Team Circle, Sec. 12:
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**Pent House Design ;)**

**Mission Statement:**

The mission is to develop stable living structures that will reduce the effects of earthquakes as much as possible. These structures should be low cost, but still made with integrity and enough room to house eight people. These shelters will be primarily marketed in Chile and other countries that are impacted by earthquakes. The main goal is to provide a shelter which has become a necessity among refugee camps in Chile and for the government of Chile to support these shelters and help incorporate them into Chile. Another stakeholder could be Habitat for Humanity in Chile because they build affordable housing and would like using our designs as long term shelter.
Context and Customer Need Development:
The team’s research included finding information about the economic status of most Chileans and the social culture. Chile is considered one of the most prosperous nations in Latin America but they still have a high economic inequality which means there are many citizens living in poor conditions with low incomes. The 2010 earthquake in Chile hit poorer communities the hardest so these shelters have to be affordable for the government and for the people. The shelter has to have structural integrity to not fall on an inhabitant and withstand an earthquake of reasonable magnitude. Culturally, Chile is very family based and they tend to live in close knit communities close to extended family. To support communities at the refugee centers, they are made to be mass produced and can hold up to 8 people for an extended family to live in. The shelter has to have a lock and at least 2 windows. Since Chile is not impoverished, electricity is also a need for the shelter. The secondary customer is Chile’s Habitat for Humanity group because they specialize in building affordable houses for people in need. They would like a design that is earthquake resistant because it would be long lasting.

Concept Generation Summary:
The methods used for creating prototype one was considering the needs of the customer and the means with which the project could be viable. It needed to be generally affordable and needed to withstand earthquakes. In order to be culturally acceptable, the prototype needed to hold 8 people and would have a partition for privacy if needed. This way, the shelter can hold more people and use less materials because fewer houses would be needed if families lived together. Although the prototype needs to be affordable, it also needs to feel comfortable for people. The shelter would also include a pent roof in order to increase space and allow for bunk beds to be put into house more people.

Test Report Summary for Prototype 1:
<table>
<thead>
<tr>
<th>Customer Need</th>
<th>Test</th>
<th>Testing Result</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficiency</td>
<td>Weight/Area Test</td>
<td>The weight of the prototype was compared to the area.</td>
<td>Pass</td>
</tr>
<tr>
<td>Cost</td>
<td>Total Materials Cost</td>
<td>The cost was calculated and compared to the predicted cost.</td>
<td>Pass, was under $5</td>
</tr>
<tr>
<td>Durability</td>
<td>Earthquake Simulation</td>
<td>The prototype was roughly thrown in a box</td>
<td>Pass</td>
</tr>
<tr>
<td>Waterproof</td>
<td>Drowning Test</td>
<td>Cardboard was soaked</td>
<td>Fail</td>
</tr>
<tr>
<td>Security</td>
<td>Ramming Test</td>
<td>Minor indentations</td>
<td>Pass,</td>
</tr>
<tr>
<td>Strength</td>
<td>Crush Test</td>
<td>Held about 200 pounds</td>
<td>Pass</td>
</tr>
</tbody>
</table>

**Concept Refinement Summary:**
During the crush test, the glue gave away so the sidings needed to be reinforced more. The roof also seemed a little unstable so 2 pillars were put in as support. The prototype held up through most of the tests and surpassed the requirements for passing many of them. Prototype 1 also did not have much preventive structures for earthquakes like a base isolator so that would be considered for the next prototype. It also did not have a door or windows that is a customer need for the shelter.

Test Report Summary for Prototype 2:

Beginnings of prototype 2 with the pillars.

Seismic Isolators added in.
Final prototype with base showing with windows and 2 doors added in.

Base isolators underground.
More supports and reinforcements were added into the final prototype meaning that it should be more stable than prototype 1. 3 windows and 2 doors were also added in so the family could have natural light and a way to get in the house. The materials that the final prototype will use will last much longer than the initial prototype.

Cost Analysis:
The final prototype was made from cardboard exclusively. The walls collectively cost $1.08 while the the roof, floor, and supports cost $0.58, $0.22, and $0.08 respectively. The total cost of the final prototype was only $1.96. The calculations for the real-world model included $200 worth of studs and $2,000 worth of concrete for structural integrity. Then $5,000 for roofing and $6,000 for stucco walls. Inside, $300 covered the cost of the drywall needed to hold in insulation and cover the studs. This came out to $13,500 plus roughly $500 in any unexpected costs. The grand total for actual production was estimated at $14,000.

Consideration of Human Needs:
Chile is an economically strong country. Taking that into account, many displaced people in Chile will be forced out of fairly comfortable living situations. Refugee shelters in Chile should be cost and space effective, but they should also provide a level of comfort that most refugee shelters would not. Displaced Chileans should not have to completely sacrifice their standard of living because of an earthquake. Shelters should include insulation, electricity, and a decent amount of free space to appropriately accommodate an average Chilean lifestyle.

Redesign Ideas/Thoughts and Conclusion:
If another team were to take over the project for a prototype 3, the original team suggests to keep the cultural aspect of the structure in mind. Chile is largely family oriented and in the event of a disaster, family is all one has.

No large changes are necessary, however, it would be best if the new team implements electricity. During the drafting phases, the plan included electricity, but was never added to either prototypes.
Earthquakes are a serious problem for the citizens of Chile. The hundreds of yearly earthquakes can be especially problematic for lower-middle and lower class citizens that live comfortably, but cannot afford a major shake-up to their living situation. Shelters need to be able to accommodate not only the number of refugees, but also provide them with comfortable living situations. The shelter that was created in the project effectively meets the specifications that would provide Chilean refugees a safe haven from the consistent devastation of earthquakes.