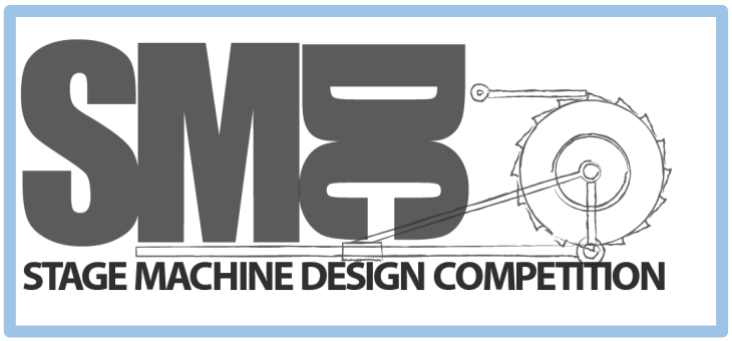

Stage Machine Design Competition 2025: Petal Drop

Design Proposal

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Theatre Department Scenic Technology Program
Level 21 at Krannert Center for the Performing Arts
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The Team

Our team consists of two second year MFAs and one fourth year BFA in the Scenic Technology program at the University of Illinois Urbana Champaign. Two group members have previously participated in the Stage Machine Design Competition. We created this team in hopes of expanding our creative technical design and problem-solving skills while getting to participate in a fun competition. We are looking forward to learning from the other teams at the competition!

Team Schedule: We established weekly hour-long meetings beginning on August 28th. Our first seven meetings have primarily been for brainstorming and collecting supplies to mock-up our ideas and to garner availability of resources for our final design. We have also added a second weekly meeting to use as our time to build and test our ideas.

Team resources: Our team has access to the scene shop located in the Krannert Center for the Performing Arts on our university's campus. This scene shop has standard wood fabrication and metal fabrication tools as well as a CNC. While we have no official funding, we have access to scrap materials in our shop.

The Challenge

Per Fusion Studio for Entertainment and Engineering with our team notes in red:

"The director and design team for a production of *Much Ado About Nothing* have decided that during the wedding scene, they'd like to see a beautiful "rainfall" of flower petals over the lovers. It is your responsibility to make this happen.

- It takes place center stage.
    - Placement of drop on the batten.
- The area the petals should cover as they fall should be an approximately 3-foot diameter circle.
    - We will need to consider how to limit the area the petals fall.
- The petals used for this effect will be silk flower petals, approximately 1½" x 1½" in size.
    - This is important for the sized holes we will need in our drop and so we can find similar size petals to test our drop.

- The petals should fall gently, slowly, and continuously for about 30 seconds (note that neither the director nor the designers have been specific about what “gently” or “slowly” means; you’ll need to make some educated decisions).
    - We will need to have control over the speed of rotation of our drop and make it easy enough for the speed to be adjusted as the designers require.
- The total distance the petals must fall (between the level the lovers stand on and the lowest masked place the petal drop device can exist) is 15 feet.
    - This is important to consider for testing our drop at the correct height, how high our refilling mechanism needs to reach, and how the distance will affect the diameter of the circle the petals fall within.
- The petal drop device itself will hang on a 1½” Schedule 40 batten and must have a footprint not greater than 20” by 20”.
    - We need to consider how to hang our petal drop, and crucially the maximum allowed size of mechanism we are building to drop the petals. If it is too complicated it will be less likely to fit within the footprint.

- The petal drop device, once installed, will be inaccessible to stagehands or crew, unable to be lowered, and must be reloadable from the ground without using a ladder or lift.
    - It will be important to consider the reloading mechanism throughout the design process. The function of the drop and the reloading mechanism are intertwined due to the restrictions of the reloading process.
- The petal drop device must be operated from 25 feet offstage of the effect; the operator will be on a level 15 feet below the level of the petal drop device.
    - Key for understanding where to run our ropes and how long our ropes will need to be in order to operate our drop from this distance.
- The petal drop device must be reloadable in less than 10 minutes.
    - We can't have an overly complicated reloading system that will take too long to set up.
- The moment in the play when the petal drop is in use has some musical scoring, but it is light and airy— meaning the petal drop device should be relatively silent.
    - We will have to pay attention to the volume while testing our drop and brainstorm solutions for noise if needed.

- The producers are interested in any device you design being reusable for other drop effects, including snow, confetti, and ping pong balls.
    - We will need to find a way to make the drop mechanism interchangeable for the different sized items.
- Device should be mechanical and operated manually, **not** motorized.
    - This is another reason that the reloading mechanism will be important to consider from the beginning. Since no motors are allowed, it will limit the options of our drop design while still having an accessible way to reload the drop.

Our team has called out the mechanical operation and reloading from the ground as our primary challenges while designing our drop. The secondary challenges are the interest in using the drop for a variety of materials and the drop radius. While every aspect of the challenge is important to consider throughout the brainstorming process, we have decided to primarily focus on the ones we have called out above in order to have more focused discussions.

Brainstorming

Our brainstorming began by ensuring we all understood the objectives of the challenge and gathering all of our initial ideas. From the beginning we were thinking about ways to limit the diameter of the petals, how to adjust for different sized objects, how to potentially refill our drop and how all of the aspects may affect our drop design.

We discussed the options often considered for drop effects in theatrical productions including a snow cradle or a drum. Due to the constraints of the competition, we acknowledged that a typical snow cradle would not be an option, however we thought about how we could build on the concept and considered building a box with a pulley mechanism that would shake the box in order to release the petals. We ended up moving away from this concept because of how much movement of the batten it would likely cause thereby making the drop harder to control.

The standard theatrical drop mechanism we ended up spending more time discussing, and eventually basing our primary concepts on, is a drum. Rather than using a shaking motion to disrupt the material being dropped it uses rotation, thus causing less disturbance to the batten and ideally being easier to control. We considered many variations of a standard drum in order to best conform to the challenge. We initially discussed having a drum on end and leaving the top open for easy access to refill it. We ended up moving away from this idea due to the challenges with creating enough movement in the drum to keep the petals from sticking without adding some kind of motor. The second idea we considered was having a drum with a second layer that could be changed out to account for the variety of materials. In this concept, the inner drum would have the largest diameter holes necessary and the smaller holes in the filter would stop too many items from being dropped at once. The filter would also have fewer holes in

order to limit the diameter of the landing location (figure 1). We realized that this double layered approach would make the drum even more difficult to refill so we adjusted the concept to have a filter sit underneath the drum that could be swapped out for the different materials rather than having the filter surround the drum. This filter will also have a funnel shape to again try and reduce the area the petals cover as they fall (figure 3). We were worried that the petals could end up just sitting on top of the filter rather than continuing through. Our potential solution for this was to use a crank and yoke mechanism that would shake the filter as the drum rotates to make sure the petals keep moving. The potential conflict with this solution was the interference between the crank and yoke and the shaft of the drum. With the filter sitting underneath the drum, we decided that it could make sense for the top of the drum to have an open slit in order for it to be refilled. With the top of the drum being open, we then discussed only having the drum rotate partially. This adjustment would also affect our idea for the crank and yoke system. After further consideration we decided that it would be a simpler solution to have an interchangeable drum rather than the filter. We still plan to keep the funnel shape under the drum in order to help restrict the distance of the petals.

Throughout this process of generating concepts for the drum, we were also discussing our mechanism for refilling the drum. We briefly discussed having a pulley system that would dump a bucket into the drum but thought that finding a way to tip or otherwise empty the bucket at the correct time would add unnecessary complications. We then discussed having a bucket at the end of a pole which would simplify the process of getting the bucket to the drop but still has complications with aiming the bucket. In order to address the aiming problem, we designed a concept with a basic slot for the bucket to slide into above the drum, once the bucket was in the slot we would pull a

string attached to a hinged trap on the bottom of the bucket to release the contents. This bucket concept could be applied to any of our drop concepts that had an open top, however we wanted to brainstorm an idea that could be more controlled than the bucket on a pole and that could be used through an opening on the end of a drum rather than on the top, as during this point in our brainstorming we were concerned with the effectiveness of the drum if it couldn't fully rotate.

Our second primary concept for reloading the drum was to use pneumatics. We began by thinking about how big of a tube we would need in order to fit each of the potential drop items through it. We found that ping pong balls, with a standard diameter of 1.57 inches, were our deciding factor. We then considered how we would attach the tube to the drop and noticed that if it were simply on the end of the drum then it would run into the shaft of the drum. To resolve that, we looked into the possibility of connecting the hose to the shaft of the drum and thereby make the shaft of the drum out of a wide diameter material like PVC (figure 2). We realized that sourcing a pillow block compatible with a pipe large enough to fit a ping pong ball was unrealistic. We also contemplated the issue of having enough air pressure to send the materials all the way up the tube and into the drop. The combination of these two complications led us back to our first concept of using a bucket on a pole.

Since we were leaning away from using pneumatics, our next step was to test out our concept of a drum with an open section on top for a bucket to empty into in order to test our initial concerns about the lack of rotation. Our mock-up and test revealed that the lack of complete rotation led to the petals building up in the bottom of the drum rather than falling (figures 5 and 6). With this result we were able to go back to the drawing board with new adjustments to make.

After our mock-up we discussed some minor adjustments that we could make. These adjustments included changing the size and distribution of the holes, making the top opening smaller, and adding a lid that would need to be opened but would allow for complete rotation. We also returned to discussing the use of pneumatics to refill the drop through the side. The new concept for the pneumatic reloading involved having one side of the drum have an opening but instead of a permanently attached hose, the reloader would be a completely separate device. The device would have a PVC section that houses the material to reload the drop. The PVC section would be supported by a stand that sits on the ground. One side of the PVC section would be open and sit against the opening in the drum; the other side will be connected to an air hose which would then be connected to a tank. Opening the tank would then result in releasing a stream of air that would push the material into the drop. We then hypothesized that some of the petals or other such material could fall out of the drop. In order to combat that we would have a section of the drop be the “bottom” and not have any open holes to limit the number that could fall out before the effect is ready. Another similar concept we discussed was having PVC run from a cart on the ground all the way up to the drop. This version would have an access panel near the ground that would be used to insert the material for reloading the drop. The challenge with this concept is the amount of pressure needed to send the material all the way up to the drop and over a corner into the drum (figure 4).

Concept Sketches

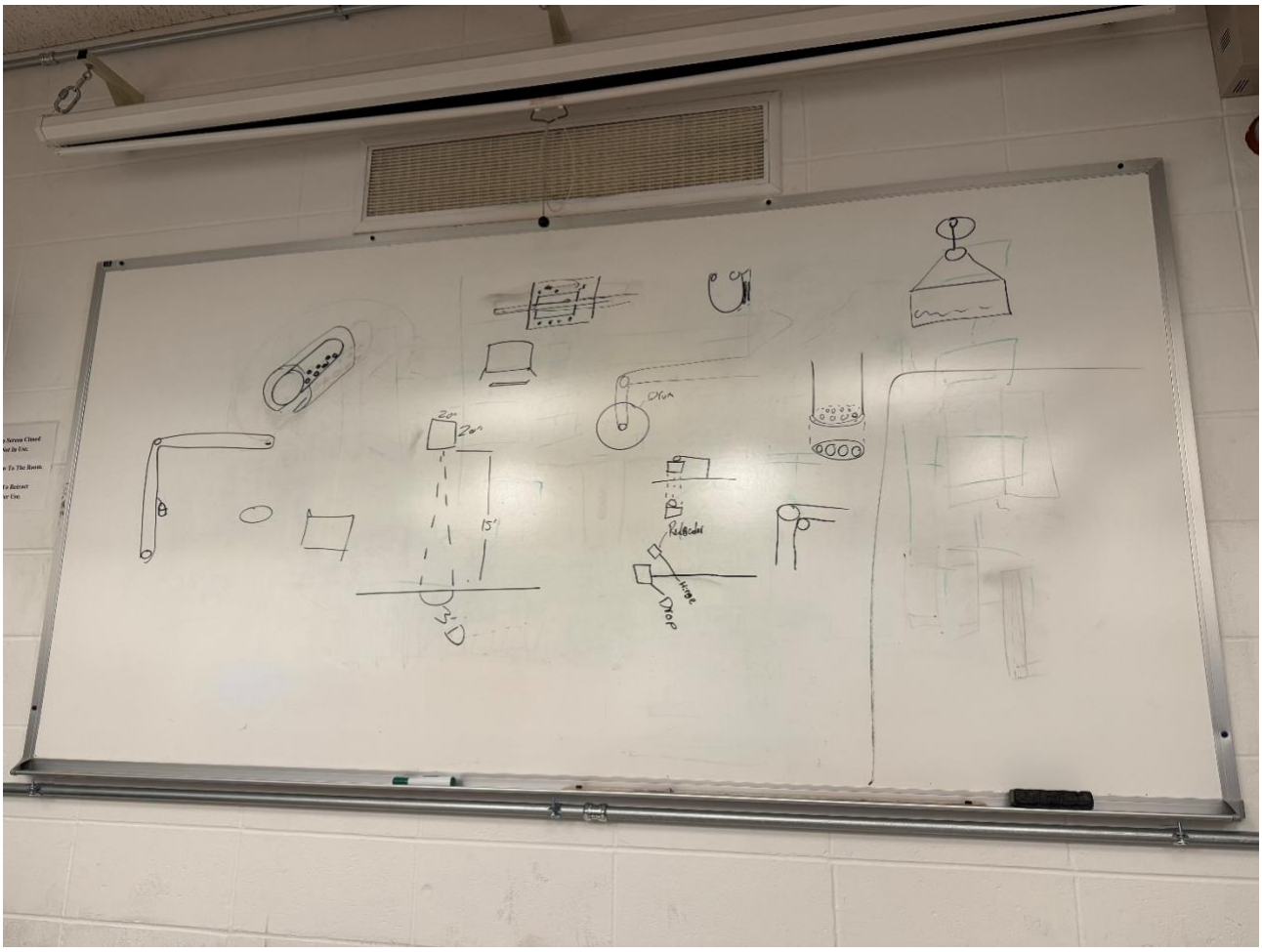

Figure 1. Initial ideas and understanding of the requirements.

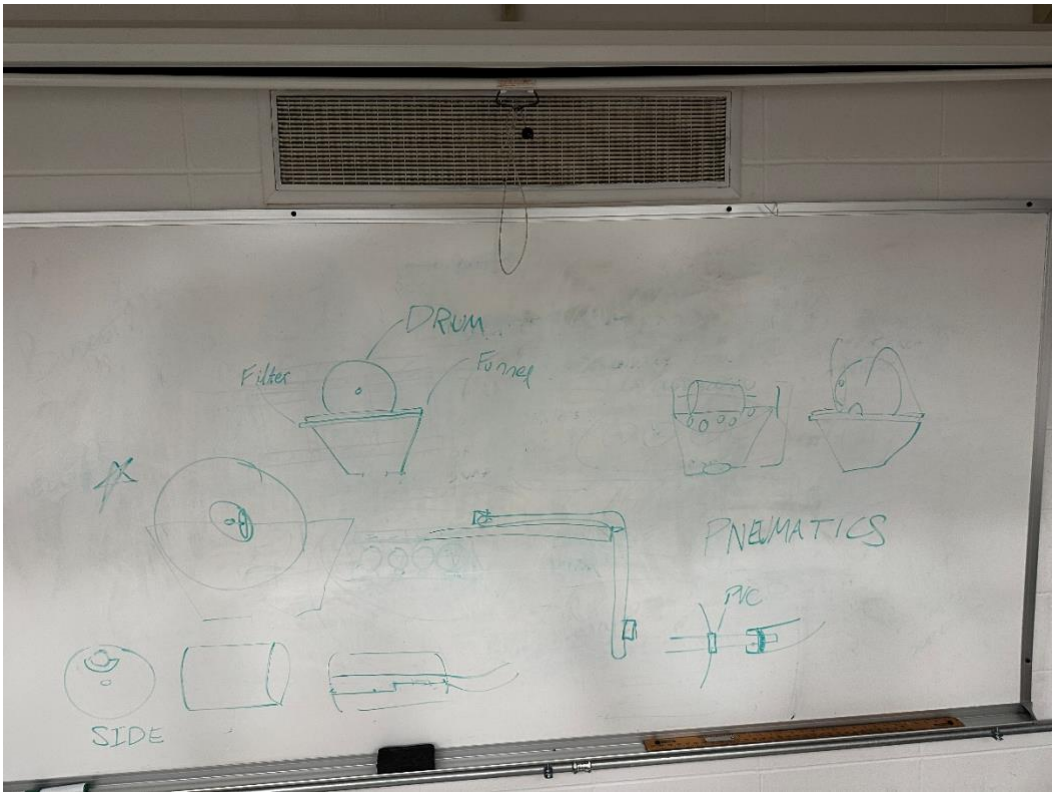

Figure 2. Initial funnel shaped filter and first pneumatic reloader.

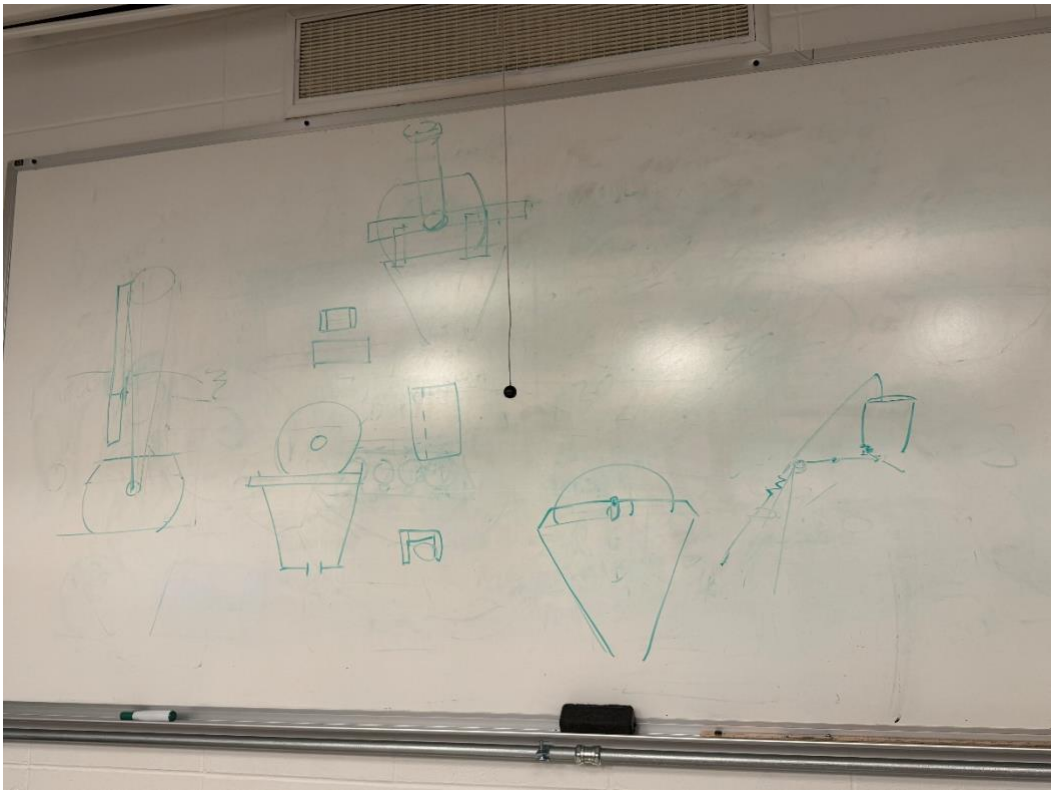
Figure 3. Funnel shaped filter. Bucket with hinged trap bottom.

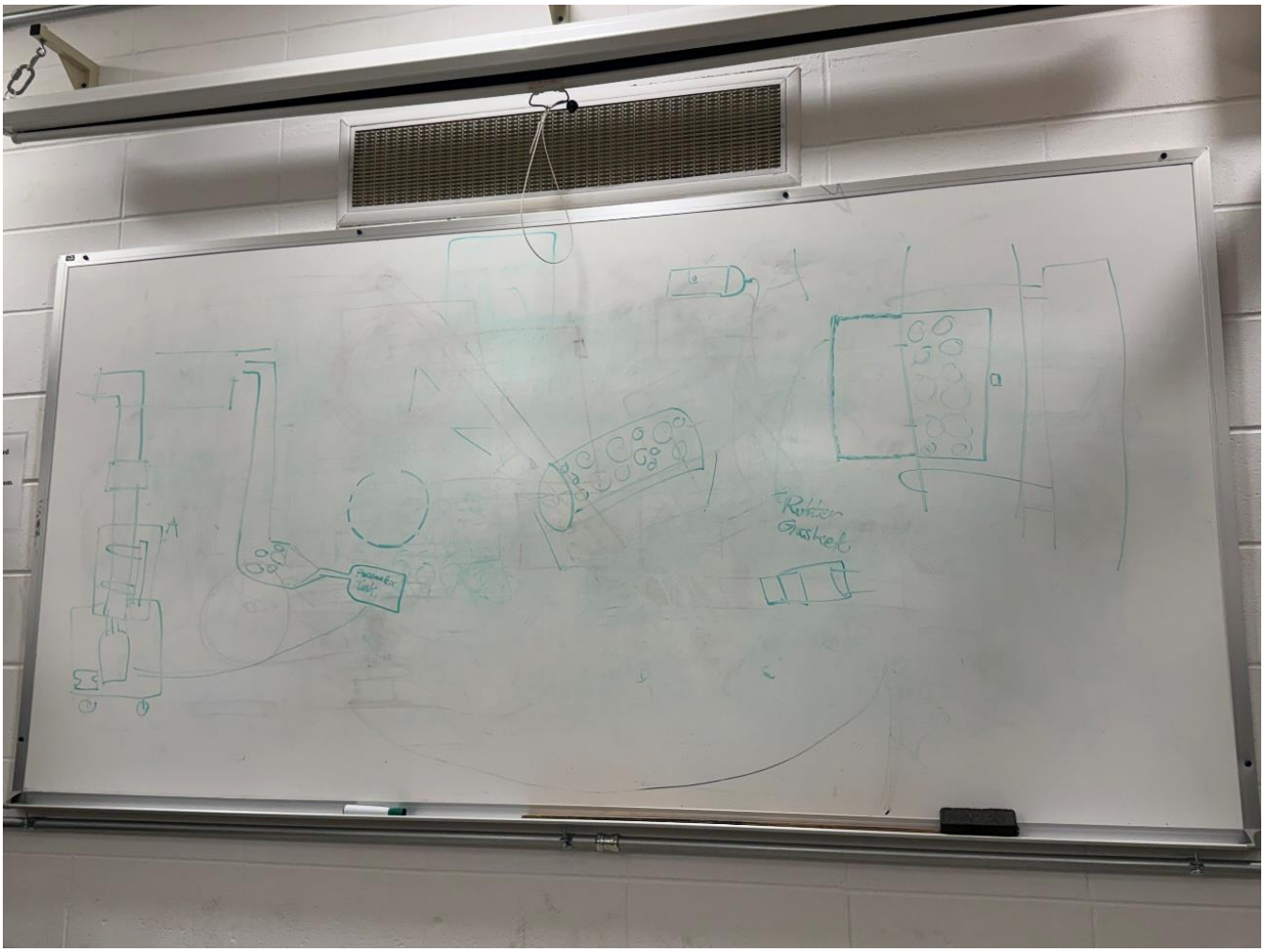

Figure 4. Second pneumatic reloader design.

Mock-up

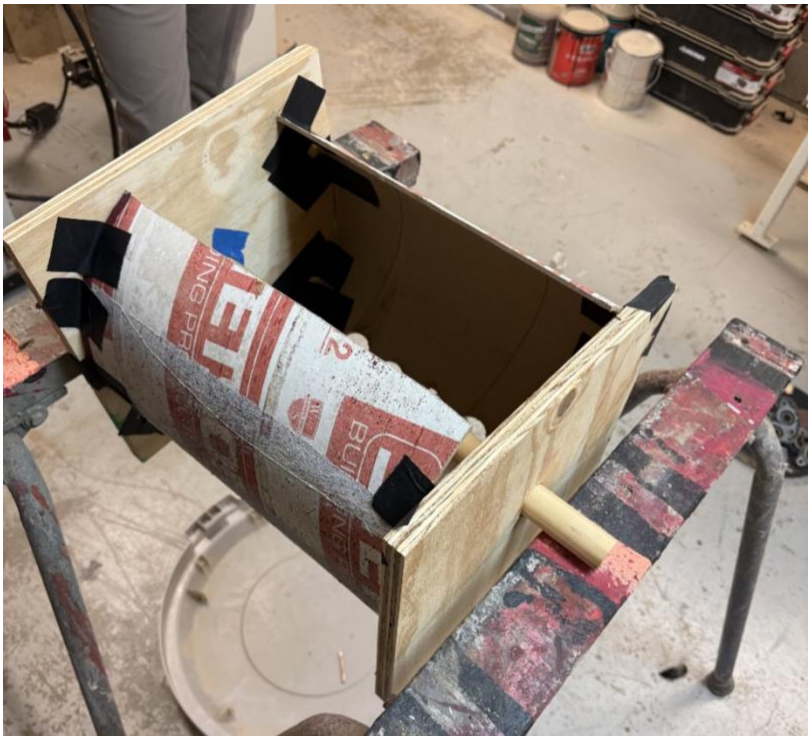

Figure 5. Initial mock-up

Figure 6. Initial mock-up.

Next Steps

As we continue our design process, we have established a general schedule with a list of our next steps and priorities within the challenge. Our next steps include:

- Building a second mock-up with our revised design. Our revised design includes changes to create more movement of the drop to help keep the petals from sticking and has a different access point to adjust for our updated reloading mechanism.
- Creating a detailed plan for our reloading mechanism and mocking it up.
- Creating a detailed plan for our rope system to actuate our drop.
- Combining all elements and test our drop at the proper height and refining the drop radius, rope operation, and reloading mechanism as needed.