Northern Illinois University

2025 STAGE MACHINE DESIGN COMPETITION

DESIGN PROPOSAL

2025 Petal Drop

Northern Illinois University

Drew Bagby, Emery Foster, Luigi LoCascio, Jorge Serraro

Faculty Coach

Tracy Nunnally

Submitted to 2025 SMDC Judges

October 17, 2025

NORTHERN ILLINOIS UNIVERSITY

School of Theatre and Dance

College of Visual and Performing Arts

TABLE OF CONTENTS

Introduction

Shakespeare's *Much Ado about Nothing* is a romantic comedy that has inspired generations. To celebrate the moment of matrimony during this production, the director desires rose petals to rain “gently and slowly" from above. They need to fall for a full “beat” for the audience to absorb. This translates to a thirty-second shower of petals within a three-foot-diameter circle, from fifteen feet above the actors. The underscoring for the happy moment is light and airy, implying this device should be relatively silent. It must be twenty inches by twenty inches hanging from a standard theatre batten that cannot be lowered for reloading, but must be reloaded within ten minutes. As many stage effects are, it must be operated offstage from twenty-five feet away. A unique aspect of this challenge is the manual operation limit—no motorized or pneumatic mechanisms are allowed to intrude on this perfect moment. The producers hope to reuse this machine in the future for other drops, including anything from confetti to ping pong balls.

For this project, the team of Northern Illinois University students will design and build a petal-dropping device for *Much Ado About Nothing.* We will create a prototype to identify potential issues and assemble a final device for presentation at the competition at the end of the semester. This proposal outlines design specifications, an illustration of the brainstorming process, detailed execution reports, and our troubleshooting methods.

1. **Design Specifications**

1.1. Petal Drop Guidelines

The rubric listed for this stage effect can be broken down into seven elements.

- Petals should fall on the floor in a rough 3’ diameter circle.
- The device hangs 15’ in the air.
- The device's footprint does not exceed 20” by 20”.
- It must be reloadable from the ground within 10 minutes.
- No actuators.
- The operation of the machine must be from 25’ offstage.
- Ideally, it should be reusable for various objects such as ping pong balls, confetti, or snow.

1.2. Operational Elements

To make the petal drop operational, our team has condensed the competition guidelines into three digestible challenges.

- A device for dispensing the petals that is no bigger than 20” by 20” but with no discernible height limit.
- A mechanism to slow the distribution of the petals, so that they last for the full thirty seconds.
- A device for reloading petals that can reach over 15’ in the air and be operated from the ground.
- A way to operate the moving parts of the mechanism from 25’ away and 15’ below.

1.3. SMDC Standards

- A written proposal with corresponding paperwork (this document) to be submitted by October 17, including design necessities and concept designs.
- A working prototype to be assembled and tested on site at the competition, along with any tools necessary for implementation and reloading.
- A final design document that includes
  - The proposal.
  - Detail design materials (estimates, parts lists, technical drawings, appropriate mathematical/engineering analyses, etc.).
  - As-built drawings.
  - Documentation of actual costs.
  - Any relevant safety and/or operation manuals.
  - Assessment of successes/failures of the design.
  - Assessment of the team's successes and failures.

2. Design Concepts

With the core concepts highlighted, our team began to brainstorm methods for dispersing flower petals without the aid of actuators. We examined everyday practical items to base the device on.

2.1. Coin pusher

As a kid walking through an arcade, the coin pusher machine is a tempting draw. Risking one coin to gain many. This concept uses a block to push the petals out of an opening. This will not only randomize the fall of the petals but also layer them as the blocks move in sequence, covering the full thirty seconds. The design also lends itself well to diverse media, and the ability to time the pushers ensures nothing can fall straight through the machine, as at least one pusher blocks the path at all times.

2.2. Snowdrop

The snowdrop is a classic example of theatre magic. Hang a piece of fabric with holes in it between two battens and shift the battens back and forth until the snow falls out the bottom. This is standard theatre practice, but adapting it to only one immovable batten was challenging. For this, a few solutions came to mind. One solution involves continuous rotary movement. We would attach the fabric of the snowdrop to a sifter via an independent pulley system, which runs from the bottom of the batten to the wings. Unfortunately, with this system, we would have to change the fabric for different types of media, such as ping-pong balls and other items. A single hole size would not work for the variety of objects. Given this inefficiency, we decided to scrap the snowdrop idea entirely. While being the most efficient for a specific type of media, it is not very versatile.

2.3. Conveyor belt

There are three types of motion: linear, rotary, and ambiguous. In the conveyor belt concept, we would use rotary motion to generate linear motion. This is also a strong contender for solving the timing issue; we could adjust the belt speed to move as slowly as needed over the 30 seconds. The downside is space. We only have 20” by 20” of surface area to fit the mechanism.

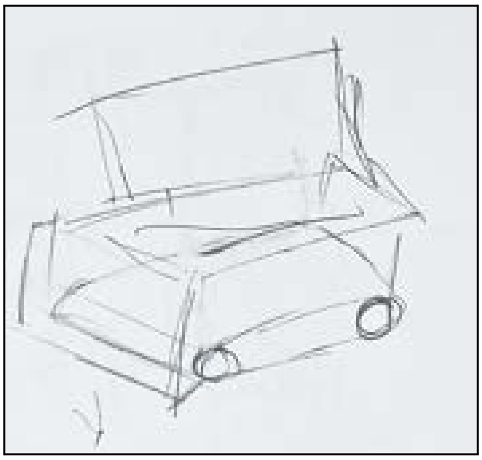

Figure 2.1 *Sketch of the conveyor belt*

2.4. Plinko

This concept rides on the idea that if the petals hit enough objects, they will be decelerated enough to reach thirty seconds of descent. This would be accomplished not with pegs but with slats that bisect one another to form a layered grid. It would be threaded with ropes to generate a shifting motion to filter the petals through like a sifter. This solution works for timing, but is difficult to control or mechanize for operation 15’ up and 25’ away.

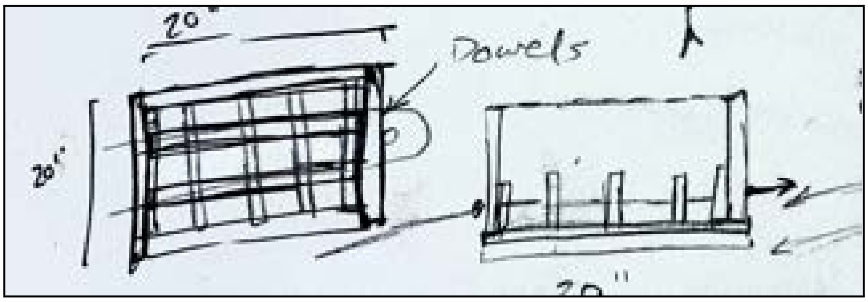

Figure 2.2 *Sketch of the Plinko concept*

2.5. Water Wheel

The Ferris wheel concept reiterates scooping up the petals and dumping them out on the other side. A hopper would give a constant supply of petals. Potential problems include ensuring the cups scoop up the rose petals and that they do not become depleted as the petals are scooped up.

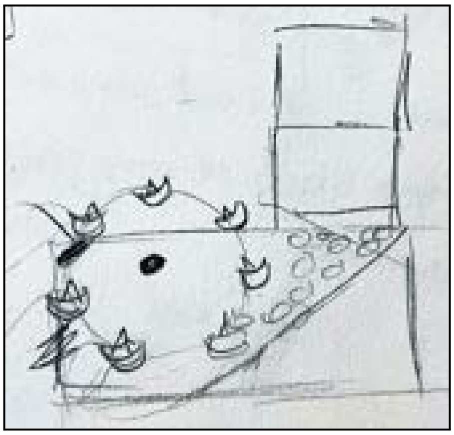

__Figure 2.3__ Sketch of water wheel concept

2.6. Archimedes Screw

With this idea, we would push the petals out of the container with a cone-like spiral. It would shovel the petals down at a consistent pace while intermittently trapping the others. This is another example of rotary motion. The concern with this design was that the petals could get stuck in the shaft as it spun.

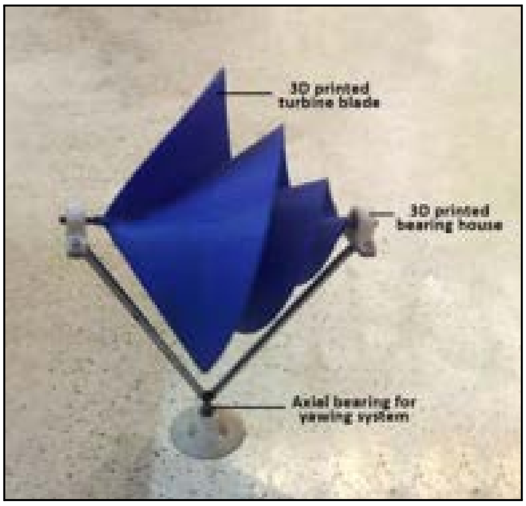

__Figure 2.4__ Archimedes screw image by ResearchGate.net

2.7. Reloading mechanism

We created a list of priorities for our reloading mechanism in addition to the guidelines outlined by the SMDC.

- It must fill the main machine with assorted items —primarily petals — with flexibility essential.
- Able to accurately and efficiently reload the machine under time constraints
- Keep the design simple
- Be clean and aesthetically effective

2.7.1. "Bucket" Reloading Device

Firstly, we start with a device that was close to a 5 Gallon Bucket, attached to an extending pole, possibly constructed from 2x4s. It contains a small pulley system that releases the bottom of the bucket, like a valve. It met the basic requirements, but improvements are needed for reusability and aesthetic use.

2.7.2. Hoppers

Another reloading approach is to have multiple hoppers on top of the device, connected via a series of shelves, with a sliding door that would allow the petals to fall by gravity. These would be stacked on top of each other because there was no height limit. They could stack as many as we need. What happens when they run out, though? We could use a combination of the hopper and the bucket device to reload the petal dropper.

3. Design Finalization

After analyzing the benefits and downsides of each concept, we decided to pursue the coin pusher idea for its efficiency in controlling the petal drop timing and cost, and for the possibility of 3D-printing most of the elements.

3.1. Coin Pusher

Of all our ideas, the coin pusher seemed the most promising, and it covers every element specified in the *Operational Elements* section of this proposal.

- A device for dispensing the petals that is no bigger than 20" by 20" but with no discernible height limit.
- A mechanism to slow the distribution of the petals, so that they last for the full thirty seconds.
- A device for reloading petals that can reach over 15' in the air and be operated from the ground.
- A way to operate the moving parts of the mechanism from 25' away and 15' below.

With this concept, the petals will trickle down from the top through a built-in funnel to prevent them from overflowing the machine. As the petals trickle down, the blocks will push them together like a waterfall until they reach the bottom of the box, then float down onto the stage. Gears will drive it, and it will be operated offstage via a flexishaft or with a pulley system similar to the design listed in the snowdrop concept.

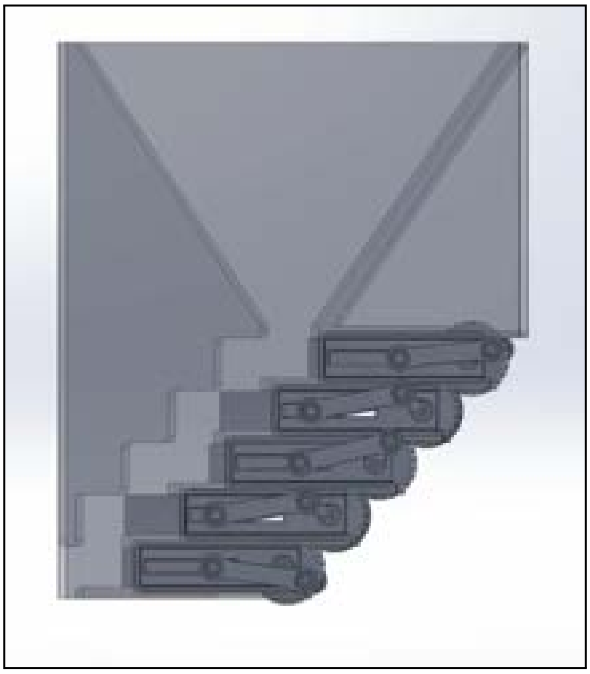

Figure 3.1 *SolidWorks model*

We drafted a prototype in SolidWorks to see if it would run as we envisioned, and it did. Then we 3D-printed the pieces we needed to run just one coin-pusher block to ensure it moved smoothly. So we created schematics to build the first version.

Figure 3.2 *Proof of concept for coin pusher*

Figure 3.3 *Close-up of ball bearing piece*

3.2. Reloading Mechanisms

Our initial idea for the reloading mechanism followed the “bucket on a stick” concept. Troubleshooting revealed issues with stability, tensioning of the dumping mechanism, and length. First, we converted our “stick” to metal tubing, which would also help with length. Additionally, we switched the bucket to a metal frame made out of 1x3” steel square tube. The tensioning issue was solved with a magnetic latch, and to achieve stability during reloading, we added a hook to the top of the device.

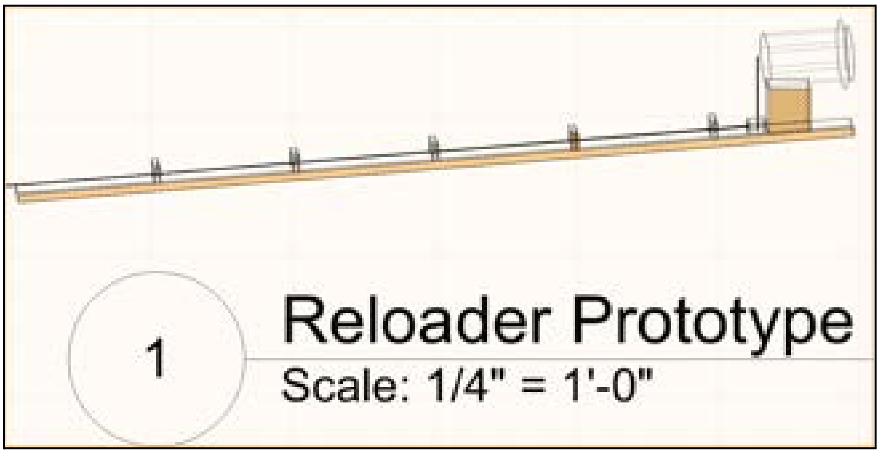

Figure 3.4 *Reloader Prototype Drawing*

4. Process

After finalizing our concepts, we begin drafting, generating a cost analysis, and building our design.

4.1. Drafting

The figures below are drafts of the exterior of the box that holds the petal-pushing mechanism. The mechanism schematics are in the appendix.

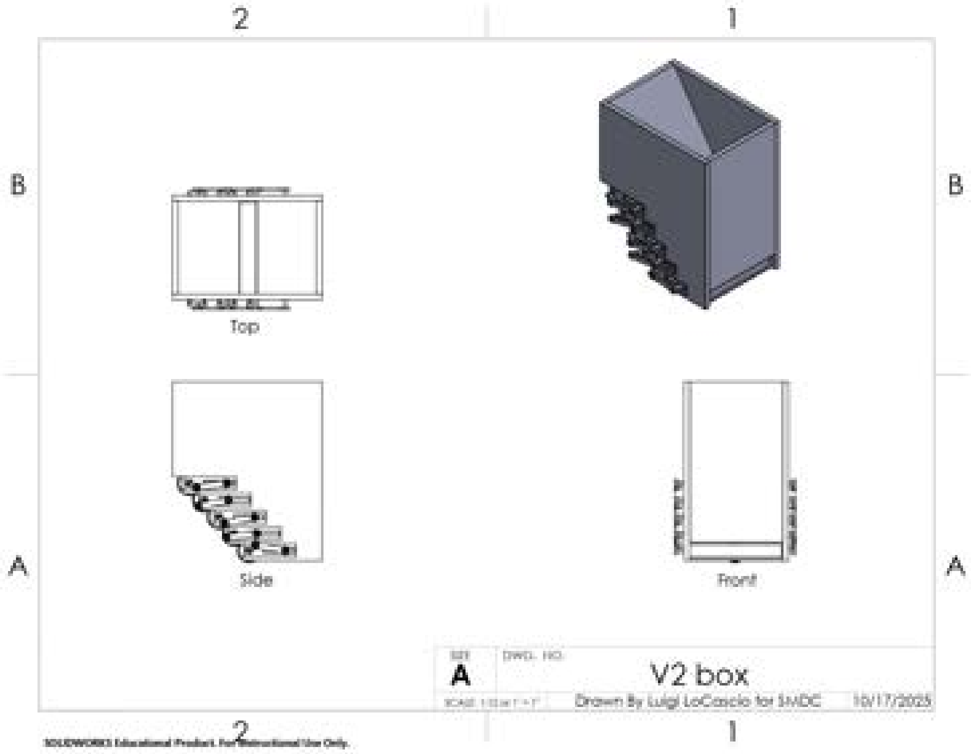

Figure 4.1 *Overall View of the Petal Drop Box*

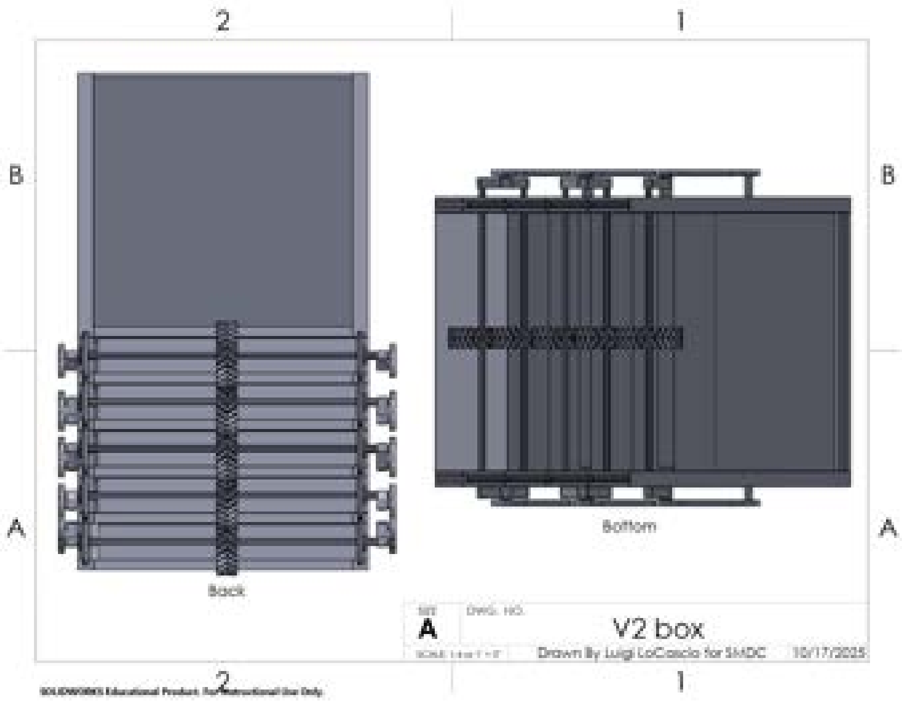

Figure 4.2 *Bottom and Back of the Petal Drop Box*

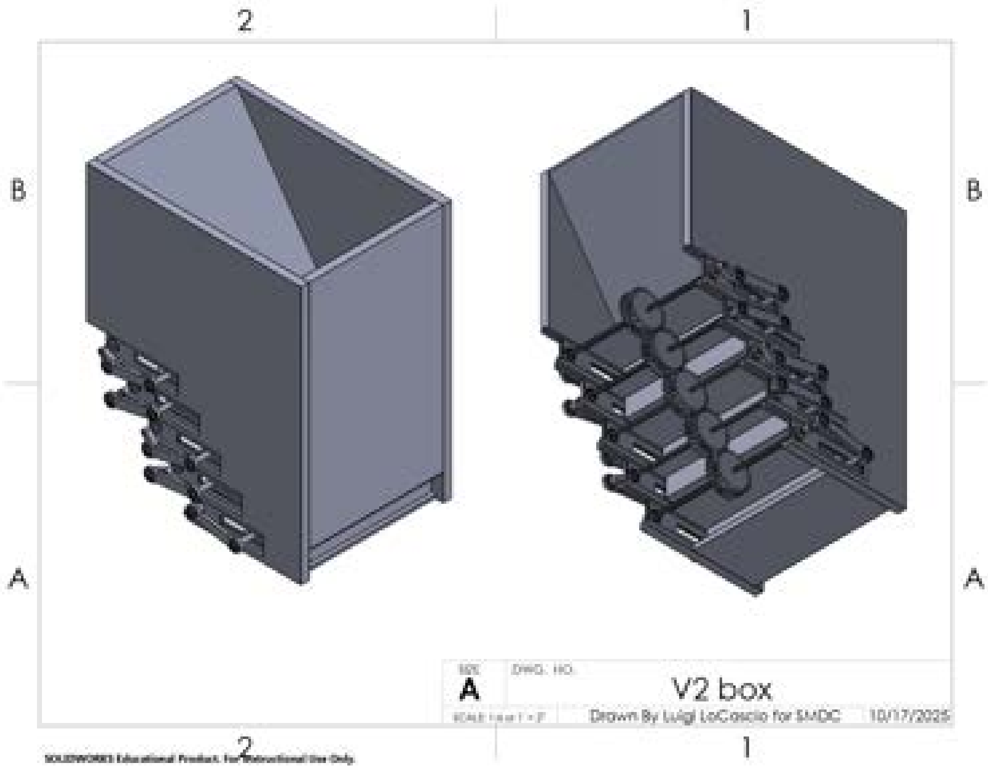

Figure 4.3 *Isometric internal view of the Petal Drop Box*

4.2. Costing Estimate

The elements of the mechanism are 3D printed, then threaded with a dowel, hex rod, and through ball bearings. Most of our costing is routed to filament, except for the metal for the reloading device. The full spreadsheet is linked in Appendix 6.1.

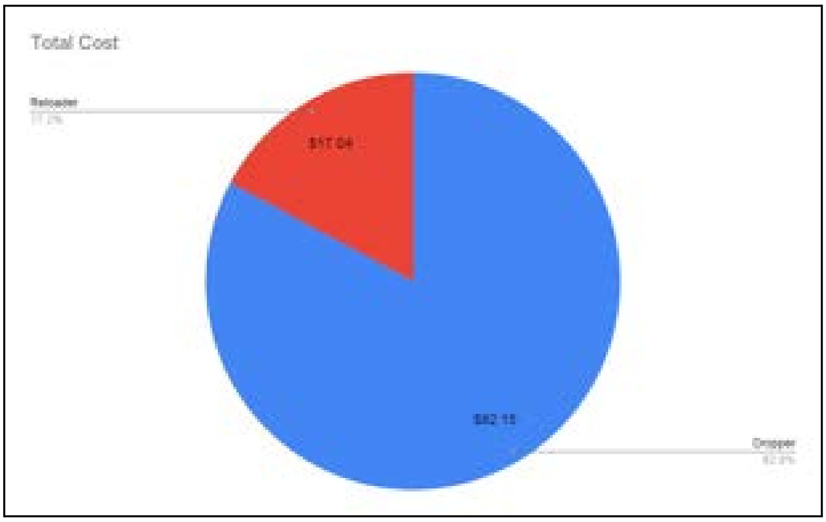

Figure 4.4 *An Overall View of the Budget for the Petal Drop Device and Reloader*

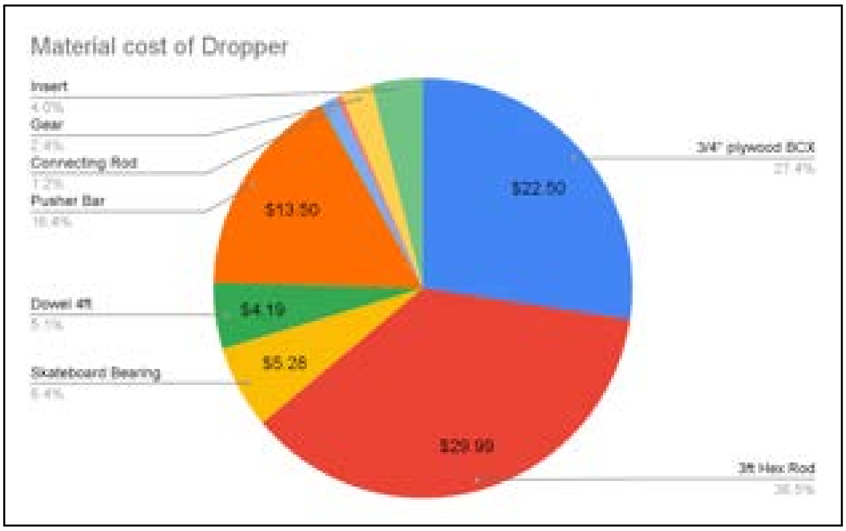

Figure 4.5 *A Cost Breakdown for the Petal Dropping Device*

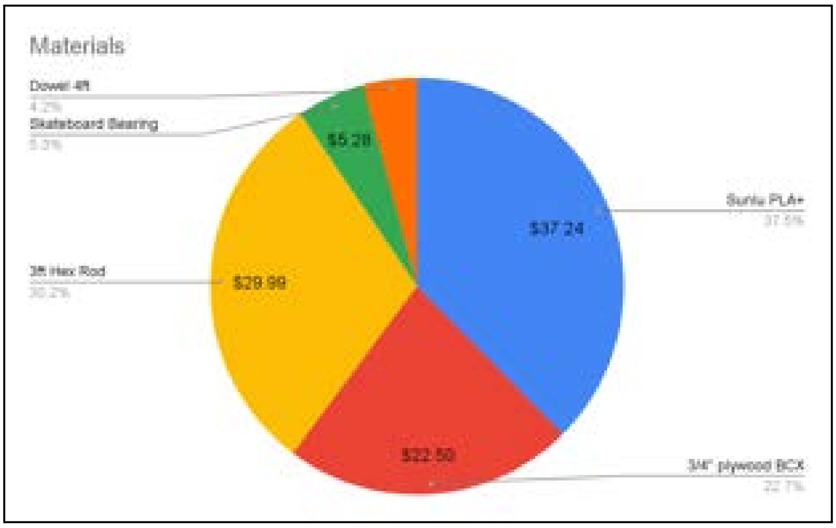

Figure 4.6 *A Pricing Breakdown for the Petal Reloader*

4.3. Build Process

4.3.1. The Petal Drop Box

We followed the drawings to cut the side panels out. We plan to use the CNC machine for the final installation to ensure precision, but for the prototype, we cut it by hand. The 3D-printed parts are grooved, so we used a router bit to notch the shelf and slide the 3D-printed inserts into the notched slots. Changing the tolerances took some trial and error, but it is now a snug fit without warping the wood. To cut out the slots for the prototype, we used a table saw for most straight cuts, then finished with a jigsaw and a slot bit in a router to create space for the 3D-printed inserts. Below is an example of one side of the mechanism with the inserts ready to be assembled and have the internal components added.

Figure 4.*7 The side panel for the Petal Drop box*

Figure 4.8 *Build progress for Petal Drop box*

4.3.2. Petal Reloading Device

After assembling the reloading device and adapting it from the bucket concept, we needed a new way to encase the petals. We found inspiration in Northern Illinois University's logo. We realized that the hexagonal logo could be extruded from a 2D shape into a container, similar to the initial bucket. Moving the pulley system from the bottom of the device, we relocated the flap to the right bottom section. This adaptation allowed us to turn the bottom-left corner into a ramp to help funnel the petal components into the Petal Drop Machine.

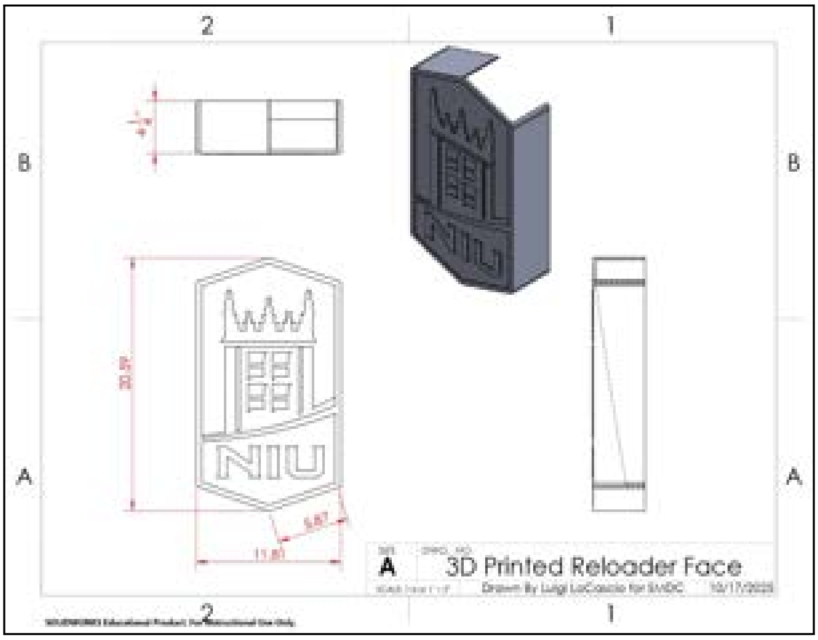

Figure 4.9 *3D Model for Reloader Face*

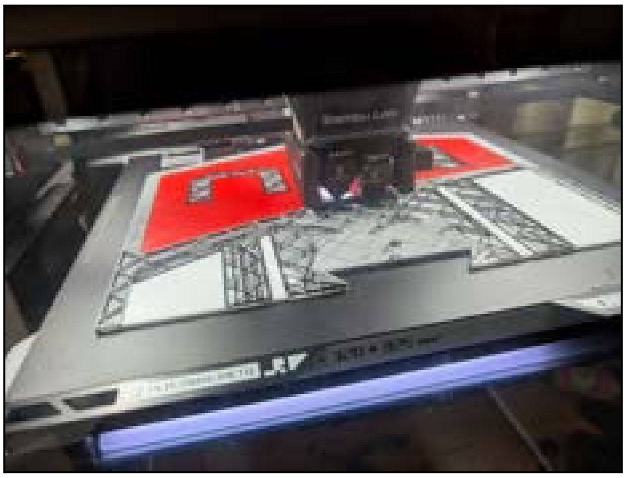

Figure 4.10 *3D printing the NIU logo*

Figure 4.11 *3D printed petal container*

We welded the frame for the Reloader and drafted the NIU logo plating for 3D printing. After the plating was printed, we will reconstruct the frame to match it perfectly. We will bind the pieces together using a threaded rod, washers, and Nylock nuts. We will bend the threaded rod around a 1.5” Schedule 40 section of pipe to achieve the desired size for hooking to the pipe to which the Petal Drop machine will be attached.

Figure 4.12 *and* ***Figure 4.13*** *Welded frame*

5. Conclusions and Improvements

The following steps for this project are to run the machine until we perfect the timing, and hone in on the external offstage operations. Additionally, we need to address the raising mechanism of the reloader and finalize the attachment points for the petal-dropping box. For the coin pusher model, constraints need to be added to the dowel and peg to restrict unwanted movement. The slotting for the insert needs to be thicker to provide more depth between the inserts. The plywood began cracking as the inserts were installed. With the overall concept, the mechanism is slightly more complicated than the “keep it simple” mantra, but it neatly covers all the original design specifications.

6. Appendix

6.1. Cost Analysis Spreadsheet

SMDC Budget

6.2. Drafts for the Petal Box Mechanisms

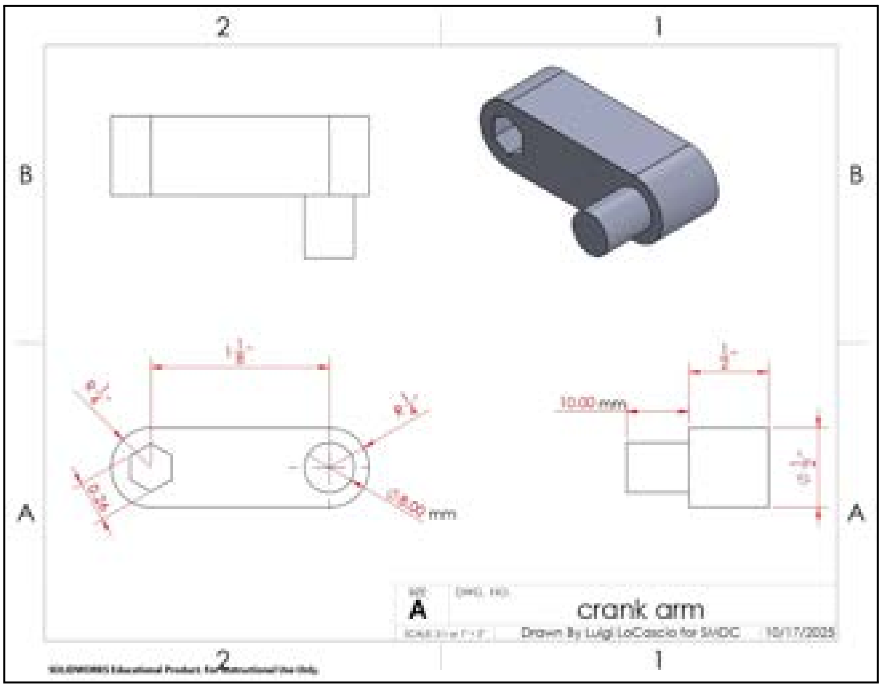

Figure A.1. *Crank Arm Drawing*

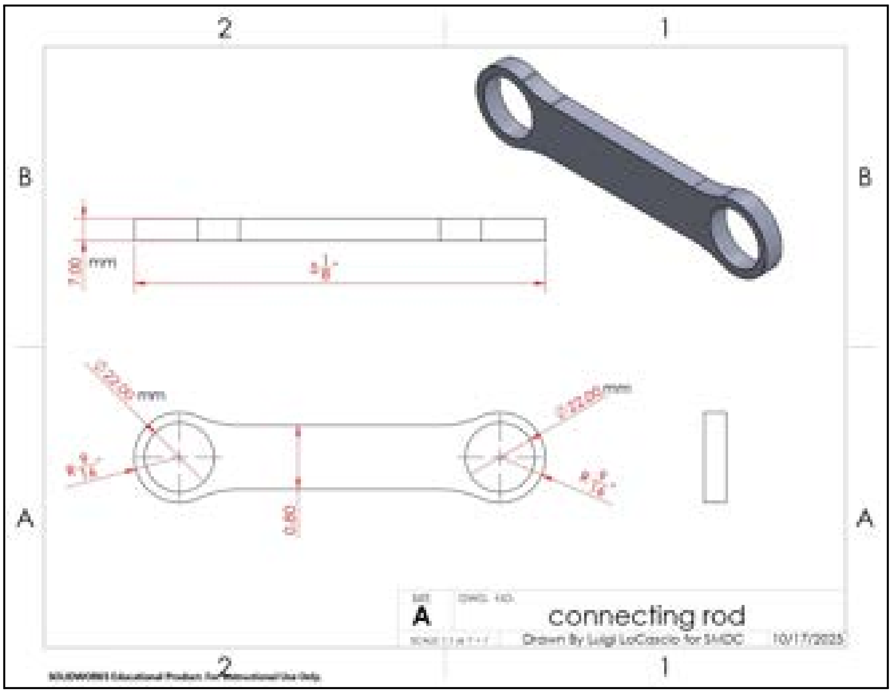

Figure A.2. *Connection Rod Drawing*

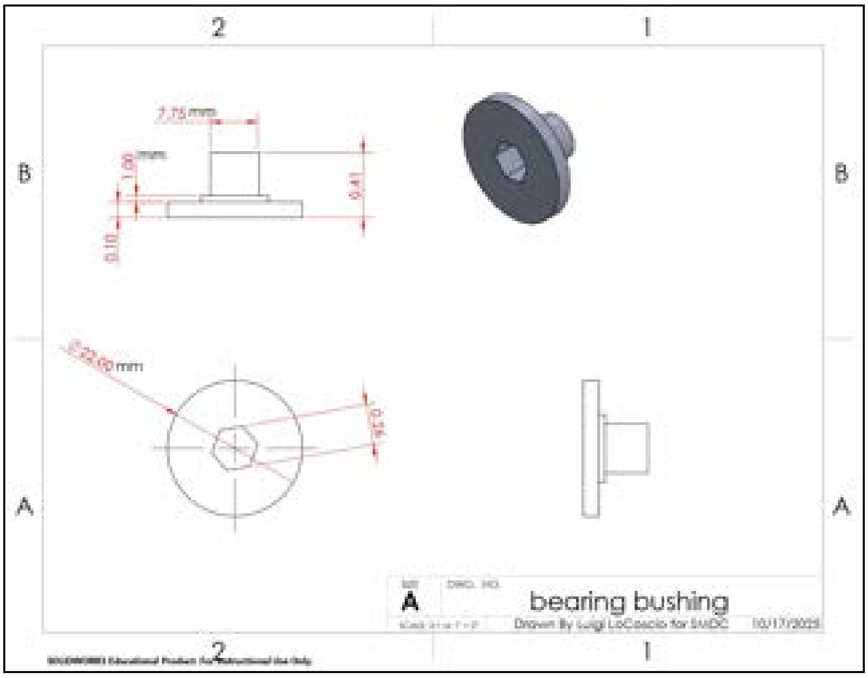

Figure A.3. *Bearing Bushing Drawing*

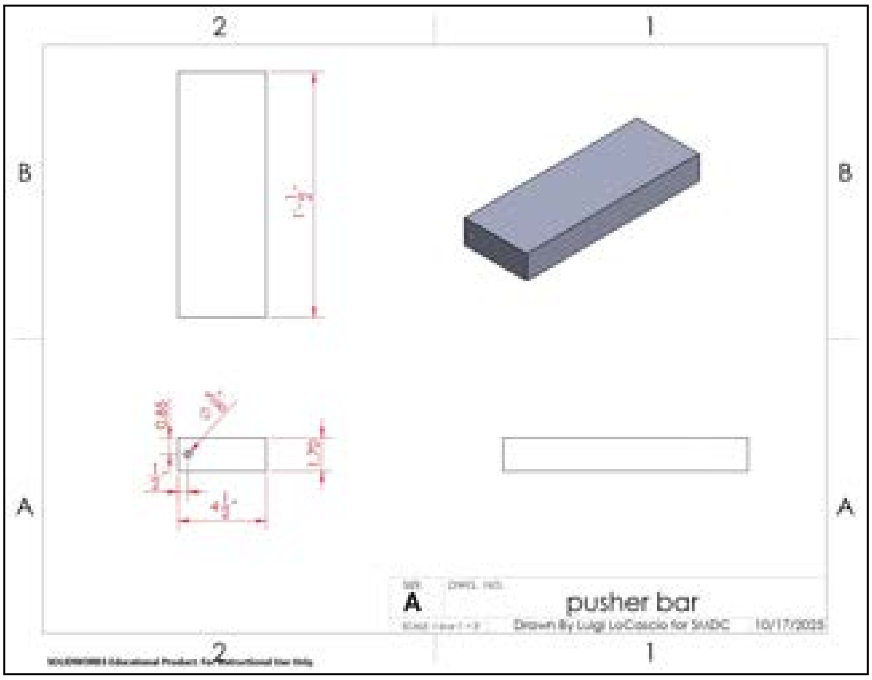

Figure A.4 *Push Bar Drawing or "Block"*

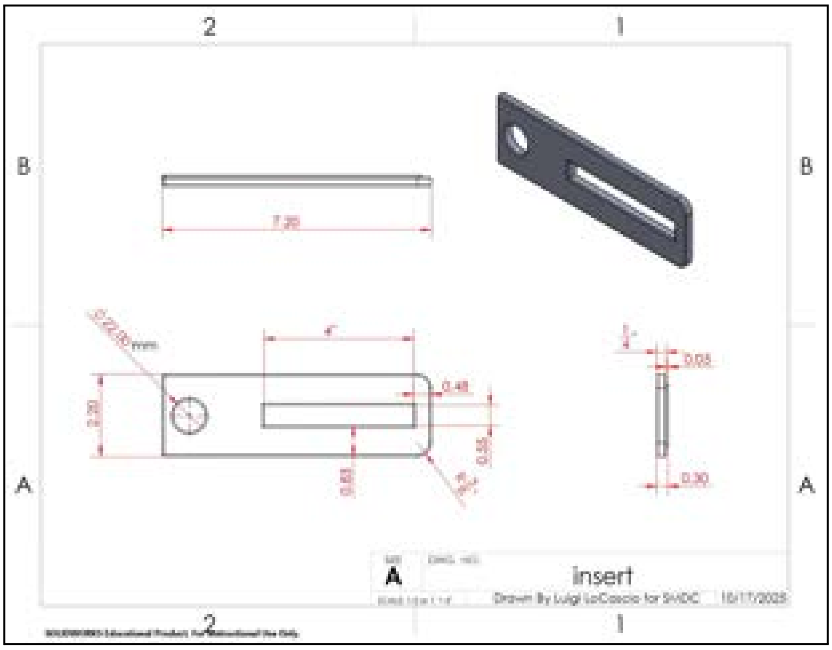

Figure A.5 *Insert Drawing for block to slide.*

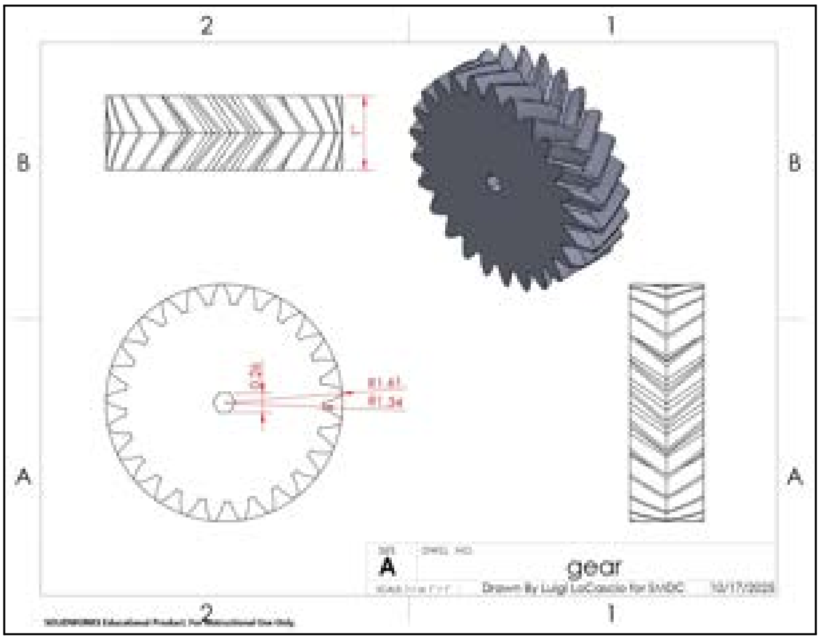

Figure A.6 *Gear to drive the shafts*

7. Bibliography

1. Morshed, Abu Hena Md Maruf, et al. “Complete Set-Up of the Archimedes Spiral Wind Turbine.” *ResearchGate*, uploaded October 2021, researchgate.net/figure/Complete-set-up-of-the-Archimedes-spiral-wind-turbine_fig2_357011420.