Team Gold Bond (Team #5)

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HESE Greenhouse Grid Project

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Mission Statement

Our goal is to increase the quickness and accuracy of greenhouse base construction in developing countries. We will do this by constructing a tarp to help efficiently create a base for a greenhouse. Our business goals include a 15% profit and the sale of at least 100 tarps. The primary market for our product will be the farmers of these developing countries. The secondary market will be any consumers in developing countries who desire an inexpensive and efficient greenhouse for recreational or even educational use, such as ex-patriots or cooperatives. We are assuming that the quality labor of knowledgeable workers will be provided. The stakeholders in this project include the users, greenhouse construction workers, HESE, designers, and the investors.
Concept Development Summary

We picked the country that we were most familiar with (Kenya) and then we used the Internet to research it. We looked up things like economical, ecological, and political facts about the nation using accredited sources like the IMF, UN, and CIA world fact book. We realized that Kenya was a very poor place with relatively hostile weather, so we wanted our first prototype to reflect that by being durable, transportable, and easy to use, but also accurate and within the allowed budget. We knew we had to make it simple so it could be repaired with materials they have there and so that workers who might not have an education could use it.
ii. We weighed it on a scale to determine if our prototype was light and easy to use (Picture 3). It passed this test and weighed around 0.1 kilograms. Next, we looked up the price of our materials online and found that they were less than $10 which was under our goal of $50. The product needs to be moved, reused, and transportable. We folded it to the size of a hand (Picture 2) and found that it passed this test. To determine durability, we folded it, stretched it, and exposed it to roughly 160-165 °F of heat using a hair dryer (Picture 4). We unfortunately found that our prototype failed this test. The next test was accuracy. It needs to accurately place the frame of the greenhouse with an error of less than 0.25 inches. We laid out a grid and measured from point to point (Picture 1). Finally, to determine if the prototype was efficient and able to be put down in less than 10 minutes, put it down, we marked the ground through

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### Test Result Summary 1

Team Gold Bond (Team 5); Robert Suder, Wyatt Knapp, Anthony Capozzoli, Dawood Walbi; Tested on February 9, 2015 / 3-4 p.m. / 313 Hammond; Greenhouse Grid Layout

#### A. Test Result Summary

<table>
<thead>
<tr>
<th>Test Result Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>i.</td>
</tr>
</tbody>
</table>

#### Prototype Testing

<table>
<thead>
<tr>
<th>Test</th>
<th>Criteria</th>
<th>Pass/Fail</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>Less than 2 kilograms</td>
<td>Pass</td>
<td>Around 0.1 kilogram (which would be .328 kg full size)</td>
</tr>
<tr>
<td>Price</td>
<td>Less than $50</td>
<td>Pass</td>
<td>Duct tape and wax/tissue paper cost &lt;$10</td>
</tr>
<tr>
<td>Transportability</td>
<td>Compactable to carrying size</td>
<td>Pass</td>
<td>Foldable to size of a hand</td>
</tr>
<tr>
<td>Durability</td>
<td>Withstand heating and rough</td>
<td>Fail</td>
<td>Melted after being exposed to heat from hair dryer</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Enable worker to mark ground with the grid points with an error of &lt;1cm maintain constant spacing</td>
<td>Fail</td>
<td>Paper not sturdy enough to</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Ground marked within 10 minutes</td>
<td>Pass*</td>
<td>*Not accurately enough though</td>
</tr>
</tbody>
</table>

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ii. We weighed it on a scale to determine if our prototype was light and easy to use (Picture 3). It passed this test and weighed around 0.1 kilograms. Next, we looked up the price of our materials online and found that they were less than $10 which was under our goal of $50. The product needs to be moved, reused, and transportable. We folded it to the size of a hand (Picture 2) and found that it passed this test. To determine durability, we folded it, stretched it, and exposed it to roughly 160-165 °F of heat using a hair dryer (Picture 4). We unfortunately found that our prototype failed this test. The next test was accuracy. It needs to accurately place the frame of the greenhouse with an error of less than 0.25 inches. We laid out a grid and measured from point to point (Picture 1). Finally, to determine if the prototype was efficient and able to be put down in less than 10 minutes, put it down, we marked the ground through
the holes, rotated it around one point and repeated until we got a full to scale grid. (results for smaller project)

iii.

1. Measurement of the hole displacement
2. Compressing the grid system to hand held size
3. Weighing of the grid
4. Heat durability testing
5. Proof of heat test
B.

i. Our team observed that wax tissue paper is not sturdy and is very susceptible to the elements (Picture 5).

ii. Yes, we need a sturdier material to use instead of wax tissue paper.

iii. No, we expected that the paper was probably not going to be the sturdiest material but thought it could be a useful resource for a first prototype.

C.

i. We could change our tests so that they’re more accommodating to the fact that this is only a prototype and not the real product.

ii. We could add a test including a fan in order to see if our prototype can still be effective in conditions with high wind.

iii. We don’t know if our results will be applicable for the full-sized finished version of our product.

iv. N/a
Concept Refinement Summary

Describe how you used Prototype #1 development and testing to guide development of

Prototype #2.

Our first prototype was made of paper material and was easily transportable but lacked
the qualities needed to be durable for the long-term. We learned that the most important
qualities are durability and accuracy because if it doesn’t work well then transportability
doesn’t matter at all.

Did you change any of the desired features?

We made our second prototype out of cardboard and duct tape instead of paper,
sacrificing transportability for durability and accurateness.
Test Result Summary #2

Team Gold Bond (Team 5); Robert Suder, Wyatt Knapp, Anthony Capozzoli, Dawood Walbi; Tested on February 23, 2015 / 3-4 p.m. / 313 Hammond; Greenhouse Grid Layout

B. Test Result Summary
   i. Prototype 2 Testing

<table>
<thead>
<tr>
<th>Test</th>
<th>Criteria</th>
<th>Pass/Fail</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>Less than 1 kilogram</td>
<td>Pass</td>
<td>Weighed 0.4 Kg (which would be 4.3 kg full size)</td>
</tr>
<tr>
<td>Price</td>
<td>Less than $50</td>
<td>Pass</td>
<td>Duct tape and cardboard cost &lt; $10</td>
</tr>
<tr>
<td>Transportability</td>
<td>Compactable to carrying size</td>
<td>Fail</td>
<td>Not able to be compacted</td>
</tr>
<tr>
<td>Durability</td>
<td>Resistant to heat, rough use, and water</td>
<td>Fail</td>
<td>Duct tape began peeling after one weekend of storage</td>
</tr>
<tr>
<td>Accuracy</td>
<td>Enable worker to mark ground with the grid points with an error of &lt;1cm</td>
<td>Fail</td>
<td>Holes not properly measured</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Ground marked within 10 minutes</td>
<td>Pass*</td>
<td>*Not within accuracy requirements</td>
</tr>
</tbody>
</table>

ii. We weighed it on a scale to determine if our prototype was light and easy to use (Picture 3). It passed this test by weighing only 0.4 kilograms (Picture 1). Next, we looked up the price of our materials (duct tape and cardboard) online and found that they were less than $10 which was under our goal of $50. Knowing that the product needs to be reusable and transportable, we tried to fold it and compact it but found that it was not able to pass this test and consequently the prototype was damaged (Picture 4). To determine durability even further, we poured water on it (Picture 3), stretched it, and exposed it to roughly 160-165 °F of heat using a hair dryer. While it withstood these test, the duct tape began peeling off after leaving it in storage over the weekend; therefore, the prototype was not durable and failed this test. Next we tested the accuracy of the product. It needed to accurately lay out the frame of the greenhouse with an error of less than 0.1cm. We laid out a grid and measured from point to point (Picture 4). The holes were not the correct size and failed this test, resulting in an error that compiled with every rotation. Finally, to determine if the prototype was efficient and able...
to be lay out a grid in less than 10 minutes we put it down, marked the ground through the holes, rotated it around one point and repeated until we got a full to grid to scale. While we were able to do it without time being a problem, it still was not accurate enough for our prototype to be considered successful.

iii.

Picture 1. Weighing the prototype

Picture 2. Laying out and measuring the grid
B.

I. We learned that cardboard and duct tape are not the best materials for a prototype.

II. Yes. The test revealed that these materials are not durable enough for our project.

III. Yes. We were surprised to find that the duct tape began to peel off the cardboard just after leaving it sit on the shelf over the weekend.
Cost Analysis

The first prototype we made was constructed out of paper material and was well under $50. Our prototype #2 could be built for full size greenhouse gridding and meet the final goal of under $50. Our prototype was made out of cardboard and duct tape, which easily costs less than the goal. This material was, however, not durable and would not be chosen for our final product.

For our final product, we would use a “Super Heavy Duty” tarp from www.tarpsplus.com. It would cost us $15.20 to get an 8’x 10’ tarp. We would have to cut the tarp to make it 2 meters by 2 meters so it would have the correct measurements. We would also need grommets to support the holes, which we could get anywhere, such as www.zoro.com at $9.62 for a 24 pack. Since we only need 4 grommets per tarp, we could make 6 tarps per 24 pack. We expect our product to make about 25 to 30 greenhouses before it will start to deteriorate. If our goal is to make 250 greenhouses per year, we would need about 10 of our gridding products per year. Therefore, we would need 10 tarps at $15.20 per tarp and two 24 packs of grommets at $9.62 per pack. We could use the extra grommets for the next year. Our total cost to manufacture our product to make 250 greenhouses would be roughly $175. The average cost of each greenhouse grid template would be less than $20. Thus our product would be a cost-effective option for the gridding of a greenhouse.
Re-Design Ideas/Thoughts

- While we were not able to present to the HESE students, in general we have decided that we would try to make our product out of a thick and durable tarp.

- If the HESE students were to take our idea and prototype #2 and build off of it, we would recommend making the model full size and out a “Super Heavy Duty” tarp from tarpsplus.com and then placing metal grommets in the 4 corners making a 2m by 2m square between them. That way they could get an actual measurement of how big and heavy the tarp is, as well as an idea of what it would be like to have to transport it. Also, they could even try to see if the ground is able to be marked in under ten minutes, which we suspect is possible although we have never been able to try it with a full size tarp. That would be our dream prototype.
References

www.tarpsplus.com

www.officedepot.com

www.zoro.com