Overcoming the Communication Challenges in International Student Design Projects

Rachel Howser—Department of Civil Engineering, Rose-Hulman Institute of Technology, Terre Haute, Indiana, 47803, howserrn@rose-hulman.edu, Phone: 812-989-5795
Matthew Trowbridge—Department of Civil Engineering, Rose-Hulman Institute of Technology, Terre Haute, Indiana, 47803, trowbrma@rose-hulman.edu, Phone: 812-249-9120
Jeffery Gauthier—Department of Civil Engineering, Rose-Hulman Institute of Technology, Terre Haute, Indiana, 47803, gauthijj@rose-hulman.edu, Phone: 512-627-5808
Nathan Bloss—Department of Civil Engineering, Rose-Hulman Institute of Technology, Terre Haute, Indiana, 47803, blossnc@rose-hulman.edu, Phone: 715-379-7942
J. David Fields—Department of Civil Engineering, Rose-Hulman Institute of Technology, Terre Haute, Indiana, 47803, fieldsjd@rose-hulman.edu, Phone: 270-991-7472
John Aidoo—Department of Civil Engineering, Rose-Hulman Institute of Technology, Terre Haute, Indiana, 47803, aidoo@rose-hulman.edu, Phone: 812-877-8594
James Hanson—Department of Civil Engineering, Rose-Hulman Institute of Technology, Terre Haute, Indiana, 47803, hanson@rose-hulman.edu, Phone: 812-877-8279

Abstract

As part of the capstone design experience, the Department of Civil Engineering at Rose-Hulman Institute of Technology teamed five seniors to design an educational complex in Khartoum, Sudan. This is the department's third international project as part of its 20-year-old senior design program. This international experience provides students many opportunities including partnering with international organizations, exposure to international design codes, standards, and customs, as well as gaining experience in the global working environment. Despite the benefits, international projects also incorporate many challenges including differences in cultural and educational environments, difficulty obtaining necessary data for design, and challenges associated with the inability for the students to easily access the site. Therefore, a key aspect in the success of an international project is communication. This is especially imperative when design standards and customs are different from those used in the United States. Students need professional contacts with engineering knowledge to provide insight to the different engineering practices in other countries. Students must also make ethical decisions on whether to follow potentially unsafe design practices used regularly in other cultures. This paper discusses the students' efforts to overcome international communication barriers to produce the best possible solution for their design project.

Introduction

The Rose-Hulman Institute of Technology civil engineering department began a tradition in 1988 of requiring a year-long, client-based senior design project as part of its curriculum. Each year, teams of four to five senior students undertake civil engineering projects submitted by corporate,

private, and governmental clients. The department uses these projects to implement principles of planning, design, and synthesis. At the end of the course, the students present final recommendations and engineering designs to the clients with due attention to social, economic, and environmental constraints of the project.

In 2005, the department decided to expand their senior design program to include international projects. The department made this decision for a number of reasons:

- It allows students to gain an international experience.
- The National Academy of Engineering report on the engineer of 2020 suggests that due to the increasing rate of globalization it has become mutually beneficial for countries to share resources in the completion of projects.[1]
- American engineers often complete the design for projects in other nations.
- It is helpful for students to gain international experience as an undergraduate so that they are prepared for the possibility of international relations in their careers.

Another reason why the department chose to include international projects in their senior design program was that these projects are service oriented. The international projects have a potential to greatly improve the quality of life for individuals within a developing nation. Over the previous two years, Rose-Hulman student teams have completed projects in Trinidad and Ghana. The project in Trinidad consisted of the design of a mission compound that would include a medical facility, orphanage, battered women's shelter, soup kitchen, and house for visiting missionaries. The project in Ghana included the design of five buildings that would serve as an agricultural training center. These projects provide students the opportunity to improve the infrastructure in a developing nation.

The 2007-2008 international senior design project is located in Khartoum, Sudan and consists of the design of the Nile Valley Academy (NVA) educational campus. See Figures 1 through 4 for the project location. The project will consist of the design of a gymnasium/auditorium building, soccer field, and office/education building. Other design aspects include a wastewater treatment system, stormwater design, the design of covered walkways that will connect buildings, and a landscaping plan. The client, Aslan Associates, is a Sudanese-registered Ltd. Co. that serves the Sudanese people through training, social services, humanitarian activities, and business development. With the country at peace and the local economy booming, Khartoum is experiencing unprecedented growth. Within the city, there is an increased demand among the Sudanese for an excellent education for their children. Additionally, there is a desire for Sudanese children to be educated in a western style in preparation for western universities. A shortage of quality educational facilities within the city makes this project a necessity.

Figure 1: Map of Northern Africa with Sudan highlighted[2]

Figure 2: Map of Sudan showing relative location of Khartoum[3]

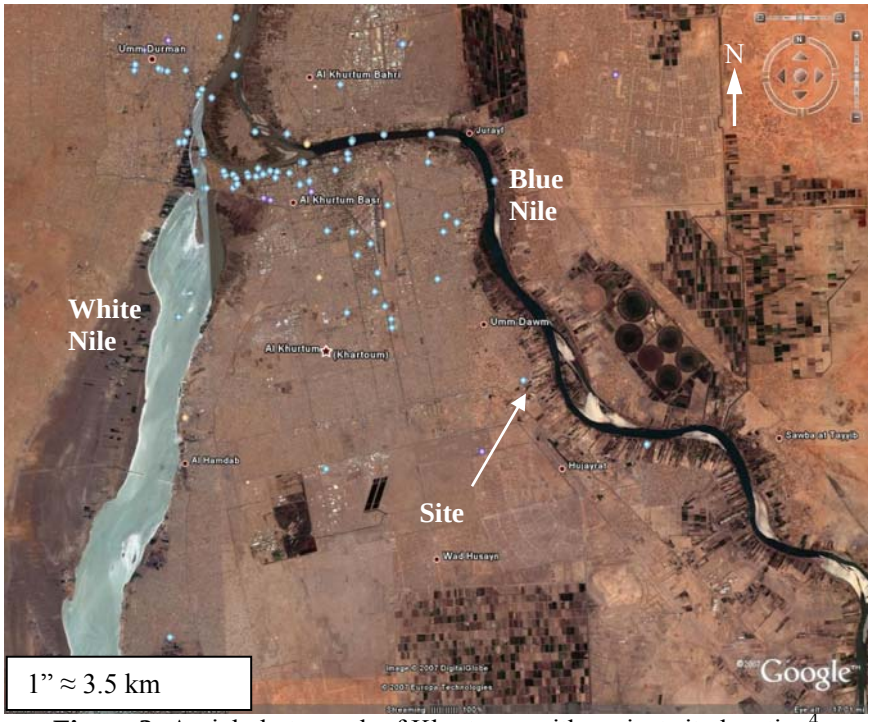

Figure 3: Aerial photograph of Khartoum with project site location[4]

Figure 4: Aerial photograph of the current site outlined in white[4]

Communication Challenges in International Projects

Several issues make international design projects more challenging than domestic projects. Many of these challenges are associated with differences in design codes and customs in other countries. There are also challenges associated with the inability of groups to access the project site. In many cases, the success of such a project pivots entirely on the group's ability to communicate effectively.

American engineering students take many things for granted. The United States has a long tradition of codes, regulations, and customs that are associated with engineering and construction work. When a student team undertakes an international project, they need to determine codes, regulations, and customs used locally at the project location. For developing countries, these codes, regulations, and customs are not well recognized in America. In this case, it is up to the students to establish contacts with people who are familiar with local engineering and construction practices. Establishing these contacts and communicating with them is a significant challenge.

Another challenge associated with international work is the distance between the designers and the project site. There is a significant amount of fieldwork required in many civil engineering projects both to assess if the project is feasible and to obtain information critical for the design. This fieldwork generally consists of a walkthrough of the site to check for environmental contaminates, unfavorable soil conditions, wetland and floodplain areas, utility locations, and any unusual features. It is also necessary to complete a geotechnical investigation and survey of the site. Due to the lead-time for a visa and economic burden associated with traveling to an international project site, it is often not feasible for a student team to visit the site. Because of this fact, it is necessary for the students to find individuals that have access to the project site to carry out these tasks for them. Often these individuals may not be familiar with engineering practices and must receive instruction via effective communication to complete accurate fieldwork.

Due to the increase in globalization, engineers, engineering faculty members, and students around the world have taken extra initiative to bridge the communication gap with the international community. A group of undergraduate students at the University of Notre Dame partnered with a group of graduate students at the University of Abomey-Calavi in Bénin, West Africa to complete research on monitoring groundwater quality in Bénin, West Africa. They presented a paper on how using common software and field experiences can aid in allowing international student collaboration.[5] Other research has been conducted involving cross-cultural international engineering challenges. These studies focus on non-native speakers of secondary languages and comparing the discourse of people of different cultural and linguistic backgrounds.[6] Civil engineering programs are not the only programs exploring international

projects in their capstone senior design projects. Undergraduate teams are forming all over the world to complete projects in every engineering discipline.[7]

Successful Communication Associated with the NVA Project in Khartoum, Sudan

The team working on the NVA project consisted of Rose-Hulman Institute of Technology senior civil engineering students Nate Bloss, J. David Fields, Jeff Gauthier, Rachel Howser, and Matt Trowbridge in addition to faculty advisors Dr. John Aidoo and Dr. James Hanson. The team was unable to travel to their project site in Khartoum, Sudan for a site reconnaissance nor were they familiar with codes, regulations, and construction practices in the area. Because of this, they were required to communicate with individuals in Sudan rather than completing the work themselves.

The first contacts the students made in Sudan were their client contact, Rick Heugel, and his wife, Clydell. Rick and Clydell are Americans employed by Aslan Associates[8] with over 10 years of international project experience in Kenya, Tanzania, and Sudan. The group met with the Heugels on a weekly basis over the course of the project via Skype, a program that allows users to make telephone calls over the internet free of charge.[9] The program also supports a video conferencing feature that was useful during the project.[10] Through contact with the Heugels, the students were able to obtain pictures of the site as well as a site layout. The Heugels provided information about the topography and vegetation and described the current structures on the site. Additionally, they examined the property for any potential environmental hazards with instruction from the students. Although the Heugels had no engineering experience, they provided insight regarding building practices in Sudan.

The next individual the students contacted was Dr. Robert Houghtalen. Dr. Houghtalen is the civil engineering department head at Rose-Hulman Institute of Technology. He is currently on sabbatical in Sudan and has access to the site. Unlike the Heugels, Dr. Houghtalen has a significant amount of civil engineering experience with an emphasis in hydrology, hydraulics, and environmental engineering. The students communicated with Dr. Houghtalen via email on an as needed basis. Dr. Houghtalen was able to aid the Heugels in looking for potential environmental contamination. He also worked with the Heugels to perform a basic geotechnical investigation of the site. Although Dr. Houghtalen's expertise was helpful to the students, he was very busy completing mission work while in Sudan and was not always accessible to the students.

The group was successful in establishing contacts with several individuals in the United States. Dr. Houghtalen's son, Jesse, spent a significant period of time in Khartoum. Jesse earned a bachelor's of science degree in civil engineering from Rose-Hulman in 2006. He came back to the United States in December and was able to describe some common building practices in

Sudan to the team. Another contact was Richard Stump, the vice president of Stanley Consultants International.[11] Mr. Stump has design experience in many countries with comparable climates and economic situations to that of Sudan. He provided technical assistance by making suggestions regarding wastewater treatment, structural systems, and low cost ways to cool the buildings.

Unresolved Communication Challenges with the NVA Project in Khartoum, Sudan

The student team encountered many communication challenges associated with their international design project. It is often frustrating for the students when their design projects do not go as smoothly as they expect. The first major challenge was establishing contact with a university faculty member in Sudan. Past international senior design teams at Rose-Hulman had established such contacts and had found them quite useful.[12] Civil engineering faculty members are generally familiar with building practices, codes, and regulations in their geographic area. The Rose-Hulman faculty members suggested that the students collaborate with a student group in Sudan and have them complete a geotechnical investigation for the project. To gain a university contact, the students searched through many sources. They explored university websites on the internet and asked the Heugels to help them search for a contact. The Heugels did eventually find the name and email address of a faculty member at the Sudan University of Science and Technology in Khartoum. The students also contacted several other faculty members in Sudan and neighboring counties as well as university professors in the United States who had studied in the area. However, the attempts were unsuccessful.

Another major challenge was communicating with the Heugels. The client's internet connection was not reliable. Therefore, communication was often slow and difficult because of the poor connection. Since the Heugels did not have any engineering experience, it was often difficult to communicate exactly what information the students needed and why. Often times, work on the project had to halt because the students were waiting on a crucial piece of information from the client.

The team also had difficulty convincing the client of the importance of engineering ethics. While extra design measures associated with engineering ethics may seem trivial to the outside community, they are actually crucial. When designers overlook these design steps, the results can be catastrophic. In 2005, a major earthquake struck Pakistan. The event resulted in over 80,000 fatalities and 200,000 people were injured. Many of these injuries were associated with inadequately designed buildings collapsing.[13]

The students determined that the standard of practice for wastewater treatment in Sudan could contaminate the groundwater table and would not be allowed in the United States. The students felt that it was unethical to design such a system and explored other options. The client originally did not understand the students' concern and wanted to move forward with a traditional Sudanese wastewater well. These wells are similar to a cesspool or a seepage pit.[14]

The students were able to convince the client that other options would provide a safer, more ethical design.

A similar situation occurred with fire safety. In Sudan current practice does not implement fire protection because it is an extra cost. The current belief is that buildings are mostly made of concrete and therefore naturally fire resistant. However, this logic is flawed in that other aspects of the building and its contents will burn including drop ceilings, wall coverings, and carpets. This created a significant ethical issue with the group members since it is generally required that any educational facilities in the United States be protected by a substantial fire protection system to protect the children in the buildings. The systems in the United States often involve firewalls, smokescreens, sprinkler systems, fire barriers, shaft enclosures, and many other safety measures. There are also a number of regulations related to fire safety including a limit to how close structures can be to each other and how many people can be present in a structure.

While not a communication challenge unique to an international project, another key issue was the bureaucracy present in the Sudanese government. The process required to gain information from the government was quite lengthy. At the beginning of the project, the Heugels provided the students with a site layout with which the students began to work. The Heugels warned the students that the government was planning to build new roads in the area and may take part of their property for these roads. After a series of communication between the Heugels and the government, it was determined that Aslan Associates would lose roughly one-third of the property to the government. This was determined four months into the students' work and required changing many aspects of the project. Some of these changes to the project included reworking the site layout and reevaluating project priorities.

Solutions to Communication Challenges

The students explored a number of solutions to their communication challenges. While the students did discover that Sudan uses the British Standard for Structural Use of Concrete[15] for their reinforced concrete design work, the students continued to try to find other codes and regulations used in Khartoum. They chose to begin design work, with the client's consent, using international, American, and British codes and regulations. The students completed design work in spreadsheets in a way that they could easily change. This allowed the students to make any corrections in a timely manner.

To develop estimates of the soil properties for the project site, the students explained to the Heugels and Dr. Houghtalen how to complete a basic soil test that would allow them to describe each soil layer using a group name. The soil test was ASTM International's Standard Practice for Description and Identification of Soils D2488-06.[16] Standard Practice D2488-06[16] steps the user through a process that concludes with the user identifying the soil group name of each sample. A significant amount of information is available on all of the soil groups and the student group was able to estimate all of the pertinent soil properties. While this method of investigation is not

preferable, it is better than not having any soil properties.

Whenever ethical dilemmas arose, the students always recommended ethical options. For example, instead of simply designing a typical Sudanese wastewater system that could contaminate the groundwater, they researched alternative wastewater treatment options appropriate for Sudan. The students then presented these options to the client. While the client may or may not choose to install the recommended system, the students did the best they could to educate the client on the importance of clean groundwater and the benefits of other systems.

Faculty Perspective

The communication challenges identified by the student authors are typically unique to international projects in developing countries or rural areas. To facilitate project success in those cases, faculty must work to establish contacts and open communication before a student team is assigned. A partnership with a local university with a civil engineering program is the ideal solution. However, this should be established well in advance of the start of the project. Other engineering disciplines at Rose-Hulman have client-based senior design projects. Those projects also require frequent communication with the client and site visits. Therefore, the challenges faced in this project are likely to be faced by student teams in other disciplines as well.

Conclusions

There are several things the students learned about effective communication, and they found that some things they did provided satisfactory results while they would do other things differently if given the chance. The students determined that the program Skype worked well. The students were able to videoconference, make telephone calls, or instant message their client easily. They also discovered the importance of gaining a contact with engineering knowledge in the geographic region of the project. If they were to start over, they would have more aggressively searched for a contact earlier in the project. They would also search for contacts within organizations such as Engineers Without Borders (EWB) and the United Nations Children's Fund (UNICEF) who have completed civil engineering work in Sudan. Another thing that may have been helpful early in the project is if the students had planned ahead and explainedthen focused on explaining to the client what the students needed from them in nonprofessionals' terms. This may have cleared up some of the miscommunication that occurred during the course of the project.

The faculty advisors for the Rose-Hulman international design projects have found them to be a positive experience. In addition to teaching students to effectively communicate, international design projects provide students with some international experience within the global working environment. They also teach students to approach other cultural environments by considering factors such as economics, society impacts, and the technology required for a project. A former

Rose-Hulman student commented about their international design experience, "This project taught me that America builds like America, and the rest of the world builds like the rest of the world. Designing for another country means that you have to think like that country and forget most things American."

Although the communication challenges associated with the NVA project often frustrated the students, it heightened their learning experience significantly. They learned what it was like to work on a real project with real problems. The students also noted the differences engineers must consider when working on international projects. Table 1 summarizes these challenges. Additionally, they learned to effectively communicate with both engineers and non-engineers about technical issues.

Table 1—NVA Communication Challenges and Solutions

Challenge	Attempted Solutions	Recommended Solutions
• Establishing contact with a local university faculty member or engineer	• Attempted to establish contact through the client • Attempted to establish contacts through email addresses obtained through university websites	• Start an aggressive search for an interested university faculty member at the beginning of the project • Faculty members at Rose-Hulman could find contacts before the senior design project began
• Determining design codes, regulations, and practices	• Searched the internet • Consulted faculty members at Rose-Hulman • Attempted to establish contact with a local faculty member or engineer • Began design work using international, American, and British codes in spreadsheets so calculations could be easily changed	• Establish contact with a local faculty member or engineer early in the project
• Completing fieldwork on project site	• Attempted to establish contact with a local faculty member or engineer and hoped to work with this contact to get a local student team to complete fieldwork • Asked client to complete fieldwork	• Establish contact with a local faculty member or engineer early in the project and work with them to find a student team willing to help complete fieldwork
• Communicating effectively with non-technical clients	• Communicated with client on a weekly basis and asked for information as needed	• Plan ahead and ask for needed information well in advance • Educate the client in advance on why certain information is needed
• Communicating the necessity of engineering ethics	• Explained the need for ethical designs as certain aspects of the project were designed	• Explain to the client early in the year the importance of making ethical engineering design decisions

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