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DEM Project Prototype 1
Testing Scenarios
Test 1. Durability
This test was conducted on October 9, 2013 at 5:30pm in the Hammond workshop.
This tray will constantly be in use, whether it is inside the solar dryer or whether it is being washed, so it must be able to withstand daily use. In this test, Prototype 1 was dropped ten times to see how it responded to overuse or somewhat careless use of the tray. The goal of the test was to simulate what could occur if the tray was repeatedly dropped after use or impacted a hard object. The following table explains how Prototype 1 reacted when presented these situations.
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	Table 1: Drop Test Results
Trial	**Observations**
1	no observable damage to tray or hooks
2	no observable damage to tray or hooks
3	no observable damage to tray or hooks
4	no observable damage to tray or hooks
5	no observable damage to tray or hooks
6	no observable damage to tray or hooks
7	slight bending to tray/ no damage to hooks
8	slight bending to tray/ no damage to hooks
9	slight bending to tray/ no damage to hooks
10	slight bending to tray/ no damage to hooks

Test 2. Easy to Clean
This test was conducted on October 3, 2013 at 2:00 pm in Hammond workshop
The tray will constantly be in use, so the cleaning process must be easy and swift. In this test, Prototype 1 will be wiped with a wet rag, which will be provided by Professor Kisenwether so that the rag had a consistency for all groups. Our group deduced from the test that it took

approximately 2 minutes for the tray and the hooks to be cleaned using the provided wet rag. This shows that our tray is relatively quick and easy to clean.

Test 3. Quality of Fast Food Drying

This test was conducted at Professor Kisenwether's house on September 30, 2013.

The purpose of the solar dryer tray is to dry fruit in a timely and effective manner. Therefore, this last experiment tested the actual purpose of the tray. First the amount of banana to be dried was weighed then cut into ⅛ inch slices. Next, the tray was filled the slices and placed in an oven where the temperature was comparable to those of the dryer for six hours. Lastly, after the allotted time was over, the tray was removed from the oven and the slices were removed from the hooks and the top of the tray and weighed. The initial weight of the banana was subtracted from the final weight of the dried banana slices to see how much water weight was lost during the six-hour drying period.

Table 2: Drying Results	
Initial Weight of Bananas (oz)	7.5
Final Weight of Bananas (oz)	0.2
Water Weight (oz)	7.3

Advancements:

In Prototype 1, both the hooks and the wire mesh that made up the body of the tray needed modification to better achieve the group's initial goals. The hooks' construction is not suitable for slippery banana slices so when tested the slices slid off or into the center of the hook. To fix this problem, ridges can be constructed on the edges of the hooks to prevent the banana slices from sliding off the hooks. Essentially, the ends of the hooks can be curved upward to ensure the slices stay on the hooks and do not slide into each other. Secondly, the body of the tray is not sturdy enough. Although, the flexibility of the tray is preferred so that the dried fruit can simply be 'popped' off the tray. Therefore, a simple frame could be added to only two sides of the tray to provide more stability to the tray without losing the desired flexibility.

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Protoype #2: Hang Dryer

Test #1: Drop Test

Throughout the duration of this experiment, the tray was dropped from four different heights and angles. Table 1 below depicts the results of this test. Figures 1, 2, and 3 show the angles that we conducted the tests. Figure 4 shows the results of the drop tests from 3 feet.

Table 1: Drop Test Data

Trial	Height (ft)	Angle Description	Observations
1	3	flat, parallel to floor	no visible damage
2	3	corner of tray	slight bending but then tray bounced back to original shape
3	3	perpendicular to floor	tray bent partially
4	4	flat, parallel to floor	no visible damage
5	4	corner of tray	slight bending but then tray bounced back to original shape
6	4	perpendicular to floor	tray bent partially
7	5	flat, parallel to floor	no visible damage
8	5	corner of tray	slight bending but then tray bounced back to original shape
9	5	perpendicular to floor	tray bent partially
10	6	flat, parallel to floor	no visible damage
11	6	corner of tray	slight bending but then tray bounced back to original shape
12	6	perpendicular to floor	tray bent partially

Test #2: Drying

The drying test consisted of placing ⅛ inch banana slices onto the solar dryer tray. Three slices were placed on the top of the tray and three slices were placed on each side of one hanger, totaling nine slices in all, as seen in Figures 5 and 6. The tray with all the slices and hanger was weighed. Next, a blow dryer was held above the fruit slices to dry them at a constant temperature of 60°C. This drying test lasted 15 minutes then the tray and the dried fruit was weighed again. Table 2 depicts the information. After the 15-minute drying period the tray weighed 6.5 grams less than before the test so it can be concluded that 6.5 grams of water weight was lost during the drying process.

Table 2: Drying Test Data	Weight (g)
Before Drying	241.9
After Drying	235.4
Weight Difference	6.5

Test #3: Minute Wash

In this test, the Solar Dryer tray was washed using a damp, cotton wash cloth. The test was conducted to see how easily and quickly the tray could be washed. The tray was washed 3 days after usage to allow the banana residue to dry and become tough. Figures 7 and 8 show the dried banana residue. It took approximately 2 minutes and 30 seconds to wash the tray and hooks completely, but this time is only for the small portion of the hooks and the tray that were used. Figures 9 and 10 show the results of the cleaning. The whole tray and hooks would take closer to 5 minutes to wash.

Test #4: Soak

In this test, the solar dryer tray and the hooks were submerged in a container filled with water. The tray and the hooks were left in the container for approximately 36 hours. After the 36 hours, rust appeared on the screws that attached the frame to the tray and appeared on the hooks, but no rust appeared on the tray material itself. Figures 11 and 12 show some of the after damage. Because of the results of this test, another material would need to be used to construct the tray. This new material would need to be able to withstand heat and water without rusting to ensure that the tray meets food grade standards.

Cost Analysis

In Prototype #2, the tray dimensions were 18in x 12in. For that prototype we would need 60 inches of wood strip and 1.5 square feet of wire mesh. The wood strip would cost approximately $0.67, and the wire mesh would cost approximately $1.00. Two yards of 16 gauge wire will be used for the hooks, and that would approximately cost $0.47 cents. The total cost for Prototype #2 would approximately be $2.14. In our Prototype #1 we did not have a frame so the total cost would just be $1.00 for the wire mesh. The actual dimensions for the solar tray is 18in x 36in. We would need 108 inches of wood strip, which would cost approximately $1.20. We would need 4.5 square feet of wire mesh, which would approximately cost $3.01. The hooks will still cost approximately $0.47. The total cost for the full sized tray is approximately $4.68, which is well below the goal budget of $10.00. These numbers were calculated from Home Depot's website.

Advancements:
In Prototype 2, we used the same materials as prototype 1. The only changes made were making the frame on just the sides to provide a rigid form, yet still retain the flexibility that was needed to make the fruit easily removable from the tray. The addition of the wood frame also adds 6 screws total to attach the frame to the wire mesh.

Re-design ideas/thoughts:
If the HESE students were to start on prototype #2 or build it from scratch, some suggestions to improve the project would be to get as much information possible about the project and get some material that they would be able to meet the standards of the project such as durable and food grade material. This means that the price of the tray would increase which Also, to change the design of our prototypes, the material of the metal should be changed to silver because silver is a better food grade material. Also, having an aluminum frame instead of wood would improve the tray but would be above the suggested budget. Finally, more information about the actual solar dryer, such as dimensions, would be beneficial to have prior to prototyping so that it is easier to see how the real object works. Therefore, an efficient prototype could be made right from the start.

Figure 1: Drop at Side Angle

Figure 2: Drop Tray Flat

Figure 3: Bending of tray after drop

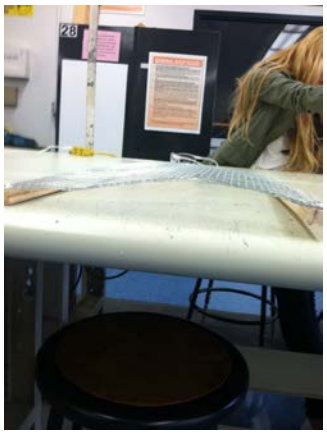

Figure 4: Drop at Corner

Figure 5: Tray drying

Figure 6: Weighing Tray and Fruit

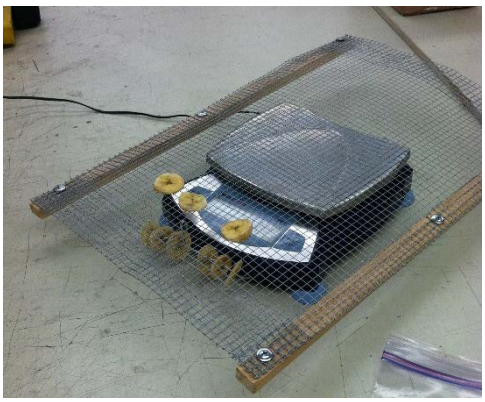

Figure 7: Banana Residue on Tray

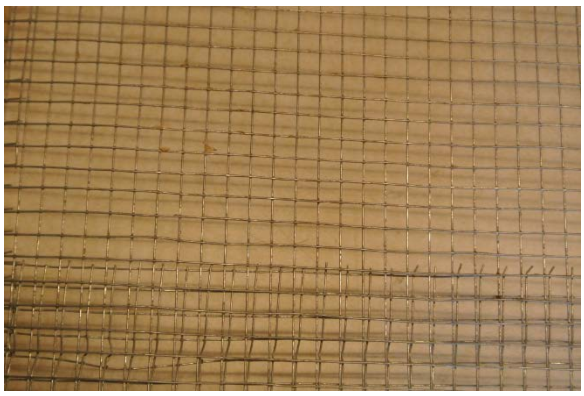

Figure 8: Banana Residue on Hangers

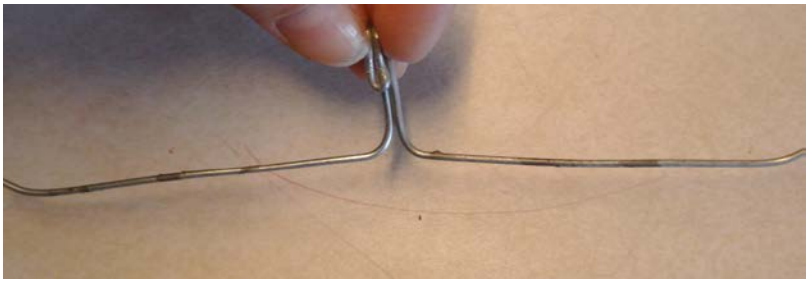

Figure 9: Tray after Wash

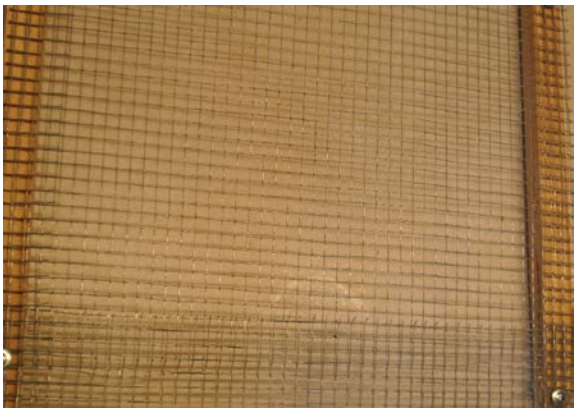

Figure 10: Hanger after wash

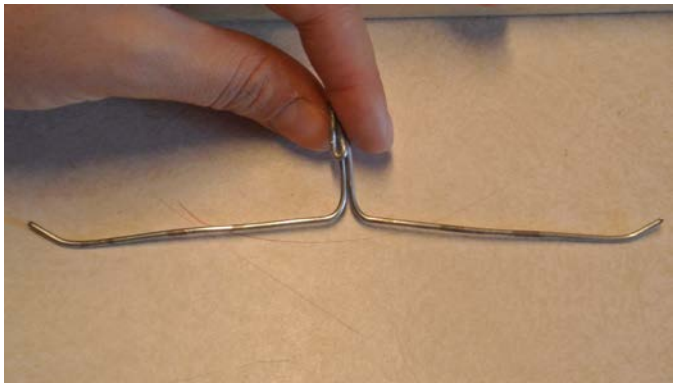

Figure 11: Rust on Screw
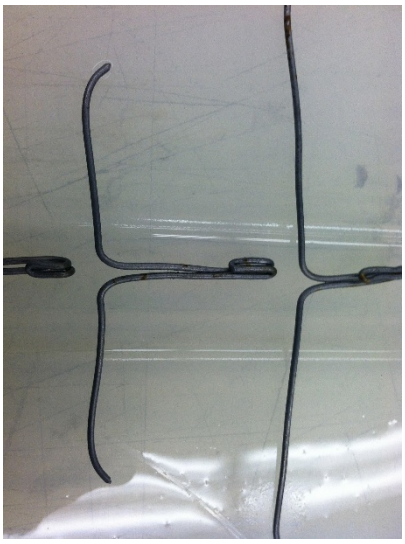
Figure 12: Rust on Hangers