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From Design Inception Through Project Completion: Constructing a Secure Homestead in Swaziland, Africa

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Beth has her Master's of Science degree in Architecture from the Illinois Institute of Technology and her Bachelor's of Architecture degree from Ball State University. Additionally, she continues to practice architecture through her own company, Muse Design. She enjoys the synergistic relationship between her role as a professor and her role as an architect, and believes that this hybrid provides real world practicality into the classroom on a daily basis.

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Abstract

This paper documents the year-long scholastic and experiential journey of a multi-disciplinary, student design team from schematic design through construction administration. The student team worked in tandem with an Architectural Technology professor designing and building a sustainable and secure homestead, or one-room home, in Swaziland, Africa. This experience gave students exposure to the design process from project programming through construction completion, and this paper will focus on describing and documenting both the student and professor experiences for the project's entirety. The student's perspective will focus on personal involvement and perceived academic outcomes from the project exposure, while the professor's perspective will focus on the learning outcomes from the student team involved in the process, as well as extrapolating how this experience could be applied elsewhere.

Introduction

The students spent the first semester in the classroom researching cultural context and refining the project scope to implement best architectural practices for Swaziland. Special attention was paid to culturally appropriate building solutions, cost efficiency, and sustainable technologies. Students worked individually and in teams to research vernacular architecture in rural Swaziland, and cultural context to better understand appropriate design methods for this area of the world. Additionally, students interviewed the community partner, who has a presence both locally and globally, to better understand the needs of the shelter's future occupants. Next, the students created individual design solutions for the safe shelter project. Student designs included three dimensional digital renderings, and physical, scaled, professional models of the proposed shelter. At the completion of the design project, the design professor and the community partner chose which student design solution best addressed the issues of cost efficiency, cultural relevance, project program, and sustainable building methods. Upon selecting the chosen design, the student team worked collaboratively critiquing and refining the chosen design.

During the summer, the professor and the students traveled to Swaziland for two weeks to build the shelter previously designed by the students, and chosen by the community partner. While abroad, students worked alongside local villagers to clear the land, excavate the earth, acquire building materials and construct the shelter. Students worked arduously for two weeks in Swaziland with many challenges, both materially and culturally.

The student team worked together to troubleshoot numerous issues that arose during the construction process. From site and location challenges, to resource and material scarcity, students worked collectively to problem solve and implement design solutions daily. Upon completion of the international service learning trip, the student team had successfully completed the proposed safe shelter.

Schematic Design

In the fall semester of 2013, twelve students enrolled in a sophomore level three-dimensional interior design studio and were each given the assignment to both design and build a scaled model of a residence for a group of vulnerable children in Swaziland, Africa. At project inception, the students spent time both inside and outside of the classroom researching historical precedents, local construction methods, climate conditions, sun patterns and pertinent cultural contexts for Swaziland. Students worked individually to come up with various conceptual designs and study models. Upon completion of the schematic design phase, students returned to the classroom for a peer review of their designs. The students and the professor exchanged critiques of each design and then students were tasked with further refining and re-designing their safe shelters. The students were given three additional weeks to refine and complete a finalized plan and professional scaled model. At project close, the students presented their proposed designs for the safe shelter project to the professor and the community partner. The community partner offered valuable insight as to the most appropriate solution, and offered suggestions for further refinement before the project could be constructed. At the semester's end, the community partner chose which design best embodied the design intent, and one student's design was chosen, see Figure 1. This design was the springboard to further exploration and study.

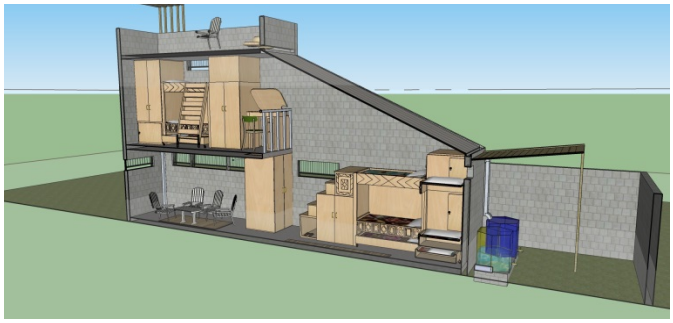

Figure 1: Student Design Work

Near the end of the fall semester of 2013, the professor was encouraged by the university to apply for a small grant to act as seed money to move the project forward. The professor was awarded the grant, and used the monies to form another partnership with a local carpenters union to build a furniture prototype of the student's design. Over the semester break, students worked alongside the carpentry apprentices to design and build the full-scale furniture prototype. Within three weeks, the furniture piece was completed and ready for display and testing. The furniture piece was revealed at an art gallery on campus, in conjunction with other artist's interpretations from Swaziland. Additionally, there was a seminar held which showcased the students' work from the semester, a short talk from the professor, and a lecture from the head of the community partnership. The exhibit was well received, and the momentum for the project continued to grow into the spring of 2014.

Figure 2: Building the Prototype

Figure 3: Finalizing the Details of the Prototype

Figure 4: Completed Furniture Prototype

Design Development

After the completion of the full-scale furniture prototype, it was evident that the scale of the project needed to be reduced, due to both time and financial constraints. In the spring semester of 2015, eight design students worked to design safe shelters for construction in the summer of 2016. The student's solutions were largely influenced by the inclusion of the earthbag construction method, and the limitations of budget and time. Students designed very thoughtful and appropriate housing options, as evidenced by the drawings seen below. These designs provided the basis for the actual construction documents used while in Swaziland. Students paid special attention to using the metric system, and the precedent of vernacular architecture in rural Swaziland.

Earthbags, which are polypropylene bags that are filled with a soil mixture are inexpensive, sustainable, structurally sound and durable, which is why this material was chosen as the primary construction method. When protected from the sun, polypropylene bags have been proven to last

upwards of 50 years (Arutchelvi 2008). Additionally, earthbags require very little construction skill, thus making it an attractive option for design students and local villagers. Included in the team's precedent research was another African case study utilizing earthbags for home construction (Sho 2014). This precedent propelled the team forward and added knowledge about this construction technology prior to traveling abroad. From this publication, the team was able to grasp the capabilities of this technology, as well as the application in an African context.

Figure 5: Student Designed Floor Plan

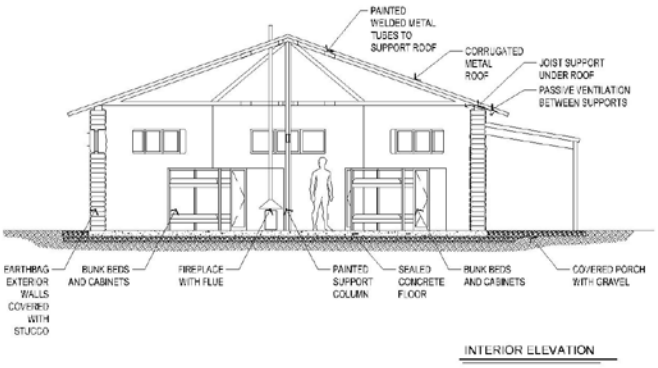

Figure 6: Student Design Elevation

Construction Documents

At the completion of the design project stated above, the professor directed two students to provide buildable and complete construction documents that would be the building blueprints while abroad in Swaziland. Two students spent several weeks finalizing the student designs, and providing details that would make the structure buildable and structurally sound. The students did an excellent job at producing drawings that were explicit, financially feasible, and buildable.

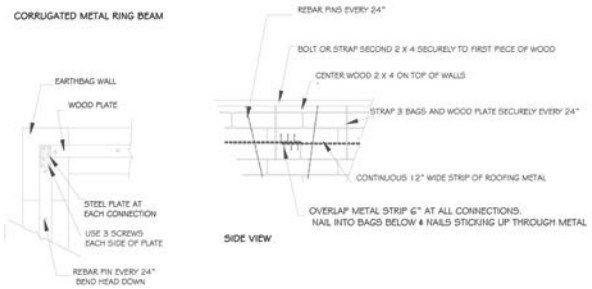

Figure 7: Student-Designed Earthbag Details

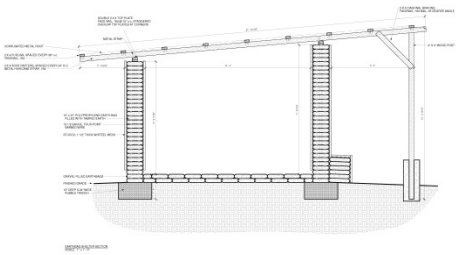

Figure 8: Student-Designed Details

Construction Process

As is true with almost all construction projects, the proposed plans needed revisions once the student team was physically on the site. Because of the lack of information about the site conditions, the team was not aware of the difficult soil conditions and site slope that was encountered. The soil was sand and clay, and the site had a significant slope which needed to be addressed in order to successfully build the building. Students worked as a team to problem solve solutions on the site each and every day. Through sketches, conversations, and trial and

error, students worked diligently to address each and every site condition which was encountered. The first issue was that the construction supplies that were promised by the community partner were not present upon the students' arrival. Each student packed two bags, one with earthbags and a hammer, and the other with tape measures. The site had knee-high native grasses on the site, and the students spent the first two days clearing the site with the claws of their hammers. The work was arduous and slow, but the students worked with diligence and positive attitudes despite the limitations. Next, students worked to dig a hole for a latrine, and the excavated soil would be used to fill the earth bags. The digging process was slow and laborious, but again, the students rose to the occasion and brought their best.


Figure 9: Clearing the Site

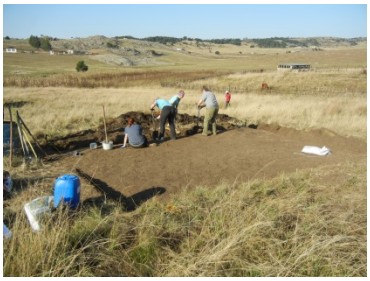
Figure 10: Leveling the Site


Figure 11: Building the Walls

After three days, the building finally started to go vertical. At this point in the construction process, students had discovered what their best fit was on the construction crew, and the team worked efficiently to dig, mix the bag mixture, fill the bags, place the bags and tamp the bags. Every student had a role to play, and the team worked as a cohesive unit to make slow, but steady strides each day. With blistered hands and sore backs, students labored day after day to complete the house for the family. However, despite our best efforts, it was evident that the team would not be able to finish the house as anticipated, so the team once again had a brainstorming session to determine how to best ensure completion of the house. It was decided to finish the last few rows of the building with concrete masonry units. The instructor purchased the material locally from a building supply company, and then hired a local mason to quickly construct the last of the building walls. Lastly, a laborer was then hired to install the metal roofing, which was already at the building site and ready to be installed. While the students were disappointed to not be there for the completion of the project, the community partner emailed completed pictures several days after the team returned home.


Figure 12: Students Applying Stucco


Figure 13: Building Interior

Through copious obstacles and limited resources, this student team gave it their all. The team worked amazingly well with material and tool shortages, rainy weather and no provided utilities. This student team was irreplaceable for the successful completion of this project, and without this team, there is no question this project would not have been completed or successful. While the experience was stressful and taxing, the students gained valuable experience on a construction site, and were able to see a project through from inception through completion.


Figure 14: Completion of the Roof


Figure 15: Completed Side Elevation


Figure 16: Project Completion

Student Perspective

From the moment I found out about the study abroad opportunity in Swaziland, Africa, I was ecstatic to be able to help a woman and community in need. Sustainable design has always been an interest of mine, so taking part in a hands-on project was exactly what I needed to do. As the trip began to approach, the group started coming together for discussion, cultural learning, and design development.

During the design process, the group researched how earth bag construction is actually an inexpensive and a very resourceful method we could use to build our structure. Initially we designed the home to be about 10'x12' but when we got to the work site in Swaziland, the client was so happy that we came to build her a house that she almost doubled the size of her floor plan! However, we told ourselves that we would figure out a way to make it happen.

We chose earth bag construction for several reasons. One, like I mentioned before, the bags are rather inexpensive (around 20 cents a bag). We actually all packed a suitcase full of earth bags to take down to Swaziland with us, totaling up to about 2,000 bags. We decided that we would need to purchase all the other materials such as rebar, cement bags, roofing materials, barbed wire, etc. at a hardware store near the worksite. The construction team conducted a literature review on how earth bag construction even helps maintain humidity levels and air quality control (Barnes 2006). During the warmer months of the year, a building made of earth bags will keep the cool air inside, as well as warmer air during the colder months. We were very pleased to learn this because we wanted to make sure the woman and the children she cared for would be living in a better environment than they were before, which was merely a holey shack made from rusted tin.

Figure 17: Building the Walls

Figure 18: Excavating the Dirt

During the construction process, most of our days consisted of digging up dirt to fill up the earth bags. We had to create a mixture of natural soil, water, and cement to fill each bag and then tamp the bags flat so they would lay level. We had previously learned that by adding the sand it helps to adhere the mixture together (Hunter). This process was very repetitive and physically strenuous. We filled, fastened, stacked, and tamped down nearly 1200 earth bags. Due to a shortage of time, we then finished off the top 4 feet of the house with concrete masonry blocks and had a reliable source finish putting on the roof.

Figure 19: Existing House

Figure 20: Local Family's Front Door

Going on this study abroad trip was one of the greatest experiences I've ever had. Not only did I learn about sustainable design mechanisms, but I also learned more about working together as a team to accomplish a very important goal: building a secure house for a woman in need. This woman was not only living with AIDS, but was also living in a shack and caring for 3 children,

two of which weren't even hers. She literally started crying when we arrived and started clearing grass to create a level area to lay the earth bags. She and her son were there every day helping us; they would walk down to the stream and get jugs of water and help unfold earth bags. This showed us how truly grateful she was that we came to help. When it came time to leave, we were actually disappointed that we couldn't stay and fully complete the house for her, even though we did all we could.

Upon returning home from Swaziland, it was nice to stay in contact with the woman who ran the non-profit organization near the worksite. She kept us up to date and sent us photos of the house after the roof was completed. I feel extremely overjoyed that I got the opportunity to better a family's physical dwelling, all while learning about sustainable design and actually getting to use my knowledge on a real jobsite.

Figure 21: The Last Day on Site

Summary and Future Recommendations – Student Perspective

From the very first time the project was introduced in one of my classes, until the time we finished stuccoing the last side of the house, I have learned so much about the entire design process. For class, we had been asked to create a guest house design that would be a place where volunteers could stay as they came to help out with the local community organization. We conducted conceptual drawings, space planning bubble diagrams, and construction documents that included annotated floorplans, roof plan, foundation plan, and section views. When the opportunity came to actually travel to Swaziland and build one of the other housing units that was for some of the local girls within the community, I couldn't pass it up.

During our pre-departure meetings, we reviewed how the use of earth bags is a sustainable and inexpensive method of construction. We watched videos on how to fill, compact, and stack the bags on top of one another. We were also informed that the house we were initially going to build wasn't going to be able to happen that summer, so we found a woman in need of a home and decided to build for her instead. This was just one example of how drastic things can change throughout a design process! We quickly sketched up some new plans and ideas for her home,

which we then took with us to Swaziland. However, when we arrived at the worksite, she asked us if we could make the layout a little bigger. Since we were doing this for her and wanted her to be happy with the outcome, we decided to go ahead and slightly increase the square footage of her house.

It was definitely beneficial for me to actually see the plans I helped create come to life. Not only did I help draw the house plan, but I helped to *build* the structure! Things didn't always go as planned either. For instance, we ran out of cement so we had to run to the nearest store and get more. We also found out we needed sand for the mixture so we ended up buying a pile from the man across the field. It was hard to keep up earth bag production when half our team was busy digging up the dirt, so two local men came early a few mornings and dug up the dirt for us so we could immediately start mixing. We also got some of our roofing materials stolen overnight, so we had to improvise and use what we had. Things will definitely not always go the way you want them to, but as designers, we were able to put our skills together and make it work.

I documented a video of our entire trip and I got to share it with our group at our debriefing meeting once we returned home to the states. I was glad that I recorded our experiences and took a lot of pictures. It helped us all remember every step we had to take to reach our end goal of a standing house. I feel like I learned so much more about the importance of the design process now that I went through the entirety of it from beginning to end. In school, we don't ever get to see our designs in the construction process, so this was such a learning experience for me, being a young and aspiring professional designer.

One way that I know would help improve the project for the future would to make sure we have all the materials we could possibly need. We were constantly running back and forth to buy more materials as we ran out. Initially we were supposed to have all our materials shipped to our work site from the states. However, that plan fell through and we were forced to stuff our suitcases and buy more tools when we arrived. If there was a way to have all the supplies already there, that would help tremendously.

Summary and Future Recommendations – Instructor Perspective

There are numerous lessons learned as a result of this student project from design inception through project completion. First, choosing a ready community partner would be the largest lesson learned. It was this community partner's first time having a student-led construction crew, and as a result, the community partner was grossly unprepared to help the student team, both financially and materially. Next, communicating action items to be completed prior to the team arrival would be a critical improvement for the future. In retrospect, if directed, local people could have cleared and leveled the site of native grasses before the students' arrival. This step alone would have saved the team several days in the construction of the building. Lastly, selecting the student team participants wisely is crucial. Fortunately, the student team was phenomenal and had a collective spirit and work ethic. Carefully screening and interviewing students is a large part of this successful project.

In the future, the instructor does plan to continue to lead teams to Swaziland for building-focused projects. However, the instructor has identified a different community partner, who is proficient

in partnering with student construction teams. Additionally, this new community partner has dedicated funding to building projects, which will lessen the financial burden for the instructor. All in all, the students really enjoyed this dynamic design-build opportunity. The instructor looks forward to leading student teams from design inception through project completion each summer while abroad.

Conclusion

Immersing students in a project from design inception through project completion is a discipline specific modality chosen for this case study. However, the importance and application extends to various disciplines and can be adapted and utilized in various university settings (Galford 2015). At the crux of this case study is a desire to bridge the gap between theory and practice. This chasm is one that exists in various disciplines in undergraduate education, not just in this specific content area. When teaching upper-level undergraduate courses that build upon pre-requisite content, course-based practice minimizes repetitive treatment of previous material. Mayo (2004) advocates a balance of fundamental course theory with active, case-based instruction so that students not only reflect upon past experience to construct new learning, they also share knowledge in a social construct. This approach was a benefit to students in this case study as they learned collaboratively, building the depth of their design aptitude.

Readers are encouraged to extrapolate the process and steps of this case study for their discipline specific content areas. While the experiences and projects of this case study maybe specific for design students, the application of exposing students to projects from inception to completion is a concept that resonates throughout various content areas.

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