

## **2006-2213: STUDENT PERSPECTIVES OF CURRICULUM-INTEGRATED INTERNATIONAL TECHNICAL IMMERSIONS**

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## STUDENT PERSPECTIVES OF CURRICULUM-INTEGRATED INTERNATIONAL TECHNICAL IMMERSIONS

abstract:

The Engineers in Technical, Humanitarian Opportunities of Service-learning (ETHOS) program at the University of Dayton (Dayton, Ohio) is founded on the belief that engineers are more apt and capable to serve our world when they have experienced opportunities that increase their understanding of technology's global linkage with values, culture, society, politics and economy. ETHOS seeks to provide these opportunities by means of curriculum integrated service-learning programming. Such educational programming – classroom projects, student organization activities, collaborative research and international technical immersion – facilitates holistic learning, ethical engineering practices, perspectives of technology integration and appropriate technology transfer.

To appropriately measure the value and effectiveness of ETHOS programming on students post graduation, efforts were made to survey all alumni having participated in international technical immersions. This survey was designed to capture results of programmatic goals and understand the role of service-learning programs on engineers' career and life paths.

This paper will describe qualitative results of international technical immersion experiences through alumni surveys and interviews. Review of these data will provide assessment of the ETHOS program's international technical immersions, classroom instruction, course resources, course facilitation and requirements. Recommendations for future development and assessment will be considered.

### **Background:**

Academic institutions are continually revising their engineering curriculum and programs in an effort to produce the highest quality practicing engineers. Both the nature of the job of an engineer and the marketplace have changed dramatically through the years. Today's engineer works in a highly competitive and global marketplace. Additionally, they are required to have far more than just good technical skills. They must also have good communication, leadership and business skills. Many innovative programs have been developed to better prepare students for the changing global economy and for the new demands being placed on engineers. One pedagogical technique that has been found to enhance the educational experience of undergraduate engineering students is service-learning. Service-learning is the integration of community service projects into the curriculum that also help to develop fundamental engineering skills through experiential learning. 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 and increase their ethical awareness and awareness of the impact of professional decisions on society and the environment.<sup>1-5</sup>

Another increasing popular addition to the curriculum of many engineering programs is international learning experiences such as study abroad. In some instances, these international learning experiences have been combined with service-learning to provide a unique learning opportunity for engineering students. Through international service-learning, students are able to develop fundamental engineering skills, foreign language skills and cultural awareness while serving the needs of the global community.<sup>8-10</sup> The sense of civic responsibility obtained by students participating in international service-learning is broadened greatly to include a sense of responsibility to the world. Many students who have participated in international service-learning have indicated that that the experience changed their understanding of the role of engineers in society and in the world<sup>1,11-15</sup>. Although most programs that include international experiences and/or service-learning have made an effort to assess the effectiveness of the program from the undergraduate engineering student's perspective, little has been done to examine the long term effects of these programs on students who have graduated and are in graduate school or are practicing engineers<sup>1,14,15,16</sup>.

### **International Service-learning at the University of Dayton:**

The Engineers in Technical Humanitarian Opportunities of Service-learning (ETHOS) program was developed in the spring of 2001 by an interdisciplinary group of undergraduate engineering students at the University of Dayton (UD). 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. Service-learning and appropriate technology serve as the core of the ETHOS program. Appropriate technology typically includes alternative and non-traditional technologies based on fundamental engineering principles that provide solutions to problems and 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.<sup>6,7</sup>

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. The ETHOS program strives to meet these objectives by facilitating a variety of activities that provide service-learning activities for students and support the advancement of appropriate technologies for the developing world. These activities include hands-on classroom service-learning projects, on-campus student organization activities and international service-learning internships. The international technical service-learning internships are a central component of the ETHOS program. Not only do these internships provide a unique educational experience for engineering students, but they also help to feed the other components of the ETHOS program by helping to identify in-class service-learning projects and providing ideas, contacts and equipment for club activities. In the international technical service-learning internships, engineering students work for eight to sixteen weeks with an organization involved in appropriate technology, sustainable development and education in developing countries. Students are sent in small groups of two or three. Although these students work together at a single organization, they typically are placed individually with host families. Being placed individually with host

families provides the students with the opportunity to become fully immersed in the culture of their placement. These experiences expose the students to alternative, non-traditional technologies that are based on fundamental science and engineering principles while enacting tangible and immediate impacts on improving the lives of those who use them. Such exposure allows students to recognize the far-reaching effects, positive and negative, of engineering and technology and thus the responsibilities of being an engineer in a global society. Upon return, students are required to write a formal technical report describing the work that they did, give two presentations to the campus community or other appropriate audience and write a reflection paper that describe how the experience affected them personally.

Since its inception in 2001, the ETHOS program has sent over 30 students to five countries to take part in summer service-learning internships. Information obtained from the reflection and technical papers and program evaluation sheets indicate that students who have participated in the international service-learning internships have gained perspectives on the influence of engineering and technology in the global world. Further, these experiences have provided growth in technical knowledge and problem solving, and in language development and cultural awareness.

### **Alumni Assessment Strategy**

Although the ETHOS service-learning internship program has a fairly well established method for assessing the effectiveness of the program from the undergraduate student's perspective, little has been done to examine the longer term effects of this program on students. While every student who has participated in programs such as ETHOS may not experience a change in attitude due to the insights gained from their time spent abroad, there are those whose educational direction and/or career path has been shaped greatly and even altered drastically as a result.

Since the ETHOS program has only been in existence for five years, it does not have a large number of alumni. However, it is still important to make an effort to obtain a qualitative assessment of the effect of an ETHOS internship on students after graduation. To obtain this information, alumni who have participated in ETHOS internships were interviewed and surveyed. The survey was designed to capture results of programmatic goals and understand the role that participation in an ETHOS internship had on the engineers' career and life paths. From this survey, general trends of the feedback were noted and certain individuals were identified as potential candidates for further discussion on their perspectives. Further contact was then made with selected individuals whose formation as an engineer seemed to be highly influenced by their ETHOS experience to obtain in depth information on the effects of this program. Furthermore, reflection papers provided by the students upon return from their ETHOS internship were reviewed. In reviewing these collections of insights provided through the student reflections, it was hoped that trends could be found in the ideas shared.

### **Trends Noted in Reflection Papers:**

Over the course of reviewing the information provided through ETHOS participants' reflection papers, several common factors were identified regarding the impact of the immersions on the view and attitudes of the students.

One positive outcome provided by the ETHOS experience which was identified repeatedly in the reflection papers was the ability to get out in the field and work with projects in a hands-on way. Although improvements have been made in most undergraduate courses and laboratories, they still can not provide the understanding gained through actually engaging with technology in its working environment. Taking fundamental theoretical concepts and applying them to real life engineering problems helped to solidify the students' understanding of those fundamentals. In many ways this validation parallels the value attributed to undergraduate internship and coop programs as well as other experiential learning experiences. The ETHOS experience provided the participants with an increased awareness of how engineering impacts the daily lives of people in all societies.

Another common outcome that the ETHOS experience provided to the participants was an understanding of another culture. Furthermore, most students indicated that the experience gave them a greater understanding of the American culture. While it might be argued that the technical skills of an engineer do not necessarily need to be tied to the cultures in which they will be applied, it should be noted that taking cultural considerations into the design of a product or device will increase its likelihood for success. Historically, designs that are technically well thought out have failed because of an insufficient understanding and application of the societal forces which made up its working environment. Consequently, an engineer who can take cultural considerations into account when determining design constraints is more capable than one who operates unaware of such realities and the influence they have on a project.

One of the most important outcomes of the ETHOS experience as noted by the participants was gaining a greater understanding of the human component of engineering. A professional is inseparably linked to their own humanity and the resultant social components of their existence. This is apparent in the energy with which participants referred to how meaningful their internships and then their course work became once a human face was put upon the problems they engaged. This realization impacted ETHOS participants in a number of ways. Looking beyond the filtered view of their works, an awareness of the impact of the consequences of engineering in the world became apparent to them. Both the positive effect an engineer can work to achieve in the United States and beyond contrasted by the sometimes-negative product that processes and technology can have on the world. This understanding also led to an appreciation for the importance of the engineering work that fostered an enthusiasm for both the educational process and greater career goals. This personal drive promoted in the participants a greater engagement and energy that will ultimately yield much higher results than if this motivation was not present. It also produced in the students the ability to understand and identify the change they are have brought and are capable of bringing to the world through their actions as filtered by their ethics and values.

**ETHOS Alumni Interviews:**  
*Interview with Current Student*<sup>17</sup>

The first interview conducted took place on January 9, 2006 with a current student. He is a fifth year student who will graduate in May of 2006 with a degree in Industrial Engineering Technology and minors in Religious Studies and Quality Assurance. Initially, his pursuit of an engineering career seemed to be based upon the most commonly recognized cultural ideals of the American society. The desire to make a comfortable living, support a family, and have a house in a safe neighborhood all aligned with his perception of the lifestyle afforded a professional in this field. His aptitudes and interest in “thinking and tinkering” also contributed to his choice of engineering as an educational path. While possessing the necessary abilities, which fit naturally in this course of study, it was also a means of achieving these other life goals.

The student attributed a few factors in explaining how he became involved in an ETHOS internship. The social justice component of his high school education helped foster an interest helping others with his skills. This interest led to an involvement in projects facilitated through UD’s Campus Ministry and the Center for Social Concern. While continuing to nurture these ideals, a presentation made him aware of the technically focused opportunity for service-learning provided through the ETHOS program.

This student’s ETHOS placement was with the Marianist Rural Development Corporation in Southern Mexico. As part of the first group to be placed in the State of Veracruz in this region, the specifics of his position were unclear and not well established. While this resulted in less engineering work than he had anticipated, he was still able to be involved in survey work to address local water table issues. He became aware that, “In applying my engineering skills to these types of situations I can have a higher impact on the status of Humanity in the world.”

Even though his internship was not highly technical, he still learned many lessons through his experience. A shift in his awareness of products costs began to take place. Not only the ability to assess the degree to which his purchases are meeting his desired need, he also gained an awareness of the impact an individuals surplus capital can have on regions outside of our country. In reflecting on this potential impact he developed a greater appreciation for the positive influence money can have in the developing world. Consequently this knowledge now plays a greater role when he thinks about his own expenditures and how what he spends for himself could yield great improvements in the lives of those in other regions of the world. This vision enables a view of the amazing improvement in the lives of a population when an investment in medicine, infrastructure, or community development has taken place.

This individual also gained a greater understanding of the significant differences which exist between various cultures are the impact these differences have on the standard operating practice of professions. Not only did he have a greater understanding of Mexican culture but also he viewed the American culture in a much different manner upon his return. He also gained an appreciation for the fact that at the heart of humanity we are all the same, yet at the same time the way we live is radically different. This experience fostered a greater sensitivity to the differences in people from different cultures as well as our own culture. This human dynamic led to a clearer understanding of how people fit into the scenario of engineering work. This human face enriched his educational background greatly in connecting his undergraduate learning with the real impact he can have on people.

The ability to do more with fewer resources was also identified as enriching to his previous engineering skills. Facing issues that were large scale and at times, overwhelming, forced him to consider both the problems faced as well as our responsibility to work towards solutions to these problems. This experience gave him a better appreciation for the fact that the abilities we have can be used to improve the human condition. An immersion into very lean operating conditions was also identified as a useful experience. In terms of operation he said, "I will be a much more prudent engineer after this experience." Applying knowledge in a situation with limited resources and equipment to generate the most effective solution strengthens an engineer's ability to better address a problem. This skill further aids an engineer in the direction of the solution of a problem when in situations with limited available resources. Furthermore, this experience enhanced this ability to better apply fundamental principles and theories to a given problem with limited resources available.

The student indicated that his involvement with ETHOS helped to guide the direction of his educational goals. Looking forward, he wants to have a higher impact on the state of the human condition in the world using his abilities as an engineer. He hopes to engage what he has termed Humanitarian Engineering. Ideally he wishes to use his skills to solve problems in developing countries. He believes he can attain this goal as an engineer by using his values and ideals to guide his works throughout his career.

#### *Interview with recent graduate*<sup>18</sup>

The second interview conducted took place on January 9, 2006. The student interviewed is currently pursuing an Environmental Engineering PhD at the University of Oklahoma. He is also a U.S. Department of Education GAANN Fellow as well as a graduate of UD's Mechanical Engineering Program. This student became aware of the ETHOS program through an in class presentation. This announcement came at a time when he was searching for something new to do. The information presented piqued his interest and led to further investigation into the opportunities provided by the ETHOS program. As a result, he ended up participating in two separate immersions over the course of the next two summers.

His first immersion was in Nicaragua, initially working with the organization *Grupo Fenix* and later with the organization *Prolena*. Through these work experience he found that having the opportunity to work on projects with the people whose lives would be greatly impacted by the implementation of these projects, served as a great source of motivation for him. Working in this manner, encouraged him to work significantly harder than he had at a previous co-op position. Despite the greater intensity with which he engaged in his projects, he found that he was energized, not exhausted by the extra effort he exerted. He attributes this energy to the fact that he was meeting the very basic needs of deserving people. Recognizing this, he continues to try to recapture this energy in his current studies and for his future career.

The following summer, this student went to work with a different site of *Prolena* located in Bolivia. During this internship, he had the opportunity to work with an engineer that he in time would come to know and considers this mentor to be an outstanding example of engineering performance. This professional displayed the strength of a broad background in many engineering disciplines which enabled him to engage in all aspects of a project. This holistic

view of engineering knowledge served as an ideal that he continues to strive for as he continues his engineering studies.

This student believes that his ETHOS experience has led to a greater understanding of the impact of engineering works and practices both locally and globally. The idea of social justice and seeing engineering as a means of working towards a more equitable world also developed in the vision of his own career. The student feels he now has a greater ability to make due with less, which strengthens him as a professional. “It is impossible not to become more open minded through these sorts of experiences,” he said when reflecting upon his change of perspectives. Working without a computer, often with basic equipment or none at all forced him to apply the fundamentals of scientific analysis to the problem at hand. This process not only honed his understanding of these concepts, but also left him less dependent upon all but the most basic tools in the completion of a task. Exposure to cultural differences and the different ways in which engineers can function in the engineering profession gave him a greater understanding that there are many different ways in which a problem can be approached. The time that was spent with an excellent, capable and adaptable engineer from another background also had a significant impact on this student. The ETHOS experience allowed him to put a face to the statistics cited when discussing the conditions of the developing world. He was no longer able to read or hear about events occurring in the developing world without connecting that information with the individuals he lived and worked with during his internships. In discussing this he said, “Once you put a face to the numbers you care about these issues more.” Because of this, the student feels that it is impossible for him to remain unaware or unconcerned as to the impact the lives of Americans have upon these people.

The ETHOS internships were a very big factor in this student’s decision to pursue a graduate degree in Ecological Engineering. He feels that this field will provide him with the opportunity to use his abilities to benefit the environment and the poor. Working in the area of the environment, especially water issues, he hopes to focus on projects applicable in the developing world. Eventually, he would like to become a professor. This will provide him with the opportunity to have an impact on the next generation of engineers. Along with this, he hopes to develop a program similar to ETHOS at the university where he teaches so that he can provide a similar opportunity to that provided to him through involvement with the ETHOS program.

*Interview with 2002 graduate*<sup>19</sup>

The last participant interviewed is a Civil Engineer who participated in the design team that initially conceptualized and developed the ETHOS program at the University of Dayton. HE graduated with a Bachelors degree in Civil Engineering in May of 2002. This alumnus was led in this process by a student named Chris Vehar who had just returned from an immersion trip to India. Some of the initial motivations behind the foundation of ETHOS lay in the design team’s common recognition that there was great potential for the use of engineering knowledge to provide assistance to underserved populations. Upon graduation from the University of Dayton he pursued a master’s degree at Michigan Tech through the Masters International Program. This individual is currently working in Louisville KY with Strand Associates Inc.



Through previous experiences this individual had come into touch with the idea that the use of engineering can truly work to change the world around us. It seemed appropriate then that the ETHOS design team worked to establish an opportunity for engineers like themselves to use their skills to address real needs of populations who have been overlooked by the institutions around them. While they hoped the internships would offer this kind of opportunity the team also recognized that the students would gain more from these experiences than the agencies and people they worked with. This in itself however was one of the larger goals of the program. To allow participants the opportunities to better understand cultures different from our own and as a result develop into an engineer who is better able to operate in a globally oriented environment. The program also seemed appropriate in the context of the mission of the University itself and the educational ideals it promotes within the student body.

The Masters International Program at Michigan Tech where he began his graduate studies was set up in partnership with the Peace Corps. After one year of graduate school, program members would spend two years of Peace Corps fieldwork around which they would prepare a thesis upon their return from this experience. It seemed the perfect opportunity to pursue further studies while applying engineering knowledge to problems in the developing world. He also viewed the benefits of adding something to science around an immersion through the thesis work associated with his travels.

Ultimately however, he did not travel to do the Peace Corps component of his work. Despite his desire to engage in such works his marriage took precedence over this experience. To replace the thesis component of his program he worked with his professors and performed independent research around the drinking water in his hometown. Work that had started as an analysis of the current system developed into design work around potential solutions for the difficulties identified in this water system.

Despite the fact that he did not participate fully in a two-year program abroad, the ideals that led to the development of the ETHOS program continue to shape the direction of his career goals. While working with his company in Louisville this engineer continued to stay in touch with his classmates from the Masters International Program. Hearing about their works the decision was made to approach his employers with an idea. He believed that if the ETHOS design team had convinced the President of the University of Dayton and the Dean of Engineering of the value of this kind of work, its importance would also resonate with professionals in his own workplace. With the confidence gained from his work with the design team he wrote a proposal where Strand Associates Inc. would purchase the materials for a water tank project that one of his graduate school classmates was working on. Further more he would fly down to work on this project as a representative of the company. After presenting these ideas the company was receptive and supportive of the project. It was empowering for him to realize that there were companies in the private sector that see the value of this kind of work and the impact it can have in developing regions. This trip also reaffirmed his passion for international service learning and its development here in our educational system.

Looking forward this engineer sees the potential for further studies in the hopes that he can pursue an educational role at a University. Through these experiences he sees the value his involvement with the ETHOS program had on his own formation and hopes to provide similar

opportunities for future engineering students. This developed global awareness also impacts his daily life. From seeking out alternative gifts through programs like the heifer project, to living the role of an informed consumer in regards to fair trade issues, it has most definitely shaped his career and his life in powerful ways. If indeed he does become an educator he hopes to work to develop an ETHOS style program at that institution in order to further promote global understanding of the impact of engineering.

As a result this engineer believes a great deal in the value of service-learning opportunities. As professional engineers, those students with a greater awareness of global issues will be more marketable and more able to operate in a global market. This immersion in language, culture, and common practices different from our own will allow them a unique recognition of the value of everyone's perspective. He also feels that these educational experiences not only set students apart in engineering understanding, but influence their attitude about the impact they can have thus empowering them to greater things through the use of their abilities. In closing this individual mentioned a quote that is at the heart of this last thought. Margaret Mead said, "Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it is the only thing that ever does." These words resonate to Bob with the true value of service-learning in education and programs like ETHOS.

### **Conclusions:**

International service-learning experiences provide a significant benefit to the educational development of engineering students. Although international service-learning can not replace technical understanding of the fundamental theories and principles obtained through a university curriculum, it can effectively educate the student on the relationship between the engineer, society and the environment.

Through the interviews and review of the reflections, the value of an international service-learning experience was assessed. The opportunity to have hands on experience with devices in the field provided a means for the students to apply the concepts learned in the classroom to real problems. Furthermore, having to function with limited materials and equipment required the students to more effectively and efficiently make use of fundamental engineering principles. One of the most profound effects of the ETHOS internships as noted by the participants was gaining a greater understanding of the relationship between engineering and humanity. Immersions serve to educate, through experience, the differences in people throughout the world and how a population's culture can play a pivotal role in the effects and implementation of our works within these cultures. The personal relationship with other peoples, which reduces the vagaries of references to distant populations into individuals and acquaintances, is also an area of growth which results. Engineers with such perspectives are empowered then to engage their work on a higher level than those without this ability. Acting as global citizens they can engage in engineering projects with a greater vision of the total effects of their works and thus incorporate this understanding in order to operate more effectively.

While the current reflections and perspectives are limited by the newness of the program itself, it is hoped that over time further information and interviewing can be collected in order to provide the information for a more qualitative analysis of these issues. Also in consideration is

partnership with other Colleges and Universities which facilitate similar experiences. Such a joint study would more quickly allow for the volume of participant assessments needed to provide real insight into the trends and effects of these experiences upon those who take part.

Overall, this implies that participation in international service-learning programs such as ETHOS can have a large impact on the formative process of an engineer. While every experience is unique, there is a definitive opportunity to enlarge the scope and understanding of the impact and operation of engineering as a profession. It also may serve to motivate and energize an individual to look beyond simply finding a solution to engage intentionally in those fields which they find most invigorating. This realization of purpose can only result in more enthusiastic and engaging professionals whose work is defined not only by technical excellence but also in the effect resultant upon humanity.

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