Fly Rocket Fly: Design Lab Report

"The J' Crispy and The Airbus A380-800"

Rockets: Test 1

<u>Overall Question:</u> How can you design a water, bottle rocket to make it fly a maximum distance. It needs to be made out of a soda bottle that will fit on the launch tube. The launch tube is 2-liter specific so how could a 3-liter bottle be modified to fit on this launcher? Is arrow dynamics and weight very important to this design? How can the prototype include these constraints be used to make this rocket fly the maximum distance?

<u>Overall Background:</u> Brady Smith had an idea of using a 3-liter bottle rocket off the launcher. To do this he concluded that the rocket would need to have a 2-liter nozzle attached to it, so it could launch off the 2-liter specific launcher as seen in figure 1. The idea is that the 3-liter has a greater volume that can hold more air and water with the same ratio as the 2-liter so when it is launched the rocket should have more thrust propelling the rocket further through the air. Research also showed that precise fins are necessary for stability. Multiple images of previous successful rockets had triangular fins that were 5 to 6 inches long. Research also showed that it is necessary to have weight in the front of the rocket so it is balanced and propelled forward as opposed to going straight up which happened to previous rockets with no weight. To initially test the 3-liter bottle design it wasn't important to include a nose cone because it was more important to test the structure of the bottle to see if it would actually work.

Figure 1

Experiment and Analysis:

_ **Launches for 9/25/15 (Day 1)**

Launch	PSI	Distance (yds)	Mass
1	60	66	600g
2	80	67	600g
3	80	66	600g

Daily Question: Will a 3-liter design launch without the 2-liter nozzle separating from the 3-liter bottle?

Daily Background: The launch tube was designed at which only an approximately 2.2cm diameter nozzle will fit tightly around the launch tube and o-ring. 3-liter bottles have a significantly larger diameter therefore the 3-liter nozzle would have to be modified. The easiest way to do this is by attaching a 2-liter nozzle to the 3-liter. This can be done by using a torch to shrink the 2-liter plastic to the 3-liter plastic. Then apply a thin layer of “Fuzor bumper repair” to make the bond air tight.

Initial Design of the Airbus: On day one it was most important to test to see if the 3-liter design will go off the launcher without damage. At first a nose cone and very precise fins weren’t important because if the design didn’t work that would’ve been a waste of time. With that being said, the initial design had the 3-liter chamber with a 2 liter nozzle fused together. The first time the 3-liter bottle melted when trying to shrink the 2-liter nozzle. The the idea came to head of filling the bottle with water to keep the bottle from melting. This worked well. On the second try with water, the bottle did not melt resulting in a solid design. Before the “Fuzor” compound was spread across where the plastic met it was important to lightly sand the area at which the compound was being used. Then the compound was spread. After waiting to dry, it was tested to be air tight by blowing into the bottle. It worked. Next was adding weight to the front so the rocket would propel forward. An additional 3-liter bottle was cut in half so it could slide on the front filled with sand. The sand was secured with a piece of cardboard covering the sand and the cardboard was secured with hot glue. The nose cone slid on nicely and was duct taped to the 3-liter chamber. Lastly was the fins. Triangle fins were used at first because that was what previous successful rockets had. They were made out of a sturdy divider plastic so they wouldn’t break off on impact. The dimensions were 5.5in X 3in X 6.2in. They were evenly placed around the rocket and attached with gorilla tape.

Analysis: The 3-liter concept was successful in the fact that the nozzle held up. It was obvious in both launches that it had way too much weight in the front. It made huge divots when hitting the ground and the nose one ended up denting and getting folded in. The rocket was also very unstable off the launcher. This could have been due to the triangular fins and or the non-aerodynamic nose cone. In conclusion the rocket needed to weigh less and have an aerodynamic nose cone.

Launches for 9/28/15 (Day 2)

Launch	PSI	Distance (yds)	Mass
1	80	29	420g
2	100	86	420g
3	120	138	420g

Question: Will reducing the weight and adding a better nose cone result in the rocket flying further?

Daily Background: Research concluded that the rocket should weigh between 350g and 400g which is slightly heavier than the average 2-liter bottle rocket. More weight was necessary because the 3-liter had more surface area and air friction so it was concluded that it needed more weight. The weight should also be slightly balanced in the rocket so it isn't too front heavy flying through the air resulting in a nose-dive. Research also showed that it was very important to have a strong nose cone so it didn't crumble every time it hit the ground.

Daily Design: To make this design the same 3-liter chamber and fins were used. Golf balls were the new source of the weight. Four balls were directly attached to the front of the chamber with duct tape and hot glue. Then there was another part of a 3-liter bottle that slide over these to protect the balls. This was attached to the rest of the rocket with duck tape. Then in the front of the rocket was a hard plastic funnel that fit perfectly on rocket. The hole of the funnel was taped over to help air resistance.

Analysis: The first launch the rocket went straight up off the launcher. This was due to all of the weight being in the center of the rocket. Before the next launch, three of the golf ball were moved to the very front of the rocket and secured with duck tape and one was left in the center. The rocket flew a lot further the second time. It was established that most of the weight needs to be in the front of the rocket. The third launch broke the record at the time with 138 yds. In conclusion, the nose one made it fly more stable and the weight decrease helped it fly further but the ins need to be modified to fly further.

Launches for 10/2/15 (Day 3)

Launch	PSI	Distance (yds)	Mass
1	100	108	420g
2	138	14 (blew up)	420g

Daily Question: Will modifying the fins make the rocket fly more stable resulting in it flying a further distance?

Daily Design: For day 3 the main rocket design and weight stayed the same. The fin shape and construction was modified. The triangular fins weren't keeping the rocket stable. Parallelogram style fins were used made out of the plastic of and old agenda. The fins were 5in long and 2.5 in tall. These fins were also attached to the rocket more accurately but good duck tape wasn't available so the fins were quite unsturdy.

Analysis: The first launched the rocket flew decent but not as well as expected. The stability was poor. It rapidly changed directions in the air. It was not further than our previous day. Everything did stay in tact. The nosecone was almost too sturdy though. It had no give so part of the front of the rocket got crushed. Then on launch two the rocket came off the launcher wrong and flew straight into the ground. It hit so hard it caused the nose one to come apart from the 3-liter chamber. The rocket was still unstable.

Launches for 10/8/15 (Day 4)

Launch	PSI	Distance (yds)	Mass
1	130	30 (blew up)	380g

Daily Question: Will modifying the fins again and reducing the weight again make the rocket fly more stable resulting in it flying a further distance?

Daily Design: For day 4 the main rocket design and weight stayed the same. The fin shape and construction was modified. The parallelogram fins weren't keeping the rocket stable. Parallelogram style fins were used made out of the plastic of and old agenda. This time hard cardboard was used and the fins were secured with tape and hot glue. This time they were a triangular fin that was slightly longer and shorter than the originals. The hot glue ended up warping the chamber. It seemed like it would fly off balanced due to the warping.

Analysis: Right off the bat the first launch sent the rocket straight into the ground again causing it to fall apart again. It wasn't possible to tell if this new fin design worked or not. Now it started to become clear that the 2-liter nozzle was slightly positioned to the side causing the rocket to fly in a certain direction off the launcher depending on how it was placed on the launcher. That is why in the past two test days the rocket flew straight into the ground.

Launches for 10/14/15 (Day 5)

Launch	PSI	Distance (yds)	Mass
1	138	116	not measured

Daily Question: If the 2-liter nozzle is positioned perfectly straight on the 3-liter bottle, will it launch more consistent and come straight off the launcher? Also, is there a way to have some give in the nose cone so it doesn't get crushed every time?

Daily Design: For day 5 everything was fresh. There was 2 brand new bottles used and a new nozzle attached. This was nearly a brand new design. It started out with the same methods bonding the 2-liter nozzle and the 3-liter one except there was a wooden dowel used in the process to help keep the nozzle sturdy when it was getting melted to the 3-liter bottle. Then a new idea was tested. Foam was cut out of an old could to fit perfectly inside a 3-liter bottle. The idea was that the rocket's nose cone would act as a shock absorber so if it did go straight into the ground again there wouldn't be anymore fatal damage. There would be a fixed distance that the nose cone could travel in relation to the rest of the rocket so it would absorb impact. Then there was a golf ball shoved in front of the foam for weight and sand inside of the funnel in the very front. This design also used the parallelogram style wing because that seemed like the most successful style. These ones were precisely attached evenly around the base of the rocket by using a string and measuring and equal distance between each fin.

Analysis: On the first launch the "Fuzor" compound failed resulting in the rocket flying 116 yds through the air with the nozzle still on the launcher. This was because we did not use enough of the compound. Even though the nozzle failed, the other parts being tested worked well. The shock absorber idea worked awesome. There was no damage to the nose cone. It also seemed to fly very stable. This design will be used again but with better reinforcements on the nozzle.

Launches for 10/20/15 (Day 6)

Launch	PSI	Distance (yds)	Mass
1	138	50	not measured
2	140	69	not measured
3	140	blew up	not measured

Question: Will adding more “Fuzor” help the nozzle stay intact?

Daily Design: The same rocket and resources were used. A new nozzle was heated and shrunk on and lots of compound was used. The compound was gooped on the inside and outside of the nozzle.

Analysis: When going to put the rocket on the launch it simply did not slide on. It was a bad idea to put Fuzor on the inside of the nozzle resulting in it not fitting on the launcher. Then with the help of a dremel tool, the Fuzor was removed from the inside of the nozzle so it would fit on the launcher. Then the compound failed again. Once it finally fit on the launcher, when pressure built up, the nozzle leaked. It ended up launching but not going far at all. The 3-liter concept just wasn't getting the results that were expected. It was too much to deal with the modified nozzle. As a result, the group decided to switch the designing to a 2-liter design because of all the 3-liter failures. The Airbus A380-800 just wasn't doing it.

Launches for 10/22/15 (Day 7)

Launch	PSI	Distance (yds)	Mass
1	138	165	not measured
2	138	170	not measured
3	138	173	not measured

Question: Will a 2-liter concept go further and be more consistent than the 3-liter?

Daily Design: The 2-liter design will use all of the research gathered in the previous tests. It will include the same shock absorbing idea and wings. There is a new idea for the weight. The rocket will use a baseball in it's nose cone for weight which was Connor Bradshaw's idea. This made a lot of sense. Baseballs are made a certain weight so they can most efficiently glide through the air in baseball games. In the very front of the nose cone there was the baseball the in between the baseball and the chamber was couch foam and styrofoam to absorb the impact. Then the wings were slightly moved back and secured with duck tape because the further back they were the more stable the rocket is supposed to be according to a rockets forum.

Analysis: 2-liter bottle rockets are far superior. The first launch of the J' Crispy has amazing results. It went alot further than the 3-liter ever did. All three launches the rocket seemed stable and flew pretty far. These were great results.

Launches for 10/30/15(Day 8)

Launch	PSI	Distance (yds)	Mass
1	138	193	315g
2	138	195	315g

Question: Will making the nose cone rounded make the rocket fly further?

Daily Design: The nose cone was the nozzle part of a 2-liter bottle. To make it more rounded like other successful rockets, the nozzle on the front had to be hack sawed off. This made the nose cone nice and spherical. Then the front had to be taped over so there wasn't any air resistance.

Analysis: On both of the launches the rocket went about 30 yards further than last test. It was cool that just by cutting a little air resistance the rocket could go so much further. The 2-liter rocket showed way better results.

Conclusion: Throughout those eight testing days it has shown that the 3-liter design simply did not work due to the fact that the nozzle had to be modified and all of the air resistance it had. 3-liter rockets are not recommended unless you have a better way to fit it on the Sherman Launcher. Air resistance, weight and straight fins were the most important factors when designing and testing a water rocket. The lab report is also significantly easier if you take many pictures of your rocket and document each and every change you make to your rocket.

Materials needed:

- First you need 2-two-liter bottles
- baseball
- duck tape
- some type of foam

- poster board

<u>How to Build the J' Crispy:</u>

1. First take one of the 2-liters and cut it in half
2. Take the nozzle end and cut off the nozzle
3. Cover the smaller open end with some tape
4. Place the baseball in the front
5. Cut the foam so it has the same diameter as the 2-liter bottle
6. Slide the foam in behind the baseball to help secure it in place
7. Take the other 2-liter and slide it into the big open end against the foam
8. Secure them with only one layer of duck tape (make sure there is movement between the two bottles so it acts as a shock absorber)
9. Take the poster board and cut out wings
10. Attach the wings with lots of duck tape
11. Put the J' Crispy on the launcher

In the end it should look something like this:

Launch Team: As a part of the Launch team I was known as a “runner” This meant I was responsible for transporting rockets from their point of impact back to the launch pad. When we got to the launch site I handed over my rocket to the people at the launch pad and I headed out to where I thought most of the rockets would land. Once a rocket hit the ground my job as a runner was to go grab the rocket and either bring it all the way to the launch pad or hand it to the next person in line that would then bring it closer to the launch pad. We often had and assembly line working when all of the “runners” were present. This made it so we didn’t have to walk as far. Being a runner was a pretty important part of the launch team.