Community Service Driven Student Senior Project and back to Community for Implementation

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Abstract

After the devastating earthquake of January 2010 destroyed most of Port-au-Prince, Haiti, and killed hundreds of thousands of people, many international non-governmental organizations (NGOs) descended on the Caribbean island nation to help not only in search and rescue but also in the reconstruction.

The author took with him three architectural engineering (ARCE) undergraduate students from California Polytechnic State University (Cal Poly) to Haiti to help in the reconstruction efforts for one week. The students were so much motivated to volunteer their services to the community that three summer internships were organized for the students through one of the many NGOs in Haiti. The students spent most of the summer out in the community and were able to focus on what the community was lacking in order to move forward with safe repairs of damaged buildings and construction of new safe and sustainable earthquake resistant buildings.

By the end of the summer internships, two of the students had each identified a problem that needed to be addressed which in turn became their respective senior projects. This paper reports on the two senior projects that were driven by the community service. The scope of the first project was to manufacture and test applicability of a device that may be used to accurately determine the compressive strength of concrete masonry block in the field. The device had to be easy to transport, easy to use for unskilled operators and was able to give test results on the spot that were easy to interpret. The second project's scope was to design and test a training device for building professionals to demonstrate the behavior of confined masonry buildings under a cyclic (earthquake) loading. Simulation of earthquake loading by shaking the table and removal of some building elements made it easier to communicate the design concepts during the trainings. Upon graduation, the two students were offered employment by two different NGOs in Haiti where they are currently implementing the results of their senior projects back in the community.

Introduction

Over the years, Haiti has suffered devastating economic and human loss of life as a result of hurricanes and tropical storms that lead to flooding and mud slides originating from land left bare by man-made deforestation activities. On October 18, 1751, Haiti experienced a Magnitude 8.0 earthquake that completely destroyed Port-au-Prince (PaP), the capital city[1]. Since then, the next earthquake, a Magnitude 7.0 struck Haiti on January 12, 2010. Ground shaking that lasted for 35 seconds resulted in more than 230,000 deaths, as many people injured, more than 105,000 buildings totally destroyed, 208,000 buildings damaged and more than 1.3 million people left homeless[2]. Building materials, construction procedures, qualifications and competency of building professional (architects, engineers, contractors) and government building regulations and including the home owners all contributed to the catastrophe. In a country where construction grade lumber, cement, structural steel, steel bars for concrete reinforcement, galvanized iron sheets, etc. are all imported, the only sustainable solution for the reconstruction is the continued use of masonry and reinforced concrete buildings. This however requires immense training and re-training of hurricane and earthquake resistant building construction technics to building professionals. The author, while in Haiti on a one year sabbatical leave from Cal Poly to help in the reconstruction efforts invited three students of senior standing from ARCE during their spring break to "shadow" him in his daily activities and learn firsthand the cause of the devastation in PaP. The students visited communities that had heavy casualties and most building failures. They visited new construction sites and damaged homes where home owners were in the process of repairing the homes. The students had a chance to visit the civil engineering and architecture senior class at the State University of Haiti (UEH) and exchange notes with the future Haitian engineers and architects in regard to building design and construction curriculum. The group was also able to visit a riverbed where sand and gravel were being harvested for the ongoing reconstruction and also witnessed firsthand the roadside production of concrete masonry units (CMU). It was not all disappointments as the students spent the last day of their visit at the beautiful Haitian beaches. Figures 1, 2 and 3 capture some of the student visit activities.

Figure 1: Community Visits (a), (b) Devastated Neighborhood and (c) New Construction Site

Figure 2: Community Visits (a) New Construction, (b) Building Repair and (c) State University of Haiti

Figure 3: Community Visits (a) Sand and Rock Source, (b) Roadside CMU Production and (c) Day at the Beach

Literature Review

ABET accreditation criteria 3 item (h) require engineering programs to provide students with a broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context[3]. Item (k) under the same criteria requires students to acquire an ability to use techniques, skills and modern engineering tools necessary for engineering practice[3].

Most Civil and Architectural Engineering programs offer a senior project or a capstone course as a graduation requirement. When one looks at engineering in the year 2020 and beyond, one has to ask some basic questions about the future engineers such as: (1) who are they, (2) what they will do and where will they do it, (3) why will they do it, and (4) what this implies for engineering education in the United States and elsewhere[4]. Dunlap[5] reported that problem based learning (PBL) may help students to experience success, improving their confidence to engage in similar activities in the future and empowering them to pursue challenges in field. By engaging students in learning and problem solving activities that reflect the true nature and requirements of the workplace, PBL may help students feel prepared to work effectively in their field. Educators seek to provide learning environment that prepares students for life as engineering professionals while NGOs rely to a large extent upon technology to deliver, coordinate, account and improve services they provide to the community[6]. It is thus important for the student engaged in a community project to first learn the needs of the community. Traditional design pedagogy plus community service learning provide students complimentary vehicles in which to refine their designs in ways that deepen their understanding and learning[7, 8]. Through the partnership with NGOs, the experiences enable students to create products that have a significant impact on the community[9]. Engineering faculty need to understand the impact of capacity building of engineers in developing countries in order to positively guide engineering students interested in projects in developing countries through Engineers Without Borders or other NGOs[10, 11].

Senior Projects

The exposure the students experienced during the one week visit to Haiti brought home answers to "what happens when design guidelines taught in class are not followed". On return to Cal Poly, two students decided they wanted to help in the reconstruction of Haiti. The author was able to organize summer internships for the two students through one of the NGOs that was actively involved in home reconstruction in the PaP community. The students spent two months in Haiti and were actively engaged in the reconstruction activities the author had introduced them to. The two students decided to use their summer experience as a bridge to identify an independent study topic for their senior project, an undergraduate graduation requirement in ARCE.

In the first senior project, Smith[12] decided to design and test a method to test the quality of CMUs in the field. The method had to be simple enough so that unskilled community members and even home owners could be able to distinguish good quality CMUs from the inferior ones. This was necessitated by her observation from the field that most blocks were made by the roadside producers with no quality control. The molds for the blocks were made to match the sizes of block in Haiti. The blocks were produced using similar methods as in Haiti. A device was made from which the height required to drop the block without crushing the block was marked. This was correlated with the compressive strength of the block. This drop device could then be taken to the field and calibrated as needed for a particular strength of block. Figures 4 through 7 show the process of production and testing of the block drop testing assembly.

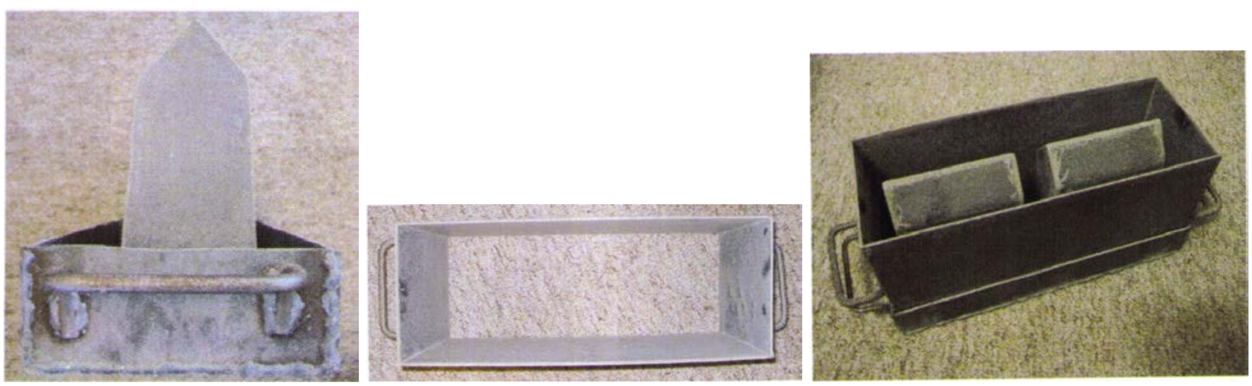

Figure 4: CMU Steel Mold (a) Base, (b) Shell and (c) Assembly

Figure 5: CMU Block Production (a) Mixing, (b) Manual Compaction and (c) Shovel Compaction

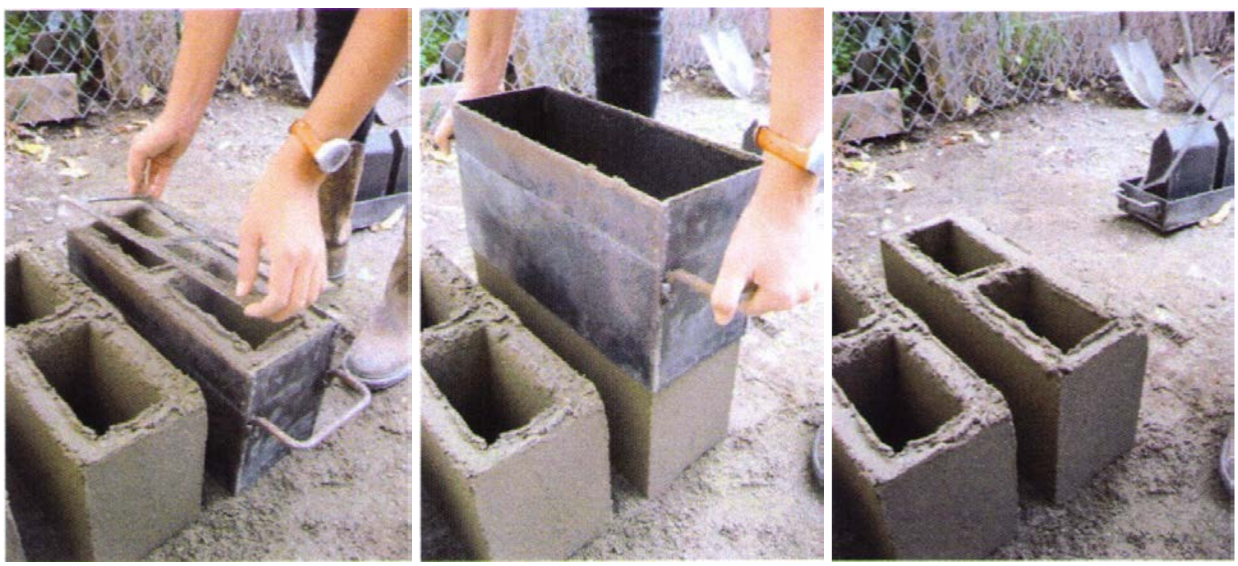

Figure 6: CMU Block Production (a) Removal of Base and Top Plates (b) Removal of Shell and (c) Final CMUs

Figure 7: CMU Drop (a) Reinforced Concrete Base (b) Assembly and (c) Positioning Lines after Calibration

In the second senior project, Biddick[13] decided to design and test a communication model that may be used to demonstrate the effect of earthquakes on unreinforced masonry and confined masonry construction, both of which are the most common in Haiti. The aim was to be able to take the model to the classrooms at the UEH, at professional schools and at workshops educating the theory of earthquake design of buildings. The CMU blocks were modeled using wooden pieces on which steel sheet metal was glued on top and bottom. Magnetic tape was glued on surfaces opposite those with sheet metal. The result was stackable blocks where the magnetic action between blocks mimicked the mortar joints. Figure 8 shows the production of the model CMUs.

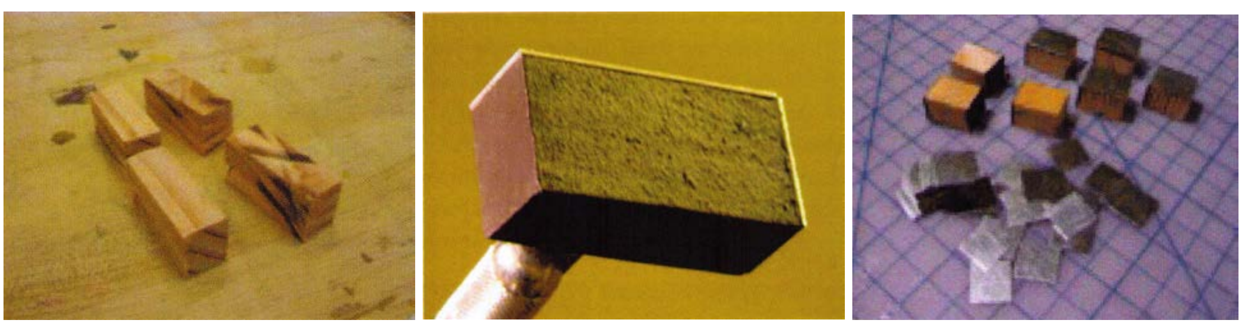

Figure 8: Production of Model CMUs (a) Wooden Pieces (b) Surface gluing and (c) Final Pieces

Reinforced concrete column and beam models were made similar to the CMU models with the exception of elastic strings that were provided to mimic longitudinal steel reinforcements as shown in Figure 9.

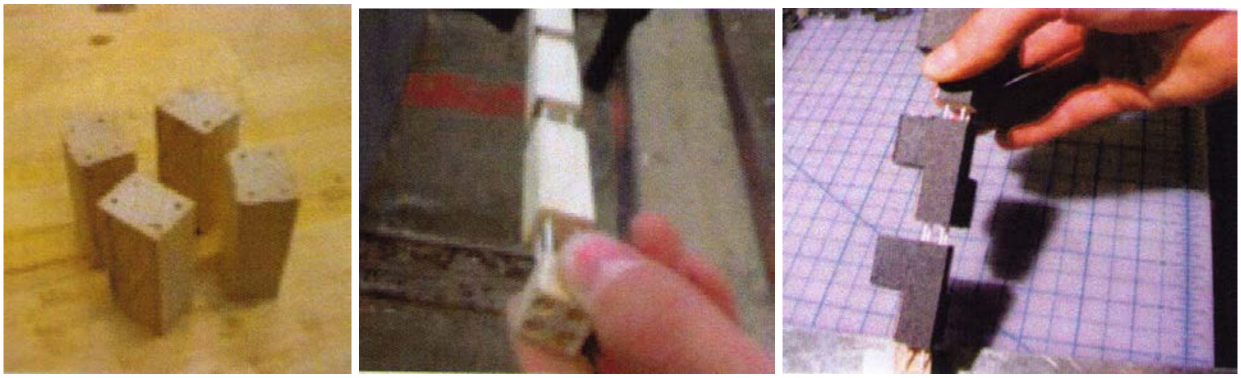

Figure 9: Production of Model Beams and Columns (a) Wooden Pieces (b) Elastic Strings and (c) Final Pieces

The pieces were used to build unreinforced masonry and confined masonry model buildings as shown in Figure 10. By shaking the buildings, the behavior of each construction type was clearly communicated by visual observation. Effect of adding beams, columns, or different wall configuration of the structure was easy to demonstrate[14, 15].

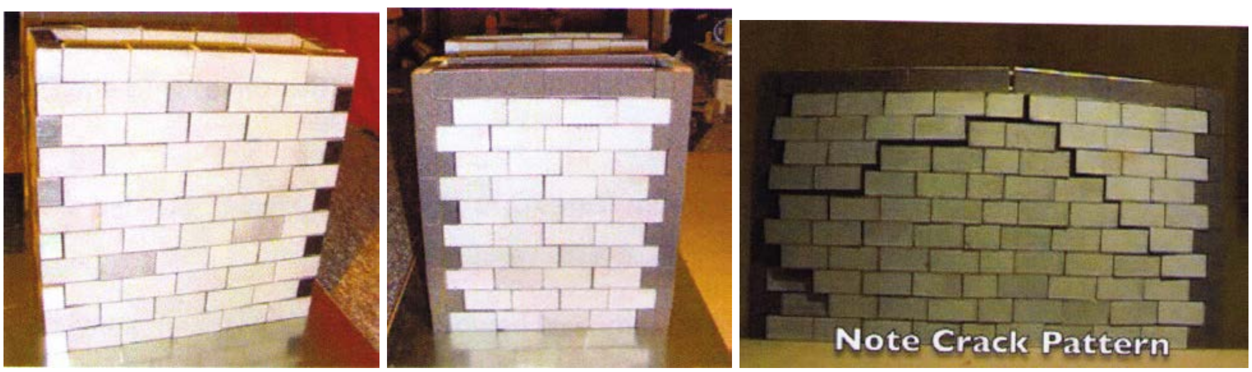

Figure 10: Building Models (a) Unreinforced Masonry (b) Confined Masonry and (c) Failure of Unreinforced Masonry Construction Demonstration

Instruction Method

The course was taught in a laboratory format. The class was scheduled to meet three days a week for three hours. Most of this time was spent by the students in the fabrication laboratories. Face to face meetings with faculty occurred at least for one hour per week of as needed by the student. As is the case with most senior projects and capstone courses, the subject matter is initiated by the student and the role of the faculty member was to give guidance as requested by the students in terms of technical and community requirements. In this course, the students collected most of their data for the project during the summer internship in Haiti where the two students worked with an international NGO providing home repairs and capacity building of construction professionals. The author guided the students through e-mails while they were collecting data in Haiti.

Deliverables by students

Each student was expected to manufacture and demonstrate the expected functioning of their testing or communication devices. The students had to present their work in twenty minutes to the university community. As required by ARCE, the students were also expected to prepare and submit a final senior project report to the faculty advisor and another one copy to the department.

Assessment

The students' assessment used the rubric shown in Appendix A. The students gave an oral presentation of their projects to the entire ARCE and Cal Poly community (faculty, students, and staff). The oral presentation was graded by the attendees using the rubric shown in Appendix B. One fifth of the final senior project grade was contributed by the oral presentation, a fifth by the regular meetings with the faculty during the quarter and three fifths from the final report as broken down in Appendix A. The two students scored all the total possible points in their presentations and regular meetings. They were self-motivated and did whatever it took to have their devices work as they expected. Failure was not an option.

No official course evaluation was conducted as there were only the two students. The students however informally acknowledged how the internships helped them focus on the needs of the community they intending to serve with their manufactured devices.

The two senior projects were completed in time for the students to graduate. Upon graduation, the two students returned to Haiti with full time employment by two different NGOs. Each student is currently implementing the results of their senior projects. They are sharing the information with other NGOs currently undertaking reconstruction and education activities in Haiti. The devises are being used by the community for field testing of quality of masonry block and as a communication tool when educating building professionals on how to design and construct earthquake resistant un-engineered confined masonry structures.

Conclusions

It is clear from the experience of the two students that:

- The two senior projects were very successful as evidenced by the fact that the NGOs in Haiti hired the two students to use the test and communication devises in the community.
- This was a great experience of a partnership between engineering education, NGO and global community that exposed students to engineering in developing countries.
- The students felt they "owned" their respective projects although they each were aware what the other one was doing. This was helpful as they helped each other depending on what each remembered from their community exposure during their internships.
- Students learn better when they are self-motivated but they need the instructors at times to show them the way.
- As instructors, there is a need to expose students to professional activities that instructors are involved in even if these may happen to be outside the scheduled classroom setting. This may include sabbatical leave activities.

- Students are hungry for exposure to the global diversity of structural engineering profession; let the faculty not let them down.

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Appendix A: Senior Project Grading

Name(s) ____

Point Distribution

Regular Meetings	(20%)	**____/ 20 Points**
Oral Presentation	(20%)	**____/ 20 Points**
Final Project Report	(60%)	**____/ 100 Points**

Oral Presentation Grading

5---- 90^+ ----A
4---- 80^+ ----B
3---- 70^+ ----C
2---- 60^+ ----D
1---- 60^- -----F

Final Report Grading

o Cover Sheet	**_______/ 5 Points**
o Preface	**_______/ 5 Points**
o Table of Contents	**_______/ 5 Points**
o Introduction/scope	**_______/ 5 Points**
o Background-literature Review	**_______/ 15 Points**
o Test Procedure	**_______/1 5 Points**
o Raw Data	**_______/ 5 Points**
o Reduced Data	**_______/ 5 Points**
o Error Analysis	**_______/ 5 Points**
o Conclusion	**_______/ 20 Points**
o Bibliography	**_______/ 10 Points**
o Appendix	**_______/ 5 Points**

TOTAL **_______/ 100 Points**

Appendix B: Senior Project Oral Presentation Grading

Grader:____________________ Group:________________________________

SENIOR PROJECT PRESENTATION GRADING FORM

Please rate the presentation on a scale of 1 (lowest score) to 5 (highest score). A 1 indicates that the characteristic was not present, a 5 indicates that the characteristic was outstanding.

INTRODUCTION	**1**	**2**	**3**	**4**	**5**
Considerations: made the necessary introductions of self and others, captured my interest and convinced me to pay attention, Indicated what would be covered and how it would be covered.					
ORGANIZATION	**1**	**2**	**3**	**4**	**5**
Considerations: communicated an organizing scheme making comprehension easy, clearly organized and the progression of ideas is easy to follow, main ideas clearly distinguished, each section was introduced and concluded well					
CONTENT	**1**	**2**	**3**	**4**	**5**
Considerations: appropriate amount of content (not too much or too little covered), supporting facts and data were accurate, facts and evidence were clearly referenced, research was current and based on the literature, information was geared toward the level of the audience					
DELIVERY STYLE	**1**	**2**	**3**	**4**	**5**
Presenter(s) were well prepared; used a variety of styles: logical, humor, etc.; did NOT read material from a script; free of idiosyncrasies: ah, like, kind of, etc.					
AUDIOVISUALS	**1**	**2**	**3**	**4**	**5**
Audiovisuals were titled, clear, easy to understand and used appropriately; presenters were comfortable and familiar with the audiovisuals used					
CONCLUSION	**1**	**2**	**3**	**4**	**5**
The conclusion summarized the presentation; major points/results and their importance were emphasized					
SELECTED PROGRAM OUTCOMES					
An ability to function in a team for the design and construction of buildings.	**1**	**2**	**3**	**4**	**5**
A knowledge of how the built environment is related to contemporary issues.	**1**	**2**	**3**	**4**	**5**
An understanding of professional and ethical responsibility.	**1**	**2**	**3**	**4**	**5**
The broad education necessary to understand the impact of engineering solutions in a global and societal context.	**1**	**2**	**3**	**4**	**5**
YOUR COMMENTS AND GRADE					