Team 7

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Kenya Dig It?!

Prototype #1

Materials:

- 1 yard by 1 yard plastic tarp
- 16 small wooden sticks
- String
- Level

Set up steps:

1. Gather materials
2. Lay tarp on ground
3. Insert four sticks through four holes in the corners and make tarp taught
4. Insert remaining sticks into the remaining holes in the tarp
5. Wrap string around the perimeter of the sticks and then through the inside grid of sticks so that the string is the same height from the ground on every stick
6. Hold level parallel to one section of string
7. Repeat step 6 for every section of string to measure the levelness of the whole area of ground under the tarp

Test Results Summary of Prototype #1

9/22/14, 8:15 AM, Hammond Building

Table 1: Prototype #1 Test Plan Outline

User Need/ Feature / Requirement	**Describe Test**	**What is "pass"?**	**Materials/ tools needed to run tests**
Easy to understand directions	Give written directions to other group to see how easy it is for them to follow	The other group is able to set up stakes with ease	• Prototype • Group willing to help with test
Speed	Time how long it takes to set up the stakes	Being able to set it up in less than five minutes	• Prototype • Stopwatch
Cost	Research how much a 6 meter by 6 meter tarp would cost	Tarp is projected to cost less than ten dollars	• Computer
Repeatable tests	Set up stakes multiple times to see if it leads to the same results	Several trials yield the same results	• Prototype
Simplicity	Set up prototype and see if we reach any problems	Have little or no problems while setting up the	• Prototype

		prototype	
Minimum number of people	See if two people are able to set up the prototype	Two people were able to set up prototype in the allotted time which we set as four minutes to account for the size.	• Prototype

Table 2: Prototype #1 Test Results

User Need/ Feature/ Requirement Test	**Pass or Fail**	**Notes**
Easy to understand directions	Pass	The other group that participated read our directions on how to use our design and believed that they could follow them relatively easily. The problem with this is that the carpenters and day laborers will not be able to read so new instructions must be made for prototype #2.
Speed	Pass	Three out of three test runs

		were completed in under four minutes
Cost	Fail	Assuming that the tarp we would use in the final design would cost 1 dollar per square meter puts us well over the spending limit for this project. Prototype #2 will involve a much smaller tarp which will reduce the cost of the project.
Repeatable results	Pass	Set up prototype three times successfully. We were able to set it up quicker each time.
Simplicity	Pass	The prototype was easily set up with no problems.
Minimum number of people	Pass	Two people were able to complete the test easily.

Figure 1 **Figure 2**

Figure 1 and 2 show Ali and Zach laying down the tarp and making it taught by staking in the four corners first.

Figure 3

Figure 3 shows the tarp after it is laid out and each stake is inserted through the tarp and into ground forming the grid.

Figure 4

Figure 4 shows the string which is wrapped around the stakes. The string is placed at the same height at each stake and then the level is held in line with the string to make sure the ground below is it completely flat.

Observation Summary

We learned from our test that our design was able to meet most of the requirements. Our tarp was relatively quick and easy to set up and it made it possible to measure the levelness of the ground beneath it. The tests revealed that we had a good plan for measuring levelness but the only problem was that it will cost more than we are able to spend which does not allow us to continue with this plan. We were surprised that we were not able to find to find any tarp at the size we wanted that met our price limit because we believed that tarps were generally inexpensive. This design must be revised to accomplish the same tasks while meeting the price limit.

Re-design ideas for prototype #2

Our team's idea for an improved second prototype involves a tarp again. The main difference is that it will be scaled to 2 meters by 2 meters. It will have a hole in each corner 2

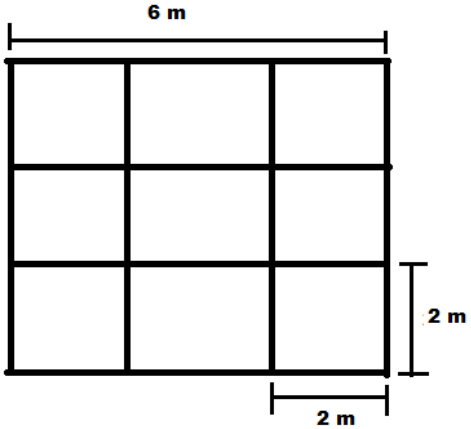
meters apart. Stakes will be stuck into all four holes and then the tarp will be removed by sliding it off the stakes. The tarp will then be moved to one side or the other and slide back over two of the stakes. Stakes will then be used to fill the remaining holes in the tarp. This ensures that the grid layout will be consisted of perfect squares. This process will be repeated until there is a 6 meter by 6 meter grid of stakes in the ground laid out with 2 meters in between each of the stakes to test the levelness. We must also make new directions for the design involving pictures instead of words because the carpenters and day laborers who will be using our design may not be able to read.

Prototype #2

Materials:

- 1 2 yard x 2 yard plastic tarp
- 16 4 in x 1 in x ¾ in wooden stakes
- 1 ball of string
- 1 hammer
- 1 bubble level

Directions / User Guide:



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Test Results Summary of Prototype #2

10/06/14, 8:15 AM, Hammond Building

Table 3: Prototype #2 Test Plan Outline

User Need / Feature / Requirement	**Describe Test**	**Define what is "pass" for this test?**	**Materials / tools needed to run tests**
Easy to understand directions	We will give our directions to other	The students are able to follow and	• Directions • Students

	students in our dorms that are unfamiliar with this project and see if they are able to follow them easily.	understand the directions we provided	willing to help with test
Speed	Time how long it takes to set up the stakes	Being able to set up prototype in less than ten minutes	• Prototype • Stopwatch
Cost	Research how much a 2 meter by 2 meter tarp would cost along with the other components	Materials for project add up to be less than $10	• Computer
Repeatable results	Set up stakes three times to see if it leads to the same results	Three trials yield similar results	• Prototype
Minimum number of people needed	See if two people are able to set up the prototype in less than 10 minutes	Two people are able to set up the prototype in less than 10 minutes for all 3 trials	• Prototype • Stopwatch
Accuracy	Measure distances between stakes and see how close they are	The stakes are within 1 cm of being perfectly spaced from	• Prototype • Tape measure

	to the exact distances they are supposed to be apart	each other for all three trials	

Prototype #2 Trials

We set up our prototype three times. The first trial was successful as we were able to set up the prototype in just under 10 minutes. It took a bit longer than the other trials because it was our first time putting together a larger scale of the project and we were learning as we went. Despite this the trial proved to be very accurate. All the stakes were separated by distances within 1 cm error. The next two trials were completed a lot faster. The second trial was completed in 9 minutes and 18 seconds and the third was completed at exactly 9 minutes. Both the second and third trial maintained the accuracy of trial one because they were both within in the 1 cm error allowed. It seemed as though a good amount of time was used up hammering the stakes into the ground. The stakes we used were short and thick which made them hard to insert into the ground. This will be addressed in the redesign of the prototype.

Table 4: Prototype #2 Test Results

User Need / Feature / Requirement	**Pass or Fail**	**Notes**
Easy to understand directions	Pass	We asked three different students from our residence halls to look at our directions

		and they were all able to follow them.
Speed	Pass	In the first trial we were able to set up the prototype in just under 10 minutes. The second and third trials were completed quicker and closer to 9 minutes.
Cost	Pass	The average price for tarps outside of the United states is around $1 per square meter ($4 for the 2m x 2m tarp) and the remaining materials would cost around $4.90 which would come out to $8.90 per kit.
Repeatable results	Pass	We set up the prototype 3 times successfully. We completed it quicker each trial.
Minimum number of people	Pass	Two people were able to set up the prototype in less than 10 minutes for every trial.

Accuracy	Pass	The lengths between the stakes were either perfect or within 1 cm of error.

Figure 5

Figure 6

Figure 7

Figure 5 shows Alex and Ali installing the first four stakes through the holes of the tarp and into the ground. This makes up the 1 yard by 1 yard square.

In figure 6, Alex and Ali are removing the tarp from the first set of stakes and are about to lay it back down to install the second set of stakes.

In Figure 7, Alex is wrapping the string around the stakes to form the grid that will be used to measure the levelness of the ground.

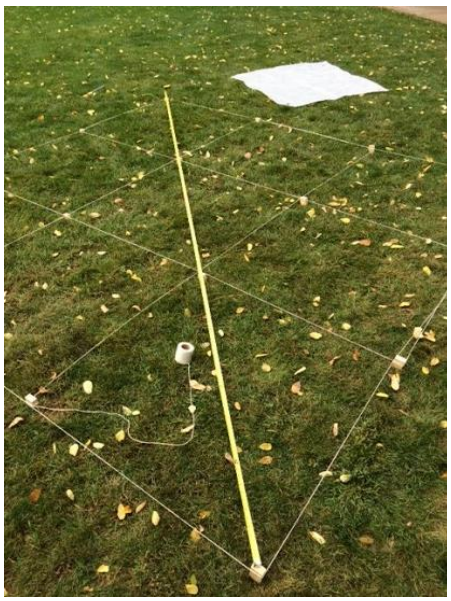

Figure 8 **Figure 9**

Figure 8 shows Ali holding the level parallel to the string to test if the ground is level.

Figure 9 provides a full view of the completed grid and the tarp used to make it.

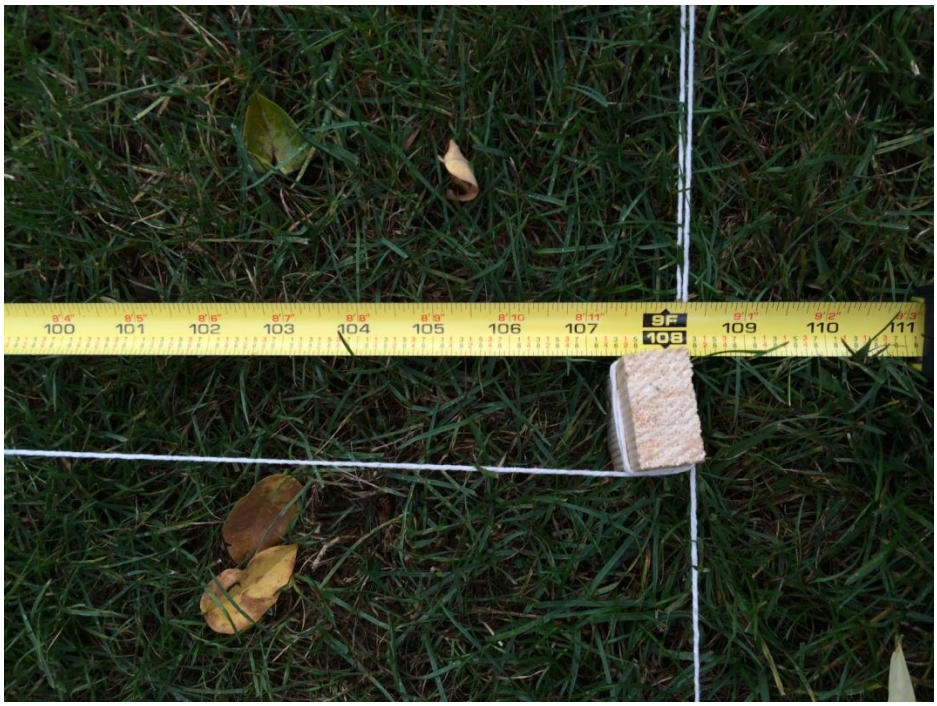

Figure 10

Figure 10 shows the measurement from a stake on one end side of the grid to the stake on the other end directly across from it. Since we scaled our project down to 1 yard = 2 meters this shows how accurate our design was because it measured almost exactly 3 yards (9 feet).

Re-design Ideas for Prototype #3

Overall we believe that our design was very functional and met the guidelines of the project well. Our main area for improvement is in the shape and length of the stakes. We hammered wooden stakes into the ground to wrap string around to test the levelness of the area in which the greenhouse will be built. The problem with our stakes was that they took too much time to hammer into the ground because they were short and wide. Prototype #3 should have stakes that are more thin and long. Good dimensions for the new stakes would be ¾ in x ¾ in x

6 in. Stakes with these dimensions would be far easier to hammer into the ground and will greatly decrease the time needed to set up the grid.

Cost Analysis

Upon looking into and analyzing the costs of actual full scale production of our prototype #2, we found that it will definitely meet the requirement for staying under the budget of $10 per kit. The main expense of our prototype is the blue woven tarp that we would use. To find out the cost for this, we asked the HESE students how much it would cost to buy tarp material like that in Africa, and two of them informed us that it would be assumed at $1/sq. m. So, for our 2m x 2m tarp, this would be 4 sq. m total, so the tarp would cost $4. The next most expensive material would be the wood for the stakes. We would need 12 feet of 2x2 for the stakes to mark the posts and do the leveling, and at 20 KES/foot, a number that I found online from a Kenyan architecture organization (Gichuhi), this would total 240 KES, which is about $2.70 in US dollars. The other material that we would need is string to run between each stake and use to determine levelness. We need roughly about 40m of string, and I found (at Walmart) that a 150ft ball of cotton string costs about $2.20. The total of all these three materials added together adds up to $8.90, which falls under the budget requirement of $10.

Source for cost analysis:

http://www.a4architect.com/2012/02/timber-prices-in-kenya-2012/