

IPRO 326

High School in Pignon, Haiti

Final Report

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01: Introduction

The IPRO 326 team's objective for this semester was to design a school so an additional 400 children would have access to affordable education in the remote town of Pignon, Haiti. We assisted our partner Haiti Outreach in realizing this goal by providing them technical assistance, project management and costing tools, as well as advice and guidelines that will hopefully improve their construction techniques.

Our end goal, beyond aiding with the construction of the school that is currently being built, was to design an instructional manual that gives details of how to construct a one classroom module. This module can be replicated to enable a school building of suitable size to be built in any available location in the Central Plateau region of Haiti.

The design for the school under construction has been developed from sketches produced by students of the small existing high school in Pignon. It comprises of seven classrooms and was designed in a way such that it can be built with local labor and materials whenever possible. A large generator on the outskirts of Pignon supplies electricity to the town for only 4 hours a day, in the evening. We investigated the potential to utilize this supply and supplement it with a solar panel electrical system that will work in conjunction with the generator to charge a battery array to power the school. This system will serve to power a water distribution system to supply water to the students, fans to ventilate the classrooms, and the first computer lab in the region, with lighting to enable night classes to be conducted.

02: Background

In 2006, a group of students at IIT created a student chapter of Haiti Outreach, a non-profit, non-governmental organization working with communities in Haiti to create clean and available water systems and other community development projects. The mission of Haiti Outreach is "To empower the people of Haiti so they're able to improve their quality of life, strengthen their families and become self-sufficient." Haiti Outreach asked local students to initiate the design of a new high school building in Pignon, a small town in the remote central region of the country. IIT's student chapter of Haiti Outreach refined the original sketches into more workable plans that were approved by the schools governing body.

IIT's student chapter decided that the framework of an IPRO provided the best way to move the project further forward as the IPRO framework encourages students from different backgrounds to dedicate significant time to a project. The needs of the school were laid before the IPRO team, who were responsible for creating the design and supporting documentation. As the team researched and discussed design possibilities, it was determined that creating an instructional manual based on one classroom module would provide the most long-term benefit in Haiti. The manual would illustrate the steps required to construct one classroom, steps that could be repeated to create a school building of a size that would meet a particular local need.

One of the design considerations was that we not only needed to meet the needs of the students, but the design also had to be environmentally friendly, as well as able to be easily maintained with little outside support. This meant that we tried to use local construction practices to produce the different components required in the building. Or from supplies that could be procured within Haiti or neighboring Dominican Republic whenever possible. We also

tried to be conscientious of the way in which we utilized electricity by using high-efficiency components. Haiti is a low-maintenance culture so all systems that are implemented must require little maintenance and what is required must be easily completed by people with little technical expertise.

It can be difficult to work within these cultural constraints and still come up with a functional design, as we are accustomed to working with modern amenities. The team had to avoid cutting corners and adopting an “It’s good enough for Haiti” mentality as we completed this project.

03: Purpose

During the summer semester, the team set forth the following objectives:

- Develop the architectural plans for the high school in Pignon
- Complete designs for the solar electrical system
- Complete designs for a water distribution and sanitation system for the school
- Create a manual detailing how to construct key details in the building.
- Raise funds or receive donations for key aspects of the investigation or for the supply of crucial components

We chose to address these issues in our IPRO based mainly on the fact that Haiti outreach wanted this from our team. Haiti Outreach has the goal of finishing the high school that is currently under construction in Pignon by September. Therefore, with such a time constraint, it seemed that aiding in the high school project was what our IPRO team should focus on for this semester. The structure of our IPRO consisted of specialized sub-teams that enabled us to complete this project in a more efficient way. The goals for each sub-team were as follows:

Structural: -

1. Determine the strength of concrete used in Haiti
2. Complete a structural analysis of the high school under construction in Haiti

Architectural: -

1. Complete drawings for high school under construction
2. Produce a graphic representation for a prototypical school building

Electrical/Plumbing: -

1. Determine the electrical and plumbing needs of the school
2. Design a renewable energy system to fit these needs while augmenting available systems.
3. Produce wiring diagrams for the school

Quantities/Cost: -

1. Define costs for the project

Fundraising: -

1. Write fundraising template letter
2. Create fundraising poster
3. Contact companies for potential donations

0.4 Research Methodology

In our IPRO, each sub-team focused on a specific area of the project and completed the research needed for this area. Some of the sub-teams used more traditional research methods, such as reading information from textbooks or academic journals. However, most of the sub-teams used non-traditional research methods. This included asking advice from professionals (who had experience in similar projects), as well as obtaining on site information from Haiti Outreach. In particular the architectural and structural sub-teams received much of their information from sources in Haiti, as one goal of this IPRO was to aid in the building of a school that is already under construction in Pignon. Therefore, on site information relayed from Pignon was vital to the completion of that portion of our project. Similar information from Haiti was also required to determine accurate cost estimates of the construction.

05. Assignments:

An attached task list includes all of the tasks that were completed after week 3 of the semester. Before this date, our team (besides beginning work on the architectural drawings) mainly focused on planning of the project and brainstorming the best way to proceed. As the semester progressed each sub-team was responsible for making sure that the work was divided between the respective members, and that the group was on time with the tasks they needed to complete. We also had weekly meetings which served as progress updates for the entire team. The completion of the tasks that were planned for this project mostly went as planned. However the Fundraising group was not able to send out letters to companies as planned, due to approval not yet being granted. Perhaps the next IPRO will be able to continue this endeavor. Also, the structural group was not able to test the material used in the concrete in Haiti as the test molds will be delivered to IIT on the day before final presentation and a 28 day cure period is ideally required before compression testing should be carried out, however the material will be tested and the results past on to our partner in Haiti.

A breakdown of the sub-teams is as follows:

Group	Name	Role	Major
01 Architectural	Franklin, Casey	Working Drawings	Architecture
	Lowe, Scott	Working Drawings, Liaison between Architectural and Structural Groups	Architecture
	Jaromin, Sebastian	Working Drawings, Plumbing Drawings w/ Mechanical Group	Architecture
	Watkins, Brett	Working Drawings	Architecture
02 Structural	Diaz De Leon Orraca, Federico	Material Testing	Architecture
	Velichkov, Veselin	Structural Assessment	Civil Engineering

03 Electrical	Dike, Chukwuderaa	Solar Panel/Electrical System Design	Electrical Engineering
	Igbokwe, Chinedu	Solar Panel/Electrical System Design	Electrical Engineering
04 Mechanical and Plumbing	Hogan, Brian	Water Sanitation, Septic System Design	Chemical Engineering
05 Quantities and Costing	Kirsch, Joseph	Data Organization	Architecture
06 Fundraising	Bailey, Nicholas	Fundraising, Electrical System Design	Mechanical Engineering
	Goldsmith, Katie	Fundraising, Minute Taking, Overseeing Reports and Presentations	Psychology
	Samuels, Janina	Image Preparation	Architecture
	Williams, Allisyn	Image Preparation	Architecture

0.6 Obstacles

Our team had some communication and organization concerns, both within our own team as well as with our partner Haiti Outreach. It was difficult to manage communication and relay information within our group as we had many different sub-teams working on different tasks at the same time. We compensated for this by holding a weekly meeting for progress reports from each sub-team as well as to aid with communication between the different sub-teams. Also, the architectural and structural sub-teams had some issues with building specifications being changed throughout the project, as it made past work somewhat irrelevant. However, the project was clear and unchanging for the bulk of the semester, so it did not affect the overall goals of the semester.

0.7 Results

Structural:

The most difficult obstacle the structural subgroup faced was the uncertainty with respect to the structural properties of the concrete that is being used in Pignon. In order to solve this problem, research was done on the standard structural tests that are conducted for such purposes. After adequate research was done on what was needed for the tests, the group then acquired and shipped to Haiti the equipment that was needed to obtain samples. These samples will be tested at our facilities to ascertain if assumptions of compressive strength are close to the reality of the material used in the construction. Additionally, the subgroup completed a preliminary structural analysis that yielded important information about the structural performance of critical members. Lack of accurate data regarding material properties made exhaustive analysis impossible. Despite lacking data, the group was able to confirm, via a rough, partial diagnosis, the soundness of design and sizing of the most important structural elements. The fact that the project is already under construction limited the options for changes to the design of the building. If

possible, efforts should be made to incorporate a sound structural logic in the earliest stages of the design. This is something that should be considered for future buildings of this nature.

Architectural:

The major accomplishments of the architectural team have been the creation of several construction documents, or architectural drawings which illustrate ways that details may be constructed and assembled to create a safer building. Another major accomplishment is the creation of an architectural statement which gives detailed advice on methods for making stronger, safer materials for construction, specifically concrete mixes.

Electrical:

This semester the electrical team was able to identify the primary electrical needs for the school under construction. These electrical needs included: lighting system for the classrooms, ceiling fans for ventilation, computers for the students, and water pumps for supplying water. In addition, another accomplishment was the simulation of the building system using a HOMER simulator which allowed for the team to adequately size the solar panels, batteries, and other electrical equipment. Finally, the electrical team was able to create the building's cabling diagram, grounding system, panel schedule, and correctly choose the over-current protection devices to use.

The research for the electrical team findings primarily came from internet sources, personal knowledge and engineering textbooks. After looking into both wind and solar energy we determined that solar was best suited for Haiti because it is very efficient, has longer lifetime, and requires little or no maintenance. Through the teams research, it was also determined that a 2 Kilo-watt solar array system and a 9.2 Kilo-Amphour battery system would be sufficient to keep the school powered, that two water pumps would be needed to meet the water needs of the school, and that the batteries that would hold the reserve power from the solar energy should be stored in a separate well-ventilated room.

Mechanical/Plumbing:

The major accomplishment of the plumbing team was the design for a sanitary restroom system for the school under construction in Pignon. Information from plumbing/septic system guides was gathered to determine the location of the system and the size of the components for the system design. A rough price estimate of the sanitary restroom system was determined by shopping for equipment online. Compared to the latrine system that is currently in place at the high school in Pignon, this potential system would create more sanitary conditions to be available to the students.

Quantities/Cost:

There was no required research for the costing and quantities portion other than researching the costs of the various materials and the rates of labor in Haiti. The research on the costs came directly from the people in Haiti who are purchasing the materials. From this research the Costs and Quantities team was able to conclude that it is beneficial to purchase building materials locally whenever possible, to avoid expensive transportation costs. Another investigation that was beneficial to the team was comparing the costs of a one story building to that of a two stories. Although the cost of the second story wasn't excessive, it was decided that the project would stick with a one story building until structural integrity could be verified.

Fundraising:

The fundraising subgroup has completed a fundraising letter, a list of companies to be contacted, and a visual poster that can be included with the letter or used on its own. The list of contacts is arranged in an Excel spreadsheet so that it can be used with the mail merge function in Word to create personalized letters very quickly. Contacts were found by locating companies in the Chicago area as well as in Minnesota where Haiti Outreach is based. The companies that were acquired are involved in a variety of industries relevant to this project, including construction and solar panel manufacturing companies. Still to be determined, perhaps by the subsequent IPRO, is whether fundraising will be done by the Haiti Outreach student chapter at IIT or through Haiti Outreach headquarters in Minnesota.

0.8 Recommendations

Structural:

In the future, IPRO team members that travel to inspect construction progress may want to retrieve samples of all materials utilized on site for further testing so as to obtain detailed data on properties of the material palette. There is a need for greater coordination between the work of the structural and architectural groups during the earliest phase of the project. By introducing more structural rigor into the beginning design scheme (and procuring the early supervision of a licensed engineer) it is possible to avoid having to work out critical structural issues in the details.

Architectural:

Based on the information that the architectural team has worked on, the best recommendation for the partner and subsequent IPRO teams is to proceed with caution, care, and preciseness in the construction of this building. The recommended next step for later IPRO's is to continue on with the project, photographing and recording progress of construction, as this would be great additions to the manual and to also continue with the design of a prototypical building. We would also like to see the design implemented and hope to send a team of students to Haiti to aid in the construction of this or future buildings in the region.

Electrical

Basically, in the ensuing semesters the next electrical team might want to do further research on energy, as new useful information might be acquired. It might be useful to look into utilizing a solar-wind system, as well as researching the mechanics of converting biomass into useful energy. Also, researching an overhead water storage system that would only use only one water pump instead of two and possibly utilize a micro hydro power system might be of use to the project. Finally looking into selling back excess electricity produced by the solar-wind system would be beneficial.

Mechanical/Plumbing:

To move forward in the project, the design should be taken to Pignon site to get the opinion of the on site users and professionals. Also, more thorough shopping could yield more

cost friendly bathroom equipment. Fundraising for some of the specific equipment could yield cheaper options, which would be beneficial to the project. In addition, the design of the leech field might need to be altered depending on the soil quality, so soil testing should be performed. Finally, the well should be tested to see exactly how much water can be extracted daily and future monitoring should be carried out to see that the leech field does not have a detrimental affect on the wells water quality.

Quantities/Cost:

The recommendations for anyone continuing research on costs and quantities would be to continue to work on the smaller details of costs and work out the labor costs more efficiently. It should be easier to figure out labor costs upon the completion of this school building and a better timeline can subsequently be made for any future buildings of similar materials and design. A major step forward would be to train a local Haitian worker so they could up date the information as it changes over time or adapt it for use on other construction projects.

Fundraising:

In addition to sending letters and the visual poster to the contacts gathered, it may be valuable to host an event featuring relevant speakers. Potential speakers discussed were the State Senator from Illinois who was born in Haiti and Tracy Kidder, author of Mountains Beyond Mountains. While it would be beneficial to invite IIT students and faculty, it would also be worthwhile to locate past Engineers Without Borders and Architecture That Matters students and supporters, as they would most likely have an interest in this project. The funding for travel by students to Haiti has to be rigorously addressed. Securing a fixed amount of money from the student activities fund for endeavors of a humanitarian nature would be the ideal scenario.

0.9 References

See attached list of references.

0.10 Acknowledgements:

One of the main references used for this project was Peter Land who contributed a large amount of knowledge, personal experience, and an excellent precedent. Professor DeSantiago helped greatly with the structural aspects of this project. Alex Miot, who was one of the IIT students who started the student chapter of Haiti Outreach, has been very supportive in every aspect of this project. Finally, Mark Taylor has been a great asset to this project and contributed a huge amount of knowledge and time to its success.