



## Capstone Design Alumni Survey

### **Dr. John Aidoo, Rose-Hulman Institute of Technology**

Dr. Aidoo is currently an associate professor of Civil Engineering Department at Rose-Hulman Institute Technology. Prior to this appointment, he worked as the Bridge design engineer at South Carolina Department of Transportation. He received a B.Sc. from the University of Science & Technology in Ghana in 1997 and a M.Sc. and Ph.D. from the University of South Carolina. His research activities include repair and strengthening of buildings and bridges using Advanced Composite Materials, laboratory and field testing of structures and the fatigue behavior of concrete bridges.

**Mrs. Shannon M. Sipes, Rose-Hulman Institute of Technology**

**Prof. James H. Hanson, Rose-Hulman Institute of Technology**

**Dr. Matthew D. Lovell, Rose-Hulman Institute of Technology**

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## Abstract

In 2005, the Department of Civil Engineering at Rose Hulman Institute of Technology (RHIT) decided to incorporate an international component into its 18 year old capstone senior design course. Over the last 8 years, the department has offered at least one international design project every year.

The Civil Engineering Department and the Office of Institutional Research, Planning and Assessment (IRPA) of RHIT have implemented an annual assessment on both the short and long term impact of international design projects. Despite the associated challenges with international projects, results indicate that the short term benefits are immediate and profound. In spring 2012, in order to assess the long term benefits, civil engineering alumni from 2006 through 2011 were asked to participate in a survey on their senior design experience and how this experience has impacted their professional growth. A total of 84 alumni completed the survey. Major comparisons were made between two main alumni groups: those who undertook international projects and those who took part in domestic projects.

Based on the responses obtained from the spring 2012 survey, a follow-up survey was undertaken in fall 2012. The objective was to further explore three interesting findings from the spring 2012 survey. Alumni who had only participated in international design projects were targeted for this second survey. This paper discusses the results of the data collected during the second phase of the assessment process.

## Introduction

Each summer, fifteen to twenty corporate or governmental sponsors submit proposals for design projects to the Civil Engineering (CE) Department at Rose-Hulman Institute of Technology (RHIT). In August each student ranks the projects, and assignments are made to maximize student preferences. Each design team includes four to five seniors, a faculty coach, the client, and the course instructor. There is no charge for the design projects other than direct costs. These yearlong, client-based projects have been the senior design capstone model at Rose-Hulman since 1988. The four learning objectives for client-based, senior design projects include: (1) problem-based learning (of the civil engineering design process), (2) communication proficiency, (3) team-work skills, and (4) project management orientation. The year-long experience contains many key elements and deliverables to achieve these learning objectives.

In 2005, members of the civil engineering faculty decided it would be beneficial for students to venture into the international arena. The dialog began when a faculty member participated in a mission trip to Trinidad during the summer of 2005. Conversations with the facilitator in Trinidad resulted in a senior design project for Rose-Hulman students. There are many good reasons to expose engineering students to international projects. For example, the explosion of knowledge precipitated by the Internet and the resulting global economy will make engineering services increasingly dependent on an international

talent pool. This is very apparent to the National Academy of Engineering as stated in its report on the engineer of 2020<sup>1</sup>. Global competition from India and China is an inescapable conclusion of Thomas Friedman in his book entitled “The World is Flat”<sup>2</sup>. The advantages of international experiences for engineering students are well documented:

- Partnerships with local or international organizations.
- Exposure to international design codes.
- Experience in the global working environment.

These are just a few of the benefits associated with international projects. However getting involved in foreign projects is not without its problems:

- Students face challenges associated with distance (e.g., site visits).
- Students have to deal with the different cultural and educational environments.
- Students experience difficulty obtaining necessary data.

Despite the associated challenges, the benefits to the students are seen as immediate and profound. Our first international senior design project (2005-2006 academic year) produced many challenges. The lessons learned encompassed all phases of the project as summarized by Hanson et al<sup>4</sup>.

### Models for International Capstone Design Projects

International capstone design projects have taken a variety of forms over the last few years: joint project, travel overseas, and stay at home. The advantages and disadvantages of each model are discussed by Hanson et al<sup>4</sup>.

### International Projects Undertaken (2006-2012)

Since 2005, the CE department has offered at least one international design project every year. These collaborations have involved four different countries: Trinidad, Ghana, Sudan and Pakistan. A summary of the scope of work for these projects are provided in Table 1.0.

**Table 1.0. Summary of International Projects Undertaken**

Year	Project Location	Model Adapted	Scope
2006	Trinidad	Stay at home	<i>Design of a missionary compound.</i>
2007	Ghana		<i>Design of an agricultural training facility.</i>
2008	Sudan		<i>Design of an educational campus.</i>
2009	Ghana		<i>Design of cocoa storage facilities.</i>
2009	Pakistan		<i>Design of a water supply system.</i>
2010	Ghana		<i>Design of hospital facilities.</i>
2011	Ghana		<i>Design of a university housing estate.</i>
2012	Ghana	Joint project	<i>Design of a modern marketplace.</i>

***Missionary Compound (Trinidad, 2006)***

This project involved the design of a missionary compound in Las Lomas, Trinidad. The compound included a medical facility, orphanage, battered women's shelter, soup kitchen, and house for visiting missionaries.

***An Agricultural Training Facility (Ghana, 2007)***

This project involved the design of an agricultural training facility. The facility included a computer training center, conference hall, caretaker house, hostel, poultry building, office space, and executive chalets.

***Educational Campus (Sudan, 2008)***

This project involved the design of an educational campus. The educational campus included an office building, a gymnasium/auditorium building, a soccer field, and a wastewater treatment system.

***Cocoa Storage Facilities (Ghana, 2009)***

This project involved the design cocoa storage facilities. The design for the site included four warehouses for storing cocoa, a roadway layout including space for parking and a container terminal, elevated and underground water tanks, a wastewater and solid waste disposal system, a stormwater drainage system, a water distribution system, and space for a canteen and washroom facility.

***Water Supply System (Pakistan, 2009)***

This project involved the design of a water supply system to provide clean drinking water to the village of Shah Maidan, Pakistan. The goal of the project was to replace the existing water supply with a system that can supply ten gallons per day per person of clean water.

***Hospital Facilities (Ghana, 2010)***

This project involved the design of auxiliary facilities for the new hospital in Kumasi, Ghana. The facilities included a three-span reinforced concrete bridge, block of flats that serve as housing facilities for the hospital employees, storm water management system, and water distribution system.

***University Housing Estate (Ghana, 2011)***

This project involved the design of apartment complexes and bungalows to house 650 faculty and staff members for a university in Ghana. The project also included the design of the water distribution network, the water storage system, the transportation network and connection to existing roadways, the wastewater treatment system, the stormwater management system, and the solid waste collection system.

***Modern Marketplace (Ghana, 2012)***

This project involved the modernization of a marketplace in the town of Mamponteng, Ghana. The project included the structural design of a warehouse, hydraulic designs for both the water supply system and the drainage system, designs of both the solid and the liquid waste management systems, and design of roadways within the market.

## Summary of Assessment Undertaken

Since 2005, the Civil Engineering department and IRPA have developed assessment tools in order to collect data on the short and long term impacts of international design projects on student experiences and professional growth.

### *Short Term Assessment*

At the end of the 2006 -2007 project in Ghana, the students traveled to present the village with their design for the Agricultural Training Facility. A summative assessment was implemented to examine the impact on students both academically and personally. A summary of the results for the short-term assessment is published by Aidoo et al<sup>5</sup>.

### *Long Term Assessment*

In spring 2012, questionnaires were sent to alumni who had been involved with international design projects as well as those involved with domestic projects. A total of 84 alumni completed the survey (11-international, 73 domestic; representing a 56% response rate). The goal was to contact these students after graduation to assess the impact of international design experience on their professional career and growth. The conclusions drawn from this study were published by Aidoo et al<sup>6</sup> and are:

- *Those that did international design projects are much more likely to undertake international trips to do humanitarian work.*
- *Student satisfaction with senior design is very high and is influenced by completing a site visit.*
- *Satisfactions with international and domestic projects are about the same.*
- *Student interest in humanitarian work is high regardless of the type of project they worked on (i.e. international or domestic).*
- *The percentage of students working on international projects in their career is greater for those that worked on international senior design projects.*

## International Alumni Interview Analysis

In fall 2012, questionnaires were sent to alumni who had been involved only with international design projects. This was a follow up to the questionnaires sent earlier in the year to assess long-term impact. The main goal of this survey was to further explore three interesting findings from the spring 2012 survey.

### Participants

Ten civil engineering alumni who participated in international projects during their senior design course sequence were invited to participate in individual electronic interviews via email to further explore three interesting findings from a survey they previously took. All of the civil engineering alumni who participated in an international project between 2006-2011 (N = 28) were invited to take part in the interview process.

## **Instrument**

These interviews were exploratory in nature. Therefore, a semi-structured protocol was chosen to allow the researchers to explore unanticipated areas of interest that may arise during the interviews. Since the interviews were completed via email, the researchers planned calls to the alumni at a later date to follow up on any aspects that may need clarification or could yield additional insightful data. The protocol consisted of the following questions.

1. *How did working on an international senior design project as a student impact your current international project work?*
2. *How would the ability to go on a sight visit during your senior design project impact your growth?*
3. *Please tell us about your interest in international humanitarian work?*
4. *Please tell us about your experiences with the cultural aspects of an international design project.*
5. *What suggestions do you have for the civil engineering department for international senior design projects?*

## **Procedures**

The first author sent the interview items to all appropriate alumni explaining the project and inviting them to participate. Interview note analysis included both open and axial coding, Creswell<sup>7</sup>. The second author began by identifying general codes through the interview notes. These codes were then grouped into related themes.

## Results

The coding process resulted in 10 codes and three themes (Table 2.0).

**Table 2.0 Interview Analysis Codes and Themes**

Theme	Code
Education	Course Aspects
	Deliverables
	International Teammates
Site	Culture
	Site Visit
	Funding Student Travel
	Technical Issues
Career	Culture
	Work Status
	Mentor
	Continuing Education

### Education

While the value alumni found in the project varied based on the project location and the issues and structure of that location, there were some common elements to an effective educational experience. During their time as students, some of the alumni worked with other students at a collaborating school in the country the project site was located in. For these alumni, this collaboration served to expose them to some of the culture of their project country. Similarly, having a client who is motivated to remain in touch with the group and work with the students was seen as key to a good educational experience. Adding a cultural liaison at the project site that understands both the American and site's cultures was thought to enhance the educational component of the students by assisting in working through cultural issues that may arise such as communication and different holiday schedules.

Alumni stated the ability to go and visit the site of the design and meet the client (and their teammates when applicable) would have enhanced their educational experience and allowed them to create a better quality project that would be more feasibly implemented than the project they ultimately turned in.

One of the suggestions to improve the international design projects was having a study abroad opportunity specifically with KNUST (Kwame Nkrumah University of Science and Technology, Ghana). Relatedly, alumni suggested finding projects in nearby countries such as Mexico, Central America, or the Caribbean. They felt this would make it more feasible for students to visit their project site.

On campus suggestions for improvement focused on adding additional lectures and readings on sociological aspects of an international project as well as other issues that are specific to an international design.

## **Site**

Site visits are crucial to the proper completion of projects and can prevent many errors when going from plan to project. While alumni would have enjoyed the opportunity to visit their site at any point in their project, they felt the beginning (potentially over fall break) would have been the most useful. All of the alumni recognize the issue of funding. However, they saw this barrier as one that could be overcome. Alumni suggested combining a variety of sources to raise the necessary funds: civil engineering department, Engineers without Borders, alumni, and students.

There were many reasons alumni would like the opportunity to visit their project site. They felt the language barriers they found in long distance communication would be reduced with the ability to talk with their client in person. In addition to communication, students felt they would learn the most about the culture of their client through a site visit. While they learned some aspects of the culture such as the slower pace of “things”, they did not feel able to fully understand and appreciate the cultural differences and then incorporate those into their design.

Further, alumni wanted to visit the site to get a “better understanding” of how things work on the ground. Designing with locally available materials, incorporating local customs, and the infrastructure of a specific location were all aspects alumni cited as different from the United States. These are things they originally took for granted when designing from their American perspectives. “When [we] began the project I thought they would have all of these items and we would be able to design like we do in the United States.”

One alumna very eloquently summed up the need for a site visit. “Having worked in Africa on projects for 3 years, I now realize how much a site visit could have impacted our design. Our design lacked a lot of practicality because we didn’t have first-hand experience with the culture and environment we were designing for. A site visit, while very expensive, could have taught us a huge amount about working in other cultures. It’s something many American engineers never experience and have no real concept of. If an engineer expects to design or work overseas, it is important to experience and learn about this.” Further, “many overseas projects break engineering down to the bare bones of practicality because construction and engineering has to be made simple. It is such a valuable learning tool to see this first hand.”

## **Career**

For many alumni, the experience of an international senior design project confirmed their interest in continuing to work on these projects in their careers. Current positions of these alumni include consulting on international projects, working for a corporation and focusing on international projects, Peace Corps, Army National Guard, and international graduate work. They think their experience on an international design project has allowed them to be successful (or even gain) their current position.



## Conclusions

While alumni found benefit to working on an international design project as seniors, they recognized a number of drawbacks from their inability to conduct a site visit. Alumni thought a site visit would not only benefit the ultimate design of their project, but would enhance their education and understanding of non-technical issues concerning engineering on international projects. Finally, while they admitted the cost factor as a barrier to the site visit, they did not find that prohibitive and offered a number of suggestions to overcome this issue.

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