2006-606: ENGINEERING EDUCATION THROUGH SERVICE LEARNING: TWO CASE STUDIES

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Engineering Education through Service Learning in Developing Communities: Two Case Studies

Introduction

This paper provides case studies of two service learning projects that University of Colorado at Boulder (CU-Boulder) students are integrating into their academic experience. The projects focus on developing communities and are managed under the auspices of Engineers Without Borders-USA (EWB-USA), a group founded by Dr. Bernard Amadei, Professor of Civil Engineering at CU-Boulder. These projects expand students' understanding of the social value of their chosen profession, and expose them to a type of engineering significantly different than what is presented in most of their classes. Specifically, focusing on developing communities provides students with the opportunity to design solutions to some of the problems faced by the five billion people on our planet who are poor. It also challenges engineering students to identify vital non-technical issues which may be the greatest roadblocks to poverty alleviation through sustainable community development.

One-fifth of human beings on our planet are unable to read, and "more than 1 billion people lack access to safe water and 2.6 billion lack access to improved sanitation."[1] In a world where these problems seem practically beyond comprehension, it's sometimes difficult to envision how individuals can make a difference. Many of the huge infrastructure projects in the developing world over the past half-century have failed within two years because the necessary education and revenue to maintain them was not available. The United Nations has identified a new approach to development – the emphasis must be on small-scale solutions developed in partnership with local communities.

Engineers Without Borders-USA (EWB-USA) uses this approach to solve issues that developing communities face. EWB-USA began in San Pablo, Belize, a Mayan village of about 250 people. In April of 2000, a representative of the Belize Ministry of Agriculture invited Dr. Amadei to visit San Pablo to examine the possibility of designing and installing a water delivery system to the village. Since the village has no electricity, running water, or sanitation, and because most villagers work at a nearby banana plantation, the responsibility for carrying drinking and irrigation water from a nearby river to the village fell to the village children. In May of 2001, the project team, comprised of CU-Boulder students and a civil engineering expert from Boulder, installed a pipeline between the nearby river and the village. This pipeline allowed the village children to go to school, rather than carrying water to the village. The entire project was completed at an approximate cost of $15,000, coupled with the labor provided by the local community.

This project demonstrated the potential of a partnership working together to help a local, developing community create a sustainable solution. All the necessary elements for success were in place on this project; an important public entity in the form of the Ministry of

Agriculture, the San Pablo community, and a skilled engineering team that included both working engineers and engineering students. Based on this experience, and the level of excitement shown by his undergraduate team members, Dr. Amadei invited a group of professionals, faculty, and students to launch Engineers Without Borders-USA. The first student chapter of EWB-USA was founded by the University of Colorado at Boulder (CU-Boulder). In the past five years, the organization has expanded to include approximately 1,800 members in 137 chapters nationwide.

The CU-Boulder student chapter of EWB-USA is currently focusing on two communities. While both could be characterized as water sanitation projects, they vary significantly in detail.

Case Study: Rwanda

Project Background

Many people vaguely understand that a terrible war occurred in recent history between two groups, the Hutus and the Tutsis, but the complicated story behind the genocide and subsequent efforts to rebuild the country remain mysterious to most Westerners. Engineers Without Borders-USA was typically uninformed about Rwanda when approached with a project to assist a community eager to rebuild its decrepit and unsanitary water system.

The community known as Muramba lies approximately 80 km from Kigali, the capital of Rwanda, along a winding network of roads. The tranquility of this region was shattered in April 1994 when genocide began, causing approximately 800,000 deaths in just 100 days. In 1997, the Interhamwe militia entered Hutu-dominated Muramba, expecting support from the local people. Meanwhile Major General Paul Kagame, who is now the president of Rwanda, had his forces move into Muramba under the assumption that the local people were indeed assisting the Interhamwe. Unfortunately, this situation left the residents of Muramba in the middle of these two warring and well-armed factions. Many refer to 1997 as "The Time of the Running" because people ran between two warring groups looking for a safe haven. Hundreds were killed.

As a result of these tumultuous times in Muramba, warring forces, looters, and neglect severely damaged vital infrastructure, including a water system serving thousands of people. With the magnitude of the destruction that occurred in Rwanda, and to a lesser extent in Muramba, the challenge of rebuilding the community is immense. Community leaders are working everyday towards improving the quality of life for everyone. In their search for solutions, these leaders sought help from Engineers without Borders-USA. There are many parts of the Muramba project that are being explored by EWB-USA. The University of Colorado at Boulder, the University of Wisconsin Madison, and the NASA-Johnson Space Center chapters are all currently working in the area. Projects have been implemented in March 2004, July 2004, January 2005, May 2005, July 2005, and January 2006.

March 2004 Assessment

EWB-USA first visited Rwanda in March 2004, where the determination to rebuild Muramba and all of Rwanda was evident both at the grassroots level and throughout the society. President

Paul Kagame met with the EWB-USA team privately for an hour in his Kigali office and offered his full support for EWB-USA efforts in Muramba. He said, "I wish to thank you for finding the time to come to our country, and your interest to help in Muramba. As you have found out, we are not short of things to do. Everything here is about engineering; how to engineer reconstruction. We are always happy when people find time to come and help with things affecting peoples' daily lives."[2] It is now official policy of President Kagame's government that there is no ethnicity. Everyone is simply Rwandan. No longer are there Hutus and Tutsis, at least on government papers.

Similarly, the Muramba community leaders offered their full support and assistance as EWB-USA undertakes these projects. In a broad and open meeting between religious and village leaders and EWB-USA representatives, the EWB-USA team offered a small supply of hybrid crop seeds. The community leaders embraced the gift, and said that likewise EWB-USA can provide the seeds for development, but it is up to the community to prepare the ground, nurture the growth, and ensure the prosperity of the projects.

May 2005 Rainwater Catchments

Sustainable solutions to the water quality and quantity problems in Muramba must include measures to diversify the current water portfolio. The area relies almost solely on one network of streams for water. The collection of rainwater, or rainwater catchment, is one means by which an additional source of water can be secured at a relatively low cost. A year of planning, design and fundraising while working with the Muramba College and Muramba Parish culminated in an implementation trip in May 2005. During this trip, gutter systems were installed on a dormitory building and the cafeteria with the drainage being stored in two 6,000 liter tanks. The dormitory system consisted of all prefabricated material purchased in Kigali, while the cafeteria system consisted of a tank constructed with locally produced bricks. This installation was based on the availability of storage tanks, budget constraints, rainfall data, and rainwater catchment potential at the Muramba College. These two 6,000 liter tanks will be replenished with water frequently throughout the year. The total added capacity over a year was determined to be approximately 535,000 liters of water.

These systems immediately provided a source of presumably cleaner water than the current system (though water quality tests will need to be conducted), while the prominent installation locations have the potential to influence the adoption of similar catchment systems in the region.

January 2006 Solar Lighting

Most recently, the EWB-USA CU-Boulder (EWB-CU) student chapter has been continuing energy and water supply development in Muramba, while partnering with the EWB-USA Johnson Space Center (EWB-JSC) chapter to work at the Mugonero Hospital, about four hours away. The dichotomy between the ambition for growth and the availability of needed building blocks was never more evident than when the EWB-USA assessment team visited the local clinic. In one room, a single rusting birthing table is almost all the equipment available for medical employees to deliver 70 babies a month. Half of the babies arrive in the total darkness

of the equatorial night because there is no electricity. In January 2006, the EWB-CU team implemented a full scale solar powered lighting system for the Muramba Clinic.

The EWB-CU team will also be working at the Mugonero Hospital, with EWB-JSC. The Mugonero Hospital sits atop a hill on the western border of Rwanda, accessible only by a red dirt road riddled with bumps and hairpin switchbacks. Constructed by the Seventh Day Adventist Church early in the 20th century, the complex relies on facilities and utilities that have deteriorated through the decades and destruction. In 1994, 3,000 people hid in the hospital chapel to escape the genocide which eliminated a third of the population in the province of Kikuyu. The priest in the church wrote an appeal to a neighboring church leader that in part said, "We wish to inform you that tomorrow we will be killed with our families." Instead of sending aid, the other priest sent the military to the complex, and they killed almost every person in the building, damaging many facilities in the process.

Today the hospital suffers from a lack of adequate quality water, and powered lighting. The EWB-CU team implemented a solar powered lighting system for the hospital's operating, emergency and patient rooms. Meanwhile, EWB-JSC will start to address the water concerns.

With the magnitude of the destruction that occurred in Mugonero and the rest of Rwanda, the challenge of rebuilding these communities is immense. Community leaders are working everyday towards improving the quality of life for everyone. Where you might expect a feeling of helplessness, there is instead a common determination to rebuild.

Case Study: Peru

Project Background

Engineers Without Borders-USA's involvement in Peru began in 2002 after Dr. Arturo Campa, an anthropology professor at Metropolitan State University in Denver, CO, requested technical assistance for the community of Santa Rita. Teams of professionals and students from the CU-Boulder made numerous visits to Santa Rita over a two-year period participating in water system rehabilitation and construction of pour-flush latrines. In August 2004, while constructing latrines in Santa Rita, residents of the nearby community of San León approached EWB-USA volunteers and requested assistance in developing a potable water source for their community of approximately 150 people. Since August 2004, three teams of EWB-USA students and volunteers have traveled to San León to begin working on the development of a potable water system while empowering the community, and building a network of supporting people and organizations within Peru.

In the United States, a team of 15 CU- Boulder students along with two professional engineers continue to spend numerous hours developing ideas, educational plans, and designs for San León. These ideas are continuously shared and reworked though communication with the Peruvian partners.

March 2005 Assessment

In March 2005, a team of EWB-CU students accompanied by a professional engineer returned to Peru to forge a lasting partnership. During this initial visit, EWB-CU found that San León residents obtain their water for drinking, bathing, and cooking from shallow hand dug pits, an irrigation ditch, and unprotected springs, all of which are prone to contamination by both human and animal waste and chemicals including fertilizers and pesticides. Adverse health effects such as skin rashes, internal parasites, and gastrointestinal diseases have been observed.[3]

The goal of the assessment was to evaluate baseline health in the community, gather information relating to the design of a potable water system, and facilitate formation of a community water committee. Community meetings were held throughout the course of the assessment to assure adequate input from the community. EWB-CU team members consulted with the local nurse and interviewed residents to evaluate public health, demographics, and water use. Respiratory and waterborne illnesses were determined to be the most prevalent health problems in San León. Currently the community of San León has 151 residents with approximately 51% of the population under the age of 16. The reported daily water demand from San León residents varied from 50 liters/day to over 130 liters/day. These water demands reported include the use of water for non-potable uses such as dust suppression. A conservative approximation of 100 L/day was determined to be an appropriate design demand, as it correlates with the daily demand on a potable water system in the nearby town of Huamanzaña.

Based on observation of the relatively coarse and poorly-sorted nature of the alluvium that exists beneath the near-surface soils, a minimum average hydraulic conductivity in the range of 50 to 100 ft/day for the alluvial aquifer was estimated by project mentor Eric Harmon, P.E. A well drilled to a depth of 30 to 50 m in this alluvium, should be able to produce well in excess of 100 L/min without excessive drawdown. The alluvial aquifer underlying the San León vicinity has little or no development at present, and was observed to be recharged by the Rio Chorobal and the Rio Huamanzaña, both of which are perennial meltwater streams from the nearby Andean foothills. Therefore the aquifer is considered to be a long term, sustainable water supply.[3]

Based on a comparison of the advantages and disadvantages of wells and springs for this community, the project team decided that development of a properly-completed and protected well 30-50 meters deep in the alluvial aquifer will provide the best opportunity for a clean and sustainable source of potable water.

August 2005 Well Development

In designing the well and planning for its construction, the team realized that there had to be more community participation in the well design and location, thus giving a sense of ownership

to San León and ultimately making the project more sustainable. Additionally, the EWB-CU team decided that hiring a local well driller was the only way to get the desired well depth of 50 meters.

Under ideal circumstances, this type of work would be done by an in-country non-governmental organization (NGO) partner, but there had been a communication breakdown between Peruvian Eco-sustainable Research and Understanding (P.E.R.U.), the in-country NGO partner, and the EWB-CU team. The organizational structure of P.E.R.U. was dependant on one person in Peru who could not handle all of the work. The CU team found it necessary to send a small group of people to meet with the community, drillers, and other NGO's. This trip was crucial in ensuring a long-lasting partnership with the San León community, and a sustainable engineering project.

This trip resulted in solidifying the support of the Trujillo Rotary Club, thus making this project eligible for Rotary Matching Grants funding. During this visit the team revisited the decision to drill a well with the community to take an official vote ensuring the community's support in moving forward. Members of the Peru project coalition taught community members an interim solution to water purification to ease the sense of powerlessness. Most importantly the decision to drill a well was revisited by the EWB-CU team and the community, and an official vote was taken to move forward.

One of the most crucial decisions made during the course of this partnership was the choice to pursue an alluvial well instead of capturing spring water. The potential spring that the team investigated in March 2005 seemed to have many promising qualities including the simplicity of a spring water-capturing box. Capturing spring water is a common method of obtaining potable water in Peru, but this particular spring had many qualities of concern to the EWB-USA team. Uncertainties included water quality and quantity during different seasons and weather patterns. This uncertainty, combined with water quality and quantity data obtained during the March 2005 visit, led to the eventual decision of drilling an alluvial well.

Conclusion

In today's world the interdependence of all people is obvious. Along with this interdependence comes the equal responsibility for ensuring economic, social, and ecological justice for all. The projects in Muramba, Rwanda and San León, Peru have helped transform ordinary engineering students into global citizens mindful of many pressing issues facing the world today. This transformation has included the increased knowledge of foreign languages, and the increased understanding of cross-cultural partnerships.

The most obvious barrier to effective communication with the distant community partners is language. Over the course of this partnership numerous students have taken language classes through the university, or have learned French or Spanish language on their own. In addition to the language barrier, students involved with this project have learned the importance of intentional listening. Often as engineers students are taught to find solutions to well defined problems but in the case of this type of work students have realized that the projects are not well defined and that listening to the community and one another is the only way to create truly

appropriate solutions. Every visit to a partner community includes community meetings where ideas are generated and shared between the community and EWB-USA volunteers.

One of the most endearing aspects of these projects for students is the experience of doing real engineering work. The necessary data for this type of work are not always accessible, thus providing an anomalous engineering experience compared with typical university engineering.

In Peru and Rwanda, EWB-USA's model of participatory development using appropriate technology has been implemented with sustained success. Over the past four years, projects in these two countries have involved dozens of dedicated students and professionals, and have demonstrated how international development can be a service-learning experience equally beneficial to the community, the students, and the professionals. Besides providing 'x' liters of potable water, or 'y' watts of electricity, in a community, the cultural interactions between the EWB-USA teams and the host communities provide for intangible yet wholly visceral character development for all EWB-USA members.

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