appropriate Technology was approved by the University of Dayton (UD) School of Engineering in the fall of 2003 as a one to three semester hour, multi-disciplinary engineering elective. This course, for the first time, gave engineering students academic credit for participating in international technical service work through the university's ETHOS (Engineers in Technical Humanitarian Opportunities of Service-learning) program. This course spanned the winter and summer semesters and included language preparation, cultural immersion and appropriate technology readings and a six to sixteen week summer service-learning experience doing technical or engineering related work in a developing country. The overall goals of this course were to provide undergraduate engineering students with an opportunity to prepare for, choose and then participate in an international technical service placement to enable them to experience another culture, apply the knowledge gained in other courses to solve unique engineering problems, gain a greater understanding of appropriate technology and contemporary issues related to global development, engineering ethics, program management and written and oral communication, become more proficient at a second language and develop professional competencies (e.g. travel safety, use of public transportation, required international documentation, etc.).

This paper will describe the design and facilitation of the EGR 330 course as related to ABET outcomes, curricular objectives and practical considerations. It will also provide assessments of the various course components including classroom instruction, service-learning internship, course resources, immersion experience and course requirements. The opportunities and challenges associated with facilitating this class will also be discussed. Recommendations for improving this course will also be made.

Background:

The Engineers in Technical Humanitarian Opportunities of Service-learning (ETHOS) program was developed in the spring of 2001 by an interdisciplinary group (electrical, chemical civil and mechanical) of undergraduate engineering students at the University of Dayton. ETHOS was founded on the belief that engineers are more apt and capable to appropriately serve our world if they have an understanding of technology's global linkage with values, culture, society, politics, and the economy. ETHOS seeks to enhance this understanding in engineering students through a variety of activities that support the advancement of appropriate technologies for the developing world.

Service-learning and appropriate technology serve as the core of the ETHOS program. In service-learning, students become involved in a project that meets specific educational objectives while providing a needed service to the community. Service-learning can range from a single

college course where the students are required to do some community service to multi-year, service projects that are fully integrated into the curriculum. Service-learning has been found to help students develop technical and non-technical skills, make connections between classes, develop racial and cultural sensitivity, enhance their commitment to civic responsibility, increase their ethical awareness and awareness of the impact of professional decisions on society and the environment and see the human side of engineering. Through service-learning, students are able to develop fundamental skills while serving the needs of a local or global community.[1-5] Appropriate technology also has many definitions but typically involves solutions to problems using alternative, non-traditional technologies that are based on fundamental science and engineering principles, are culturally appropriate, can be made and maintained by the local people, promote self reliance and help to feed the local economy. Ideally, appropriate technology is also environmentally sustainable, dynamic and adaptive but still capable of providing immediate improvement to the lives of those who use it. [6, 7]

The educational objectives of the ETHOS program are to challenge students to think creatively and independently, to work as a team, communicate effectively, and to address issues of appropriate technology, environmental ethics, social responsibility, and cultural sensitivity. ETHOS seeks to meet these objectives through a variety of activities that support the advancement of appropriate technologies for the developing world, locally and globally. These activities include hands-on classroom projects, on-campus student organization activities and international and domestic internships.

ETHOS has incorporated research projects into several undergraduate Mechanical and Aerospace Engineering Courses. To date, most of this research has focused on insulative brick materials used to make alternative wood burning cook stoves for use in developing communities. These alternative stoves, or "Eco-Stoves", are much safer then the ground fires they replace, significantly reduce smoke in the home and require less wood for fuel which saves money for the consumer and helps to reduce deforestation. Through these projects, students perform research that helps development organizations while being exposed to the social and cultural issues associated with these projects. Additionally, these projects provide students with the opportunity to develop course related skills and skills in project management, teamwork, communication and an understanding of sound and ethical business practices. Students are also provided with an opportunity to view engineering as a vocation and to consider the impact of engineering decisions on people and the environment.

In addition to classroom based service-learning projects, ETHOS provides service-learning opportunities to engineering students through an on-campus student organization, the ETHOS club. The objectives of the ETHOS club are to provide local and domestic technical service-learning opportunities to engineering students and to promote the awareness of global technical issues and the effect of technology on societies and cultures in developing communities. Although very new, ETHOS club activities have included club meetings, on-campus demonstrations, guest lecturers, field trips and sponsorship of awards for local and state high school and junior high science fairs.

A primary objective of the ETHOS program is to offer technical service-learning internships to engineering students with organizations involved in appropriate technology, sustainable development and education in developing countries. Since the inception of ETHOS in 2001, 27 students have traveled to various countries to work with partner organizations and communities to assist in finding appropriate, sustainable and effective solutions to technical challenges while gaining a better understanding of the global interaction of technology and

society. In the fall of 2003, a one to three credit hour course was approved as an elective by the School of Engineering which enables students to earn academic credit for preparing for and participating in an ETHOS internship. This one to three credit hour, service-learning course spans the winter and summer semesters and includes language preparation, selected readings and discussions on appropriate technology and cultural immersion, independent project research and a six to sixteen week summer service-learning experience focused on technical or engineering related work in a developing country.

EGR 330 Course Description:

EGR 330, Engineering Design and Appropriate Technology was developed to provide students with academic credit for preparing for and participating in an ETHOS service-learning internship. This course is offered as a permission required course during the winter semester and is limited to fifteen students. Although the course is offered during the winter semester, it spans both the winter and summer semesters. During the winter semester students meet once a week for two hours to prepare for their internship experience. These preparatory meetings include language preparation, and selected readings and discussion on cultural immersion and appropriate technology. Additionally, students are expected to do independent research related to their internship. During the summer sessions, students participate in the six to sixteen week ETHOS summer service-learning internship. The objective of this course was to provide engineering students with an opportunity to prepare for, choose and then participate in an international technical service-learning internship that exposes them to another culture, provides them with the opportunity to apply the knowledge gained in other courses to solve unique engineering problems, and to gain a greater understanding of appropriate technology and contemporary issues related to global development, engineering ethics, program management and written and oral communication. Furthermore, provides the students with the opportunity to become more proficient in a second language and develop professional competencies (e.g. travel safety, use of public transportation, required international documentation, etc.).

In accordance with ABET criteria, the ETHOS course was designed to have the following outcomes:

1. Enhance the ability of students to apply knowledge of mathematics, science and engineering fundamentals: *The internships require simple mathematical calculations and application of basic engineering principles. Basic math concepts are required to plan a travel budget for the internship.*
2. Enhance the ability of students to use techniques, skills and modern engineering tools necessary for engineering practice: *Students are required to research their internship placement and technical concepts related to the service placement as part of the preparatory process. This research requires the use of the Internet. Students are required to communicate with the ETHOS director and the ETHOS community during their internship via e-mail and through the use of a Quickplace site. While serving on the internship, students have limited access to modern engineering tools. In most cases, students are required to improvise by designing and building simple tools that can be used in place of some of the higher tech engineering tools. Upon return from their internship, students are required to prepare various reports and presentations using Microsoft office software.*

3. <u>Enhance the ability of students to design and conduct experiments, analyze and interpret data</u>: *Students are required to design and conduct experiments, and analyze, interpret and report data as part of their service-learning internship.*

4. <u>Enhance the ability of students ability to design components, systems and/or processes to meet desired needs</u>: *Students are challenged to design or participate in some aspect of a design that appropriately meets the needs of people in developing countries as part of their service-learning internship.*

5. <u>Enhance the ability of students to independently identify, formulate and solve engineering problems</u>: *Students are required to solve or provide input which will help solve open ended engineering problems as part of their service-placement experience (internship). Identification and formulation of these problems requires an understanding of the culture, history of the problem, material and equipment limitations and an understanding of appropriate technology.*

6. <u>Expose students to developing creative, innovative solutions to engineering problems</u>: *Limited materials, time and equipment and appropriate technology considerations require the students to develop creative and innovative solutions to the problem(s) during their service-learning internship.*

7. <u>Enhance the ability of students to function effectively on engineering and interdisciplinary teams</u>: *Preparatory workshops, especially the cultural immersion workshops, include team-based activities. Participants in the cultural immersion workshops are from a variety of majors and engineering disciplines. In most service-placements, the students work on projects that involve teamwork. The teams working on these projects are diverse in major, discipline, education level, gender and ethnicity.*

8. <u>Enhance the ability of students to communicate their ideas/solutions effectively to both technical and non-technical people</u>: *Students are required to write a technical report, a reflection paper and to present their experiences and/or work to the campus community or a specific class. Furthermore, students are required to write reflections as part of the cultural immersion workshop on non-technical issues. Students are required to submit electronic weekly status reports to the ETHOS director while participating in their service-placements. In most cases, students are required to speak and to write in Spanish or another language while participating in their service-placement. Students are exposed to a second language during their language preparation workshop.*

9. <u>Provide students with the broad education necessary to understand the social, environmental and economic impact of engineering solutions in a global context</u>: *This course has been specifically designed to help students understand the societal and less directly, the environmental and economic impact of their engineering designs and decisions. Formally, students are exposed to appropriate technology during the appropriate technology workshops. The appropriate technology workshops directly address these issues. Readings assigned through the various workshops as well as the service-learning experience also expose students to these issues.*

10. <u>Help to develop in the students a commitment to ethical behavior, leadership and service within and outside of their profession</u>: *Leadership and engineering ethics issues are imbedded in the various aspects of this course including assigned readings on appropriate technology and culture, reflection papers and the service-placement experience.*

11. <u>Enhance the students' knowledge of and ability to think critically with regards to contemporary issues:</u> *Students are exposed to contemporary issues such as sustainability, appropriate technology, cultural sensitivity and environmental protection through the assigned readings, workshops and the service-placement experience.*

12. <u>Enhance the students' commitment lifelong learning that will enhance their personal and professional development:</u> *Although not explicitly taught in this course, the service-learning internships are carefully selected to foster a love of learning in the students. A major component of Appropriate Technology is learning from those that are being served. Service-learning internships enable the students to experience that learning can occur in variety of places and from a variety of people.*

13. <u>Enhance the students' knowledge of economic and market forces so the can function in a business and industrial environment</u>: *Exposure to the concept of appropriate technology through the workshops and service-placement experience expose the students to a unique understanding of the economic and market forces that drive business and industry in developing countries.*

When the ETHOS program was first established, students did not earn academic credit for preparing for and participating in the service-learning internships. Despite this, the program still attracted many students. However, there were several reasons for creating EGR 330 and offering academic credit for preparing for and participating in the service-learning internships. The main reason for creating EGR 330 was to officially recognize the technical and non-technical knowledge gained by the students as a result of preparing for and participating in the service-learning internships. Another reason for creating EGR 330 was to provide a way for the ETHOS facilitator to hold the students accountable for turning in their post-internship documents. Also, EGR 330 was created to permit students to take a reduced "traditional course load" so that they have more time to prepare for their internship. The final reason for creating EGR 330 was to provide some revenue to the School of Engineering through tuition dollars which could be used to help pay for faculty and graduate student facilitation of the internship preparation sessions.

The EGR 330, Engineering Design and Appropriate course was offered for the first time in the winter 2004 semester. The course structure is summarized in Table 1.

Table 1. Course Topics and Schedule

Winter Semester	
Topic	**Number of Meetings**
Introduction and General Information	1
Appropriate Technology	2
Language Preparation	4
Funding international development	1
Cultural Immersion	6

Summer Semester	
International Internship	6 week minimum

Educational materials used for EGR 330 included the textbook, *Appropriate Technology: Tools, Choices and Implications,* by Barrett Hazelton and Christopher Bull[7] and an ETHOS Course Binder, assembled by the course facilitators. This course binder included all major documents and forms, course instructions, requirements and syllabus, course checklist and special readings. Additional handouts were provided by the faculty facilitating the language preparation and cultural immersion sessions.

Course requirements for EGR 330 included attending all sessions offered during the winter semester as indicated above, complying with the ETHOS Service-learning Contract provided in the course binder, participating in group fund raisers and submitting a budget prior to travel, weekly electronic status reports during the internship, technical report, reflection paper and travel expense report after returning from the internship and giving two presentations during the fall 2004 semester. The presentations could be either reflective or technical. One of the presentations had to be given on campus, but students were encouraged to give the second presentation off campus. Course grades were issued in accordance with Table 2. Since the students were not able to complete all course requirements prior to the end of the winter semester, students were issued a "P" (in progress) grade and the grades were changed once all course requirements were met.

Table 2. Grading for EGR 330

Item	Weight (%)
Class attendance	10
Weekly Status Reports (6 – 12)	10
Reflection Paper	20
Technical Report	30
Expense Report	10
Presentations (at least two)	20
Total	**100**

Nine students were officially registered for the course. Two students choose to participate in the ETHOS program without receiving academic credit. One student participated in the preparatory classes as a special readings course for which he wrote a research paper on appropriate technology.

ETHOS Funding:

In 2004, the total expenditures of the ETHOS program were approximately $30 K. These expenditures included program implementation costs as well as costs associated with general operation and administration. General operation and administration expenses included staff support and travel, and library and other miscellaneous costs. These expenses accounted for about 20% of the total budget. The remaining 80% of the budget was used to cover the internship costs of the students including travel, housing, and other costs as indicated in Figure 1.

Significant financial support for the ETHOS program came from a variety of sources including The University of Dayton's Honors/Scholars Program and New Engineer Program, Center for Social Concern, Department of Mechanical and Aerospace Engineering and various Marianist Communities on campus. Soil Enrichment Haulers served as a corporate sponsor for

the ETHOS program. Students and the ETHOS administration also requested financial support from family and friends to help with internship travel and living expenses. By including family and friends, the students provided a pathway for global learning and awareness since the student were then accountable to family and friends as well as ETHOS and university administration. Students also organized various fundraising events including a benefit concert at a local establishment and various tournaments held on campus. ETHOS students, staff and family also cleaned up the University of Dayton Arena after an event in order to raise money for ETHOS. Through these activities, the students raised approximately $700.
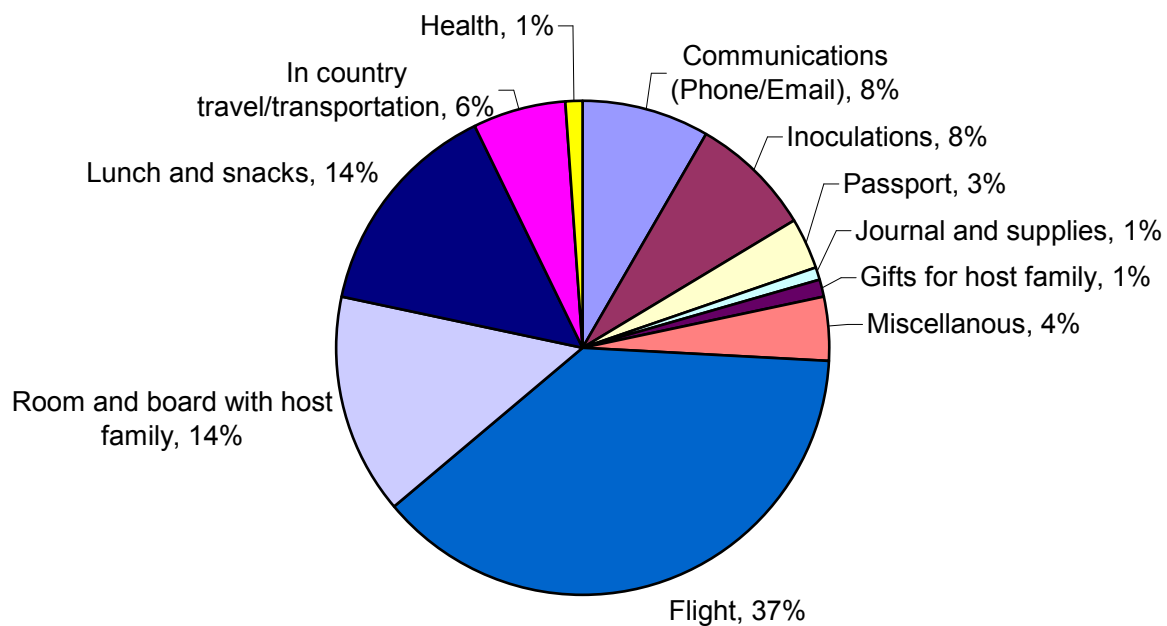

Figure 1. Total Internship Expenses

Assessment:

       Efforts were made to assess the value and effectiveness of the preparatory sessions, course materials and internship experiences through two surveys. In both surveys, students were asked to respond to statements by providing a score from one to five indicating how effective the course or internship experience was at meeting a specific objective or to what degree they agreed with the statement. A score of five indicated that the project did an excellent job at meeting the specified goal or they strongly agreed with the statement, whereas a score of one indicated that the project did not meet the specified goal or they strongly disagreed with the statement. Students were also asked to provide detailed responses to various questions on each survey.

A summary of the results generated for a survey given to the students to assess the effectiveness of the internship preparation sessions is provided in Table 3. From this survey, it was found that the students benefited most from the language preparation sessions, cultural immersion sessions and the course binder. Some students commented that more language preparation sessions were needed as many students identified their inability to communicate effectively as a major hurdle in their internship experience. The students did not feel that the text book was helpful in preparing them for their internships. They went on to explain that this was due in part to the fact that many of the students were not able to obtain a copy of the text book in a timely fashion and also much of the information provided in the textbook was specific to a certain technology and many of the students did not receive specific information regarding their placements until fairly late in the semester. Overall, most of the students felt fairly well prepared for the trip, although many felt that more needed to be done to secure placements and travel arrangements by an earlier date.

Table 3. Summary of the Results Generated for Internship Preparation Sessions and Course Material

	Average
The sessions on Appropriate Technology gave me a better understanding of Appropriate Technology.	4.25
The sessions on Appropriate Technology gave me a better understanding of the ETHOS mission.	4.25
I enjoyed the sessions on Appropriate Technology.	3.57
The text book was as asset to this course and will be useful during my internship.	2.14
The ETHOS binder provided by Pinnell and Eger was an asset to this course and will be useful during the internship.	4.63
The language prep course helped to sharpen my Spanish speaking skills.	3.75
The language prep course was important for this internship.	4.71
I enjoyed the language prep course.	4.25
The cultural immersion course provided very useful information regarding travel.	4.29
The cultural immersion course provided very useful information regarding safety.	4.43
The cultural immersion course helped to enhance my cultural sensitivity.	4.38
I enjoyed the cultural immersion course.	4.63
The session with Dan Daly on stoves provided me information that will be very useful for my internship	3.83
The weekly business meetings were important for organizing the internships.	4.38
The individual group meetings with Bill were important for organizing the internships.	3.86
The fund raisers were worthwhile efforts for raising money for ETHOS travel.	4.00
The fund raisers were helpful in spreading the word about ETHOS.	4.00
The fund raisers were effective community builders for the ETHOS group.	4.38
I feel well prepared for this trip.	3.50
Total Average	**4.06**

A more comprehensive assessment was given to the students at the end of their internship experience. Results of this survey are summarized in Table 4. Although the numerical averages of this survey appeared to be fairly high, comments generated from this survey ranged from extremely positive to very negative. While some students were very pleased with the experience as a whole, other students expressed great frustration over the apparent lack of organization in

the internship placements and travel arrangements. Some students were disappointed with the fact that the internship did not provide structured technical work for them while other students liked having the freedom to "create" their own work. Some students were disappointed with the cultural experience because their placement was not in a very rural area, while other students felt isolated because they were in such a rural area. Most students felt the cultural experience was the best part of the internship. Some students felt that they should be required to be more involved in planning the internship placement and in making the travel arrangements. Some of the students were confused about the expense reports and requirements to write a technical report. A majority of the students realized the importance of language preparation as many struggled with the language barrier.

Table 4. Summary of Results of Comprehensive ETHOS Program Survey

Survey Question Category	Average Rating
Questions relating to how well the course met the objectives of ETHOS.	4.10
Questions relating to how effective the internship placement sessions and materials were.	3.60
Question relating to how finances were handled during internship (reimbursement, cash advance, etc.)	3.93
Questions relating to the student's overall experience.	4.21
Questions relating to quality of placement (supervision, suitability of work, host family, etc.)	2.71
Questions relating to the course expectations including turning in the expense, technical and reflection reports.	3.69
Average	**3.82**
St. Dev	**0.62**

Conclusions and Recommendations:
During its pilot year, EGR 330, Engineering Design and Appropriate Technology, met its educational objectives. Assessment results provided useful information on how the course can be modified and improved. As a result several changes will be made to the EGR 330 course for the winter 2005 term. One change will be to substitute the required text book with selected readings and to work towards building an appropriate technology library as part of the ETHOS program that student participants can use as a resource. Another change that will be made is to work towards securing student placements within the first six weeks of the semester so that the students can conduct research that will be helpful to them with the technical aspect of their internship. The ETHOS administration will also continue to work towards identifying more internship opportunities and partners so that the program facilitators appropriately match the partners' needs with the students' talents. As part of this, the ETHOS administration will work towards identifying domestic internship opportunities to allow more students to participate in this course. The ETHOS administration and participating students will strive to communicate more effectively with partner organizations to ensure that the students have sufficient technical

guidance on projects. Likewise, the ETHOS facilitators will emphasize to the students the importance of proactively identifying areas in the community where the students can provide technical assistance. The ETHOS administration will make a more concerted effort to encourage students to do independent language preparation to supplement that provided through the course. To facilitate this, the ETHOS program will purchase language preparation tapes that will augment the on campus resources that already exist. The course binder will be modified in several ways such as providing more specific instructions for the students on filling out the expense report and reducing the redundancy in forms and assessment materials.

References:

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