Shoot n' Sail

Group 4: Lauren Davis

Deborah Kasner,

Yinan Kuang

Alex Reiner

Step 1: Brainstorming

Idea: Wind-up Boats

Why we didn't choose it: The idea was too simple. It did not have enough challenges for gamesters' mentalities.

Idea: Racing game with slots: A ball is on a track. It can be moved up and down. Slots within the track allow the ball to drop through.

Why we didn't choose it: Project required design to fin in a 10" x 10" cube; it was too small to be fun and functional.

Idea: Mini foosball table

Why we didn't choose it: It was too small to be fun and easily operational (happened to most of our ideas)

Idea: Skee-ball track with launcher

Why we didn't choose it: It was too small to be fun and functional.

Idea: Wind-up boats with launcher

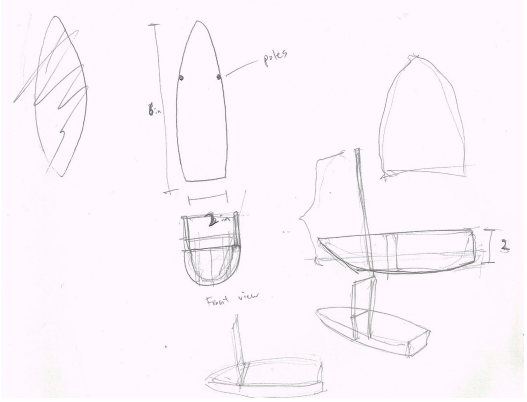
Why we didn't choose it: Who needs to launch the boat when it winds up?

Idea: Boats powered by launching balls

When we chose it: It had boats, but the player moved them through active participation. It had a launcher; this was really "cool." The materials only had to fit in a 10" x 10" cube; therefore, they could have unlimited play space. Essentially**,** the idea was a game in which two players could race their boats to the finish line by shooting balls at a felt sail.

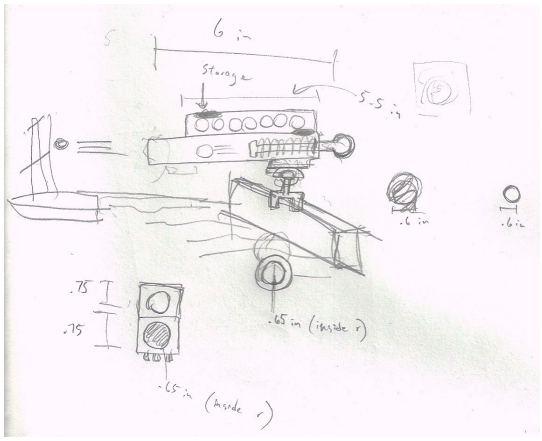
Step 2: Initial Design

Fundamentally, the idea was a game in which two players could race their boats to the finish line by shooting balls at sails on the boats. We decided that we would create a track with two lanes and create guns that could change the height angle of their shot, but they had no horizontal mobility to ensure that the arc of the shots would be in line with the track. Once we had decided on the direction of our project, our ideas began to flow. Within about 30 minutes of creating our initial concept, we had produced rough sketches of what the boat and the ball gun would look like (see figures 1 and 2). At this point, we realized that we had to make deadlines and begin to tackle the SolidWorks modeling.



Y. Kuang

Fig. 1: The Boat

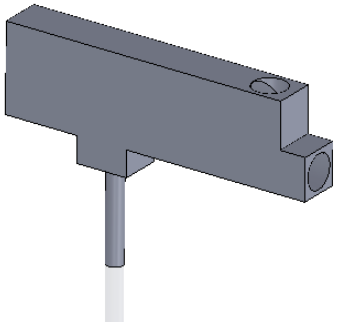


Y. Kuang

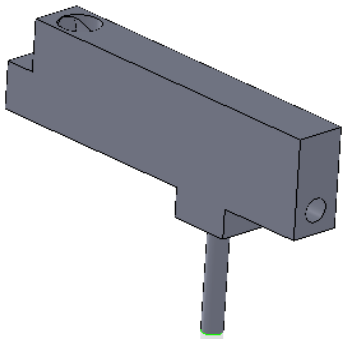
Fig. 2: The Gun

Step 3: The Ball Gun

We decided to work on the ball gun first. Our initial idea was to create a spring loaded gun that utilized a plunger much like a pinball table to shoot balls out of a barrel. We would simply use gravity to allow balls to drop down from an upper chamber into the barrel of the gun as the plunger is drawn back. With our design in mind, we began work on the gun. Some of the initial questions that we had to answer were what materials we were going to use and the general scale of the gun itself. We decided that the housing of the gun could be 3D printed; whereas, while the plunger could be machined. Also, we envisioned the gun being attached to the water tub through some kind of clasp to be determined at a later date. The scale of the gun was based on the size of the balls to be shot out which we chose to be 0.625, and then we apportioned the gun respectively as shown in our initial sketching (see figure 2). The initial 3D model of the gun was created without much trouble (see fig. 3).



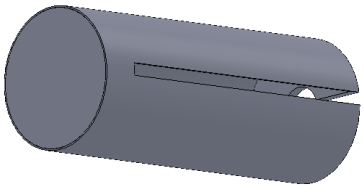
A. Reiner



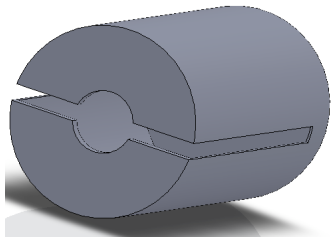
A. Reiner

Figure 3: (left to right) ball gun front and ball gun Back

However, one aspect of the gun we continually struggled with was the reload mechanism. It became increasingly difficult to ensure that only one ball would drop down from the upper chamber at a time. There were essentially two potential issues with this. One was that the diameter of a ball would not be large enough to keep the subsequent ball still in the chamber from falling down enough beyond the circumference barrel to jam the plunger. The second potential issue was that the subsequent ball would fall in between the rings of the spring and also jam the plunging mechanism. Our initial solution was to create a plunging mechanism that encompassed the spring. Therefore, it would prevent the ball form falling between the springs (figure 4).



L. Davis

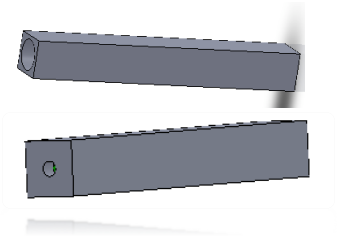


L. Davis

figure 4: ~~F~~ront and back of the plunger for reloading gun

But this hollow-bodied solution was immensely difficult to machine, and it incorporated more variables into the equation than we had time or means to address. This included variables such as the spring constant that would have to be pulled back far enough for the ball to drop. At the same time, it would allow the ball to be shot a reasonable distance without pulling it back to the reloading position. In addition, because this plunger could not be machined, it would have to be 3-d printed. Because of the design of the plunger, we would have to formulate a method to attach the handle of the plunger to the body inside the gun.

In the end, time and material constraints made us revise our initial idea. We decided that it would be better to create a manually loaded gun as opposed to an automatic one. Thus, the final SolidWorks model was created (figure 5).



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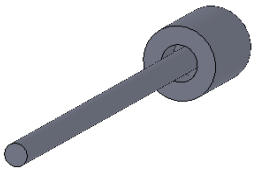

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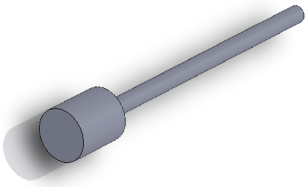

Y. Kuang

Figure 5: (clockwise from bottom) ball gun back, ball gun, front, plunger front, plunger back.

Once the design of the barrel of the gun and the loading mechanism were decided upon, the usage of the gun was considered. The easiest part to take into account was the handle of the plunder (figure 6) that is necessary to keep the plunger from flying into the gun. This makes it easier for them to pull the plunger. In addition to the use of the gun, we created a hinge (figure 7) that the gun would be attached to. The hinge would prevent the gun from being turned side to side in an effort to prevent the balls it shot from flying outside the path of the boat. However, we ran into difficulties during the 3-d printing process and the hinge printed glued shut. Thus, we were required to use an already created hinge.

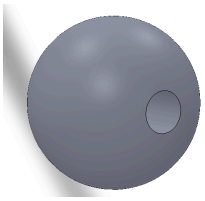

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Figure 6: Plunger Handle

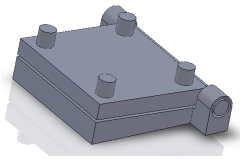

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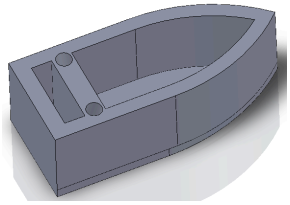
Figure 7: Ball Gun Hinge (attempted and final)

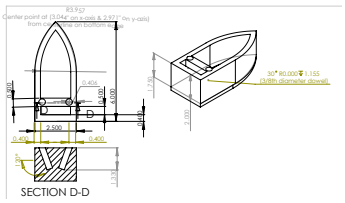
Step 4: The Boats

The boats were the simplest part of both the design and mechanical workings. Because it was really a prop more than a working piece, exact specifications did not have to be followed. The only critical dimensions in the boat were the wholes for the dowels. They had to be the correct diameter to match the wooden dowels we chose. Therefore, while our SolidWorks model of the boats were characterized by exact angles and clean points, our boat had none of those because of the machinery used to create them (figure 8).

Step 1: SolidWorks Model



Step 2: SolidWorks Drawing



Step 3: Machined Boat

Step 6: The Assembly

We began assembly by assembling the individual, self-contained parts first; these were the guns and the boats. The main body of the gun was 3-d printed with the exception of the spring. Thus, to assemble the gun, we were required to insert the plunger with the spring surrounding it in the barrel, and then attach the plunger handle on the outside with glue using a d-clamp to hold the plunger in the firing position as the glue dried (figure 9). While this process seems simple, there was a problem. Since there was an error in the 3-d printing, the barrel of the gun on one end was not completely square making the opening oval-shaped. As a result, heavy filing was required to make the plunger fit within the barrel and move easily.

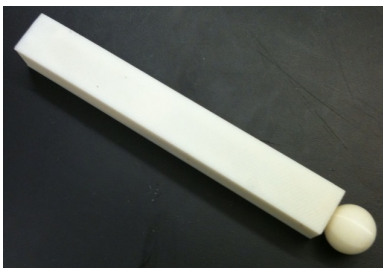


Figure 9: Gun

Figure 10: Functional Gun

After the boats were machined, the only step left was two insert the dowels that will hold the sails. Like the gun, this should have been a relatively easy process; however, the different types of wood caused some problems. The very lightweight and grainy balsa we chose for the hull of the boats was ideal for buoyancy, but also it created significant amounts of pulp during the machining process. This pulp filled in the holes when they were machined. Because of the wood, the cuts in the boat were not very clean, and thus cuts were made through parts of the boat where they were not meant to be. However, this did not affect the stability of the dowels in the holes, which with the help of some filing, fit snugly within the supports (figure 10).

Figure 10: Boats

Figure 11: Filing Dowels

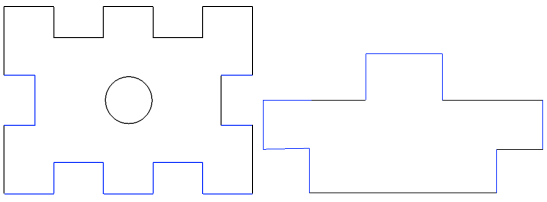
The next step in creating the final product was the interactive parts of the project. In this sector, we hit a decent number of impediments to make us alter our original plans. The first of which came in the form of missing parts. Our original sail material was a lightweight, waterproof canvas. However, this part was unexpectedly delayed in arriving and a substitute was needed.

We couldn't use any sort of paper, so we decided our best bet, at this very short notice was a cotton t-shirt (figure 11).

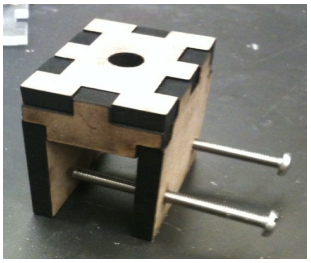
Figure 11: Boats

In addition to the sail, we ran into some problems with the mechanism that attaches the gun to the tank of water. Originally we had hoped to make a flat-top binder clip that had holes for screws; however, our "meam 150" team member specified that this was a difficult process, and because of time constraints, she would rather drill holes in an already existent binder clip. Yet, the hinge design and the bend in the original binder clip made vertical screws inappropriate. Instead, we decided to create something similar to a d-clamp that would go over the side of the tank. Therefore, the clamp could easily adjust to different widths, and we would not have to worry about the design of the hinge or the gun. This part was created using laser-cut pieces of MDF and two screws (figure 12). This was to be attached to the gun via a dowel that would connect the hinge to the d-clamp. Since the hinge didn't print correctly, we were forced to glue a hinge to the d-clamp instead.

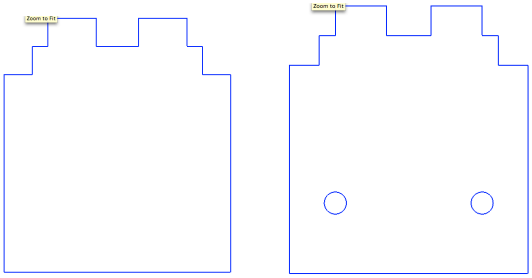
Step 1: Sketch parts for laser-cutting Step 2: Lasercut parts and press-fit them together



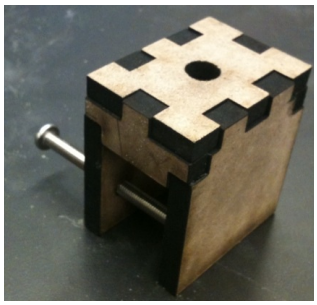
Top Sides



Front



Front Back



Back

Finally, while this attachment is used in conjunction with the hinge to keep the gun from firing balls outside of the tank, there was no need to encase the tank. However, there was a need to create lanes that would keep the boats in their separate paths. Because the entire game is adjustable to any medium-sized container, it was not efficient to create a laser cut acrylic set of lanes to float on top of the water, as we had initially planned. Instead, we made use of bungee cables that could be adjusted to any length and width. This increased the adaptability of the game and allowed it to fit different lengths (figure 12).

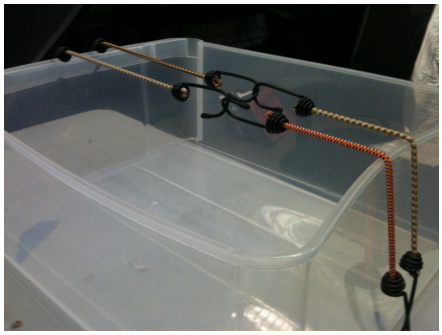


Figure 12: Tank

Step 7: Completion

During our setup, we ran into some issues. Unfortunately, the wood that we used to machine the boats was made of an extremely porous material that easily became waterlogged. In conjunction, because we did not have canvas, the cotton sails also became saturated and heavy. The boats became off balance and would not stand up properly. To rectify this, we decided to use four bungee cords for each lane. Two bungee cords would be placed inside the dowels and two would go outside. This would enable the boat to stay upright and experience minimal friction as the boat was propelled to the other side. Thus, the creation of the Shoot and Sail came to fruition. In the end, it only had one gun because one failed to 3-d print, a store-bought hinge, and an off-kilter boat. Though the look from inception to completion has changed, the idea is the same: take aim, hit the sail, finish before the person next to you, and HAVE FUN!!!!