The Soggy Frittatas #8

The Castle
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Figure 1 Picture of the Prototype
Mission Statement

The goal of The Soggy Frittatas is to design a safe, durable, inexpensive, and comfortable shelter for refugees in South Sudan and other developing countries. The structure has to be easily built, repairable, and has to conform to the cultural standards of the occupants. These shelters will enable a sense of community and entrepreneurship to help establish homes that have the potential to be more than a shelter.

Context and Customer Need Development

Before the structure could be designed, the region and culture of South Sudan had to be researched. It was decided that each individual would do preliminary research. The group then met to discuss new ideas and complete the necessary research for areas that were not studied as well. Then, as a group, the research was compiled and the most important parts were chosen and a background research report was created based upon those facts. One of the main reasons why South Sudan was chosen was because of the constant turmoil and ongoing conflict. Alongside of this, South Sudan is one of the most recently formed countries, who also face damaging climate effects. South Sudan has both humanitarian and environmental problems challenging them to grow as a nation. This intrigued both emotional and engineering interests, so as to help create a more efficient way to house refugees. The multifaceted problems inspired the group to choose South Sudan. Soggy Frittatas hopes to create a shelter that can help alleviate both aspects of the challenges in South Sudan.

South Sudan only recently succeeded from Sudan in 2011. Before this Sudan had always been the center for war and conflict. Sudan is known for having two of the longest civil wars in Africa’s History. The first civil war started in 1962 and lasted for ten years. Once oil was found a second civil war broke out lasting for twenty nine years. The statistics for these first two wars were unknown, but According to BBC the Civil war in South Sudan that only lasted two years displaced over 2.2 million people(5). These people had to completely pick up and leave behind everything to move to safety.

South Sudan is culturally and ethnically diverse. They are a predominantly traditional religious country with many ethnic groups following their own specific beliefs. However most of these groups have very similar systems and rituals, with some even sharing languages. According to Britannica, “The most important linguistic grouping in South Sudan is that of the Nilotes, who speak various languages of the Eastern Sudanic sub-branch of the Nilo-Saharan language family. Chief among the Nilotic peoples are the Dinka, Nuer, Shilluk, Bari, and Anywa.”(4). This allows for very easy communication between groups throughout South Sudan.
Most of the people who follow these traditional types of religions rely on farming and agriculture to provide for their families.

Due to much of the area being underdeveloped, the shelter will need to be easily transported and constructed. Because of this, and the fact the existing majority of homes in the area are made of wood (1), the shelter will also be made of wood. However, it will be constructed more effectively than their existing structures. Furthermore, the weather extremes of the area will need to be taken into concern. The climate has seasonal extremes of a very dry season, and a very wet season, subject to constant flooding. The majority of the population is rather young, with just over 50% being under the age of 19 (1). Moreover, most of the household livelihoods of the residents is crop farming (1). This, coupled with the figure of 1,643,484 internally displaced persons (2) will be taken into account when designing our shelter.

The secondary customer is ROOTS. ROOTS is a Washington Based nonprofit partnered with ROOTS Project, a South Sudanese NGO that help provide women and children with safe opportunities to education. Located in Juba the capital of South Sudan ROOTS also provides arts and crafts opportunities to the women of South Sudan so that they develop it as a skill and eventually help provide for themselves. ROOTS was chosen because of their location in Juba, it being the capital of the South Sudan. Roots uses schools to teach the women in. The shelter, the Castle, can be easily modified to provide a larger area for ROOTS to operate. Also the Castle has features like, the water containment system, that would be a large asset to ROOTS.

First, all of the customer needs were broken down and ranked in order, as shown below. When designing any new prototype, it is very important to consider the needs of the future customer. The needs were then weighted with a percentage based upon which were the most important:
Figure 2: Customer Needs

- Durability: 20%
- How easy the shelter is to build: 15%
- Inexpensiveness: 30%
- Comfortability: 8%
- Multi-purpose: 7%
- Fits more than 6 people: 20%

**Concept Generation Summary**

First, prototype sketches were drawn independently as a brainstorming activity. Then, each of the five best shelters (as picked by The Soggy Frittatas) were judged according to the criteria listed above. After picking a winner, the pros of the other designs were identified and incorporated into the top design and the cons were limited.

![Figure 3: Initial Drawings](image)

![Figure 4: Drawing](image)
Using the sustainable development goals from above, a weighted matrix was created and evaluated five shelters. The Castle, the Ham house, the Windmill, a house, and the tepee. Most of
the shelters had common elements including water collection systems and elevated floors. After matrix, the Castle yielded the best results with the Ham House coming in second.

From the two most promising sketches, the Castle and the Ham House is where there was division in making a decision for the shelter. The best features from both like water collecting system from the Ham House and the structural integrity of the Castle, were combined.

**Test Report for Prototype 1**

![Test Report for Prototype 1](image)

Figure 7: Test Report for prototype 1

The first test was the Crush Test. First, 75 lbs of paper was placed on top of the structure, but nothing happened. Next Jared and Sean stood on the shelter and still no damage occurred. Eventually Jared, Sean, Tyler, and Gage all stood on top, and at last the shelter was defeated. Success was set for the test at 100 pounds, and the Castle was stable and sustained five times that weight.
The second test was the Ease of Assembly Test. This test’s purpose to mimic the length and difficulty of building our actual structure. The set goal to pass the assembly test was construction of the prototype in under one man hour. Sean and Gage were able to successfully pass the test completing the assembly in 20 minutes total. With a 1:15 scale this would take the equivalent of 10 man hours to complete.

The third test was the water test, to test the ability to hold water and to withstand massive amounts of water during the rainy season in South Sudan. The goals were for the Castle to hold water without leaking for one minute under a faucet. It was able to withstand the water test and didn’t allow any water to leak into the shelter.
The design team did not conduct the wind and aesthetically pleasing tests. The wind test seemed unnecessary. After more research, we concluded that winds would not be a major issue with the shelters in South Sudan. Also, since this was a prototype built from cardboard and such, it could not be judged whether it would be visually pleasing or not since the materials used to build the actual model and the prototype differ greatly in appearance and texture.

The design team conducted the cost test to determine if the shelter is affordable for the refugees. The full scale model should be under five hundred dollars to become affordable to South Sudan refugees. Using the fifteen to one scale, the scale model, prototype one, should be under thirty three dollars. The first prototype was made at only a cost of one dollar and sixty cents. This is perfect since a cheaper shelter will allow the possibility to make more, thus, helping more refugees in South Sudan.

**Concept Refinement Summary**

After receiving the results from the prototype testing, the primary focus shifted from structural refinements to making the shelter more aesthetic and fulfilling of Maslow’s hierarchy of needs. Inside of the Castle, a waste of space was noticed inside of the structure. After the crush test decimated the Castle, a look inside the Castle revealed that the support beams to the roof were not structurally sound, due to the fact that they detached from the roof. After viewing this, a decision was made to make this one of the main focal points of change to improve upon. The second major change to improve upon was the roof. The roof provided a basic need and access to water. The prototype was able to hold water successfully, but it lacked a way for the people to access it. The water was a standing puddle on the roof. Therefore the second prototype needed a system to contain the water and be readily accessible. Moving forward from this, research was made into the materials available in South Sudan. It was found that local wood in South Sudan could be used and that cement and mortar can be supplied from the Juba cement factory. The ability to construct the shelter with basic tools like hammers and nails also helps the construction process. These important background details give the possibility to completely build the structure in South Sudan if necessary.
After the Solidworks construction of prototype two was created, many changes were analyzed for their respective effectiveness. Testing for this updated prototype were not able to be conducted or researched through online research. This prototype does have two main changes and upgrades from the previous structure shown on the front page. Change one which can be seen on figure 1 is, the addition of a center beam to support the roof. The crush test from prototype one highlighted the weakness of the structure. The corner support beams were the first to break and were also taking up much living space.
The second major change that came from the prototype test results was the pipe and tank. The water test proved that the Castle was strong enough to hold water, but had no way of accessing it. Therefore the roof was slanted and a pipe was added to improve the overall use of the structure.

**Cost Analysis**

Shelters Materials: 32 pieces of ½ inch plywood, 4 2x4 cross beams, <250 heavy duty framing nails, and cement

- Plywood: ½ inch wood = 7.49$ x 32 = 239.68$ (9)
- 2x4 Cross Beam/Stud = 3.29$ x 4 = 13.16$ (8)
- 3-¼ Steel Coated Nails: 30 lb pack = 31.92$ (approximately 500 nails) (7)
- Cement: 1 100lb bag of Quikrete = 34.63$ (6)

In summation, the total cost of the Castle is $319.39. The goal was to be under five hundred dollars, which was calculated to be about one fifth of the average earnings of a resident of South Sudan. These are just the input costs, but if mass production of these shelters were to occur, cost could easily be reduced by 25%, which could allow for new features like sheet metal or aluminum to be placed around the outside of the walls for further protection. These potential options increase the versatility of the Castle.
All of the prices were taken from retail stores online.

**Consideration of Human Needs**

The human needs of the inhabitants of the shelter were highly considered. First off, a large part of the design was focused on a base human need—water. The top of the Castle is designed to be able to catch and hold rainwater, especially in the dry season. This water can be used for any number of daily needs. Going up Maslow’s pyramid, the shelter has plenty of window space to allow for seeing the outside world, as well as being a source of comfort. Furthermore, the interior was maximized for space, allowing for the inhabitants to feel together and have plenty of space of their own to work with as they please, such as implementing their own walls or dividers, if desired. Additionally, due to the rectangular shape, the shelters can easily be aligned to form a neighborhood of sorts. Many shelters can be built together to create a larger area where a marketplace can be employed.

**Considerations for Overall System/Camp**

The design consists of majorly lumber as the building material. The lumber could easily be shipped there in crates since the lumber could be laid down on top of each other, but the lumber could, also be used from the large supply of lumber South Sudan has. South Sudan can use home made bricks for the floor. These bricks are very similar to mud bricks, so they are made relatively easily. We have also entertained the idea of importing cement for a very sturdy base.

The design is perfect for making a community. Since all houses are squares they could use a model like New York City as a city set-up. The houses would basically be made in a grid. They could make easily fill up any given area since the square shape is very simple to line up. The square maximizes the perimeter to area ratio, so it uses space the most efficiently. Since refugees probably want to be about five feet from each shelter on all sides, each shelter will need four hundred square feet for each shelter, including the distance from the other shelters. This makes a very simple equation to maximize shelter use. Just divide the area, in square feet, by four hundred to determine the amount of shelters in a given area.

Each shelter is very basic, thus, can be modified for use in a variety of ways. The shelter could be made into a store by simply adding shelves and a table to checkout at. They can also be modified in a food stand to get food at or a small grocery store by adding the essential materials inside. The Castle has the ability to store water, which can come in handy at a restaurant or store where they could sell the water. ROOTS can use each shelter as a school, or could possibly
remove a wall from two shelters and combine them since the dimensions would obviously lineup.

**Re-design Ideas/Thoughts and Conclusion**

If another team were to take over for prototypes three, they should look at the best way to implement crutches or stilts of some sort without compromising the floor’s strength. One of the earlier rough designs included a way to elevate the shelter off the ground to help with the rainy season flooding, but as the shelter got into the design phase and prototyping, an effective stilt design proved troublesome. Other than that, there wasn’t much else wrong with the prototype. More extensive testing and different methods of testing may prove useful to find flaws that were not found during prototypes I and II.

From all the evidence presented above, one can see how useful and effective the Castle would be for those in South Sudan, and anywhere else. The Castle was created with those in unfortunate situations in mind, and as such is an excellent shelter. The Castle is a strong, sturdy structure that fulfills both functionality as well as aestheticism. In addition to its strength, it can catch and hold rainwater, to help in those arid, dry months. The Castle’s simple design also allows for easy repair as well as easy group dynamics. The Castle is truly a spectacular design for all situations.
Works Cited


