Precision Launcher

Dido and the MC^2 Launchers

Background

Our objective is to create a precision launcher operated with the use of a 5 pound weight that has to launch a foam-like projectile 30 feet inside a target.

It could not be a simple catapult design, but it could not have anything to force it besides the weight.

At FEDD, we were scored by how far the projectile went, as well as where it landed on the target.

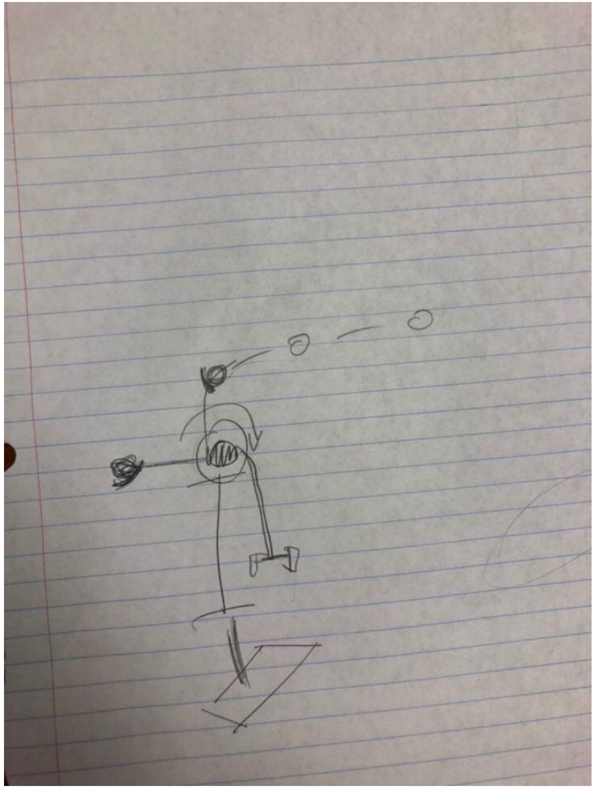
Initial Design

Initially, we planned to build a launcher that would propel the ball using a pulley system

The weight, tied to the pulley, would be dropped and the wheel of the pulley would spin at a high velocity.

An arm attached to the wheel would cradle the ball and release it once it rotated to the top of the pulley.

This design soon became clearly impractical and we decided we needed a new one.



Revision

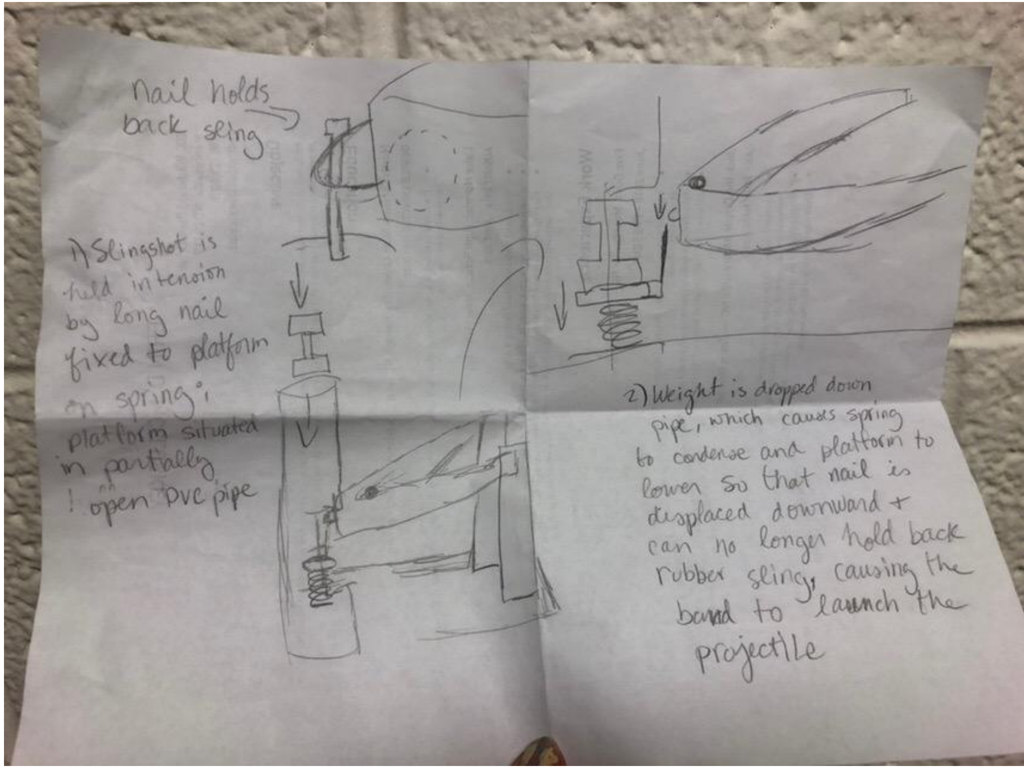
Rather than let a pulley absorb most of the energy of the weight and hope it would fling the projectile thirty feet, we considered other more efficient means of launching a ball.

Thinking of traditional slingshots, we decided that we could modify that simple design to involve a 5-lb weight in its operation.

Strong elastic, we know, can store lots of potential energy when pulled back at tension. This could provide us with the force needed to launch a projectile a reasonably long distance.

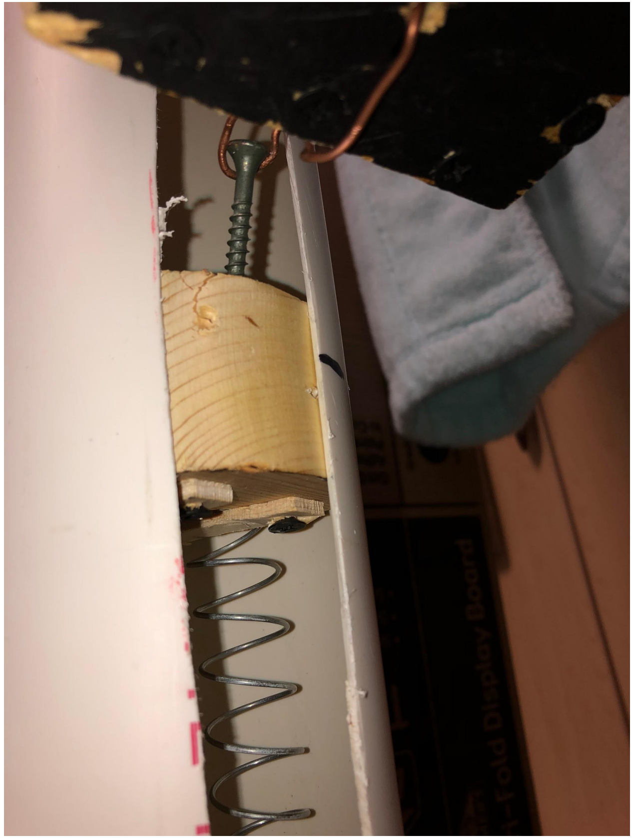
Final Design

The design we settled on would consist of a large slingshot drawn back and held at tension by a mechanism that would release the sling upon having the weight dropped on it. This mechanism, at the bottom of a PVC pipe, would consist of two wooden platforms attached by springs, the bottom platform being fixed in place and the other being able to move freely up and down the pipe.



Final Design (cont)

A nail sticking out of the top platform would have a wire looped around its head; the wire itself extending from behind the center of the elastic band. After hooking the sling onto the nail head, the projectile could be loaded and the sling launcher would remain at a state of high potential energy until a weight was dropped down the PVC pipe, displacing the upper wooden platform and attached screw, leaving nothing to hold the sling back. The elastic would then snap forward, launching the projectile.



Materials

The base of the launcher, arms of the slingshot, and the box that cradles the projectile were all made using scrap wood from the craft center as well as screws and equipment available there.

The PVC pipe, springs, and latex tubing used for the sling were all purchased from Ace Hardware for ~$30.

The 5-lb weight, mini hockey ball we used for the projectile, and the wooden platforms inserted into the PVC pipe were all obtained for free courtesy of the McEneny family.

Construction and Roadblocks

None of us had much experience working with wood or tools, though we were forced to familiarize ourselves with the woodshop in order to translate our design into reality. The base of the project was the first thing we made; it consists of two 2’x3’ boards of scrap wood screwed together to make for a heavy, sturdy base. Next we attached the arms of the slingshot, though they were extremely wobbly. A man working in the shop saw what we were doing and recommended we use wooden blocks as support for what were essentially upside-down table legs. We took his advice and, sure enough, they were far sturdier.

Construction and Roadblocks (cont)

Dido assists Erin as she pre-drills the wooden support blocks for our “table legs”

Construction and Roadblocks (cont)

Originally, we planned on using mesh to cradle the projectile in the sling. We used a tough thread from the Engineering Resource Room to sew the mesh onto the latex tubing. After a holding the sling onto the arms and doing some test-launches, however, the mesh tore and we realized we'd need a stronger material for the cradle if it was going to withstand all of the force of being held back at a great deal of tension

Sewing our doomed mesh to latex tubing in the brickyard

Construction and Roadblocks (cont)

Instead of using a mesh material to hold the ball in, we realized we needed something that was durable and solid, with a compartment, in order to keep the ball in without gravity causing it to drop. Our idea was to create a wooden box, which would have four sides, and be open on the other two to allow the projectile to be launched. We also drilled two holes near the bottom of the box to loop the wire through and stay connected to the screw.

Construction and Roadblocks (cont)

We also ran into a roadblock for attaching the springs to the two pieces of the wood in the PVC pipe. We asked Dr. Adams, and took his advice of putting two indented grooves on both sides of the wood to hold them in. However, we found out that the grooves were not able to withstand the pressure of the weight being dropped, and caused the springs to deattach. In order to fix this, we cut out four thin pieces of wood and screwed the top and bottom wood pieces to the top of the spring to keep it in place.

Fine Tuning

We had to make many improvements in order to get the projectile to launch 30 feet. The first thing that we changed was changing the dimensions of the box that held the projectile. It had been too wide, and because of this it was constantly catching the projectile on its way up after being launched, and as a result would actually go backwards. Another thing that we figured out was that once we attached the box and the wire to the screw, it would actually face downwards causing gravity to drop the ball before we could even launch it. In order to fix this we tied the wire higher up along the back of the box, which allowed the box to be at an upwards angle, solving the gravity problem, and allowing the projectile to launch further at the same time.

Compartment with wire looped after tuning

Fine Tuning (cont)

The last roadblock that we ran into was the positioning of the screw that we screwed into the side of the top piece of the wood holding the springs. We first screwed it into the side of the wood, but figured out that this did not allow the wire to slip off once the weight fell down. We then decided to screw it in to the top of the wood instead, to allow for a higher probability of the wire slipping. However, even after this, we had to account for the angle as well. If it was too steep, it would cause the wire to slip before the weight was even dropped, and if it was too flat, it would cause the wire to not slip at all. We kept trying different angles, until we found the equilibrium spot that allowed the wire to slip off only when the weight was dropped.

Final Product and Performance

Once we figured out the fine tuning, the ball was able to go about 25 feet, which meant that we did not reach the goal, but it was still sufficient enough to at least get us a percentage of the points at FEDD. At FEDD, we ended up having a misfire to start off, which caused a little bit of panic, but we realised it was only because we dropped the weight down incorrectly, which caused the ball to catch itself on the box and launch backwards. However, on our second try we hit the second circle on the target, which was exciting. Our other two attempts were short, and we realized that we should have moved up the launcher a little bit closer to the target.

In Retrospect

We did not end up getting scored at FEDD for unknown reasons, but we did realize that we could have done some things better in order to get a better score. First of all, we could have determined the average distance that the projectile launched by taking 10 trials, measuring, and averaging. This could have saved us a few points in terms of getting the launcher the right distance away from the target. Another thing that we could have done was to continue moving up the wire loop to get the box even more angled, which could have extended the how far the projectile went, potentially to 30 feet.

What We Learned

We learned many things, not just about engineering, but about life skills that will be needed in the future. First of all, we learned how to work as a team efficiently, and how to use each person's strengths to the group's advantage to get things done. In order to do this, we had to learn how to communicate well and stay focused on the little parts of the project as well as the whole at the same time.We also learned how to keep trying to find a solution to our problems, even if it seemed like there was no hope. We had encountered a few situations where we almost gave up, but our commitment to the project kept us going until we found the solution.

Advice for Freshman

The biggest piece of advice for freshman is the time management. Our group had good time management across the whole period, and we were still working until the very last day. This means that there should be meetings consistently, and the group should make their own deadlines to get specific parts of the project done. This will keep the group less chaotic, and will also allow time for the group to make adjustments if something in their project goes wrong unexpectedly.

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