Fly Rocket Fly: Design Lab Report

Rocket Name: Wavehog Willie

12/21/16

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Purpose

Question: You need to design and build a rocket , how do you do so? What factors do you have to take into consideration when planning your design? This rocket has to not only be made out of a 2 litre soda bottle, but it has to fit over a launch tube as well. To design your rocket you must do extensive research and planning. Over time, as you must improve upon your rocket design so that, when launched, the rocket can reach its maximum distance.

Literature Review

Before brainstorming the overall design of the rocket, my team did a lot of research. There were several rocket design reports available from last year. We found there were patterns in a lot of the data collected, and that many past teams came to similar conclusions on the ideal rocket design. We based our design upon the projects with the most success. As we moved on later in the experiment, there were aspects we decided to change and thus go against those original findings. This sometimes brought us success, while other times ended in failure.

One of the most important aspects of the rocket design was mass. The rocket cannot be too heavy, but it cannot be ultra light either.The most ideal mass based upon the literature review was somewhere between 350-400 g. In order to achieve this mass, my partner and I chose to use clay to achieve this mass, as it was the easiest to work with.

Before conducting our research, I had assumed the most ideal nose cone shape would grow narrower as towards the tip of the rocket. By taking a look into past rocket reports, it's evident that the most ideal nose cone shape is something more spherical rather than cone shaped. A lot of rockets had something small and round at the tip of the nose. For example, a golf ball or an easter egg. The popularity and success of this design made my partner and I want to incorporate something similar into our design.

The design of the fin is probably one of the more important aspects of rocket design. Its key that that the fins are oriented toward the direction of travel, and that the fins should be place towards the back of the rocket. The fins can protrude too far from the rocket, remember you are designing fins not wings. While it is possible to design a successful rocket using two or four fins, three is the ideal number and most designs contain three fins.

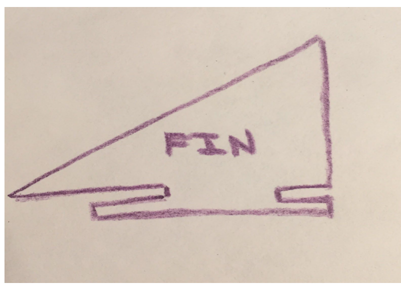
There are two variables one can change during the launch, pressure and launch angle. More pressure does not equal a better launch. If you launch a rocket with too much pressure it may explode. According to past rocket reports, 120 PSI is the ideal pressure to launch at, and the ideal launch angle is either a 45° angle or a 60 ° angle.

Testing and Development

Launch Day 1

2016 September 30

For the very first launch my partner and I went for a very basic design. This rocket consisted of a single chamber and three fins. These were made out of a plastic and had been 3D printed. The design we had printed included a small ridge. To secure the fin to the body of the rocket, we used an epoxy. Of course before attaching my partner and I made sure to measure the circumference of the rocket and divide it into three in order to make sure the fins were evenly spaced around the rocket. The nose cone had been shaped from clay. Using clay allowed us to control the mass of the rocket. The rocket ended up being 515 g,and very top heavy. This wasn't our ideal mass, seeing we were striving for that ideal point between 350-400 g. We opted out of doing a two chamber rocket seeing that in our research, most attempts at two chamber rockets were particularly unsuccessful.



(Fin design from the side)

<u>Results:</u>

Launch	**PSI**	**Angle**	**Distance (Yds)**
1	130	45	102
2	130	45	Blew Up

My partner and I decided to keep the PSI and launch angle the same for both launches.Our first launch was rather successful. The rocket blowing up the second time around could have been a result of damage inflicted upon the rocket as it landed on the first launch. One major flaw in this design was the rocket has far too much mass. In the literature review, most designs called for about 340-400 grams. This rocket was 100 grams too heavy. The fins also weren't fastened well enough. We hadn't given the epoxy enough time to dry, so the fins weren't sturdy by the time it came to launch.

Launch Day 2

2016 October 4

For this launch, my partner and I made two separate rockets. I made a rocket almost identical to the first design. I used the same fins, attached them with epoxy, and the nose cone was made out of clay. The mass of this rocket was 125 g. Maxwell's design consisted of a sharper nose cone constructed from a funnel and tin foil. This design also had three fins, but they were constructed out of cardboard instead of being 3D printed. We predicted the first design would do incredibly well seeing it had less mass than our original design, and was sturdier. The design that used a funnel as a nose cone didn't appear it would do well.

Results:

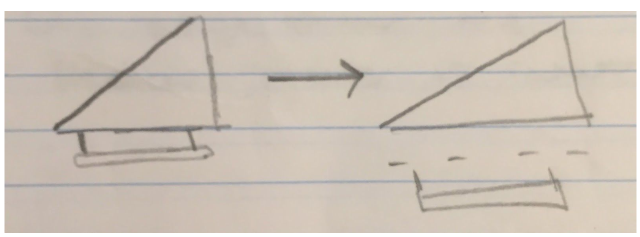
Launch	PSI	Angle	Distance (Yds)
Rocket #1	100	45	20
Rocket #2	100	45	21

The rocket constructed by Maxwell ended up going slightly farther than the rocket I had constructed. Maxwell's rocket went exactly one yard farther than mine. Only rocket #1 survived the launch with little damage. Both rockets weren't very good designs, seeing they only went 20 yards. This is probably due to the little mass both rockets had. When launched, the rockets had more vertical displacement than vertical displacement.Mr. Darlington stated the rocket I built could have done well, but it was far too light. 125 g is not enough mass for a successful rocket to launch.

Launch Day 3

2016 October 6

We made several severe changes in our design for this launch. First we lengthened the rocket by attaching a second soda bottle to the body of the rocket. The first soda bottle would act as a chamber while the other half would act act as a nose cone and make the rocket longer. There was also an adjustment made to the nose cone. Instead of just shaping a nose cone out of clay, we took a half of a 3D printed sphere and attached it to the front.



(Detaching the protrusion from the fin)

Result:

Launch	PSI	Angle	Distance (Yds)
1	115	32	187
2	110	41	200

Launch Day 4

2016 October 13

There were quite a few adjustments made between launch day 3 and launch day 4. We had spent a lot of time sanding down the fins. The idea was we wanted the fins to become thinner towards the end, that way there would be less air resistance. We also drastically reduced the mass of the rocket. On launch day 3 the rocket had a mass of 500 g, now the rocket is 350 g. The nose cone of the rocket remained the same.

Results:

Launch	PSI	Angle	Distance (Yds)
1	130	45	213

This launch ended up being our best. We didn’t mess around a lot with the launch angles or the PSI, and that ended up working out real well. The ideal mass appears to be 300 grams. The only thing that ended up getting damaged was the nose cone. Based upon this launch, it is unclear whether the sanding of the fins, this new mass, or the combination of both led to the success of this launch.

Launch Day 5

2016 October 19

For this launch we reduced the mass to 300g. The body of the rocket is made of two soda bottles. One full soda bottle acts as the chamber and will be fastened over the launcher, while the other is a half of a soda bottle that has been fastened over the first in order to lengthen the rocket and form the nose cone. At the end of the nose cone we again used clay and half of a 3D printed sphere to create the shape we wanted. Instead of epoxy, this time we used Krazy glue to fasten the fins. This seemed to be stronger than the epoxy.

Results:

Launch	PSI	Angle	Distance (Yds)
1	135	42	207
2	135	42	188

Despite our changes, the rocket did not do better than launch day 4. Further sanding down the fins appeared to not make any more of a difference, and loctite was not any stronger than epoxy, seeing the fins ended up falling off.

Launch Day 6

2016 October 25

The rocket designed for this launch was nearly identical to launch day 6. The only adjustments we made was in the attachment and overall quality of the fins. During the last launch the fins were rather unstable and easily broke off. For this launch we attempted to make the bond between the rocket and the fins stronger. We used Krazy glue to attach the fins again, but this time we tried to support the fins with duct tape. We also sanded down the fins more in an attempt to make them smoother and more aerodynamic.

Results:

Launch	PSI	Angle	Distance (Yds)
1	130	40	60

Despite our attempts to improve the fins, the still fell off during launch, causing a rather disappointing launch.

Launch Day 7

2016 October 27

This rocket had a mass of 250 grams. We chose to launch at 130 PSI because this is the pressure that had been most successful in the past. Our body, again, consists of two bottles attached to each other. One bottle acts as a chamber while the other serves as a nose cone. At this point the 3D printed fins are far smoother than when we first started using them. We have attached the fins using krazy glue and duct tape.

Result:

Launch	PSI	Angle	Distance (Yds)
1	130	40	Blew Up

We're not sure why the rocket blew up during this launch. There could be many variables at play. The pressure may have been too strong for this particular bottle. For the next launch we're going to use a different bottle.

Launch Day 8

2016 October 31

Result:

Launch	PSI	Angle	Distance (Yds)
1	135	45	203
2	130	45	168
3	130	47	173

Contrary to what we discovered in the literature review, the ideal pressure is not 120 PSI. Instead it appears as though the most ideal pressure for a rocket is about 130-135.

Launch Day 9

2016 November 2

For this launch, the Wavehog Willie was about 250 g. This design was fairly similar to the one we launched on day 8, except it was better constructed. The 100 mile an hour tape we applied was far smoother because I used a pencil to smooth out the bumps. This made the rocket more aerodynamic and less likely to fall apart.

Result:

Launch	PSI	Angle	Distance (Yds)
1	135	45	139
2	135	35	Blew Up

Launch Day 10

2016 November 4

For this launch we used a different set of fins. Instead of going with the 3D printed fins we opted for a different design. Maxwell constructed three fins out of house siding. These fins were a lot thinner, but also longer than our original fins.

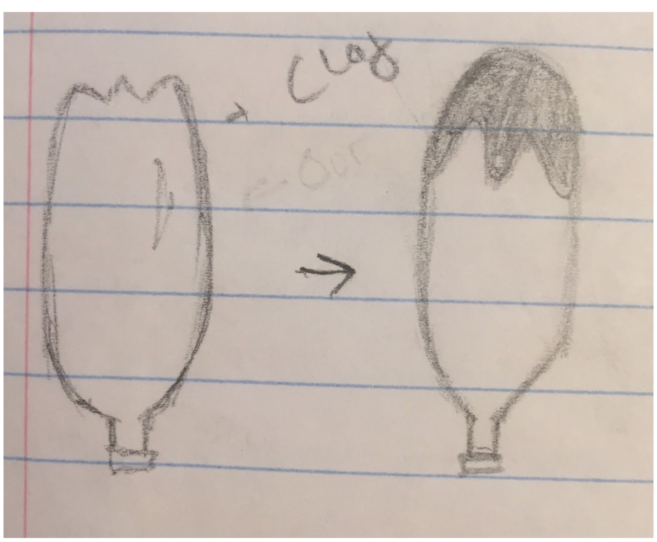
Result:

Launch	PSI	Angle	Distance (Yds)
1	135	45	140

These fins didn’t work as well as our other fins. If we had to choose our original 3D printed fins or these new fins made out of siding for our final design, I would choose the 3D printed fins. They are sturdier, and performed better.

Conclusion

Maxwell and I went through several different phases of design when making our rocket. Some aspects of each of these prototypes were better than others. I wouldn't consider our final rocket to be the best design. If anything, our fourth rocket prototype was the best. Launch #4 gave us our greatest distance compared to every other launch, 213 yards. So what made this design so superior? First there was the body of the rocket. My partner and I found that a rocket with a longer body goes farther. This doesn't necessarily mean a rocket with two chambers, seeing that rockets made of two bottles spliced together tended to not make it off the launcher. Instead we used one bottle as the chamber for the rocket, and cut another bottle in half. We then placed this half a bottle over the chamber bottle and taped and/or glued them together. I would recommend using both so that your rocket remains sturdy and the two halves don't fall apart. Not only does this lengthen your rocket, but you also have the basic shape of a nose cone in place. To construct the nose cone we primarily used clay. This way we could reach the ideal mass (350 g) and easily create the spherical shape we were looking for. At the very tip we applied a half sphere (3D printed).



Between the two fin designs, the 3D printed fins were far superior. Not only did they last us the entire project due to the sturdiness of the plastic they were made out of, but they could easily be sanded down. When attaching the fins to the rocket, use epoxy. Epoxy works far better than krazy glue and loctite. Instead of covering the rocket with duct tape, use 100 mile an hour tape. This tape can be easily smoothed out with your fingers or a pencil. When constructing your rocket, give yourself plenty of time before the launch to put things together. You never know how long you will need for a glue to dry or if you're gonna need more duct tape. The period before physics class is probably the worst time to be building your rocket.

Launch Team

For rocket day, I was in charge of check in. My duty as check in was to not only record the teams and the name of their rockets, but to also record the pressures at which these rockets were launched, and how far they went .This was an incredibly difficult job seeing there was a lot of people at rocket day. I was very busy trying to get the distances over walkie talkie, and making sure the rockets were being launched in a timely and orderly fashion. The biggest challenge was organizing the rockets in the same order I had written down, so I wouldn't get distances mixed up. It also didn't help there were first graders launching rockets with us that day. It was a struggle to get the first graders to sort through the pile of rockets and distinguish which was theirs. Despite the challenge this role brought, I'm glad I was assigned it. I was kept busy the whole time, which was better than standing around.