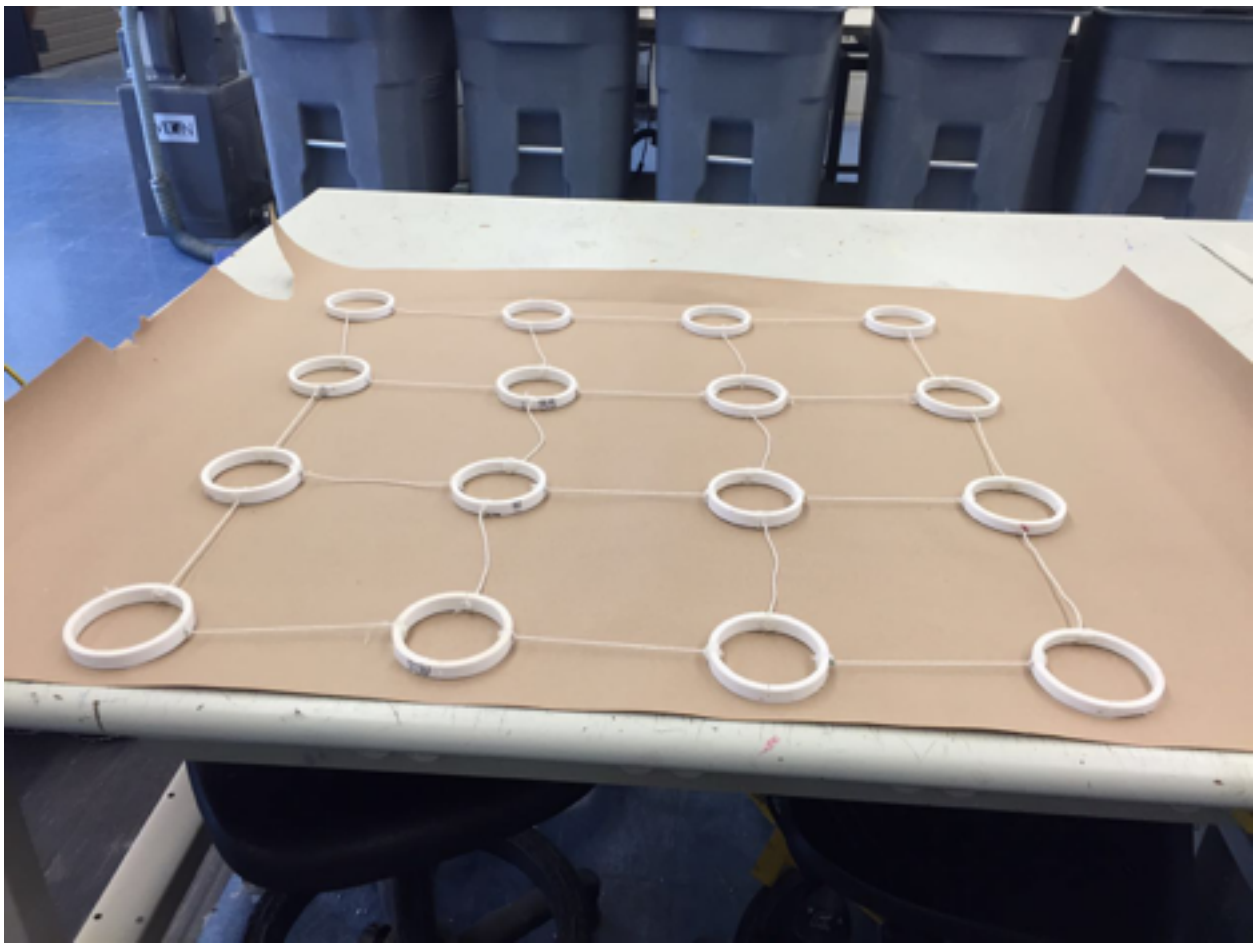
HESE Project — EZ Grid

EDSGN 100



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Mission Statement:

Our mission is to help battle the issue of hunger in poverty stricken communities by engineering products that assist in the construction of greenhouses. The name of our first product is called the EZ-Grid. The EZ-Grid is a simple 6 by 6 meter greenhouse layout that allows for quick and accurate placement of greenhouse foundation stakes. Our goal is to make the product as simplistic and as cheap as possible which will allow us to appeal to our desired consumer market through our supporting organization HESE. This consumer market consists mainly of illiterate and impoverished families in Africa. We aim to do this all without sacrificing the standard for production of a high quality product.

Summary of our Design:

Our design which is called EZ grid is used for greenhouse. It is used to make the position where the wood of greenhouse should be placed, which will save most of time at the installation. After making the hole, it is easily to be pack up and do the following steps. We used different tests to promise the time of storage and precision. It can tolerate hard climate and store for a long time, which will not occupy a large room for storing. For the developing countries, it has a really high cost performance that does not need high education to work on it. It can also adapt different environment such as high humid and temperature.

Location Research:

Sierra Leone

Location and population: Sierra Leone is a country in West Africa bordered by Guinea and the Atlantic Ocean. There are about 6 million people that live there. [1]

Climate: It has a tropical climate and is filled with savannah and rainforests. Due to the fact that the country is bordered by the Atlantic Ocean, Sierra Leone's climate is wet and rainy. [2] Even though the climate is wet and rainy, the country's percentage of arable land is only 7.95%. This may be something for us to take into account because Sierra Leona depends on that feeble 7.95% along with imports, to feed its nation, which might not be enough. This also might mean that our product may only be practical in that small 7.95% area because no one is going to want to build a greenhouse on non-arable land. [12]

Religions and Languages: There are sixteen ethnic groups that inhabit Sierra Leone. Each ethnicity maintains their own language and customs even though English is the official language spoken by the Sierra Leonean government. The country is predominantly Muslim and religious violence is a very rare occurrence in the country. [3] Language may be a barrier when it comes to designing a user-friendly product. Religion should not be much of an issue however because Muslims do not prohibit the consumption of vegetables, which is what our product would be aiming to help produce. [4]

Resources: Natural resources in Sierra Leone consist of diamonds, titanium, and bauxite. Mining is big in Sierra Leone and it is a significant component of the Sierra Leonean economy. [5]

Currency and GDP: The country utilizes the Leone as its monetary unit and overall had a RGDP value of $4.1 billion in 2013, and produced a mere $679 per capita. Sierra Leone is well into the bottom half of the rankings of nominal GDP by country, and 51% of the population is living below the international poverty line of $1.25 per day. [6][7] This is very important to keep in mind because we need to take into consideration that these people have no money for maintenance fees, and all of the underlying costs besides the cost of production need to be taken into account. Our product will need to be self-sustaining and durable.

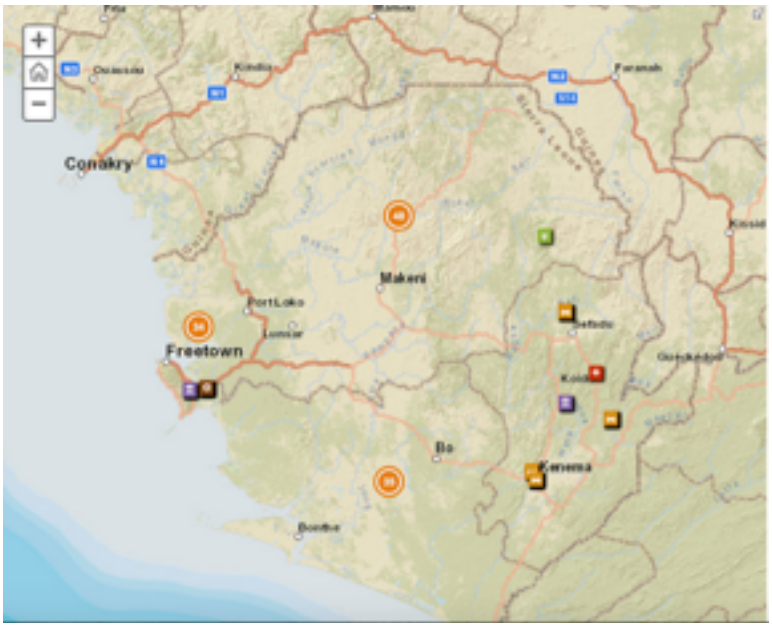
Agriculture: Two-thirds of Sierra Leone's population is directly involved in subsistence agriculture. Since Sierra Leone's climate is wet, rice farming is very common. As a result, rice is one of the staple crops. [8] Considering the fact that diamond mining leads to lots of land degradation and water contamination, this might be an issue for the agricultural sector of the

Sierra Leonean economy. This might be an issue because rice is one of the staple crops and rice farms utilize pools of water to grow rice stalks.

Education: Due to the civil war that took place from 1991-2002, over 1200 schools were destroyed. Although it is legally required for education to be provided from elementary throughout junior high school, a shortage of schools and teachers leaves one third of all school aged children deprived of education. According to UNICEF, only 43% of adults are literate. [7] This may affect our design process because if we produce something that requires a complicated instruction manual it will most likely never be put to use because the consumer wont be able to read how to set it up.

Food access: Rice is the staple food of Sierra Leone and is served at every meal daily. Potato leaves, cassava leaves, okra soup, fried fish and groundnut stew are some of the foods in Sierra Leonean cuisine. [10] Only 57.5% of the total populations utilize improved water sources (water is a recurring issue). [7] Sierra Leone is not self sufficient in producing their own food and as a result, food is one of Sierra Leone's biggest imports. This is probably the most important component of our research because our product aims to help poor families produce their own food instead of buying it.

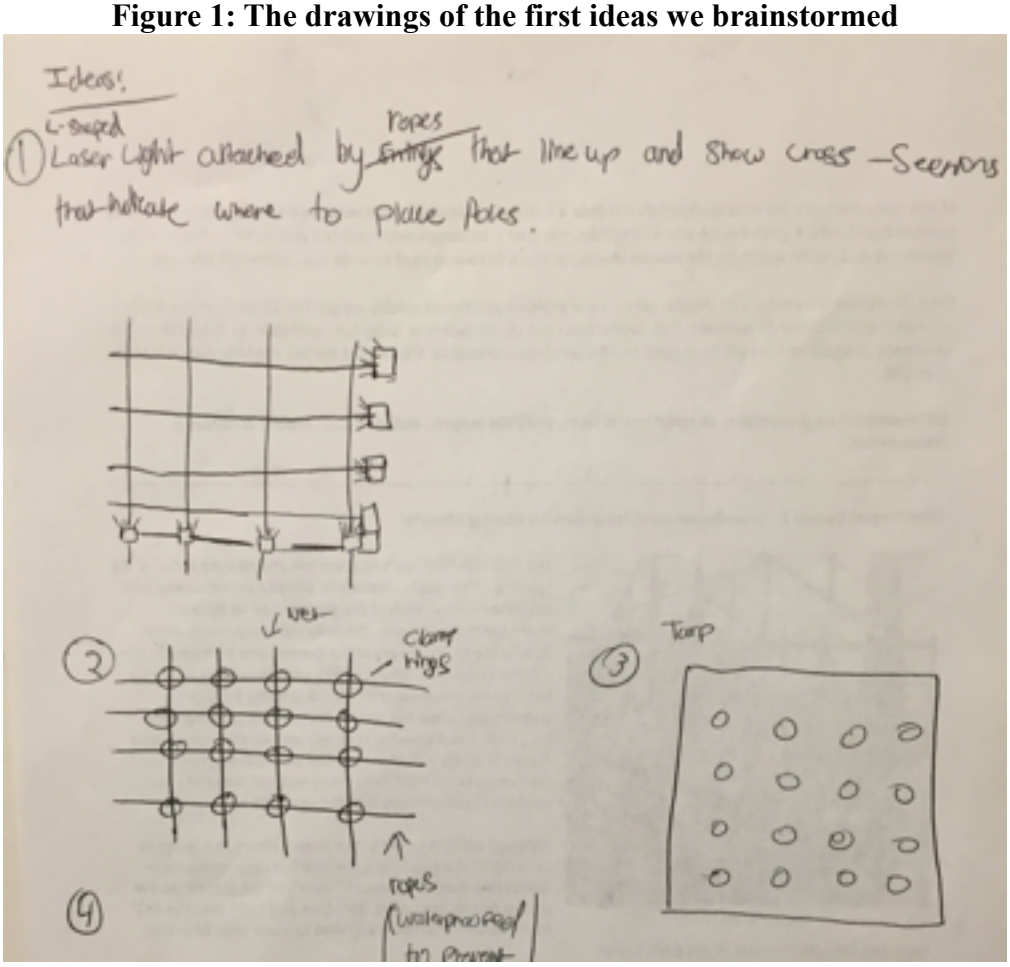
Figure 1 (below) shows how there is clearly not enough effort being put towards the improvement of food production. Out of all the government projects that are being worked on, only one out of nine is an agricultural project (the green box). This is a huge issue considering the fact that Sierra Leoneans don't produce enough food for their own country, and as a result they need to import food, even though the majority of the population cannot afford to purchase it. This is important to us because we hope that our product will help contribute to a solution for that problem.



Selection Matrices

The way we began our search for a good DEM project concept was by brainstorming things that could form a grid pattern. We brainstormed and thought of three ideas in total. The first was a laser grid. The lasers would be attached in the form of an L shape and the intersections of the laser beam would represent where to place the stakes of the greenhouse. The second idea was an arrangement of sixteen rings in four rows and four columns that were all attached by rope. This "net" idea would have the hole of the PVC rings represent where to place the stakes. The third idea was a tarp with holes that would allow the consumer to simply roll it out and place the stake through the hole in an accurate greenhouse pattern. The original sketches of these first three ideas are depicted in figure 1.

Figure 1: The drawings of the first ideas we brainstormed



All these ideas seemed to be appealing, but it was hard to decide which one was superior. We decided to do a concept screening as a method of choosing which concept to proceed with. After doing so, we decided that the laser grid idea was too expensive, had significant underlying costs (such as maintenance), and was not durable. The concept screening is summarized in table 1.

Table 1: A summarized form of our concept screening

	Concepts			
	A (ref)	B	C	D
Selection Criteria		Laser Grid	Tarp Grid	Net Grid
Cheap to produce	0	-	-	+
No underlying cost	0	-	+	+
Durable	0	-	+	+
Portable	0	0	+	0
Quick to set up	0	+	+	+
Sum +'s	0	1	4	4
Sum 0's	5	1	0	1
Sum -'s	0	3	1	0
Net Score	0	-2	3	4
Rank		3	2	1
Continue?		No	Yes	Yes

We decided that since the negative aspects of the laser grid outweighed the positive aspects, it was a good idea to continue on with the other two ideas and eliminate the laser.

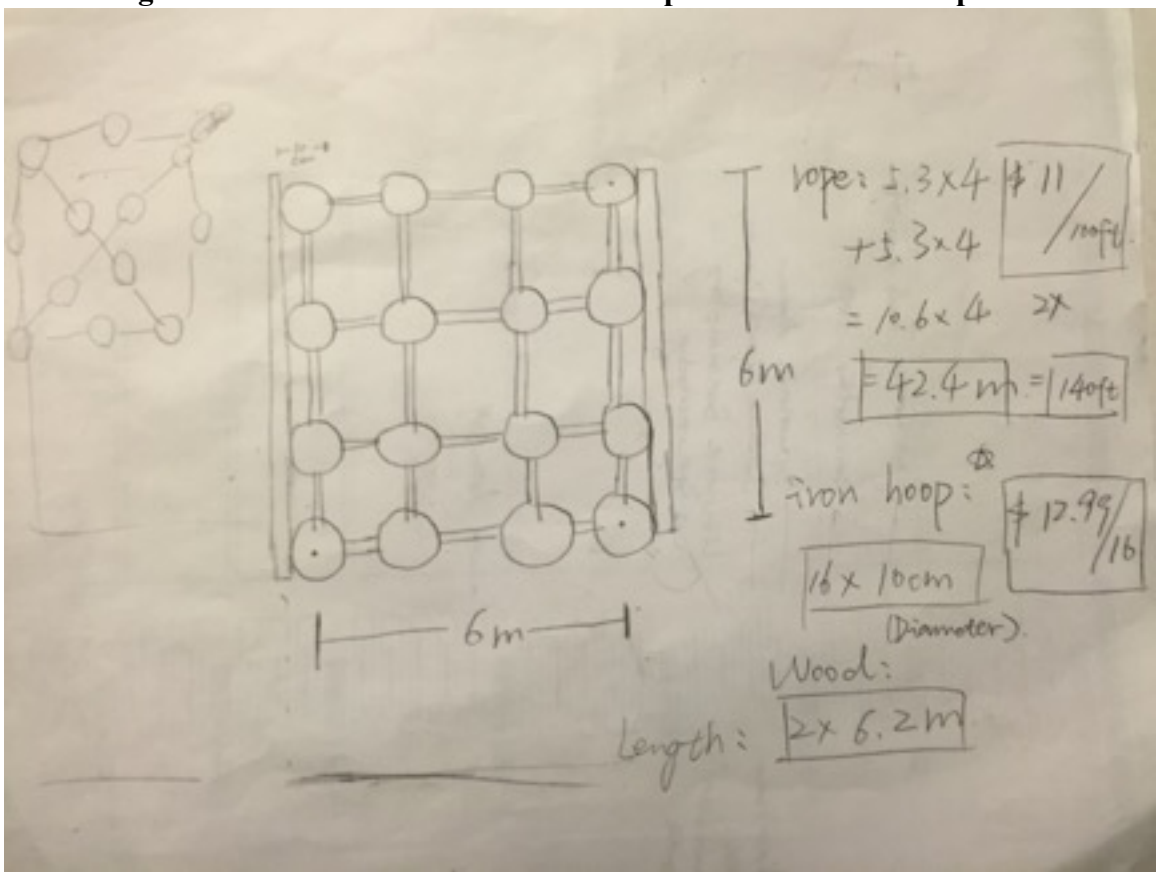
After we eliminated the laser we made a decision to take our two better ideas and weigh them against each other in a scoring process. We felt that the underlying cost was the most important aspect of the concept because if there are underlying costs, the product will not be able to be maintained and the consumer will eventually abandon it. We felt the second most important feature was durability because if the product is not durable it will break easily. The next most important aspect was the production cost. This is important as well because if the product is too expensive it would be unrealistic to distribute it to a developing country. The fourth most important characteristic is the portability. Considering that this product would be shipped all the way to Africa it would be preferable for it to be easy to ship and be carried home by the consumer. We felt that the speed of set up was the least important because both concepts were strong in that area and there was no need to factor that in as much as the other aspects that varied in strength amongst the two concepts. The weightings and scores are summarized in table 2.

Table 2: Summarized form of our weighted concept scoring

		Concepts				
		Net Grid (Reference)		Tarp Grid		Rating 1 - Much worse than other concept 2 -Worse than other concept 3 - Same as other concept 4 - Better than other concept 5 - Much better than other concept
Selection Criteria	Weight (%)	Rating	Weighted Score	Rating	Weighted Score	
Cheap to Produce	20	5	1	1	0.2	
No Underlying Cost	35	3	1.05	3	1.05	
Portable	15	3	0.45	3	0.45	
Durable	25	2	0.5	4	1	
Quick to set up	5	3	0.15	3	0.15	
	Total Score	3.15		2.85		
	Rank	1		2		
	Continue?	Yes		No		

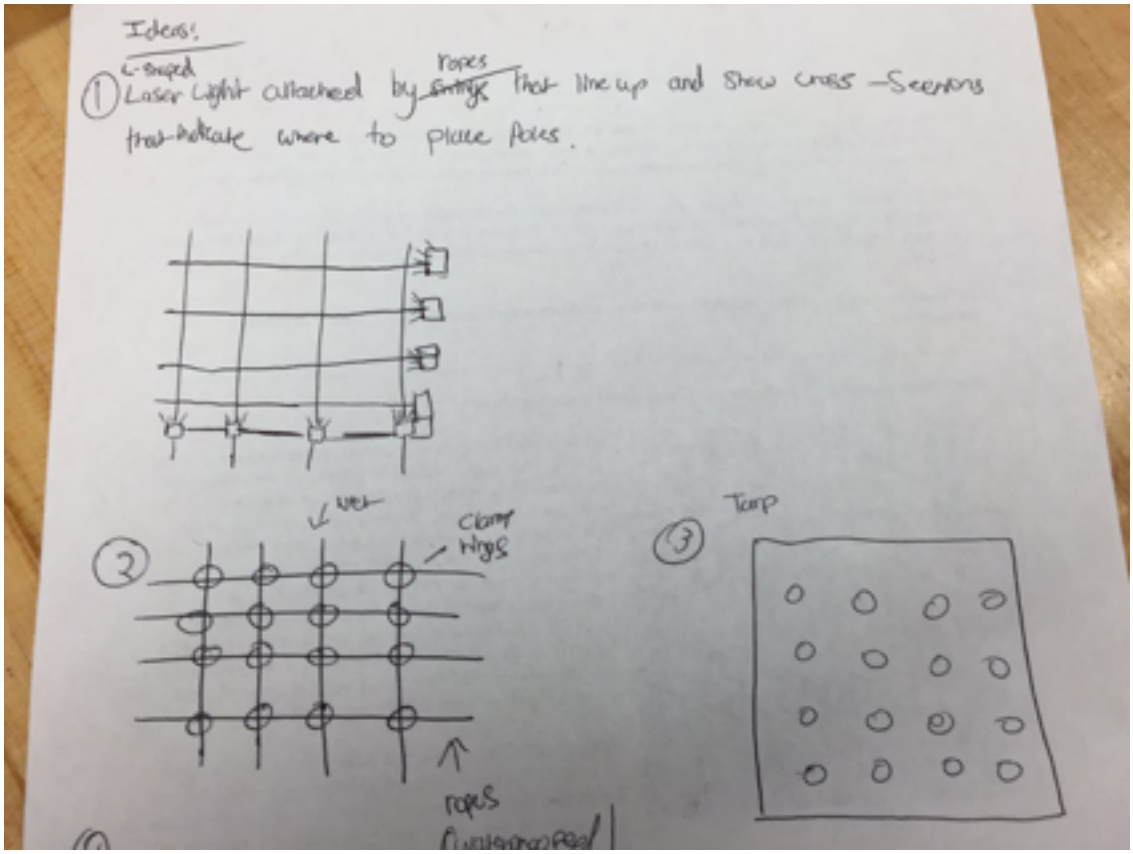
After seeing that the net grid concept scored higher than the tarp we decided that the net had strengths in more crucial areas than the tarp did. We then made a decision to continue on with the net concept and build a prototype for it, instead of building one for the tarp. We then began to draw out the sketch of the net grid in more detail, which is shown in figure 2.

Figure 2: Our second sketch of the concept that we decided to pursue



Prototype Planning, Fabrication, and Testing

a. Prototype one



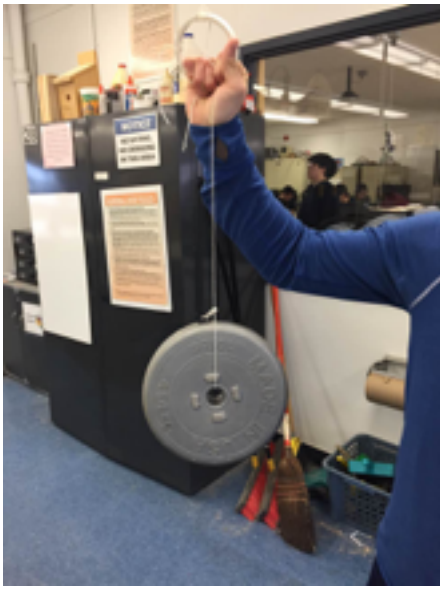
i. *Before the first cut, we came up with several plans.*

For the first one, we used 8 laser lights attached by ropes and line them up and show crosses, each of the cross-section is the place where we place poles. However after further consideration we don't want to use this plan because each laser light cost a lot and 8 laser lights will definitely exceed our budget.
The second plan: We want to use a 6x6 tarp and drill 16 holes on it and all these holes are evenly distributed. These holes are exactly where we place poles.
The third plan is that we use 16 rings with 10cm diameter and then use the ropes to attach each of the rings. The length of each part of rope is 1.7m.
We find out that the second plan and the third plan are both feasible. If we have enough time we would like to test both of two plans. However because we did't have enough time so we finally decided to use the third plan as our finally plan because the overall cost is 28 dollars which far less than our 50 dollars budget.

ii. *Test of our prototype.*

Use need / Feature / Requirement.	Describe the test	What is 'pass'	Materials and tools needed to run the test
1. Accuracy of grid layout	Measure each side of the prototype to make sure all the rings are in the exact same spot.	If the grid is symmetry and each ring is positioned exactly where it should be, then the prototype passes this Accuracy test.	Ruler Yard stick
2. Durability of the materials used for the test.	Apply 60 newtons force to each side of the grid and observe if the prototype breaks.	If the prototype doesn't break or deformed, then the prototype passes the durability test.	30 Newtons weight.
3.Portability	Fold up the net and see if the prototype successfully rolls up into a shape.	If if remains in shape and portable, it passes	NONE
4.Security of the rings attachment	Run water over the glue or the rings and see if the glues become weaker.	If the glue on the rings doesn't weaken then the prototype passes this test.	NONE

* Our first test is Accuracy test. The reason why we did this test is that accuracy plays an important role in the stability of overall structure. we measured each side of the prototype and the position of each rings. We found out that the error is within 0.4 cm, which attain our expectation. Thus our prototype definitely pass the test one.



* For the second test we apply 30 Newtons force to the grid to see if our prototype breaks or deformed. After observation, we found out that our prototype was still in good condition and we didn't notice any deformation at all. Thus we believe that our prototype passed the Durability of the material test.

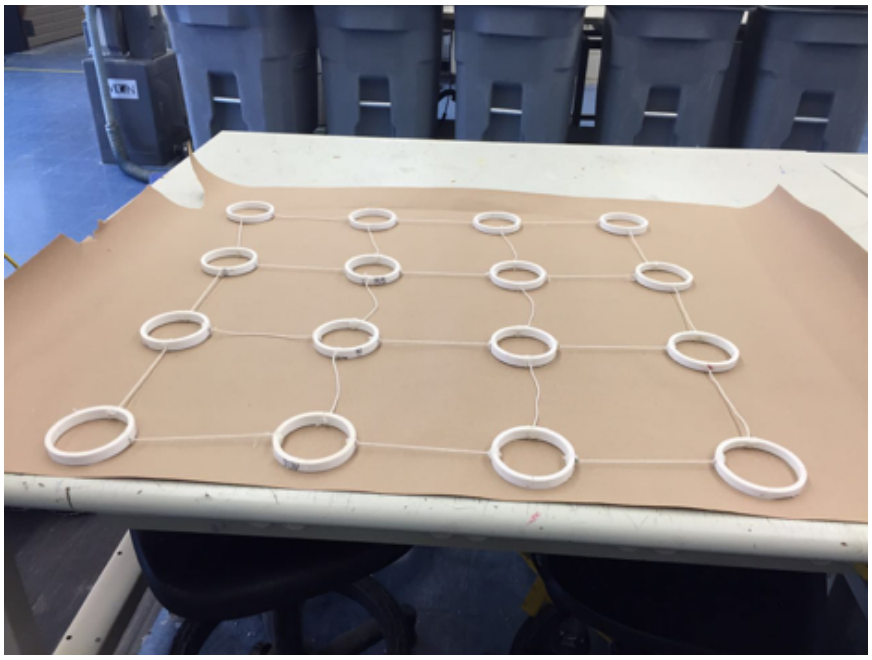
* For the third test, we fold up the net and rolled up our prototype into a shape, however when we tried to unfold our prototype, all the ropes somehow tangled with each other. We spent about 20 minutes trying to untangle these messed ropes but unfortunately we couldn't make it. Finally we decided to cut one of the rope to free other tangled ropes. After a great effort we finally made our prototype same as before. Definitely our prototype did not pass the portability test because there is great probability that ropes will tangle

with each other and extremely hard to be freed when we tried to fold them up.

* For the forth test we wanted to test the security of the rings attachment. We believe that the attachment(glue) is the weakest part of our prototype so we must make sure that the attachment (glue) will stand the pull force and does not break even in an extremely humid condition. So we decided to run water on the rings and apply a 30 N force on it. As a result, the attachment is still intact and in a good condition. Therefore we believe that our prototype passed the security of rings attachment test.

iii. *Observation summery*

According to four tests and our observations, we do believe that our first prototype is successful. Our first prototype successfully proved that the grids layout is accurate, the materials we used are strong and durable. Also these material are in good condition even in extremely wet or humid



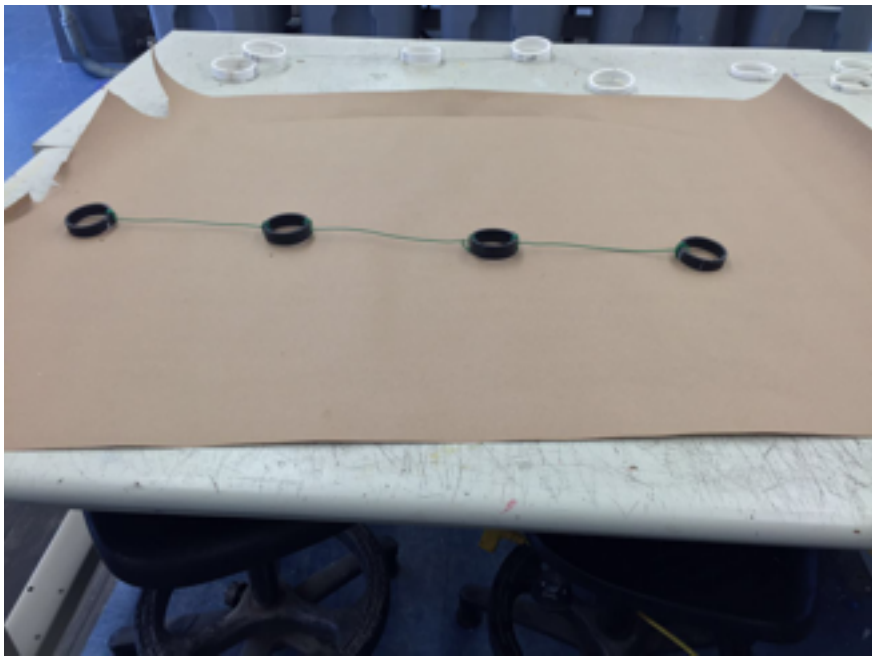
conditions. Most importantly, it shows us the defect of our prototype: ropes are very likely to be tangled when we tried to fold the prototype up. If we didn't run these four tests, we would never find out what is good about our prototype and what is bad about our prototype. These tests provide us with insight of the functionality of our design and any changes needed to make our work a pleasure to use.

b. Prototype two

i. How would the result of prototype 1 lead us to prototype 2?

Because our prototype passed the Accuracy of layout test, durability of material test and security of the rings attachment test, it means that we don't need to worried about the material or accuracy in our second prototype. All we need to do is to figure out what improvement can be made to prevent the ropes from tangling with each other when we tried to fold our prototype up. Obviously the best solution is to use other material to replace the ropes. After further consideration and discussion, we decided to use metal wires to replace ropes.

ii. *Tests*



Use need / Feature / Requirement.	Describe the test	What is 'pass'	Materials and tools needed to run the test
1. Accuracy of grid layout	Measure each side of the prototype to make sure all the rings are in the exact same spot.	If the grid is symmetry and each ring is positioned exactly where it should be, then the prototype passes this Accuracy test.	Ruler Yard stick
2. Durability of the materials used for the test.	Apply 60 newtons force to each side of the grid and observe if the prototype breaks.	If the prototype doesn't break or deformed, then the prototype passes the durability test.	30 Newtons weight.
3.Portability	Fold up the net and see if the prototype successfully rolls up into a shape.	If if remains in shape and portable, it passes	NONE
4.Security of the rings attachment	Run water over the glue or the rings and see if the glues become weaker.	If the glue on the rings doesn't weaken then the prototype passes this test.	NONE
5. Easy to layout	Layout the prototype within 2min	If the prototype can be layout within 2 min, then the prototype passes this test.	NONE

Result:

Our first test is Accuracy test. Just as our prototype i, we measured each side of the prototype and the position of each rings. We found out that the error is extremely small, which attain our expectation. Thus our second prototype definitely pass the test one.
For the second test we apply 30 Newtons force to the grid to see if our prototype breaks or deformed. After observation, we found out that our second prototype was still in good condition and we didn't notice any deformation at all. Thus we believe that our second prototype also passed the Durability of the material test.
For the third test, because metal wires are ductile and can be easily bended over, we believe that our second prototype passed portability test successfully.
For the forth test we wanted to test the security of the rings attachment. Again we decided to run water on the rings and apply a 30 N force on it. As a result, the attachment is still intact and in a good condition. Therefore we believe that our second prototype also passed the security of rings attachment test.
For the fifth test, by using metal wires instead of ropes, we successfully solve the 'ropes tangled' problem. Now we can easily layout the whole prototype without any difficulty. Thus our second prototype passed the final test.iii.
According to five tests and our observations, we do believe that the test was successful. Our second prototype works better compared with our first prototype.These tests provide us with insight of the functionality of our design and tell us what changes needed to make our work a pleasure to use. We are all surprised how making prototypes and running tests will inform us with new ideas to solve the problems and making our design a better work.

Lesson Learned

a.

We have made prototype 3, which changes the ropes to become electric wire. For prototype 1 we used the cotton which is easily to install and pack. But the biggest drawback is that if we packed it up willingly. It can be easily entwined and hard to unlock. So in the prototype 2, we changed the material of ropes to be steel wire. But it is too hard to pack up since it is such a large piece of equipment. Some part of the ropes cannot become straight, which may influence the position of the greenhouse. Finally we chose electric wire as the ropes of connection. The hardness of the electric wire is at the middle of the steel wire and cotton which is hard to twist yet easy to pack up. And if we can do the next prototype, we should pay more attention to the size of prototype. It should have the same size as the real one that we should shrink same degree in width and length, both in the ropes and rings. Specifically, the width and length is 6 meters and the diameter of the rings is 10 centimeters. So we should shrink 6 times less than the real one. In the next prototype, the width and length will be 1 meter and the diameter of rings will be 2 centimeter. At that time, we will have better knowledge of its disadvantages and advantages. For the tests, we should pay more attention to the hardness of ropes and simplicity of packing up. We will keep all of tests of the 3 former prototypes.

b.

We followed the steps well. First, we read the materials about greenhouse and knew what we should do. We got 4 ideas and listed both the advantages and disadvantages of each. After choosing the ideas, Derek made the blueprint of the real one and prototypes which included the size, material and the price of them. Manny and Bryan choose the appropriate material of prototypes. After choosing the materials, we worked together for connection and testing. We finished the first prototype in time and summarized the disadvantages of prototype 1. After comparing several material of string, we shopped on the internet for electric wire. I think the reason of success is we following the steps and finished everything on time.

c.

We wasted a lot of time to choose the material of ropes. In the first prototype, the ropes got twisted together and we had to cut one of ropes in order to untangle it. From that, we learned we should give up promising the whole. For choosing the material of the second prototype, due to the limit of material, we wasted much time to search and wait. And we only used a small amount of electric wire for our project. The majority of the rest of wires were not being used, which may influence the budget in total. And for the second and third prototypes we only did the quarter to represent the whole. So it is hard to find the disadvantages as whole. On the other hand, our second and third prototypes are only the advanced for the first one. Also some of tested cannot be used on them. And the reason of that is the time wasted on waiting. Also we did not communicate well to solve the extra money spend on the electric wire.

d.

I think we have really knowledge about developing countries. We can only get news and ideas from the internet and television. We lack the real experience to develop our design such as climate and weather. Just like the greenhouse project, we should put our design on the land and we did not know the soil texture which may influence the position and precision of inserting the wood. And for the climate, the humidity may influence the keep of our design and use in the future, which cannot be acknowledged by location research. But we can improve after actual use, which will be the work of company.

Another suggestion is that we should have more material choices. What we used were the rest of the used material. For example the materials of rings were the PVC find in the design room, which is different from what we thought- metal rings. With the improvement of material, our design will be more efficient and convenient.

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THANK YOU!

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