Curling Minigame

By Yiming Aizezi and Junze Wang

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Description, Introduction, Format

We never thought that a simple game on the Nintendo Switch would be the inspiration for our next engineering project. “Clubhouse Games: 51 Worldwide Classics” is a videogame

developed by NDcube. It features 51 fun and engaging games from around the world, ranging from standard chess to a virtual fishing competition. While all the mini-games were excellent, one strategic gem stood out: “Toy Curling” - A mini version of Curling, where two players competed in who can get their “curling stone” closest to the middle in a turn-based duel. This minigame was so captivating that it kept two nearly grown adults hooked for an impressively long time.

We felt that our school’s common room lacked some fun. Our last 2 years before university created a tense but studious atmosphere. What better way to liven up the room’s atmosphere than making “Toy Curling” a reality?

Problem: To create a more fun space for everyone in our school community

Solution: Creating a physical version of “Toy Curling” that can be enjoyed by all

Aspiring Engineers: Yiming Aizezi, Junze Wang

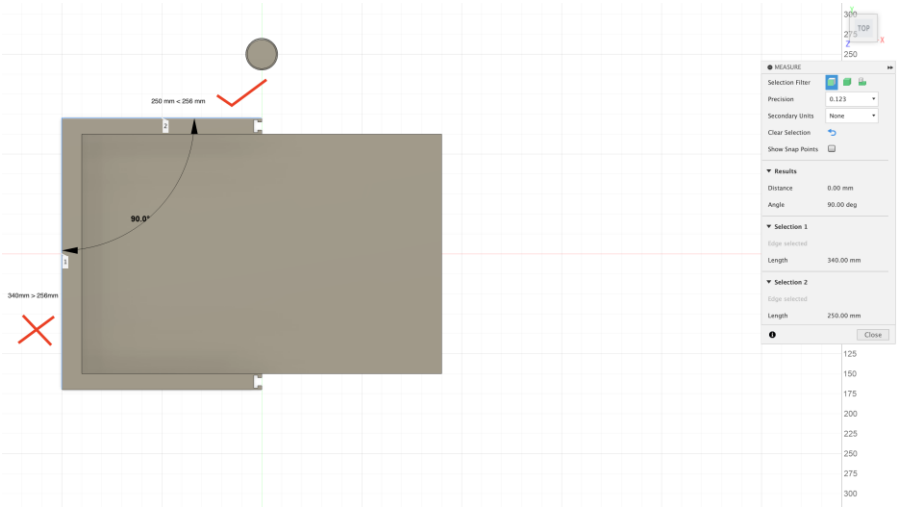
Initial Ideas/Designs #1 – Acrylic Board and cylinder trigger mechanism

Sunday, 3rd of November 2024:

We decided to purchase a few various kinds of acrylic boards as the base for the entire project. We wanted something that was smooth enough, such that 3D printed plastic curling stones can glide around. We also needed to be able to draw on this material using plain whiteboard markers. A standard acrylic board met all our criteria.

I remade the acrylic board in Autodesk Fusion 360 and began to create walls around it so that the mini curling stones will not fly out of the minigame. I planned to create 2 sections which would attach to each other and the board; however, it still was too big. I measured the sides and found that one side is 340mm long, which is too big for my 3d printer's print plate of 256x256x256mm. My first draft design can be seen in figure 1.

Figure 1:

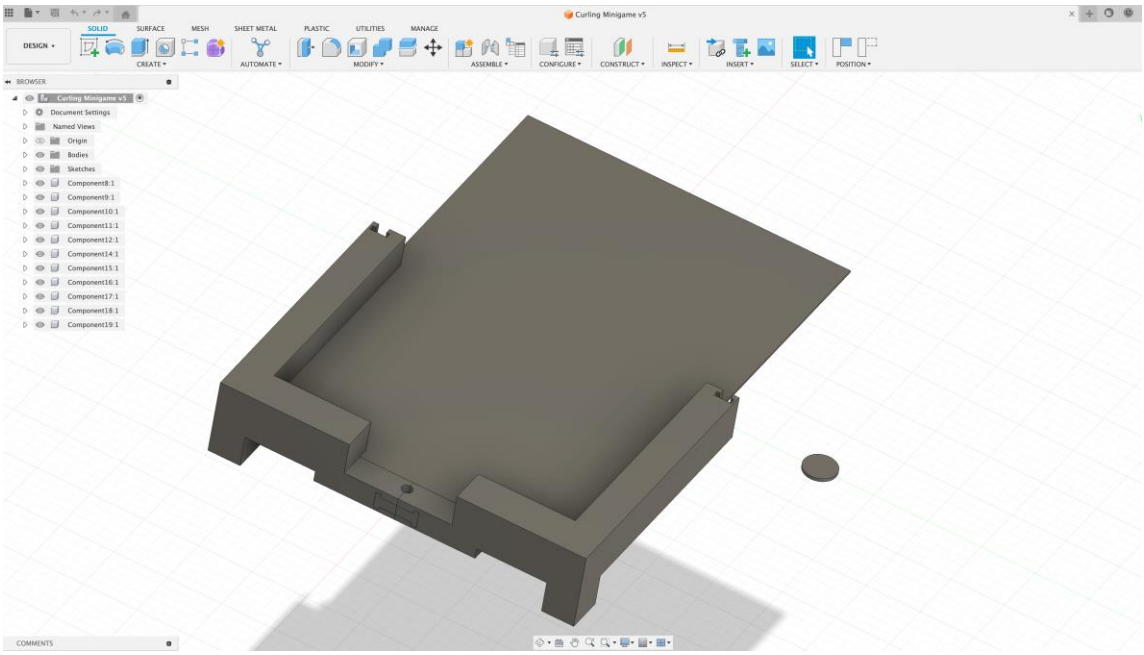


<u>Saturday 9th of November:</u>

To fix the issue of a limited 3D printer print bed, I redesigned the walls. My new design made the outer walls of the minigame into 4 sections instead of 2. This would allow the print to fit on my 3d printer's print plate. I also plan to only make one half of the walls for

now since it is a perfect reflection. I can just reflect and copy and paste the entire half of the wall to finish it when I am ready. Figure 2 shows my progress so far.

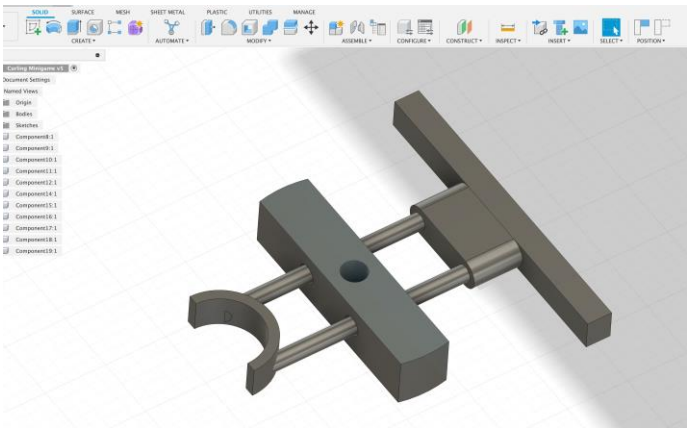
Figure 2:



Saturday, 16th November:

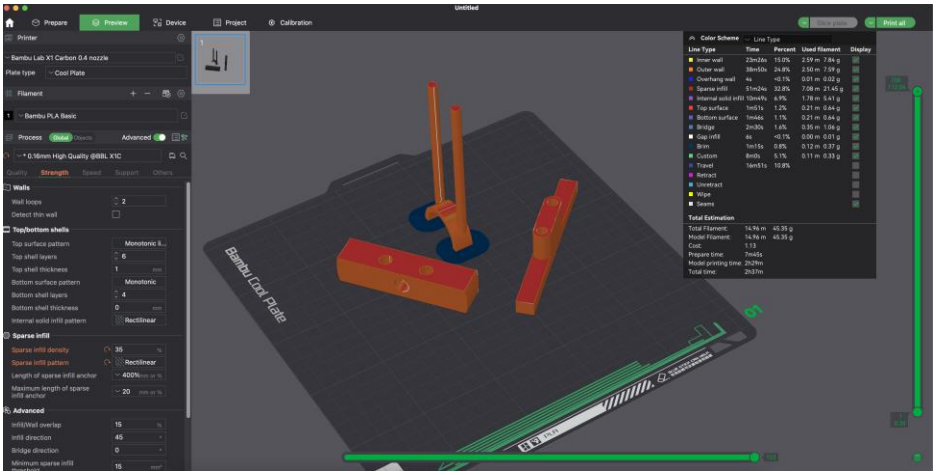
We created the trigger mechanism today; the design is shown in figure 3.

Figure 3:



Then we wanted to test if it would work, so I put the design in Bambu lab, shown in figure 4.

Figure 4:

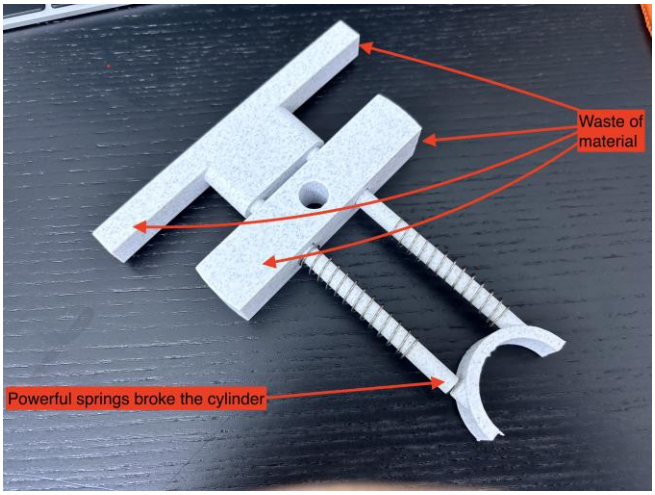


The design came out nicely, however we realized a few flaws with the design:

- The springs were too powerful, so the spring compartment cylinder broke
- A waste of material caused by the design (the handle and the connecting base)
- Forgetting to consider of the location where the ‘curling stone’' can be put, since when it turns angle the trigger is not aligned with the ‘curling stone’

All these issues can be found in figure 5 below.

Figure 5:



November 22nd

Our previous idea to create an angle-changing mechanism was to attach a cylinder from the mechanism to the side rim of the minigame. This cylinder would be fixed and will not turn. However, the mechanism on top of it will be able to change angle.

This has a few flaws:

- The force of the spring will directly affect this cylinder. A thick cylinder is impractical, and a thinner one will be broken instantly.
- As the angle changes the location of the ‘curling stone’ will change significantly. Meaning it is possible that the curling stone will be pushed out of the mechanism. This is impractical.

Initial Ideas/Designs #2 – Circular rim angle turning mechanism

(Still November 22)

Then we thought of a new idea together on my whiteboard at home. We created a circular hole in the minigame's rim, which has a center at the curling stone's location. We would create a cylinder that would move around in this ‘donut’ shaped hole in the rim. And this would fix the issue of a change in angle, does not change the location of the curling stone, meaning it will not push the curling stone out.

And yet this mechanism still had the first issue of being too weak. This mechanism was not a very big improvement from the last time. So, we ended up brainstorming Ideas the next day on the white board.

(Unfortunately, I forgot to take a photo of our brainstorming)

Initial Ideas/Designs #3 – Donut turning mechanism

So, we thought of a third idea. A donut shaped hole along with a donut shaped mechanism. This mechanism is smaller than the hole so you may change angles easily. Fixing both issues of strength and center location change due to angle.

Figure 6:

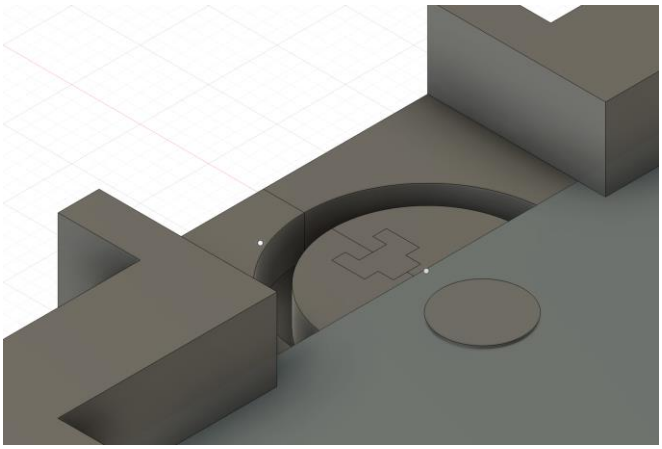


Figure 6 above shows the new mechanism's donut shaped hole.

Figure 7:

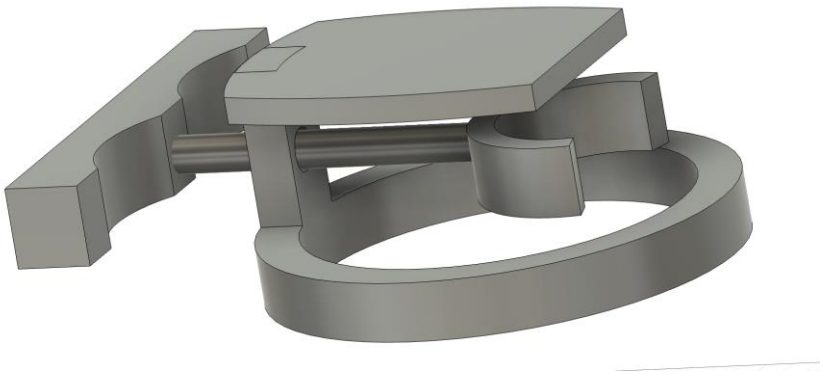


Figure 7 shows the mechanism without the rim. As shown above, the donut shaped mechanism is a full donut. However, in figure 6 we see that the donut shaped hole is

halved. The other half would always remain under the white acrylic board. Meaning it cannot be pulled out.

Figure 8:

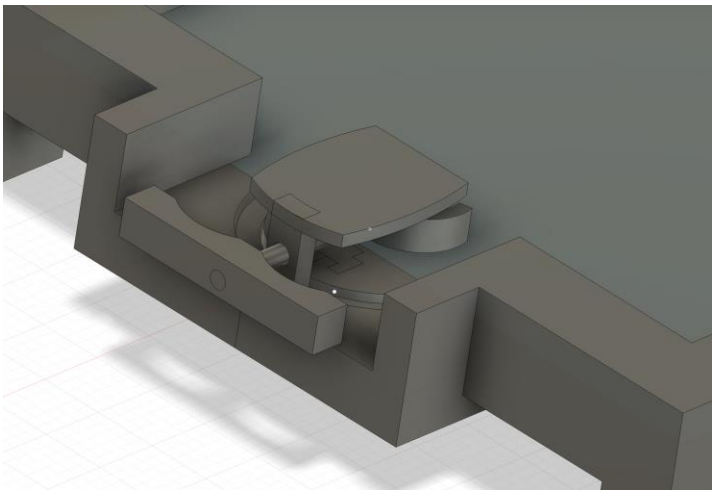
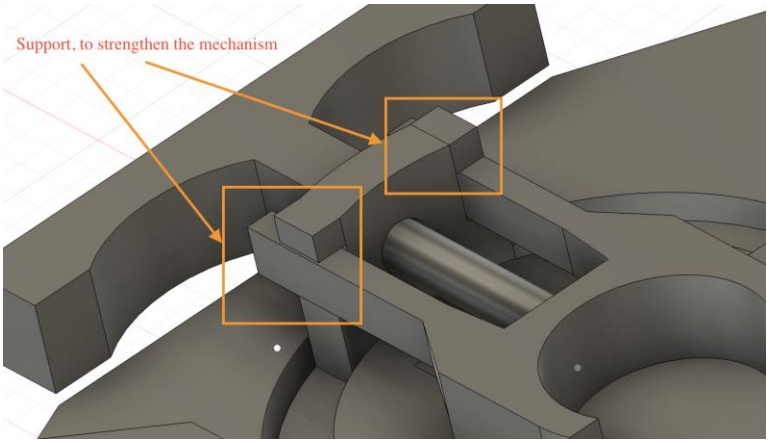


Figure 8 shows the donut mechanism in the donut hole in the rim.

November 30th

The mechanism for the launcher is complete. Although its function is achieved, we want to make it look better. On top of that, I also want to improve its strength.

Figure 9:

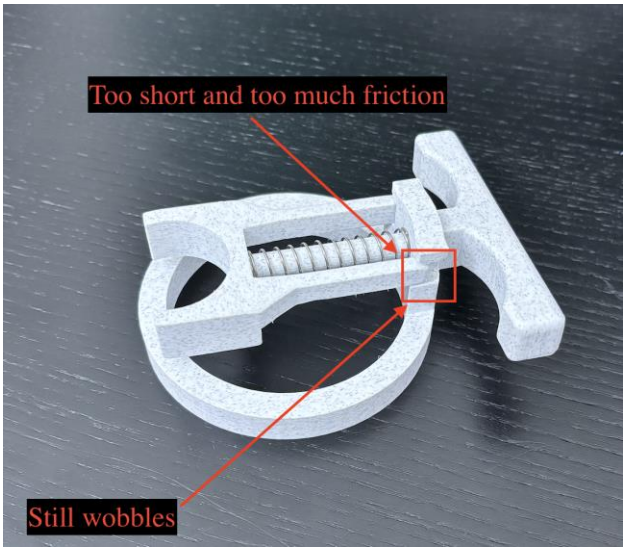


To achieve this goal, I have created a support that slides past the stationary component of the mechanism (figure 9). Before, only the cylinder was connected to the donut mechanism. Now, there are also these two rectangular boxes which are gliding past the stationery part. This should prevent the mechanism from turning angles vertically. Due to the circular nature of the cylinder, the mechanism could accidentally change angles such that the mechanism no longer works.

December 8

We successfully 3d printed the shooting mechanism from figure 9 above. The print can be seen in figure 10.

Figure 10:



While the print came out smoothly, and the supports we removed smoothly, we still had issues with the design: in figure 10, the extra two supports I added to “strengthen the mechanism (figure 9)” seems to be too short; It also wobbles around, even when its completely pulled back. Also, holding this design in real life allowed me to figure out another issue. The force from pulling the spring will be applied onto the main base of the project. This means that you may have to hold the walls while pulling the springs.

Optimization & fixing errors

(still December 8)

In other words, we have finished the stage of designing an idea. Now we have moved to the stage of optimization, and fixing errors. I have made a table below to clearly show the issues and what we plan to do to fix them.

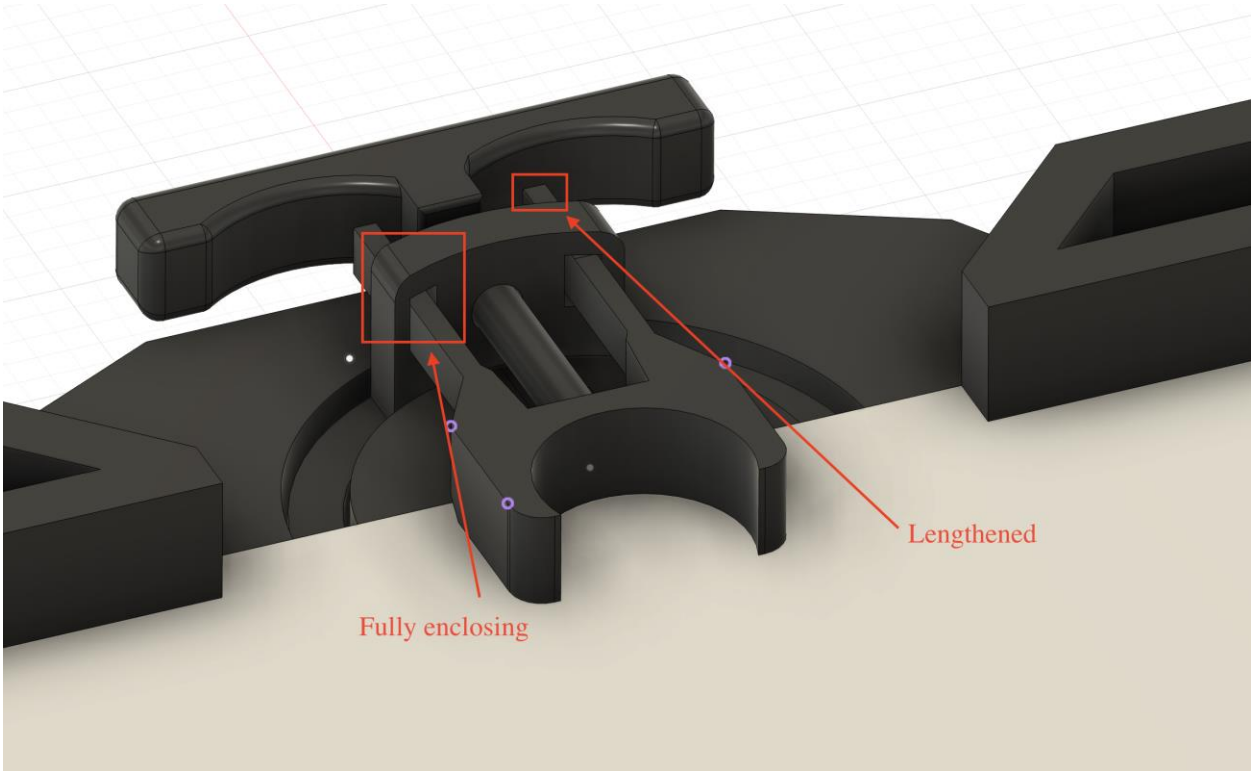
Table of issues and solutions

Issue	Solution
1) Supports are not long enough	Increase the length in the design
2) Wobbly mechanism adds unnecessary friction	In figure 10, we see the sides of the "support" is not covered. We can cover this to prevent wobbling and friction. Additionally, we can also make the hole larger to account for the imperfectness of 3d printing.
3) The main project is not heavy enough, pulling the spring back may not be a satisfying experience	We will create empty spaces in the walls, which may be filled with sand to add weight. This also minimizes print time and amount of filament used.

<u>December 9:</u>

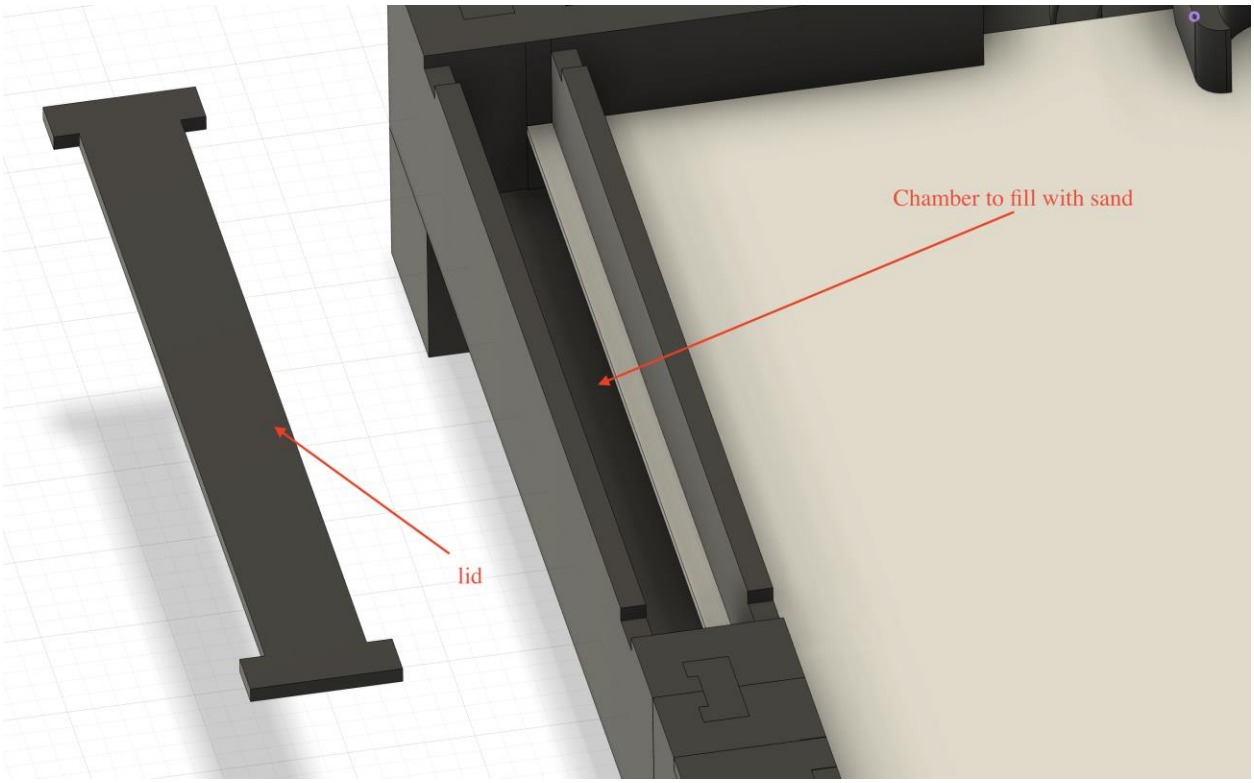
To fix the first two issues from the table of issues, we optimized the design. This is seen in figure 11. We first lengthened the “support mechanism,” then we made the hole fully enclosing.

Figure 11:



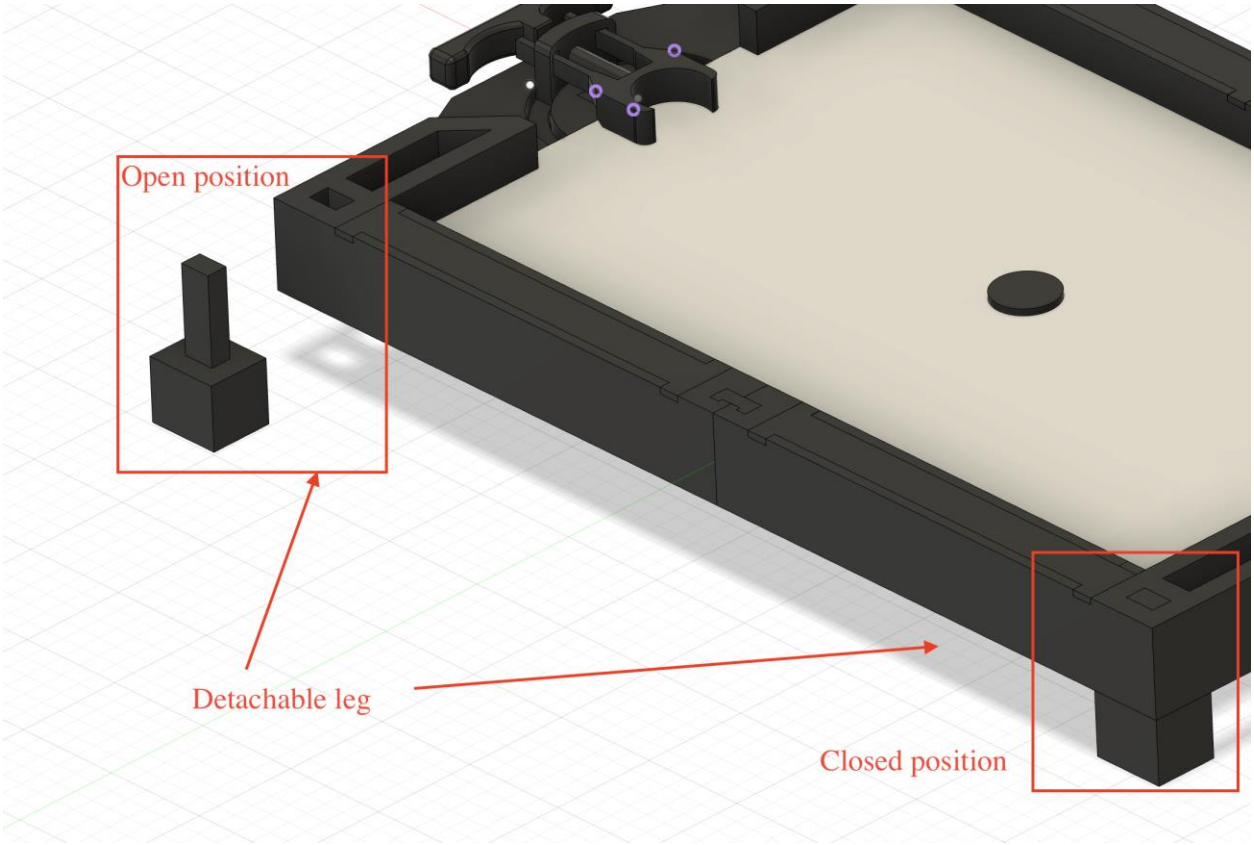
To fix issue 3, we created an empty chamber in the walls. This can be filled with sand to add weight. Or even other heavy items. Chamber and lid seen in figure 12

Figure 12



We also found another issue with 3d printing. If you want to print curved surfaces more smoothly you should print it vertically. Therefore, I plan to print the walls vertically (there is a curved section near the shooting mechanism). However, the legs they are standing on would mean that tons of support would be needed. Printing them upside down would not be ideal as well, because support would be generated on the curved areas (not good for smoothness). To fix this error, I created detachable legs which can be printed separately. Now we can print the entire wall at 1 height without support. This change is seen in figure 13

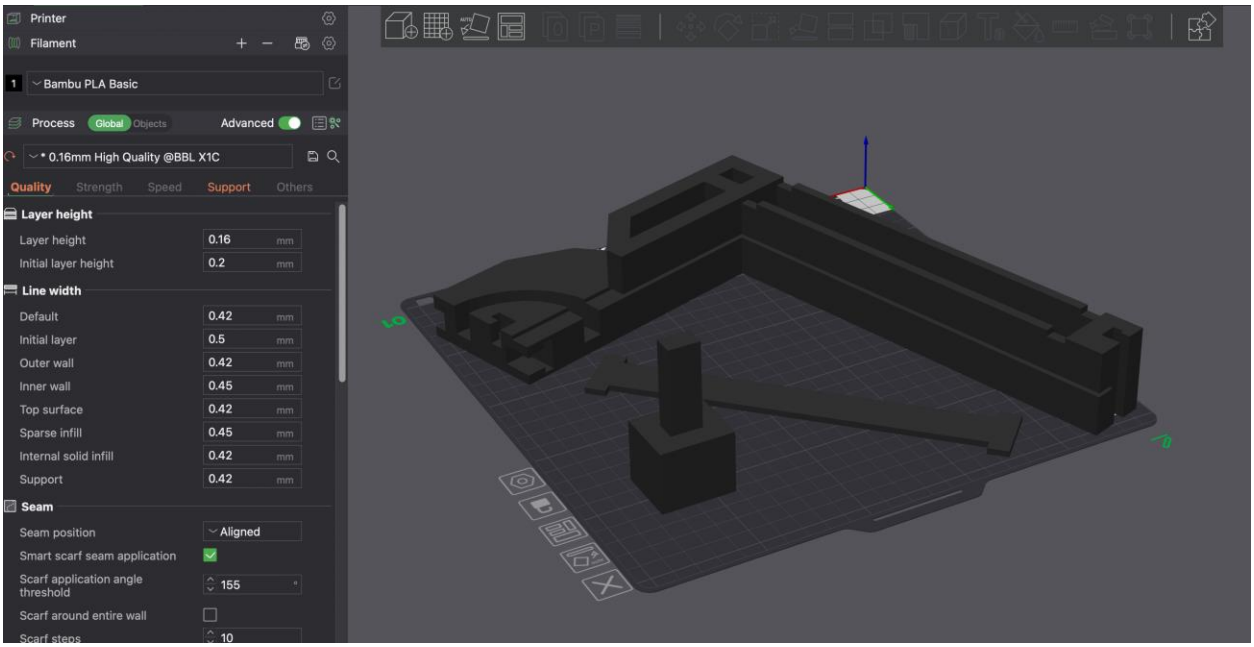
Figure 13:



December 11:

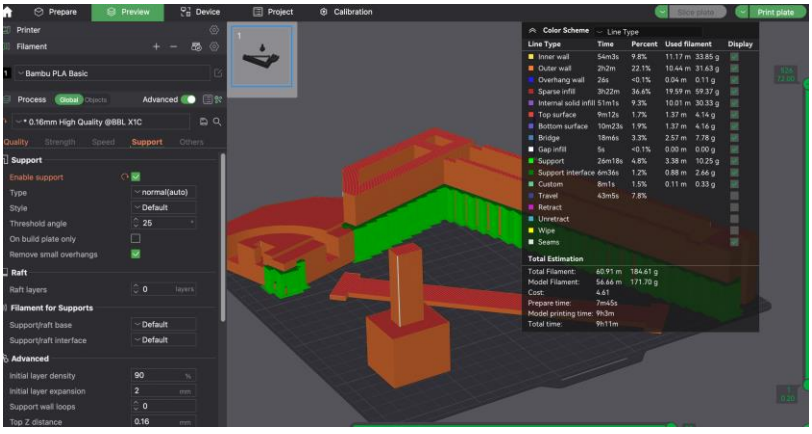
I wanted to begin printing the project. However, we have met a major roadblock: Not being able to print midair (support required).

Figure 14:



In figure 14 we can see part of the wall. I have split the wall into sections from the beginning to account for the limited size of the print plate. After moving the project at an angle, I was able to fit this part of the wall in the print bed.

Figure 15:



In figure 15 we can see the preparation section of the Bambu Studio app. The automatic support generation is in the way of a crucial component of the wall. Due to the layer-by-

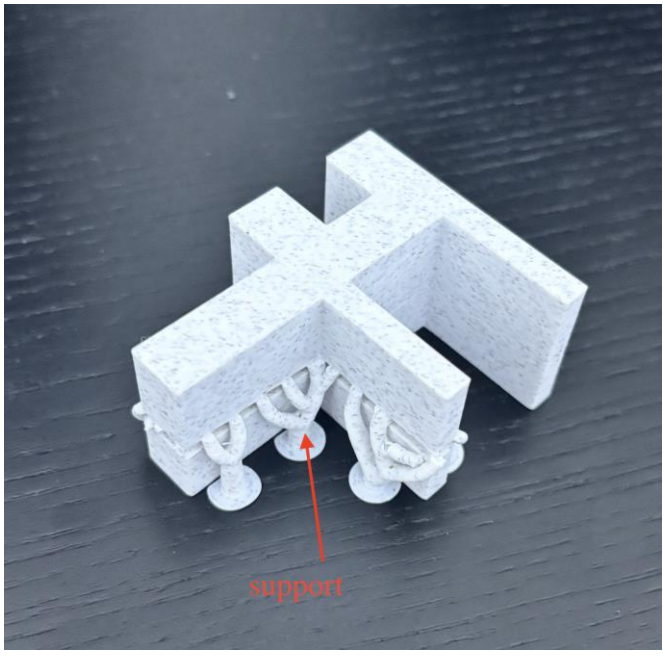
layer printing nature of 3d printers, support is required for any layers which are floating. The slip where the white acrylic board is supposed to fit in is a location where support is needed.

This is an issue because the support is added in a very awkward location. This will be hard to remove and may add imperfections in this crucial section of the work.

To combat this issue, I am going to create a small test print. I will use it to determine if I can fix this issue with the changing of support settings.

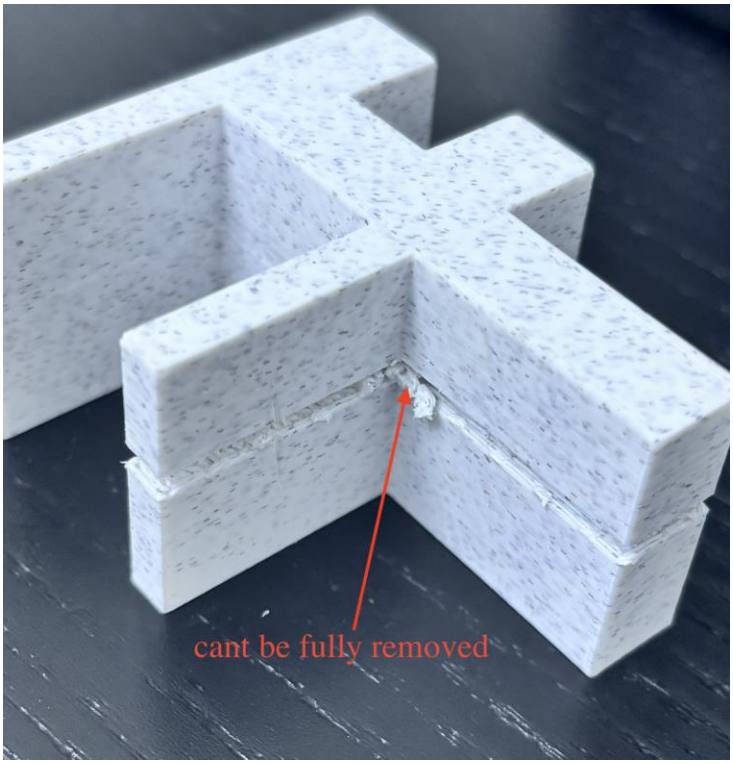
December 12

Figure 16:



The test print is complete. And figure 16 above shows the print along with the support.

Figure 17:

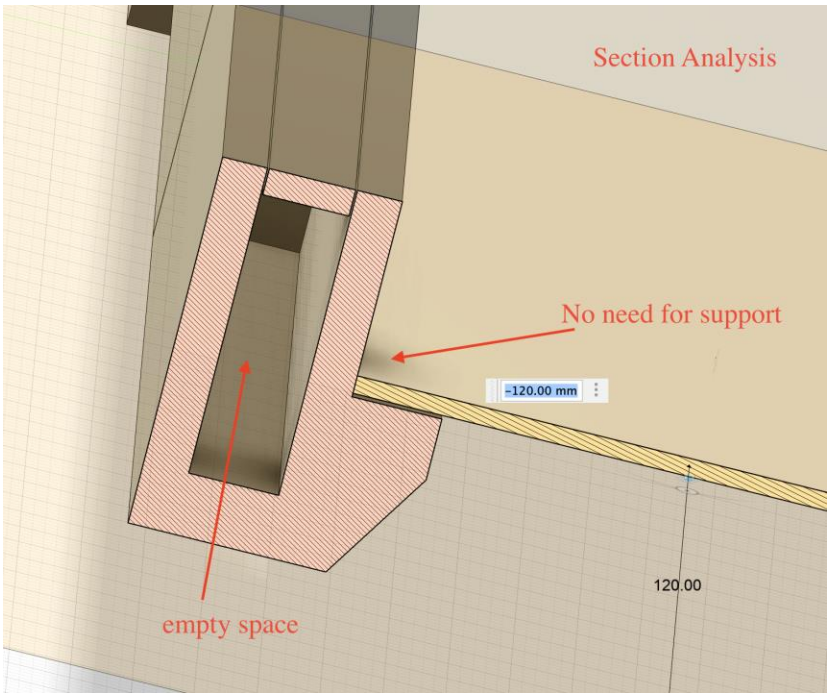


I used a sharp knife to cut out the support. However, I was able to fully remove all the supports generated inside. I have determined that changing the support settings will not be enough.

December 18th

To fix the issue from last week on the requirement of support for the slip mechanism for acrylic board, I have redesigned the walls.

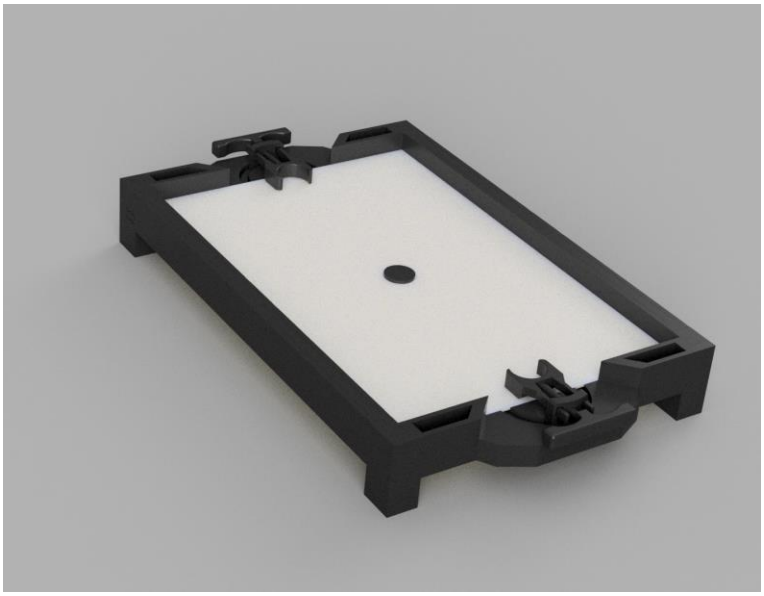
Figure 18:



A section analysis of the wall can be seen in figure 18. The mechanism no longer features an overhang area, thus no longer needing support. I plan to use special glue or tape to prevent the board from being pulled upwards. However, due to the position of the minigame, the board will not fall out easily. Furthermore, this mechanism makes it easy to change the board for a new one if needed. The minigame can be simply flipped upside down, and the board will fall out. I have added empty space in the walls, with a lid on top for this updated design as well. I plan to buy heavy materials to place inside the walls to weigh the minigame. Or I may leave it empty. Regardless, this design will save both filament and time.

I will begin the printing process as soon as I get access to my 3d printer. The final version so far is seen in figure 19.

Figure 19: our progress so far



5 Jan 2025:

I have gained access to the 3D printer again as I came back home from holidays. I noticed that the curling stone is only around 4g, while the force from the spring is very powerful. I believe this will be our next issue to fix. In the next few days I plan to 3d print every single component 1 by 1. It will take around 1kg of filament total, and more than 40 hours to print everything.

10 Jan:

Figure 20:

As seen in figure 20 above, I have printed ¼ of the wall and its corresponding mechanism. Though the mechanism has no issues, the wall has a few.

Figure 21:

Figure 21 shows an issue with the attachable leg for the corner of the wall. I chose a tolerance of 0.2mm, however my printer prints more accurately than anticipated. This gap may cause issue with attaching the legs since there is so much empty space.

Figure 22:

This same tolerance issue occurs for the lid as well, seen in figure 22.

The most crucial issue, however, is shown in figure 23. There is a large gap between the mechanism and the wall's cutout to fit this mechanism. This causes the shooting mechanism to be wobbly. This may affect the gameplay thus it must be fixed.

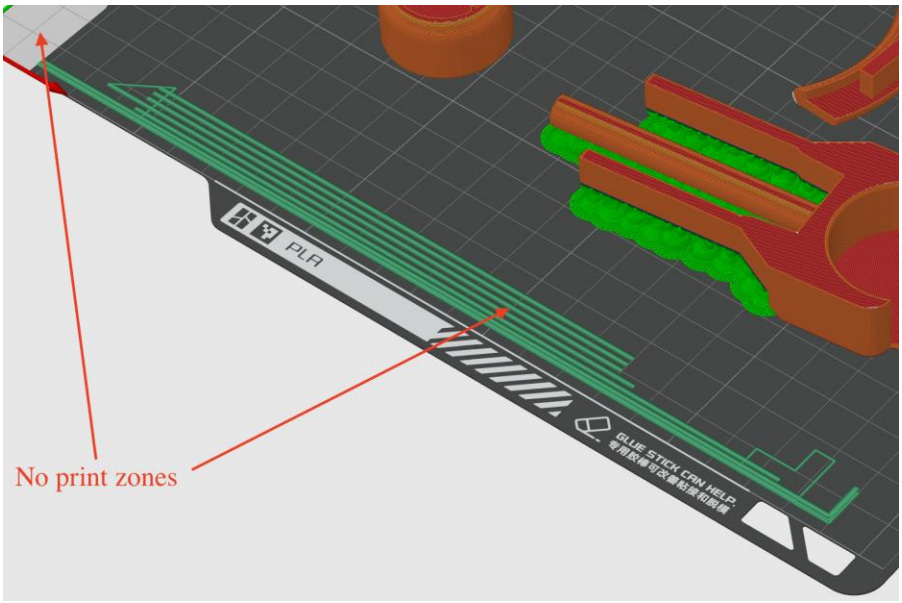
Figure 23:

The solution for these issues is to redo all the tolerances for every single attachable section in this design. I have finished this redesign just now, and I will now begin printing once again.

12 January:

When designing the components, we designed them to fit on 256x256mm board. However, there are small cutouts where you may not print anything. These zones are shown in figure 24

Figure 24



The green purge line in figure 24 is printed first to make sure everything goes smoothly. It also helps clear out any residue. Because of this, some wall prints cannot fit correctly while others can (because they are mirrored versions and other geometric reasons).

To fix this issue, I paused the print in the beginning, and then manually removed this purge line. This way, I get the extra space required to print the walls. This process is shown in figures 25 and 26

Figure 25

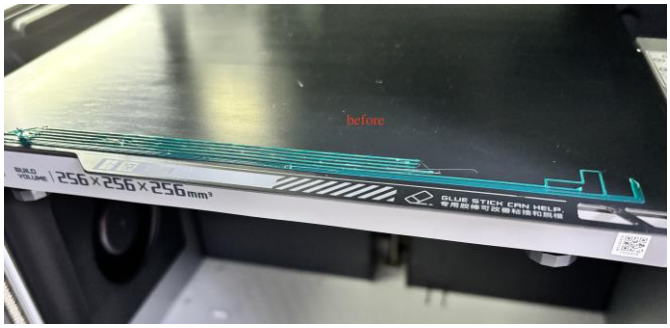


Figure 26

While testing out the printed components, I found few issues:

- The donut mechanism has too much extra space going up and down, this causes the mechanism to be wobbly. I fixed this by increasing the thickness of the donut section.
- There is no natural area to grip the mechanism, making it awkward to launch the curling stone. I fixed this by designing a part that goes on top, this part is made to be gripped.
- The rectangular side attachments of the curling mechanism were too loose. This made the mechanism wobble left and right. I fixed this by making the gap smaller.
- When the mechanism is pulled back, the curling stone remains in its original position (not pulled back). To fix this I created a small platform in which the curling stone is placed. Since this platform is connected to the mechanism, it pulls the curling stone back with it. The force pulling backwards does not exceed static friction, hence the curling stone stays. While the force pushing forward exerted by

the spring overcomes the static friction, causing the piece to launch forwards with only a horizontal component. The dynamic friction reduces the curling stone's speed to an extent. This is perfect since the springs are too powerful.

Friday 17th January:

After printing a demo version of these upgrades, everything worked perfectly. I finished printing the rest of the components, taking around 25 hours to print. I have also improved the design of the curling stone by making it taller and fitting a metal ball inside to add weight. This design proved to be very good since it made the curling stone heavier and more realistic.

Conclusion:

In this project, we learnt the importance of persistent effort. We found out that nothing works on the first go, and constant improvement is the best way to success. Taking risks for designs that unique helped us develop a satisfying minigame for our school community.

I believe we could have improved the design by choosing a larger acrylic board. I still think the springs are slightly too powerful even with the weighted curling stones. Perhaps, I could have perfected the design of the curling stones even further, such that it won't flip no matter the strength.