Fly Rocket Fly: Rocket Lab Report

The Violette 3000 Series

1/22/16

Question:

The purpose is to build a multi-tank bottle rocket that will fly the farthest possible distance. The rocket must be constructed so the bottles remained spliced together during multiple launches. The design must also have a nose cone that is light enough for the rocket to fly an optimal distance, but durable enough to survive multiple impacts with the ground. The fin design and material must keep the rocket stable and survive impact as well.

Background:

For the first rocket, it's design is based off of the research from the U.S. water rocket website. The instructions made learning to build the first rocket simple. The first step was to splice two bottles together, as shown in the tutorial. Make sure to sandpaper the splicing joints so the glue will hold better. The spliced area was reinforced with black duct tape. No further bottles were added at this point, since it was likely that different types of glue would need to be experimented with. The fins were made from cardboard because it was reasonably sturdy and lightweight. The cardboard was reinforced with black duct tape. The fins were hexagonal in shape and were attached to the bottle and each other at the edges. The design was called "box fins," and they were located approximately three inches from the base of the rocket. The nose cone consisted of half a plastic easter egg filled with a golf ball and styrofoam. This was then glued and duct taped to the top of the water bottles.

For the second rocket built, the process was much the same. Three smart water bottles were spliced together, glued with Gorilla Glue Epoxy, and reinforced with duct tape. The fins were constructed from white poster board and covered in duct tape, but on this model the three fins were shaped as parallelograms and spaced evenly around the rocket and about three inches from the base. The nose cone was also nearly identical. Again, it was made out of half a plastic easter egg filled with foam and sculptee clay.

Experiment and Analysis:

Figure 1: Launch Day #1

Trial #	PSI	Distance (yds)
1	60	0 (did not leave launcher)

Figure 1: The nose cone of the rocket was not airtight. The bottles had been spliced bottom to bottom, leaving one top open within the nose cone. Pressure was able to escape through the nose cone and layers of duct tape and and the rocket was unable to leave the launcher.

Figure 2: Launch Day #2

Trial #	PSI	Distance (yds)
1	80	0 (blew up)

Figure 2: Covered the original rocket's nose cone with glass cloth and resin and additional duct tape to prevent loss of air pressure. Pressure did not escape, but rocket broke at splicing location and did not fly. Glue was too weak.

Figure 3: Launch Day #3

Trial #	PSI	Distance (yds)
1	100	0 (blew up)

Figure 3: A full rocket was not launched on this day to conserve materials. Instead, two bottles - this time seltzer bottles - spliced together were tested for strength. A different glue was used - Gorilla Glue Epoxy - that had worked for another group. The glue did not work in this trial because it was not mixed and applied properly, and was not allowed enough time to set. It is also likely that the bottles were too weak.

Figure 4: Launch Day #4

Trial #	PSI	Distance (yds)
1	130	28
2	130	50
3	138	25

Figure 4: Gorilla Glue Epoxy was used again to splice two Smart Water bottles together. Glue was mixed for nearly a minute, applied evenly, and allowed thirty minutes to set before applying duct tape to splice. Splicing joint held through all three launches.

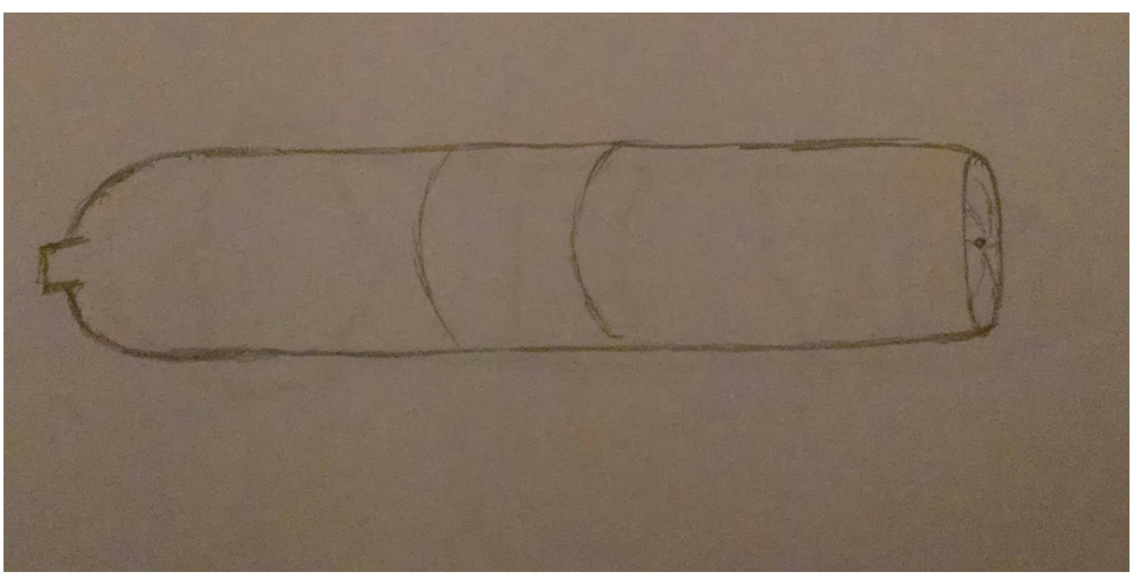


Figure 5: Launch Day #5

Trial #	PSI	Distance (yds)
1	138	196
2	138	203

Figure 5: The Smart Water bottles tested, as shown in Figure 4, were used as a base. Nose cone made from a plastic easter egg, foam, and clay covered in glass cloth and resin was reused, as were the original box fins. The rocket was stable in flight and the nose cone was not crushed upon impact after either launch. The fins were loose after two launches and needed to be reglued.

Figure 6: Launch Day #6

Trial #	PSI	Distance (yds)
1	139	179
2	139	187

Figure 6: Starting on Launch Day #6, the same rocket began to be tested for durability. It was tested to see how many launches it could go through before: the splicing broke, the nose cone was crushed, the wings were broken loose, or other significant damage occurred.

Figure 7: Launch Day #7

Trial #	PSI	Distance (yds)
1	138	169
2	138	150

3	138	175

Figure 7: The rocket it still being tested for durability. After five total launches over two separate days, nothing has changed or been significantly damaged. Splicing shows no signs weakness. Box fins were not loosened.

Figure 8: Launch Day #8

Trial #	PSI	Distance (yds)
1	138	175

Figure 8: No changes have been made. The rocket continues to hold up after three days of launching at high PSI and six separate launches. Nose cone shows no signs of being crushed, the fins are still firmly attached, and the splicing joint is still solid. The bottles themselves do not show any sign of weakness either.

Figure 9: Launch Day #9 - Old/Original Rocket

Trial #	PSI	Distance (yds)
1	138	164

Figure 9: The original rocket continued to hold up after another launch. Everything was in good shape, except for the splicing. The location of the splice began to loosen and show signs of weakness after the launch. The rocket was not launched again this day so it did not break, and was reserved for rocket day. The rocket also never flew as far as its second launch, for undeterminable reasons. Nothing physical was changed about the rocket - could easily be wind, angle launched, etc.

Figure 9.1: Launch Day #9 - New Rocket

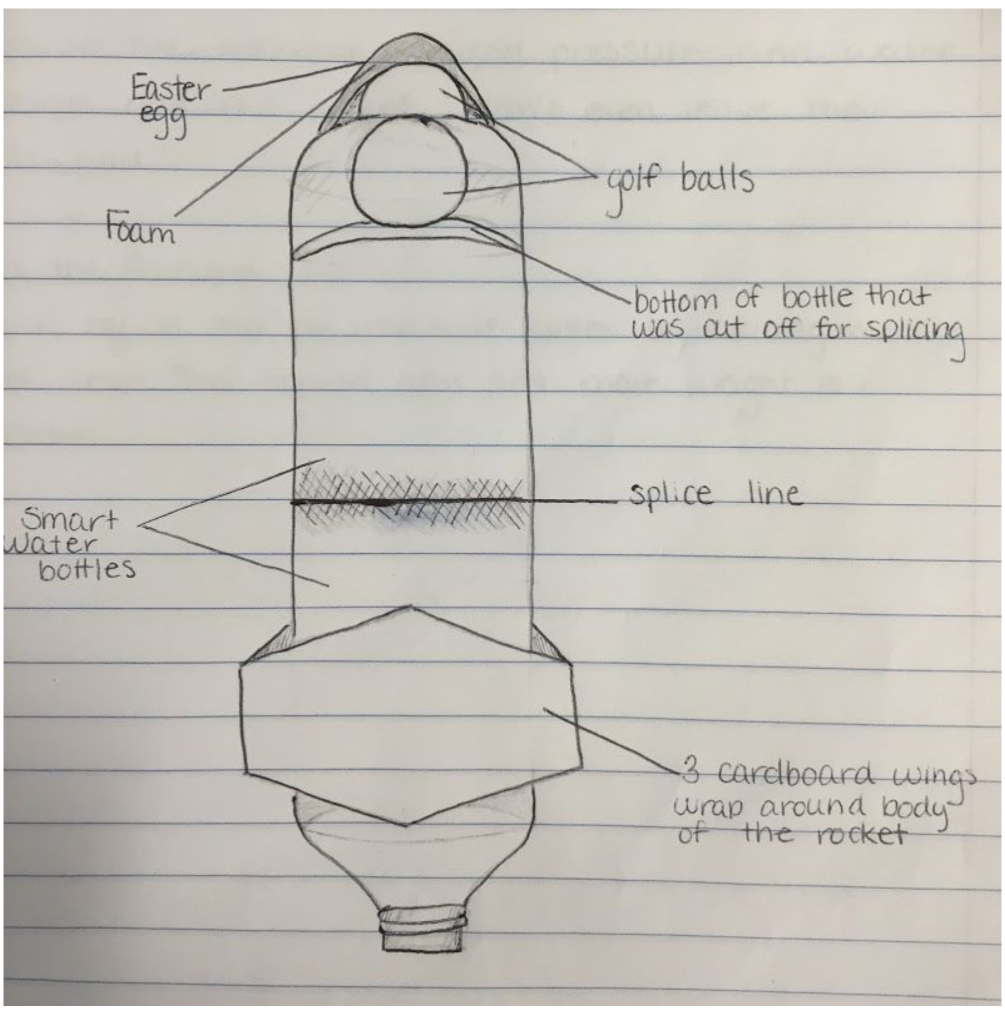
Trial #	PSI	Distance (yds)
1	138	203
2	138	175

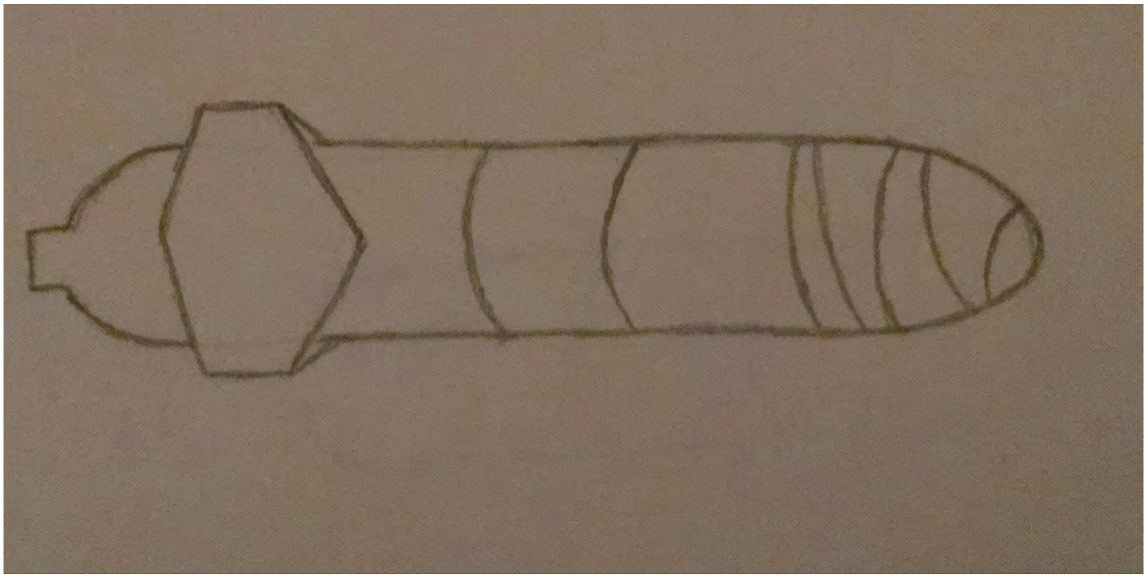
Figure 9.1: The new rocket was the same basic design and splicing method. The fins were parallelograms in shape and stuck out from the rocket. It was designed as a backup should the original have broken. It was launched as an experiment in order to see if it would fly better and farther with a lighter nose cone and different fins. It flew farther than expected - equal to the original. The fins held up despite being a slightly weaker design. The nose cone was severely dented upon each impact, but was easily fixed when re-pressured.

Conclusion:

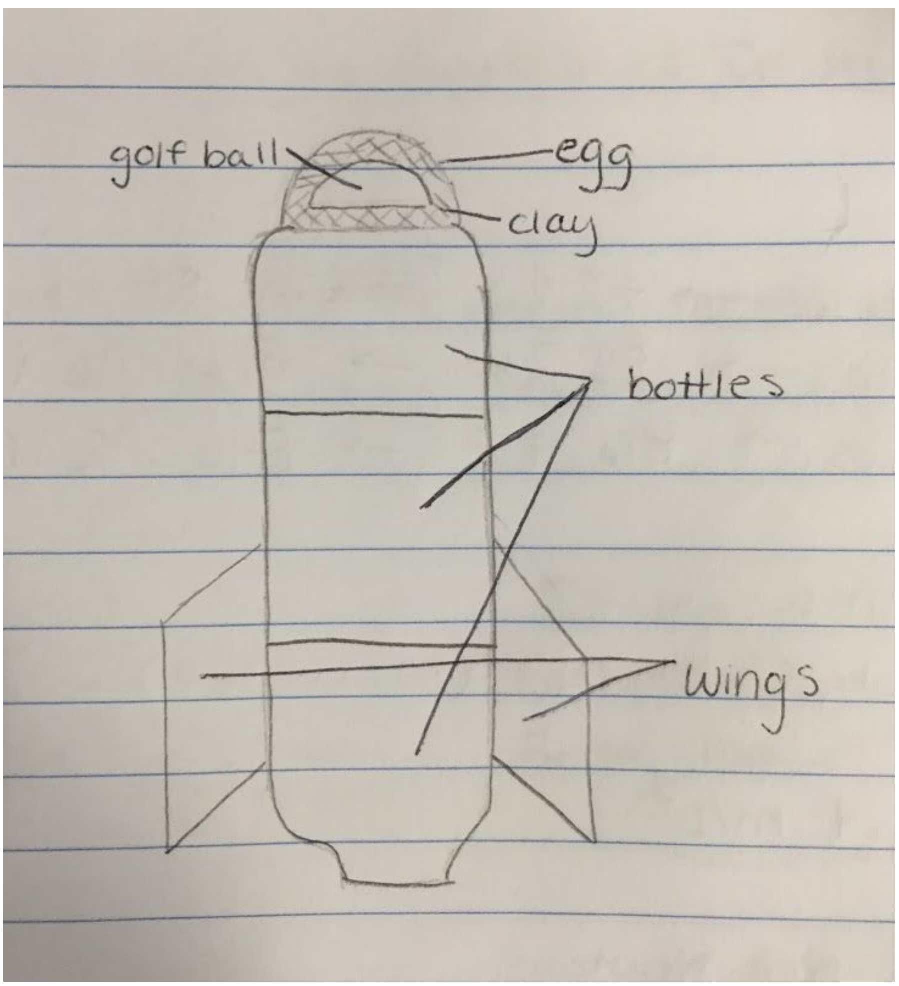
The most important and difficult aspect of the multi-tank bottle rocket is the splicing. The first rocket was built completely before its splice was tested, and the bond failed, wasting effort put into the original design. Testing different glues and methods of bonding before completing the design makes the rest of the construction much easier. Assuring that the entire rocket is airtight is also important. One launch day was essentially wasted because of a careless error.

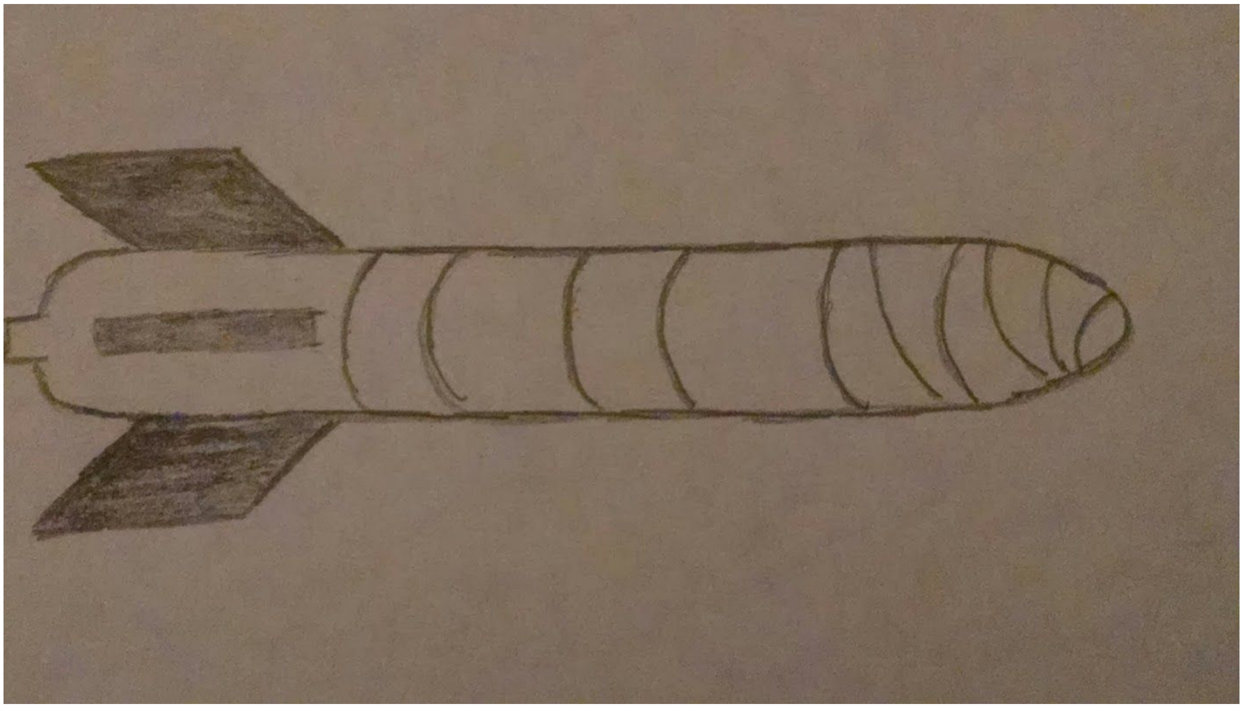
The final design of the original rocket consisted of two and a half smart water bottles. The bottles were spliced together following the tutorial on the US Water Rockets website and with Gorilla Glue Epoxy. Duct tape coated the splice area to add additional strength. Do not apply duct tape until the glue on the splice has had ample time - at least thirty minutes - to set. The original box fins - constructed of three cardboard hexagons covered in duct tape, and which wrap around the rocket's body about three inches from the base - were used. The fins were slid on from the bottom of the rocket. This fin design was durable and easy to make. They were also easily removed and reattached to other models when necessary. The nose cone covered in glass cloth, resin, and duct tape was also used. The resin needs to be thick to avoid dripping off before drying and allowed several hours to harden - it is best to leave it overnight. The resin prevented the nose cone from being crushed or dented on impact.





The second final rocket was made of three smart water bottles spliced together with Gorilla Glue Epoxy, again following the method on the US Water Rocket site. The three fins were made from poster board covered in duct tape, and were parallelograms with a width of about 6 and ½ cm and a length of approximately 11 and ½ cm. They were spaced evenly around the body of the bottle. The fins were attached with more duct tape to keep them stable on the rocket. The nose cone was made only from half a plastic easter egg, sculptee clay, and a half a gold ball, all covered in duct tape to keep it in place. This rocket was launched only on the last two launch days, simply to see if a lighter nose cone and different fins would allow the rocket to fly farther with more stability. At first, the new design did seem to make a difference, but it went far further the second day it was launched. This design flew a greater distance, but was less durable.





Launch Team: Runner

On launch days, my job was to retrieve launched rockets after they had landed, and return them to the launch site. I also went after rockets that traveled off course into the woods and returned them to the owners. When necessary, I also stood in to mark the landing location of the each rocket so the distance traveled could be measured.