Haitian Earthquake Relief
Edesign 100
Section 022
Spring 2016
Dr. Ritter
Team 3
Team Another One
Justin Happ (justinhapp6@gmail.com)
Josiah Mooney (mooney.j.n@gmail.com/jnm196@psu.edu)
Ryan Means (means.ryan13@gmail.com)
WEI-CHENG HSU (hsuwillson@gmail.com/wfh5069@psu.edu)
Mission Statement:
In January of 2010 Haiti was hit with a devastating 7.0 magnitude earthquake. The quake leveled many of the country’s structures, but most importantly, many communities lost their homes. The goal is to provide affordable and readily available temporary housing for those affected by the disaster. These homes will be easily constructed using local materials. While their physical homes may have been destroyed, these temporary housing units could help the Haitian people hold on to their sense of community and culture through a difficult time.

Context and Customer Need Development
Team Another one worked together to find out background info regarding Haiti. They looked through multiple reliable sources to fully understand the needs and personalities of the customers. With these known, they were successfully able to construct the prototype accordingly. For example, since the economy of Haiti isn’t strong and the annual salaries of the inhabitants are very low, they took that into consideration and made sure the material cost wouldn’t exceed $500 per unit. After collecting the necessary data, the team learned how devastated of a country Haiti really is. This only made them want to improve their prototype and contribute to the relief efforts in the country that have been present for almost six years.

Throughout the team's vast research of relief organizations, they decided on a secondary customer. The American Red Cross was unanimously picked by each of group member. This organization is one of the largest relief efforts, and attend to the people and community during events such as earthquakes and other natural disasters. With the primary customer being Haiti and it’s devastation from the earthquake, these two customers can relate immensely.

Customer needs can be separated in categories to help Team Another One better construct a prototype, so that’s what they did. Some human needs are more important than others, and were taken into consideration; the earthquake as well. The list of most important customer needs in this scenario consists of: stable structure of the home, cheap materials, and able to fit an average-sized family. After this initial list, there was the list of secondary needs. This consists of needs that are still important, but aren’t as needed as the primary ones. Some secondary needs considered were adequate lighting, functioning water source, and electricity.

Concept Generation Summary
The team had discussed about target specifications first. They decided six specifications which are most needed for those displaced people.

Table 1. Target Specification

<table>
<thead>
<tr>
<th>User Need</th>
<th>Specification</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>water resources</td>
<td>within half-mile radius for</td>
<td>water would be the sources</td>
</tr>
<tr>
<td>Feature</td>
<td>Requirement</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------------</td>
<td>--------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>water</td>
<td>displace people most needed</td>
<td></td>
</tr>
<tr>
<td>stable structure</td>
<td>structure stand for one year</td>
<td>there might be aftershock</td>
</tr>
<tr>
<td>easily repairable</td>
<td>repair under 30 minutes</td>
<td>After earthquake, there would be shortage on repair material and worker</td>
</tr>
<tr>
<td>cost of material</td>
<td>less than 500 dollars</td>
<td>there are too many displace people need shelter, so we need to decrease the cost per shelter to build more shelter.</td>
</tr>
<tr>
<td>bathrooms</td>
<td>at least 1 bathroom per 4 units</td>
<td>bathroom can make environment cleaner and decrease the possibility of plague</td>
</tr>
<tr>
<td>feasible living for 6 months</td>
<td>70%+ people say “yes”</td>
<td>rebuild the house was a long-term mission, they might need to live in shelter for more than 6 months</td>
</tr>
</tbody>
</table>

After finished the target specifications, the team started to sketch several possible structures that could be used as a shelter.

A. One large Central Unit that has a stove to cook on and space for any furniture that inhabitants may have. Four units to sleep in.
B. Box design with a tilted roof to collect water. Everything is placed in room.

C. Tent Design with a bed underneath the slanted tarp on either side. Large space in the middle.
After Team Another One sketched possible structures, the team used a scoring matrix to see which kind of structure would reach most of the target specifications.

![Scoring matrix](image)

At last, the box design with a tilted roof to collect water had scored highest, so the team decided to build a physical prototype of it.

**Photos of Prototype 1:**

![Prototype Multiview](image)
**Table 2. Summary of prototype testing**

<table>
<thead>
<tr>
<th>Test #</th>
<th>User Need</th>
<th>Test</th>
<th>Test Results</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Safety from weather conditions</td>
<td>Sprayed prototype with water and used a fan to represent a storm.</td>
<td>The prototype withstood the conditions provided by the fan and water, surviving the simulated storm.</td>
<td>Pass: The structure was minimally affected by this test.</td>
</tr>
<tr>
<td>2</td>
<td>Transportability of materials</td>
<td>Weighed the prototype to see how difficult it would be to move the materials needed</td>
<td>The prototype weighed approximately 0.25 kg</td>
<td>Pass: The prototype’s weight resulted in a feasible weight for</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td><strong>3</strong></td>
<td>Easily repairable</td>
<td>removed the hinges from the door, then attempted to reassemble the door to simulate how easily it can be repaired.</td>
<td>It wasn’t too difficult to fix the hinges on the door and return it back to its previous state.</td>
<td>Pass: considering the door was able to be repaired back to its original structure, we concluded this test was successful.</td>
</tr>
<tr>
<td><strong>4</strong></td>
<td>Cost efficiency</td>
<td>The sum of all materials used throughout the prototype needs to be under a certain price. If the prototype doesn't pass, the expenses may be too high for the shelters to be built.</td>
<td>The dimensions and materials from the prototype were taken and converted to find the unit. Resulted in $274.51.</td>
<td>Pass: The resulting price came out to be $274.51 per unit, which is under the maximum price of $300 per unit.</td>
</tr>
<tr>
<td><strong>5</strong></td>
<td>Human comfort</td>
<td>The shelter needs to give the inhabitants an idea of home comfort.</td>
<td>9 square meters is the average space for a home in developing nations</td>
<td>Pass: Our prototype was about 15 square meters, resulting in a sufficient amount of space for inhabitants.</td>
</tr>
<tr>
<td><strong>6</strong></td>
<td>Stability</td>
<td>Crush Test: placed the prototype in a confined area and proceeded to add more weight until it collapsed.</td>
<td>Failed at around 280-360 lbs.</td>
<td>Pass: The shelter withstood a very large crush force compared to its own weight.</td>
</tr>
</tbody>
</table>

the final product, allowing transportation of materials to be possible.
Test 1: Safety from weather conditions

Figure 2: Prototype in weather conditions

A. Simulation of storm and harsh weather condition of the through the use of water and wind with a fan and spray bottle.

B. Prototype 1 in the midst simulated storm and weather conditions.

Test 2: Transportability of material

Figure 3: Prototype on the scale
Test 3: Easily repairable

Figure 4: Repair test

4A. Door before

4B. Removal of the door

4C. Repairing the door

4D. Prototype after repairment
Test 4: Cost efficiency

Test 5: Human comfort

Through research and using already equipped knowledge, the team concluded that the prototype could house an average-sized family comfortably.
Test 6: Stability

Figure #: Prototype undergoing crush test

A.  
B.  
C.  
D.
Concept Refinement Summary

Due to the relative success of the first prototype Team Another One did not want to deviate too much from the original design. They decided to keep the basic overall design because it is functional and simple enough for almost anyone to build. However to improve upon the first prototype they decided to make the windows and door removable to improve on ventilation. Also, foamboard was the most expensive material and it was realized that the gutters could be slimmed down to cut cost but still keep the water collection system functional. The last change to the prototype made was to add a back door and to make the units be able to be paired up so larger families could still all live under one roof.

Test Report Summary for Prototype 2

Unfortunately, due to time constraints the team were not able to build a second prototype. However, due to the equivalent design, the second prototype should have the same results to the tests as the first. Also, the ability to connect two units should improve upon human comfort.

Cost Analysis

Team another one analyzed the prototype and real shelter cost. For the shelter, they had set an upper limit of 500 dollars, and calculated that cost would be 274.41 dollars which is lower than upper limit price.
**Table 3. Prototype Cost Analysis**

<table>
<thead>
<tr>
<th>Material</th>
<th>Cost per Square Foot</th>
<th>Area (ft^2)</th>
<th>Total Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardboard</td>
<td>25 cent</td>
<td>634.84 ft^2</td>
<td>$158.21</td>
</tr>
<tr>
<td>Foamboard</td>
<td>75 cent</td>
<td>154.4 ft^2</td>
<td>$115.8</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>789.24 ft^2</td>
<td>$274.51</td>
</tr>
</tbody>
</table>

For the real shelter, the team will use local woods to build the wall and floor in order to decrease the transportation cost and material cost. Additionally, the team will choose plastic to build the roof. Last, it is pretty hard to find the specific price for the materials team another one choose, but team another one estimate the cost for all material and fix should be less than 500 dollars (around $450 to $500).

**Table 4. One Real Shelter Cost Analysis**

<table>
<thead>
<tr>
<th>Material</th>
<th>Cost per Square Foot</th>
<th>Area (ft^2)</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woods (local)</td>
<td>Depend on the local price after negotiation with local government</td>
<td>634.84 ft^2</td>
<td></td>
</tr>
<tr>
<td>Plastic roof (import)</td>
<td>$0.557</td>
<td>154.4 ft^2</td>
<td>$47.9</td>
</tr>
<tr>
<td>Worker</td>
<td>Depend on local workers wage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fix</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>789.24 ft^2</td>
<td>less than 500 dollars (between $450 to $500)</td>
</tr>
</tbody>
</table>

In Haiti earthquake, there are an estimated 1.3 million displaced people. Team another one assumed a shelter can hold 4 people, so 350000 shelters will need to be made for all displace people. Team another one’s final estimate for total cost for those shelter should be around 157.5 million dollars to 175 million dollars.
Consideration for Human Need

At the most fundamental level, the goal was to provide safety and protection from the elements. This design includes gutters that will catch all of the rainwater from the roof. It also included a filter at the end of the drainpipe so the rainwater can be used for drinking or cooking. Haiti has an extremely warm climate, which prompted the inclusion of a white roof in order to keep the internal temperature down. Another main focus was the design’s ability to retain a sense of family and belonging. The average sized home in developing nations is 9 m^2. At just over 16 m^2, the prototype design includes enough space to keep families in tact and relatively comfortable while they are displaced. Also the strong, stable structure we built will give families a sense of safety that they may not have had in their previous home.

The design created incorporates the most basic amenities for survival and protection from the amenities. The final design takes advantage of the Haitian climate and collects water for refugees. On a community level, the designs are long, narrow, and flat, allowing for many structures to stand adjacent to one another, and refugee camps can be densely packed with the communities that the earthquake nearly tore apart.

Considerations for overall system/camp:

After the prototype is fully constructed and finished, the team then needs to consider the following next steps in relief efforts: contact the company that produces the materials, and determine the set-up process. Since the materials are lightweight, they would be able to successfully transport them to the needed location via ship, and then truck once the materials enter the Haitian port. The majority of the materials used comes from Brazil, which has a close proximity to Haiti.

Because so many Haitians were affected by the devastating earthquake in 2010, Team Another One needed to make sure the final design could work within a large community. Because of the ease of transport our materials, the units can be constructed in a neighborhood-like format to give a sense of community to the displaced people. With a certain area given, these units could be placed next to each other and still will allow plenty of room between, so the inhabitants don’t feel cramped.

As for community needs, the team will accommodate as needed. The displaced people are the reason for the relief effort, so if they specifically prefer something, Team Another One wouldn’t hesitate to change their ways to their preference. The secondary customer is just as important as the displaced people and they will be accommodate in the same way.

Re-design ideas/thoughts and conclusion:

One way the team could improve the current design would be to change the nature of the testing. In specific, the “drop test” would be another great way to test the design’s ability to withstand poor weather conditions. The heavy rains test could have been done better as well, to better test the function of the gutters. The final design could be improved
if the structure was built from relatively light materials that don’t compromise strength and fully deconstructible.

The project could be improved if specific guidelines were given for how much money was allowed to be spent on the design. If a specific cap were given to our design, it would allow us to better understand what design the parameters are, and allow the team to make additional improvements to the design should they find that the structure is well within the budget. The Haitian people had their country, communities, and homes torn apart by the Earthquake that hit in 2010. The goal was to build an adequate structure to live in during their time as refugees. It is our hope that our design can provide more than just a roof over their heads, but to preserve their sense of community, belonging, and optimism for a better future.
citations


