Fly Rocket Fly

Warthog Willie - 2

Table of Contents

Purpose

Question: Man once used 2-liter bottles to drink out of, but that was the primitive way of life. Man has evolved to do much greater things with their 2-liter bottles. What would you think if I told you that we can construct a gnarly rocket out of said 2-liter bottle? You're probably shaking in your boots at the thought of this; however, let's take it one step further. Ask yourself, "How can I turn a measly 2-liter bottle into a radical flying machine going distances that I'd never thought imaginable?" Well, I'm about to learn you a thing or two to help you untie this Gordian knot.

Literature Review

Literature Review

Reading all of the past students lab reports really gave me some good insight on how to build a successful rocket. One of the first things I learned was that mass was extremely important. If your rocket was too heavy or too light it wouldn't fly very far at all; like in Goldilocks, we had to find the mass that was just right. One of the works of literature I read told me that the ideal rocket mass was from 350g to 400g. My partner and I found this mass far too heavy to be a successful rocket. We experimented with masses from 800g to 50g just to get a feel for which mass was best for our rocket and we eventually settled on 250g.We had much better results with the same rocket, yet at a lesser mass. When our rocket was 800g, the nose cone was way too heavy and brought the whole rocket right down into the ground just yards after launching. When our rocket was 50g, it flew straight up and spun around until in slowly fell back down, only a few yards from the launcher.

An area we struggled with greatly was securing pieces to the bottle. We researched which substance would be best for gluing plastic to plastic and we found that epoxy would be our best choice. We knew we would need a backup because we only had a little epoxy left at our houses. For our back up we decided on Loctite super glue. To use epoxy, we had to apply the substance on the fins and hold in it place on the rocket for 30 minutes so it would stay on tight. If you don't hold the fin for 30 minutes, the fin will either slide off or just barely stay on. Super glue was our next best choice, but didn't work nearly as well as the epoxy.

Fins are extremely important to having a successful rocket. The shape of the fin doesn't matter as long as it is aerodynamic and looks like someone at Nasa might use your design. I know that sounds weird, but it's true. A way to improve your fin is to sand the leading edge so it "cuts" through the air better and can go further. The fins should orient the rocket towards where you want the rocket to fly. The fins also shouldn't extrude far from the body of the rocket. You don't want 12in fins on small rocket, the

fins would outweigh the rocket and prove to be a poor design. That being said the fins should be placed on the neck of the bottle, this has been proven to provide the best results with each launch.

Another important aspect of the rocket design would be the shape of the tip of the rocket. You'd think that cone shaped tips would work better for your rocket, however this is not true. It's been proven that parabolic/spherical tips have worked better gaining more distance in launching. Reading about the Von Karman ogive helped us out greatly when we were researching which tip shape was the best for us. We decided to go with spherical shape for our rocket.

Some other general lessons regarding rocket launches, pressure is important. A normal two-liter bottle will blow up at 120psi. If you wrap your bottle in duct tape or something else that will help keep your rocket together, that will increase the amount of pressure your bottle can handle. Having more pressure will reduce the amount of time it takes for the water to leave the bottle resulting in more stress on the bottle. If you are splicing, your rocket will be heavier and should require more pressure to keep up with the other rockets, with that in mind you should make sure your rocket can handle the pressure.

Testing and Development

Mission #1 2016 – September 30th

Launch Day #1

Mission #1 Preparation

To prepare for the launch my group wanted to test a higher mass than the recommended 350g – 400g to see what it would do to the rocket. We wrapped our tip in clay and tried to make it into a sphere as best as we could. We tried using epoxy to glue the fins on before class, but it didn't seem to want to stay in place.

Mission #1Results

First Launch - 130 PSI - 45° - 102 yds

This wasn't bad for our first launch. The rocket was spiraling at the tip when it was launched. This most likely happened because we made the tip out of clay and it must've been uneven. We also lost two fins mid-flight of the rocket because we didn't allow the epoxy enough time to completely dry. Our rocket weighed 515g which felt like too much weight for a rocket. We wanted to try to see if going over the recommended weight would give us an advantage over the other rockets, but it didn't. Everyone's rocket that flew further than ours was much lighter.

Second Launch – 130 PSI – 45° - Blew Up

This was a tragic event; our rocket blew up on the launcher. The first launch must have really weakened the rocket because the bottom of the rocket just blew out. The bottom, not the sides, but the bottom. We had to reinvent the whole rocket, because we knew this design wasn't going to work out.

Mission #1 Recommendations:

To improve our rocket, we are going to reduce the weight of the rocket because our rocket was far too heavy to go extremely far. Another improvement we are going to make is going to be to put the fins on the rocket with epoxy long enough for the epoxy to actually dry. We rushed the job that time and tried to glue them on the class before we had to launch.

Mission #2 2016 – October 4th

Launch Day #2

Mission #2 Preparation

To prepare for this day we looked at all of the recommendation from the last launch and put them into play. We built two rockets from scratch since our rocket blew up. We reduced the weight of the 1st rocket to 125g and the 2nd rocket to 60g. We used a coke bottle for one of them because we researched what a venturi was and wanted to try it out.

Mission #2 Results

First Launch - 100 PSI - 45° - 20yds

This rocket was a disgrace to all of mankind, once it left the launch pad it spiraled out of control. This rocket was far too light to go anywhere.

Second Launch – 100 PSI – 45° - 21yds

This rocket was just as bad as the 1st one, this one was even lighter and just as bad. We are going to scrap this rocket. .

Mission #2 Recommendations:

We really need to make our rockets heavier, they just spiraled out of control right from the launch pad. We learned that the rocket can't be too heavy or too light as this point. We have yet to find the perfect mass for the rocket, but we are going to experiment until we find the perfect mass. There also seemed to me some leakage in the tip so we plan to seal that with glue.

Mission #3 2016 – October 6th

Launch Day #3

Mission #3 Preparation

To prep for this launch my group took one of the designs that we had during the last launch and improved upon it. We added a lot of weight to the rocket equaling 500g. Even though this is still above the recommended weight we decreased the weight from our 1st launch. We also used 100mph tape which is used to fix airplane parts. We wrapped that tape around the rocket so it could handle the stress of higher PSI's. We also kept the

Mission #3Results

First Launch - 115 PSI - 32° - 187yds

Today we tried a different angle and a higher psi. The added weight made the rocket more stable during the launch which helped a lot. We could add more pressure and weight because of the tape we put on. We also tried a different angle which seemed to help out our distance.

Second Launch – 110 PSI – 41° - 200yds

We broke 200yds with this launch which is very rare for the rocket launch. Even though we lowered the psi we increased the angle by 9 degrees. Changing the angle of the launch must of attributed to the large increase in distance. Because of this I think we are going to try to stay around a 45-degree angle.

Mission #3 Recommendations:

The group that went before us had a rocket that blew ours out of the water and their rocket was only 200g. Our group will try to reduce the weight of our rocket even more to try and beat them. We both have similar designs so I think reducing the weight will benefit our rocket. We are also going to remove the lip on our fins. This is causing a lot of loss in aerodynamics which is reducing the amount of yards we can get.

Mission #4 2016 – October 13th

Launch Day #4

Mission #4 Preparation

To prepare for this launch we took out a bunch of the clay that was previously in our rocket to reduce the weight. Sanding the lip off of our fins was a grueling task. I first tried to sand the fin by hand, but that took 15 minutes for one fin. I was shown a tool by the higher ups that let me just grind the lip off within seconds. This made the task much easier and smoother. Now that the lip is off of the fin it is much harder to actually glue it to the bottle. Our epoxy rations are dangerously low so we had to use the last of it for the fins. Our rocket ended up being 350g after finishing it.

Mission #4 Results

First Launch - 130 PSI - 45° - 213yds

This launch was fantastic! We reached 213yds, which is a decently far distance. Everything went smoothly for us, the fins stayed on. We were skeptical about the fins because we took the lip off of them which added a lot of surface area to glue them, but they stayed on.

Mission #4 Recommendations:

Even though this rocket launch was our best to date I believe that we can still do better. Nate and Jacob's rocket flew much further than ours so we will still try to reduce the weight of our rocket. Something else we will try to do would be to sand the leading edge of the fins so that the rocket can fly through the air much smoother.

Mission #5 2016 – October 19th

Launch Day #5

Mission #5 Preparation

To prepare for this day I sanded the leading edge of the fins, this is to increase the aerodynamics of the fins. We also took more clay out of the rocket to the reduce the weight to 300g. This felt like a better weight all around even though it was below the recommended weight. Our whole class has come to the conclusion that the person who did the study about the ideal weight being 350-400g was wrong. The best group's rocket only has a mass of 190g.

Mission #5 Results

First Launch - 135 PSI – 41.1° - 207yds

Sanding the leading edge of the fins didn't really seem to help. In theory it should help, but maybe not on this scale. We didn't improve in distance, which was quite the disappointment after trying so hard to make it better. The tip of the rocket got damaged when it landed so that may alter our findings in the next launch.

Second Launch – 130 PSI – 42° - 188yds

This launch was worse than the first one and that was probably due to the fact that the tip of the rocket was damaged. The damaged tip contributed to a lack in aerodynamics. The fins stayed on no problem which was a relief because the fins had a smaller surface area to attach them.

Mission #5 Recommendations:

Nate and Jacob's rocket is still doing fantastic at their mass of 190g. We are still slowly going to reduce the weight of our rocket until we reach a new max distance, but until then we will be searching for the perfect mass. The fins took quite the beating during the last landing so we will have to fix them and reattach them using super glue since we ran out of epoxy.

Mission #6 2016 – October 25th

Launch Day #6

Mission #6 Preparation

To prepare for this launch we reduced the weight of the rocket to 250g which felt just right for our rocket. It wasn't light to the point where it was flimsy, but it felt light enough to be able to withstand a beating. This is the first day that we didn't have epoxy for our fins so we used super glue. The super glue kept the fins on, however, they felt flimsy. They should have no problem staying on, but I guess we will see.

Mission #6 Results

First Launch - 130 PSI - 40° - 60yds

Today did not go over well, rocket only went 60yds which is one of our worst launches. The fins fell off mid-flight, which means that the super glue didn't hold up. There was nothing at the launch pad that we could reattach the fins with so we could only launch once today.

Mission #6 Recommendations:

To improve our rocket, we are going to try a different brand of super glue since the current brand didn't hold up well today. The weight felt like would do good if it had fins to go with the rocket so we are going to keep the rocket at 250g

Mission #7 2016 – October 27th

Launch Day #7

Mission #7 Preparation

To prepare for this day my group just had to find a different brand of super glue that we could use to attach the fins. We settled on Krazy glue which seemed to do the trick. The fins were slightly wobbly, but they were on the bottle firmly.

Mission #7 Results

First Launch - 130 PSI - 40° - Blew up

This launch was a complete disaster, the fins just stayed in the same place while the rocket went. By this I mean that the rocket launched off of the launcher, but the fins stayed back at the pad. The super glue didn't hold up like I thought it would and we are seriously going to have to figure out something to use to attach the fins. There was snow today so that could've also affected how well the glues effectiveness was.

Mission #7 Recommendations:

We are having a very hard time finding something to use to attach the fins so they stay. Ever since we ran out of epoxy our rocket building world has been turned upside down and nothing has really gone our way. We are determined to find a sort of glue to attach the fins to the bottle. We are even considering using tape and glue just to ensure that the fins will stay on the rocket.

Mission #8 2016 – October 31st

Launch Day #8

Mission #8 Preparation

We are securing our fins with super glue and tape this time to ensure that the fins will stay on even if it means that we will lose some distance. We still kept our rocket at 250g because we have yet to have a successful launch with it and we want to see how this mass fares.

Mission #8 Results

First Launch - 135 PSI - 45° - 203yds

This launch was much better from the past couple launches. We secured the fins with super glue and 100mph tape which seemed to do the trick. We are going really quickly today so I think we are going to be able to fit in another extra launch. Now we know that our 250g rocket has potential to go the distance, we just need to experiment with the other factors now.

Second Launch – 130 PSI – 45° - 168yds

Since we have ample time to launch we are going to experiment with psi and launch angles. We only changed the psi by 5, but we know that numbers in this ballpark will give us the best results at this point. Lowering the psi in this case didn't help, it lowered the distance from the previous launch by over 30yds.

Third Launch – 130 PSI - 47° - 173yds

We changed the angle by two degrees higher this time to see if more hang time was better. At 130psi changing the angle did give us an increase in distance, but not by that much. Our tip got damaged by this point so we are going to have to change out the tip for a new one.

Mission #8 Recommendations:

To improve our rocket, we are going to replace the tip with a brand new one so that it remains aerodynamic. We are still trying to find a glue that will work for our fins without spending our hard earned money at the hardware store.

Mission #9 2016 – November 2nd

Launch Day #9

Mission #9 Preparation

To prepare for this launch we had to replace the tip of the rocket with a new one because of the damage it had sustained the launch before. We didn't use tape on top of the glue today because we thought that at this point the glue would have solidified and acted as a fortress for the fins to not fall off.

Mission #9 Results

First Launch - 135 PSI - 45° - 139yds

This launch didn't go as well as we'd hoped. The rocket flew very wobbly and I want to say that because the fins weren't on the bottle as tightly as they should be.

Second Launch – 130 PSI – 45° - Blew up

The fins just flew off of the bottle seconds after the bottle was launched. The fins must've sustained some damages during the landing of the first launch.

Mission #9 Recommendations:

We really need to get our stuff together and find out how we can put our fins on securely. We are going to use the tape again, but I am hesitant because it is expensive tape. With that being said, we still need a successful rocket so I will have to man up and use the tape.

Mission #10 2016 – November 4th

Launch Day #10

Mission #10 Preparation

I manned up and used the tape today, let's hope we can break 200yds today. We are still keeping the rocket at 250g. Using the tape should help the fins stay on so our rocket has some stability.

Mission #10 Results

First Launch - 135 PSI - 45° - 140yds

This was the launch before rocket day and we still have a long way to go. The whole rocket was wobbly during the entire flight, spiraling. The rocket got damaged so we are just going to make a new one. We are sticking to our old design, just with a new bottle.

Mission #10 Recommendations:

We are going to fix the fin issue that we continuously have to face. We are going to bend the bottom of the fin to create a larger surface area for the glue to stick to. This should put an end to our problems, if only I thought of this sooner.

Rocket Day

Conclusion

I have learned a lot over all of these launch days and I plan on summarizing all of the most important parts that led me to my final design. There is not one single factor that really reigns supreme over all of the other. Everything needs to work together in harmony to have a successful launch.

I'm going to start with the launch pad setup. We used a 45-degree angle because we got constantly good results with it and in theory, a 45-degree angle should make the rocket go the furthest. We also went with a 50/50 water air ration for the bottle. We got the best results when we used this ratio, even when we read the recommended percentage was 80% water. The higher the pressure the further you rocket can go, but you have to make sure that your rocket can withstand all of that pressure. To help the bottle withstand the pressure you can wrap it in various different wraps, like tape.

For the rocket design we went with splicing. We found that the longer the rocket, the further its potential of distance could be. To make a successful splice you really need to focus on the tip of the rocket to make it as even and aerodynamic as possible. Making sure that there are no air leaks in your rocket is essential as well, air leaks will cause your rocket to lose a lot of distance. You also want to have a light mass for your rocket, but not too light. It has to be able to withstand a blow, but also be light enough to soar through the air. The fin design is crucial for your rocket; your fins help guide the rocket through the air to make it as stable as possible. You don't want your fins to extrude from the body of your rocket too far, this will cause imbalances in the rocket as it is harder to keep your wings balanced the larger they are. For the tip of the rocket I would go with a spherical design. Spherical tips have been proven to go the furthest for rocket launches.

Launch Team

For the launch team I relayed distances that I found using a range finder commonly used by golfers. Once I found the distance I relayed the information to Maddy, because she recorded all of the distances. I also helped with the prep work by filling up jugs with water so we could use the water for the rocket launches.