AC 2012-5500: HIGH TECH HIGH TOUCH: LESSONS LEARNED FROM PROJECT HAITI 2011

Dr. Yan Tang, Embry-Riddle Aeronautical University, Daytona Beach

Yan Tang received a B.S. degree and a M.S. degree in automatic control theory and application from Nanjing University of Science and Technology, Nanjing, China, in 1995 and 1999, respectively. She received a Ph.D. degree in mechanical engineering from University of Central Florida, Orlando, Fla., in 2009. She is currently an Assistant Professor in mechanical engineering at Embry-Riddle Aeronautical University, Daytona Beach, Fla. Her research interests include intelligent control, robots, and applications of biomimicry techniques in engineering.

Dr. Marc Compere, Embry-Riddle Aeronautical University, Daytona Beach

Marc Compere is an Assistant Professor of mechanical engineering at Embry-Riddle Aeronautical University in Daytona Beach, Fla. Compere's current research in sustainable technology focuses on water purification, concentrated solar power for electricity generation, water desalination, and solar powered air conditioning. He has developed and delivered two of Embry-Riddle's solar powered water purification systems to Haiti with university students. His background is in modeling and simulation, hardware-in-the-loop and driver-in-the-loop control systems, robotics, mechatronics, vehicle dynamics, and hybrid electric power system dynamics.

Mr. Yung Lun Wong
Mr. Jared Anthony Coleman, Embry-Riddle Aeronautical University
Mr. Matthew Charles Selkirk, Embry-Riddle Aeronautical University

©American Society for Engineering Education, 2012

High Tech High Touch: Lessons Learned from Project Haiti 2011

Abstract – In this paper, we will share our experiences and lessons learned from a design project for providing clean water to a Haitian orphanage (Project Haiti 2011). Supported by funds from a renewable energy company and the university president's office, five engineering students and two faculty members from Embry-Riddle Aeronautical University successfully designed and installed a solar powered water purification system for an orphanage located in Chambellan, Haiti. This paper discusses the unique educational experiences gained from unusual design constraints, such as ambiguity of existing facilities due to limited communication, logistics of international construction at a remote village location, and cross-cultural differences in water usage. Multiple positive outcomes were achieved, such as our students developing a global perspective, our faculty gaining experience in leading an overseas student trip, and the provision of daily water for children and surrounding community in Haiti. Our students' perspectives will be shared, as well as the framework for support from our community and university administration. Project Haiti 2011 was a big success for all the participants and the stakeholders. We hope that this paper inspires others to pursue similar service learning experiences, and is found to be a repeatable engineering education model for international community improvement projects.

Introduction

In January 2010, Haiti was struck by a devastating earthquake that killed hundreds of thousands of people, caused significant damage to key infrastructure, and left survivors without food and potable water. The orphanage of the Ann Clemende Julien Foundation (ACJF), a non-profit organization dedicated toward providing an education to impoverished Haitian orphans living in Chambellan, Haiti, has seen an increased number of children since the deaths of their parents during the earthquake. Provision of clean water for these children is extremely important to keep them healthy, because they may easily have life-threatening water related diseases due to inadequate water and sewage treatment, factors responsible for the cholera outbreak in October 2010 in Haiti. A team of faculty advisors from mechanical engineering and students from different engineering fields at Embry-Riddle Aeronautical University was assembled to design and install a purification system. It took the team four months to design and test the system. In August 2011, the team successfully delivered and installed the system at the orphanage. This project not only has benefited the orphans by providing sanitary drinking water, but also has provided a great learning experience for team members, as the team has tackled several design challenges and overcome many unexpected issues.

The paper is organized as follows. We first present the design challenges and several issues encountered during the project. Then, we summarize our lessons learned from this project. Through this paper, we are trying to share a model that can be used by other engineering educators to create similar service learning experiences.

Design Challenges and Logistic Issues

Project Overview

This project was intended to design a solar powered water purification system to provide clean, purified water for 600 orphans. The untreated underground water is pumped from a well with a depth of 150 feet and then goes through a 5-stage water filtration system to produce clean drinking water at the flow rate of 2 gallons per minute. The system also needs to store, regulate, and distribute 1,200 gallons of water.

As shown in Figure 1, the system is composed of five major components including the solar panels, the submersible pump, the water filters, the storage tank, and the battery pack as an alternative power source. The 4 135 watt solar panels provide power for the submersible pump, the UV filter, and slight lighting needs. The submersible solar pump can deliver up to 6 gallons per minute and lift up to 200 feet maximum depth capability. The pump turns off automatically by a float switch when the storage tank is full. The five-stage water filters (Figure 2) include a 20 micron pre-filter and a 1 micron sediment pre-filter to remove sediments, a KDF/GAC filter and a carbon GAC filter to remove heavy metals and enhance the taste, and a UV filter to kill bacteria and germs. These filters are designed to remove 99.9% of all contaminates and 99.999% of all microorganisms, and can purify up to 200,000 gallons of water per year. The batteries are only used when the solar panels cannot provide enough power, such as during cloudy or rainy days.

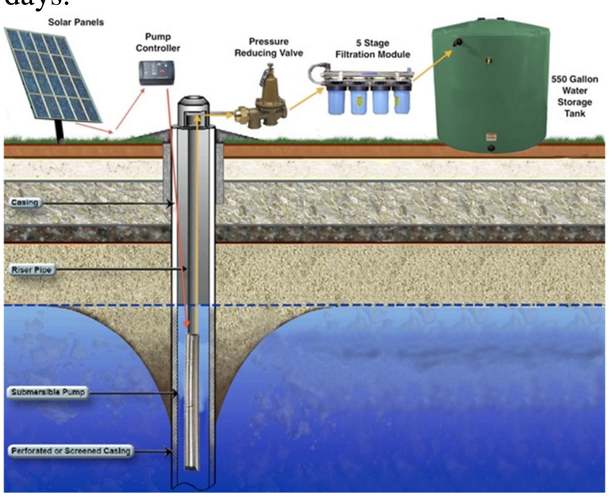

Figure 1 The Schematic of the Solar Powered Water Purification System

Figure 2 Five Stage Water Filters

After the system was installed, we compared the water quality of the treated water from the system and the untreated city water these orphans usually drink. The results (Figure 3) show a significant improvement in water quality.

As an extracurricular activity, the project took the team four months from design to delivery and successful installation. Although the system is mainly made up of off-the-shelf parts, due to lack of communication with end users, it was very hard for the team to finalize the design. Furthermore, the team was challenged by several logistic issues during delivery and installation of such system in the orphanage, which is located a ten-hour driving distance away from Haiti's capital, Port-au-Prince. We present the design challenges and logistic issues in the next section.

Figure 3 (a) The untreated city water which has numerous bacteria growth spots with multiple species

Figure 3 (b) The filtered well water which shows only 2 bacteria growth spots

Figure 3 Water Purification Result

Design Challenges

The design challenges arose from uncertainty and ambiguity about end user needs. Since there was no direct communication, such as email or phone, available in the orphanage, we were not able to get in touch with the staff there to know their needs and obtain the site information. All the information we had was from the project sponsor, a renewable energy company CEO, and the director of ACJF, who is a pastor in Redding, Connecticut. Neither of them can provide a clear list of needs. Also, the well was not drilled yet, so we were unaware of the well depth and water quality. Such ambiguity created uncertainty in our design decision.

For the pump selection, we were told the well depth would be around 200 feet, which was estimated based on a recently drilled well nearby at a higher elevation. Since the depth was an estimation figure, the decision based on this number may result in either an overqualified pump, or one which cannot be used to provide enough lift. Either scenario could increase the budget and jeopardize the investment. In addition, the uncertainty on pump selection also places a hold on sizing the power of solar panels. The project halted at this stage for about couple of weeks until we received the sponsor's agreement on this estimation.

The initial need of the project was provision of clean water to the orphans. When students had almost finished the design and testing, new requests arose, such as providing utility water for construction, lighting needs in the whole building, and extra power for appliances and computers. After negotiating with the sponsor and the orphanage director, we decided that these needs would not be addressed in this design. However, such change did give the team certain setbacks.

The effectiveness and duration of the water filters mainly rely on water quality. However, since the well was not drilled yet, no water analysis was available for us to predict the water turbidity, sulfur level, arsenic level, and microorganism density. Therefore, the team had to adopt a common configuration of a water filtration system, which may not last as long as used in normal situations.

One interesting design issue arose due to culture difference. When we designed the final water delivery system, we naturally came up with a design using a fountain with multi water bubbler faucets (Figure 4). However, our design did not please the staff at the orphanage because they could not figure out how to use them. As a result, we modified the design by adding a normal faucet they are familiar with so that they can use it to fill buckets easily.

Figure 4 The Fountain with Multi Water Bubbler Faucets

Tackling these design challenges gave students the experience of solving open problems with constraints and adopting working solutions even without sufficient information.

Logistic Issues

In addition to the above foreseeable design challenges, additional logistic issues were encountered. Some of these issues could have possibly resulted in failure of the project. Based on our experiences through Project Haiti, we strongly suggest that these logistic issues should be paid more attention, especially for such projects implemented in a third world country.

Travel Embargo

Some airlines have summer box and bag embargo on certain flights. Under the embargo, oversize, overweight, and excess baggage will not be accepted on these flights. Haiti is on the seasonal embargo list of American Airlines, which means that we could not check oversized and overweight parts, including the solar panels and the box holding water filters and the pump.

Fortunately, not all airlines enact the embargo. We successfully brought these oversized parts to Haiti by buying tickets from an airline without an embargo. If we had been aware of the embargo, we might have either chosen different travel dates or a different airline.

Accommodation and Dining

Our flight destination was Haiti's capital Port au Prince, while the orphanage is located in Chambellan which is ten-hour driving distance away. Having a safe place to stay in Port-au-Prince before we head for the orphanage is extremely important to ensure the team's safety. Through our contact with Nehemiah Vision Ministries (NVM), an international organization focused on transforming the lives of Haitians, we were able to stay safe and healthy in Port-au-Prince (Figure 5).

Figure 5(a) The NVM Volunteer Dorm Figure 5(b) The NVM Dining Hall

Figure 5 The NVM Campus Facilities

Translator

Although we brought most parts to Haiti, we still needed to buy other components there, such as pipes and fittings. As it was a ten-hour bus ride from Port-au-Prince to Chambellan, we had to go through several check points during the trip. Such purchase and travel needs could not be completed without a translator. Our local translator, "Junior", a language teacher at the University of Haiti, provided us tremendous help in shopping and passing check points.

Lessons Learned

All team members felt that this trip was a life changing experience. As the university president Dr. Johnson said about on our project: "we are more than high-tech – we are high touch. It's a nice blend of engineering and caring for people." We would like to extend our success to have broader impacts. As many references indicate, project-based service learning (PBSL) not only benefits a community but also provides a rich learning experience [1-4]. We hope what we learned from this PBSL experience will motivate more engineering educators to explore effective projects and strategies in PBSL to enhance engineering education.

Winning Factors

We have successfully commissioned a solar water purification system in Haiti. When reviewing the whole process from design to installation, we all agreed on the following determining winning factors: the support from the sponsor and the university administration, the committed team, and the past experience of travel in Haiti. If any of these factors had a weak link, we would not have been able to complete the project.

The biggest barrier to completing the project was the cost. The sponsor raised and matched funds to pay for all hardware and contract the drilling of a 125 foot well. However, in order to send the team to the orphanage to install the system, we still need around $10,000 for travel funds. We were very thankful that the president generously provided us with the travel support when he heard of our financial needs. Such high-tech-high-touch vision not only leads to the success of this project, but also transforms how our students perceive their identities as engineers.

As an extracurricular project, this could not have been successful without a committed team. All students in this team spent a lot of their spare time in designing, communicating with end users, and trouble-shooting problems. None of the students had worked on the similar project, so they could easily get overwhelmed by the above design challenges. All students were motivated by the meaning of the project, and their hard work and perseverance made the project successful.

As explained above, any logistics issue could easily become a failing factor if not resolved. One faculty member's past experience of traveling in Haiti as a volunteer helped us achieve a hassle-free trip to Haiti, despite the danger of violent crime. Without the Haitian translator and the accommodation and dining we received from the NVM and the orphanage, our health, and even safety, may be threatened, in addition to the completion of the project.

Recommendations

While we have successfully completed the project, we realized that we benefited from some lucky factors that may not be repeatable. As a result, our one-time success in PBSL may not be sustainable, or make broader impact on other engineering education community interested in PBSL. We still would like to provide some recommendations based on our limited experiences. We plan to conduct a more qualitative and quantitative analysis to develop a PBSL model including finding project resources and funding support, to logistics arrangements and project implementation.

More and more universities may intend to integrate PBSL in engineering education due to several benefits, such as achieving higher retention rate in engineering and enhanced awareness of social impact of engineering [5]. Those who are interested in doing similar projects in a third world country may wonder how to find these opportunities. Establishing a partnership with those nonprofit organizations (NPOs) helping third world countries would be a good approach. These organizations have strong needs and rich experiences in taking volunteers working on the projects in third world countries. All the projects we have been involved were initiated through such NPOs. Campus Crusade for Christ International is such an example of NPO.

As we explained above, the sponsorship is critically important for implementing similar projects due to the high travel cost. Many NPOs may only provide project opportunities without funding support. As a result, the team needs to be responsible for fund raising. Based on our experience, we would suggest trying the following resources: university administrations, university Board of Trustees, the alumni association, and local churches.

In addition, logistic issues should receive more attention. For example, if your project requires shipping of oversized baggage, you need to ensure the travel dates and flight will not be affected by the travel embargo. You also need to be fully aware of primitive living conditions in order to plan for the trip to ensure the health and safety of the team during the stay.

Conclusion

This paper presented our experience of designing and installing a solar powered water purification system for a Haitian orphanage. We reviewed our experience from the perspectives of design challenges and logistics issues. We also identified winning factors that led to the successful completion of the project. Although we were unable to develop a PBSL model through this project, we will conduct more qualitative and quantitative analysis for future similar projects, such that other universities may benefit from our results.

Bibliography

1. Tsang, E., *Projects that matter: Concepts and models for service-learning in engineering*. Vol. 5. 2000: Amer Assn for Higher Education.
2. Duffy, J., et al., *Service-learning projects in core undergraduate engineering courses.* International Journal for Service Learning in Engineering, 2008. **3**(2): p. 18-41.
3. McCormick, M., et al., *Enhancing engineering education: Learning to solve problems through service-learning projects.* Engineering, 2008.
4. Smith, J., et al., *New Partnerships Linking Universities and NGO's on Education for Development Engineering-Case Study From Engineers Without Borders Australia.* IGIP-SEFI Proceedings, 2010.
5. Angela bielefeldt, et al, *Measuring the impacts of project-based service learning.* 2009 ASEE Annual Conference