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# GRIDDING SQUARE

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Team 6/Team Dance



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Greenhouse Gridding Project

# Test Report Summary

## PROTOTYPE 1

### Summary

Prototype #1 was a basic template of our ideas. It was a 1x1 ft. cardboard square that would be traced to find the grid points of the grid. The first prototype was tested with chalk on a concrete surface rather than on dirt and grass. The first prototype was successful in showing us where we needed work on our design.

As a team, we feel like this design was a huge success. This prototype design was durable, simple, cheap, and fairly accurate. We were actually a bit surprised by how accurate the grids were. We learned that in order to maximize accuracy, it is important to use a thin tracing tool. The thicker the edges in the tool, the more error occurs.

**Table 1: Summary of Prototype #1 testing (Hammond Loading Dock)**

(October 6, 2014 at 9:00 am)

User Need/Feature/Requirement	Test	Needed to pass	Materials/tools needed to run tests	Trial 1 (Carl Santoleri)	Trial 2 (Austin Malencia)	Trial 3 (Jack Titus)	Notes
<b>Time necessary to build the 3x3 square</b>	For this test, we are finding the average amount of time to build the 3x3 grid	Less than ten minutes	A timer (We used our phones and a watch)	2 minutes 53.28 seconds  PASS	2 minutes 48 seconds  PASS	5 minutes 15 seconds  PASS	The average time to complete the grid was 3 minutes 39 seconds. Trial 3 was intentionally longer. We were examining the correlation between time and accuracy.
<b>Making a perfect grid</b>	After completing	All points $\leq$ 1 centimeter.	Yardstick, Miter Square, string	The right angles were	The right angles were	The right angles were	Much of the error was

	the grid, it is necessary to check the accuracy of the grid.	All angles $90^\circ \pm .5^\circ$ .		all good (checked with Miter Square). The diagonals were slightly off, one being 51 inches and the other 51.125 inches. The grid points were about 0.25-.5 inches off. PASS	good. Diagonals were off. The one diagonal was 51 inches and the other was 51.25 inches. The inside posts were off point by .25-.5 inches. PASS	on point. The diagonals were very close, one diagonal being 51 inches and the other was 51.125 inches long. The grid points were less than .5 inches off. PASS	caused by the chalk that we used for tracing. The chalk dulled near the completion of the grid. Therefore, the lines became thicker and harder to estimate.
<b>Durability of the Prototype</b>	This test is a measure of how many grids the prototype can produce. This is important in Third-World countries where materials may not be able to be replaced.	Produce three grids.	None	PASS	PASS	PASS	The prototype square made three grids and was estimated to make at least three more

The grid is successfully created	The grid must be completed.	A successful 3x3 grid is created.	Chalk, the prototype square, the pavement	PASS	PASS	PASS	None
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**\*\*NOTES:** The thickness of the chalk caused the largest amount of error. In future tests, we will have to find a way to trace with the edges of the square with more precision. The prototype measurements may have been slightly off; however, this did not affect the overall success of the prototype. The prototype needs to have pointed corners, which would significantly help with tracing. It is not necessary to have a spot for the posts on the prototype. Future prototypes of this design will be made to a larger than 1 ft. x 1 ft. scale.

## PROTOTYPE 2

### Summary

In design 2 we chose to scale up our prototype in several aspects. First of all we used solid wood and aluminum corner spikes, as opposed to the cardboard in design 1. (See Figure 2.1) Secondly, we increased the overall size, from 1ft x 1ft to 3ft x 3ft. Overall, this design was a great improvement from prototype 1.

We ran this prototype through a battery of tests and in various locations. These tests were on grass and dirt, and additionally flat ground and unlevelled ground. We also tested the design by making a full-sized 6x6 yard grid. We were extremely pleased with the results. The results showed that our design produced very little error and was able to construct the grid in less than ten minutes. These proved that our design was extremely accurate, even in poor conditions. Lastly, the design came in under the \$10 cap, at about \$6.50 to make one gridding square. With every design, however, there are flaws; we discovered the spikes were a little small and depending on the location, grass or dirt, the spike mark was hard to find. Figure 2.2 shows the Solidworks CAD model of Prototype #2.

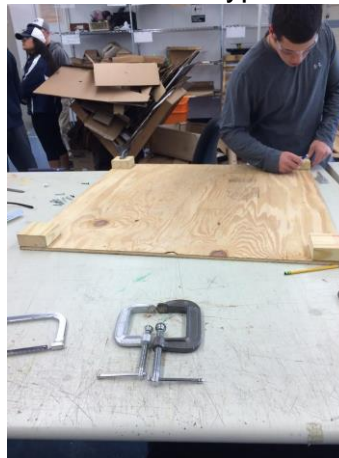


Figure 2.1: Constructing Prototype #2

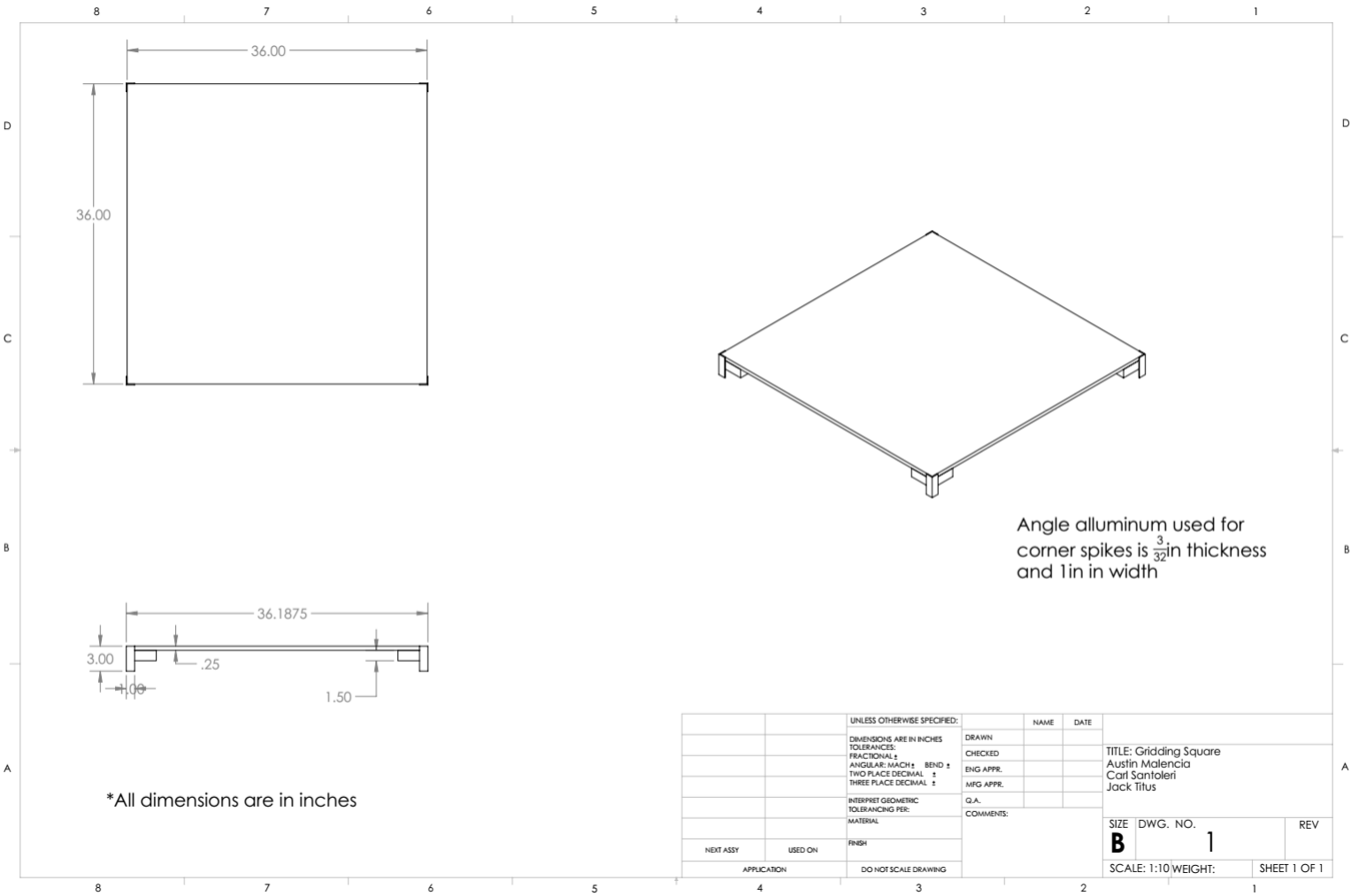


Figure 2.2: SolidWorks sketch of prototype #2

**Table 2: Prototype #2 Testing (Outside Stone Hall, East Residence)**

(October 13, 2014 at 8:00 am)

User Need/ Feature/ Requirement	Description of Test	Pass	Materials/Tools Needed for the Test	Trial 1 (Austin Malencia)	Trial 2 (Carl Santoleri)	Trial 3 (Jack Titus- in front of Hammond Building)
Time Necessary to build 3x3 grid	We are testing to see how long it takes to create the necessary grid.	Time $\leq$ 10 minutes	A timer and (Watch phone)	4 minutes 49 seconds  PASS	5 minutes 1 second  PASS	3 minutes 39 seconds  PASS
Diagonal Test	We will measure the length of the diagonals to see how accurate the square is.	Diagonals are no more than .25 inch different from each other.	Measuring Tape	Diagonal 1: 153.125 inch  Diagonal 2: 154 inch  FAIL	Diagonal 1: 153.375 inch  Diagonal 2: 154.375 inch  FAIL	Diagonal 1: 154.875 inches  Diagonal 2: 155.125  PASS
Right Angle Test	This test checks to make sure	$90^\circ \pm 1^\circ$	Square	$90^\circ$  PASS	$90^\circ$  PASS	$90^\circ$  PASS

	that all angles are 90°.					
Durability Test	This test is a measure of how many grids the prototype can produce.	≥ 30 set downs	None	4 grids 3x3 + 2 grids 6x6 = 108 set downs		
				PASS		

**\*\*Notes:** The size of this prototype was 36 in. x 36 in. with ½ inch plywood, and the angle irons protruded the bottom by 3 inches. The first two trials were not done on perfectly level ground, which accounted for some of the error. The third trial was done in the grass, which is not ideal or even realistic conditions because once the ground is leveled, there would be no more grass.



Figure 2.3: The posts line up in the test.



Figure 2.4: Laying down the prototype



Figure 2.5: The posts line up perfectly.

**TABLE 3: Full- sized grid testing (In front of Hammond Building) (October 20, 2014)**

User Need/Feature/Requirement	Test Description	What is Pass	Trial 1 (Jack Titus)	Trial 2 (Jack Titus and Austin Malencia)
Time necessary to build 6x6 (full-sized) grid	<b>This test measures how long it takes to build the full-sized grid.</b>	<b>≤10 minutes</b>	<b>13 minutes 40 seconds</b>  <b>FAIL</b>	<b>7 minutes 57 seconds</b>  <b>PASS</b>
Diagonal Test	<b>In this test we will measure the diagonals to measure the accuracy of the square</b>	<b>≤ ½ inch</b>	<b>Diagonal 1: 308.875 inches</b> <b>Diagonal 2: 308.25 inches</b>  <b>PASS</b>	<b>Diagonal 1: 307.75</b> <b>Diagonal 2: 308.25</b>  <b>PASS</b>

**\*\*Notes:** In order to complete the full sized grid in under ten minutes, two people must be working together to finish the grid.

Figure 3.1: The 6x6 grid marks and the right angle.





## Cost Analysis

Although one might think Prototype #2 would be expensive due to the wood and aluminum, it is relatively cheap. However, you cannot make a single one of these designs for under ten dollars. The materials are only purchasable in larger quantities, thus making it more expensive. However, two of these designs can be made for a total of \$13.00, making the average cost for a single design to be \$6.50. This cost includes the price of the plywood and the aluminum angle irons used to make the design. The price for the angle aluminum is \$5.26. This is right within the price goal for the Greenhouse Gridding project. There is minimal labor in assembling the Gridding Square.

\*Prices are based off of local Lowe's prices\*.

\*[http://www.lowes.com/pd\\_55965-37672-11365\\_0+2z8vj\\_\\_?productId=3058167&Ntt=angle+irons&pl=1&currentURL=%3FNTt%3Dangle%2Birons%26page%3D1&facetInfo=\\$5%20-%20\\$10](http://www.lowes.com/pd_55965-37672-11365_0+2z8vj__?productId=3058167&Ntt=angle+irons&pl=1&currentURL=%3FNTt%3Dangle%2Birons%26page%3D1&facetInfo=$5%20-%20$10)

## Re-design ideas/thoughts

We were very pleased with the design of this prototype, however some ideas for improvement are found in the corner of the gridding square. Essentially, prototype #3 is a combination of our first and second prototypes. At each corner there would be a square hole for a rebar stake to be driven into the ground. Additionally, the angle aluminum on each corner will remain, and help form a channel for the rebar to go. The essential part of this rebuild is the fact that the center of each cutout square, must be 1 meter apart to ensure an accurate 6x6 meter grid. Lastly, we found that the corner spikes were just slightly too small at 4 inches. Therefore we chose to enlarge them to 5 inches or 12.7cm.

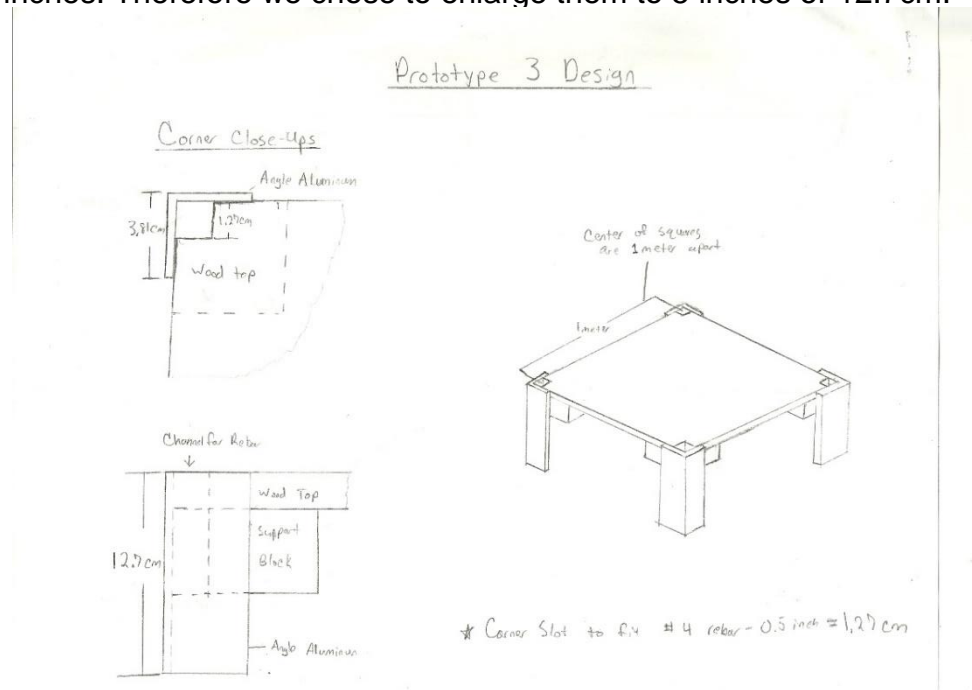


Figure 4.1

## USER ILLUSTRATED GUIDE



Figure 1: Place the Gridding Square in the ground.

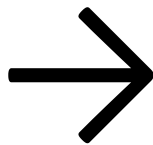


Figure 2: Step on corners of Gridding Square to set in the ground.

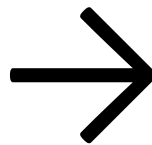


Figure 3: Mark the four corners of the square in the ground, using the bamboo skewers.

To Figure 4

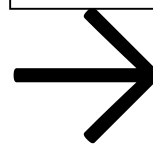


Figure 4: The first square in the grid is marked.

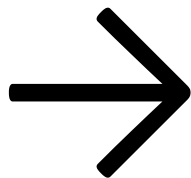


Figure 5: Pick up the Gridding Square.

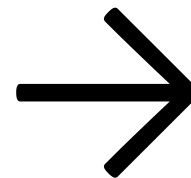


Figure 6: Align next to the first square.