#Equipe Uma
(#One Team)

Presents:

Eco-Grid

EDSGN 100
Section 21
Instructor: Jesse Mcternan

Team Members:

Matt Hine       Zach Gloeckner       Catherine Yoo       Chris Winner
1. Mission Statement

Our main goal is to try and find a cheaper (<$50), more efficient way of creating a (6m x 6m) greenhouse grid for farmers in Mozambique. This greenhouse grid will provide a template for farmers to mark the location of posts that create the overall structure of their greenhouse. This template ideally, decreases the amount of time to mark the posts, which will make our grid more efficient. To keep cost lost for people in Mozambique, we considered creating a grid constructed out of rope. With this design we will able to make it affordable as well as durable for the farmers, which is also important because they will not have to purchase one every time they purchase a greenhouse from greenhouse manufacturers in Mozambique. Our business goal is to maintain a quick and efficient way of setting up greenhouses so that greenhouse organizations in Mozambique will consider it and produce our product. The primary market for this would be to the organizations, GRO greenhouses and Mavuuno Greenhouses limited. While the secondary market, would be the farmers that receive our product from GRO greenhouses and Mavuuno Greenhouses limited. Our assumption for this is that they have the materials needed to set up the grid, which, in turn, makes our grid affordable and convenient to manufacture. The main stakeholder in this product would be the organizations, which are mentioned above, in charge of bringing greenhouses to farmers in Mozambique as well as producing these grids.

2. Summary of HESE

HESE stands for Humanitarian Engineering and Social Entrepreneurship. It is currently working project that brings together students and faculty members at Penn State University with the same goal; to develop cost-effective solutions to the problems that people in developing countries face on a daily basis[5]. Currently, they are helping small-scaled farmers in developing countries to set up grids & glazings for their greenhouses. Our customers are farmers that HESE is helping; small-scaled farmers with very little money and resources.

3. Location Research

Mozambique’s climate is considered to be tropical - subtropical. Most of Mozambique’s land is arable (62.69%)[1]. Mozambique mostly consists of coastal lowlands, however, there are mountainous areas towards the western part of the country[2]. Mozambique is quickly turning into one of Africa’s most successful countries even though their unemployment rate is still at 17% [3]. The basis of their diet centers around the cassava root, so farming can be very important. They don’t produce enough food to supply the entire country so most of their imports are food [4]. They produce 14.83 billion kWhr of electricity per year, which ranks 83rd in the world - most people do not get to use resources like Americans do. The lack of resources and power must be considered when designing the product for people living in these conditions.
4. Selection Matrices

Some concepts that we focused on while designing our prototypes are accuracy, time, durability, cost, and ease of use. Because we were to design a product for farmers who may not have resources such as electricity, we had to consider designs that consume less time but accurate and easy to use. For small-scale farmers, low-cost, durable product was needed. We ranked the important concepts as followed:

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>Time</th>
<th>Portability</th>
<th>Durability</th>
<th>Cost</th>
<th>Ease of Use</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>15%</td>
<td>5%</td>
<td>15%</td>
<td>15%</td>
<td>25%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Overall, we focused the most on accuracy and ease of use for our product.

5. Prototype Planning, Fabrication, Testing

- **Prototype 1**
  - **Plan**
    - After writing down our selection matrices, we combined our ideas to come up with a cheap, durable, easy-to-use product that is also accurate and less time-consuming. The design must be cheap overall, so we decided to use strings (in full-scale, ropes may be used instead) and geometry to approach accuracy and cost. We designed a grid that guarantees accuracy which farmers can lay on ground to mark the spots for holes.

(Left) The accuracy of the first prototype is poor. (Top right) Overall picture of the first prototype, laid on the ground. (Bottom right) The corners of the first
prototype are pulled & fixed to the ground by nails.

- **Test Results**

<table>
<thead>
<tr>
<th>Test Description</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accuracy</strong></td>
<td>Use the prototype to map out a grid. Then measure with ruler how accurate the markings were made. Fail - Accurate, but could be better (0”-½”)</td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td>Time the overall process of gridding (ie. untangle, secure, mark) Pass - Less than 3 minutes</td>
</tr>
<tr>
<td><strong>Portability</strong></td>
<td>Fold, keep, transport the prototype Fail - The strings tangle together</td>
</tr>
<tr>
<td><strong>Durability</strong></td>
<td>Pull the prototype strongly from 4 directions Pass - Very durable</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>Calculate how much it will cost per making one product Pass - Very cheap ($3-$30)</td>
</tr>
<tr>
<td><strong>Ease of Use</strong></td>
<td>Consider illiterate, small-scale farmers. Consider unavailable power and resources. Pass - Anyone can use it; no outside power required</td>
</tr>
</tbody>
</table>

- **Observation**

- Although the prototype did not completely pass all the requirements, the test was successful. The strings weren’t tied tightly enough so often they became loose, affecting the accuracy of the grid. The prototype was difficult to keep untangled as well. Because we found some failures in our prototype that can be fixed, we reconsidered our design to improve our second prototype.

(Above) Strings of Eco-Grid tangled.

- **Prototype 2**
The final product of the 2nd prototype.

- **Test Results**

<table>
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<tr>
<th>Test Description</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Accuracy</strong></td>
<td>Use the prototype to map out a grid. Then measure with ruler how accurate the markings were made.</td>
</tr>
<tr>
<td><strong>Time</strong></td>
<td>Time the overall process of gridding (i.e. untangle, secure, mark)</td>
</tr>
<tr>
<td><strong>Portability</strong></td>
<td>Fold, keep, transport the prototype</td>
</tr>
<tr>
<td><strong>Durability</strong></td>
<td>Pull the prototype strongly from 4 different directions</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>Calculate how much it will cost per making one product</td>
</tr>
<tr>
<td><strong>Ease of use</strong></td>
<td>Consider illiterate, small-scale farmers. Consider unavailable power and resources.</td>
</tr>
<tr>
<td><strong>Better than Prototype 1</strong></td>
<td>Has it improved?</td>
</tr>
</tbody>
</table>

- **Observations**
Although portability is still an issue, it has improved - each edge of the prototype was colored so that it is easier to “untangle” the product if it ever gets tangled. Also, it is very hard to skew the grid due to the diagonals on the grid.

6. Lesson Learned

a. **What if there was a third prototype?**

   If there was a prototype three our team would create a larger scaled version of our actual product. Doing this would allow our team to gather more accurate data that we could use to improve our overall design. We could spot accuracy any possible accuracy errors with more precision. This would also allow us to use a more similar material to the rope we will plan on using for our final design. With this new material we can spot any differences in our time, ease of use and durability test. Different sized product will produce new results that may differ, allowing us to fix any potential design flaws. We would also add two tests to our third prototype. These experiments would test for durability in weather and usage over time and would also test the ease of use with packaging and portability. We could physically mark the ground instead of using a piece of cardboard and screws, pushing our design to be more realistic. We would also be able to test portability by packaging in one location transporting over a distance and then setting up again. This would allow us to work out our transportation problem. We would keep all of our original tests and only add two.

b. **What went well?**

   Our team got together and from the very beginning and seemed to skip over the forming, storming norming stages of teamwork and skipped straight to the performing stage. This is when a team has high enthusiasm and high efficiency in their work. We were working on all cylinders whether it was communicating new ideas and thoughts or expressing and working through disagreements. We worked particularly fast when building our prototype. We had a sort of assembly line type of set up where each team member had their own job in setting up the grid. For example, one would tie, one would cut, one would glue, one would tape. We stayed organized by designating a team folder where we kept all paperwork in one place and also took pictures to help document our design process.

c. **What did not go well? what would you change? What roles would you change?**

   What did not go well was our first prototype. With our first prototype we found that the knots and a few of the grid lines were very loose and this led to a very faulty prototype. Our accuracy test was very off and we also added too many grid lines because we did not understand what the customer really wanted. After the first prototype, however, we greatly improved our second prototype by reducing the number of lines and making the strings tighter by using a template to create our product. A form of communication that worked really well was the use of google docs, email and text messages to allow us to keep in contact with everything we did.
throughout the design process. If I could change anyway the team would operate I would just say that we should work more, timewise. If we worked together for a longer amount of time then we could have continued to make our product more specific toward our client.

d. **How could the DEM project be changed for the better?**

I believe the DEM project could be improved by possibly only giving the design requirements in the beginning of the assignment. This would allow teams to use more creativity as opposed to directing thoughts toward a general idea. In our case the project description mentioned using a tarp to mark holes for posts. With this idea planted in teams heads from the start I think a lot of teams used this method to create an accurate grid pattern. This takes away from the creativity of students and may reduce the value of this project. If I were to change anything else I would change the fact that we could only pick from two projects. If there was anyway we could choose from other projects or improve upon other concepts that would be really fun for the future.

**References**


