Analysis of Data

We were able to collect and analyze data on all three stability tests. As we analyzed the data, we also made refinements to our prototype.

Test #1 : Angle Test

The data from this test showed that we could move the crutch from 45 degrees to 135 degrees from the horizon. These results were better than we expected. We did have spillage occur when we were less than 45 degrees and more than 135

degrees. Test results are in the table below.

Test #1 angle results_redacted.pdf

Test #2 Variable Weight Test

The data from this test indicated that we could walk 30 feet with liquid ½" from the top with varying degrees of success based on the amount of weight at the bottom of the cup holder. We varied the weight from 50 grams to 250 grams. The amount of liquid spilled is listed in the chart below.

Data indicated that the optimum weight to have in the bottom of the holder was 100 grams. We repeated the 100 gram test 5 times to determine the consistency of our results.

Test #2 varying weights results_redacted.pdf

Test #3 Constant Weight Test

We determined that the 100# weight at the bottom of the cup holder was optimum, we then wanted to run a third test. We kept everything constant, a crutch height of 6'0", and 100 gram weight at the bottom of the cup. We ran three tests in order to get an average data value of how many ounces spilled under these conditions. Our average amount was 0.82 oz, which was well within our constraints. We concluded our testing at this point.

Test #3 constant weight results _redacted.pdf

After we adjusted our weight and height, we were able to complete 3 trials with

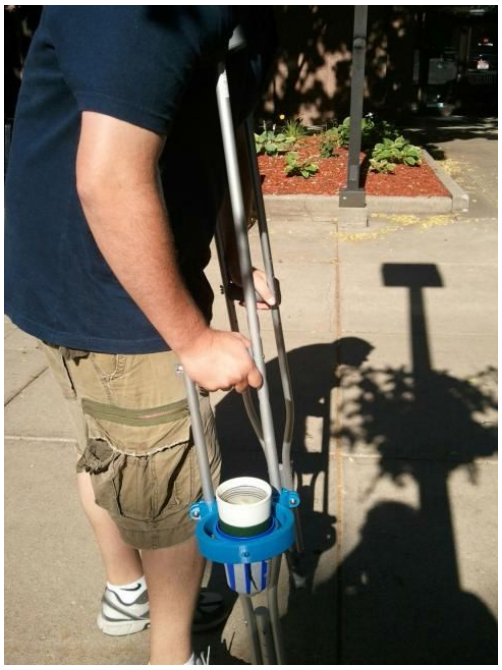
Test # Cup description	Amount of Spillage	Rating
1 – Starbucks cup – 15 degrees	none	
2 – Starbucks cup, 20 degrees	none	
3 – Starbucks cup – 25 degrees	none	
4 – Starbucks cup – 30 degrees	none	
5 – Starbucks cup – 35 degrees	none	
6 – Starbucks cup – 40 degrees*	none	
Average	0	

Started to spill at 45°

sustained success. Some of the liquid still spilled, which made us want to change a few things with our prototype.

Future Design Changes

Given the results of our testing, we would make a number of design changes to our prototype. The first thing we would change is building the 100 gram weight into the prototype. This would be similar to the Gyro Bowl that we looked at when evaluating existing products. We would also make sure that the weight is as flat as possible and close to the cup. Flattening the weight would help decrease the chance of the cup swinging while the user walks with the assistance of crutches. Decreasing the distance between the weight and the cup would decrease the moment acting on the cup, also decreasing the chance of swinging.



Test # Cup description	Amount of Spillage	Rating
1 – Starbucks cup, no weight added.	Did not test	
2 – Starbucks cup, 50 grams added.	19.85 – 17.25 = 2.6 oz	2
3 – Starbucks cup – 100 grams added.	a) 0 oz b) 2.3oz c) 1.55 0z d) 3.15 oz e) 2.85 oz	a) 5 b) 2 c) 4 d) 2 e) 3
4 – Starbucks cup – 150 grams added.	19.95 – 18.25 = 1.7 oz	3
5 – Starbucks cup – 200 grams added.	19.7 -16.45 = 3.25 oz	2
6 – Starbucks cup – 250 grams added.	19.85 – 16.6 = 3.25 oz	2
Average		

Another prototype change we would make is the way the cup holder attaches to the crutch. Currently, our prototype bolts to a crutch. This is practical for testing a prototype, but we want our final product to be top-shelf dishwasher safe. If the holder is bolted to the crutch, the user would have to spend a significant

Everything constant, 100 g weight, 6' crutch height

Test # Cup description	Amount of Spillage	Rating
1.	1.05 oz	4
2.	.61 oz	5
3.	.8 oz	5
4.		
5.		
6.		
Average	0.82 oz	5

amount of time removing the bolts from the product. However, if there was a snapping or pressure fit mechanism, they would be able to easily remove and replace it without taking an extended period of time.

A third design change would be to find some mechanical way of dampening the oscillation. The oscillation is caused by the momentum of the weight and the cup. We dampened it for our testing by using friction tape. This was quite effective, but not aesthetically pleasing or practical. We took a long piece of friction tape and tore it down the middle in equal parts. Then, we twisted the strips and placed them between the cup holder and frame, over the hinge. This was surprisingly effective, and reduced the momentum.

For our new design, we would use some type of bearing system that has a moderately high viscous oil. They would have to be removable so the design can be put in the dishwasher.

Our design would also be improved if the beverage holder could be on a hinge, and fold up when not in use. It would eliminate some of the room needed to maneuver when on crutches.

We would also alter a design specification. We would change the first specification to read "Minimize spillage: no spills if liquid is ¾ inch or greater below the top of

the cup" Currently our specification states a distance of ½ inch. We found out that when liquid is only ½inch away from the top of a cup, it is most likely going to spill, crutches or not.

Along with this, we would also include some sort of cup cover to help preventing spilling. This would attach to the cup holder so it would swing along with it. A user would be able to easily slide it up when removing their cup, and slide it back down when they are ready to start walking.

These ideas are annotated on the sketch below: