2025 Stage Machine Design Competition

DESIGN PROPOSAL

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Introduction

For this project, Team V from Missouri University of Science and Technology will design and implement a petal drop mechanism for a production of *Much Ado About Nothing*. This mechanism will be used during the wedding scene and drop silk petals onto the couple at a specific time in the music score.

1. Design Constraints

- It takes place center stage.
- The area the petals should cover as they fall should be an approximately 3-foot diameter circle.
- The petals used for this effect will be silk flower petals, approximately 1½” x 1½” in size.
- 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).
- 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.
- The petal drop device itself will hang on a 1½” Schedule 40 batten and must have a footprint not greater than 20″ by 20″.
- 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.
- 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.
- The petal drop device must be reloadable in less than 10 minutes.
- 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.
- The producers are interested in any device you design to be reusable for other drop effects, including snow, confetti, and ping pong balls.
- Device should be mechanical and operated manually, not motorized.

2. Weighted Objective Tree

To disperse petals over a wedding, we want a design that is reliable, simple, safe, and cheap. Our objective tree highlights our requirements and constraints.

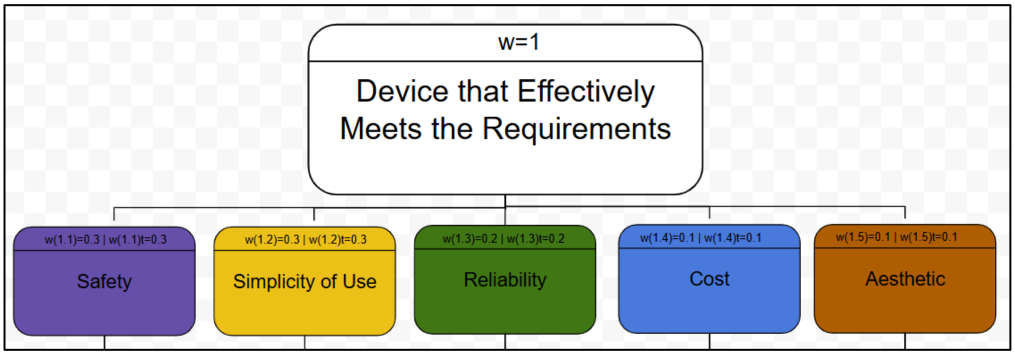

Figure 1

Prioritizing safety at 0.3 (out of 1). Focusing on preventing operator mistakes and minimizing hazards, we will limit mechanical hazards and the inputs required.

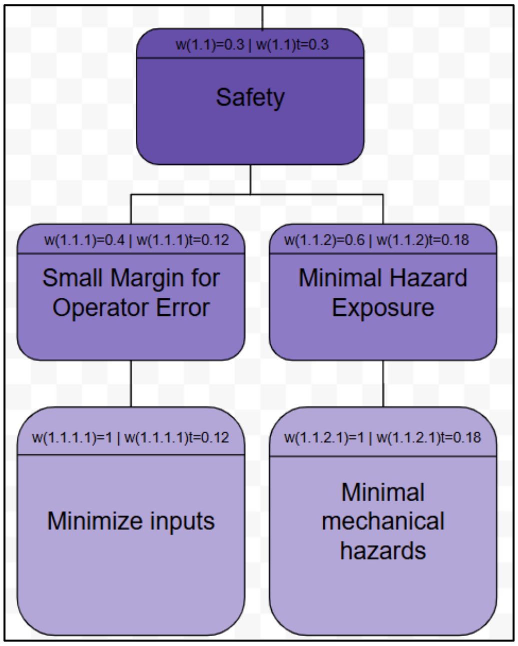

Figure 2

The simplicity of use is also weighted at 0.3. We will limit time spent by making the parts easy to make, use, and maintain. This will be done by having simple parts that are easy to access, an efficient way to reload, and obvious directions on how to use the device.

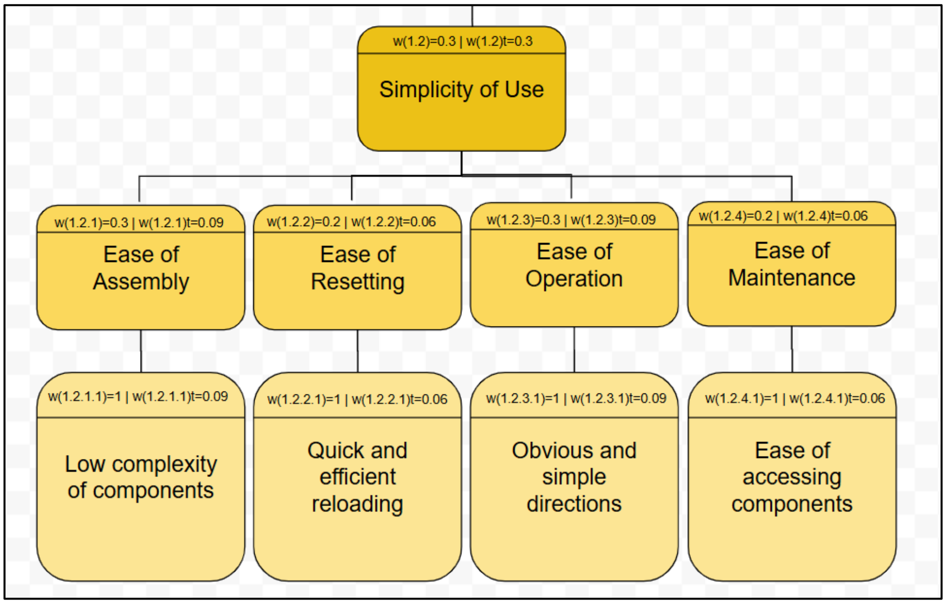

Figure 3

Next is reliability at 0.2. We will have consistent operation by decreasing the possible points of failure as well as making the device usable with other materials.

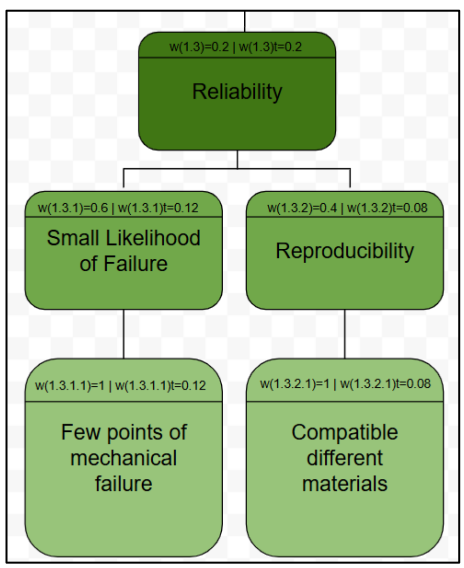

Figure 4

Cost is placed at 0.1. We will limit the cost by using all materials bought (minimizing waste) and buying cost-effective materials.

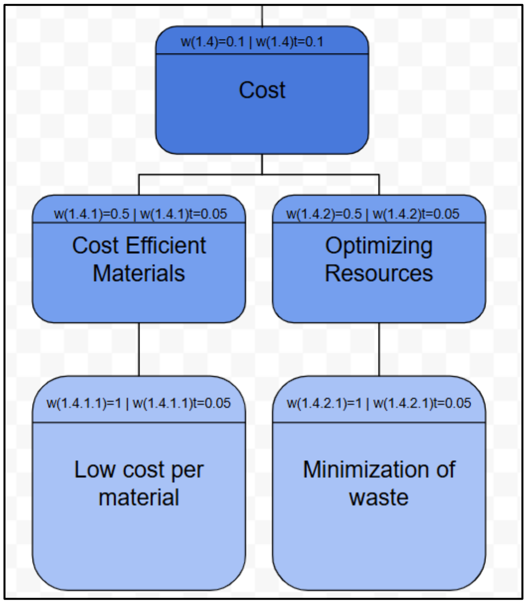

Figure 5

Aesthetic is also weighted at 0.1. We will make our design visually pleasing by making a sleek, professional exterior while also not standing out to be visible to the audience.

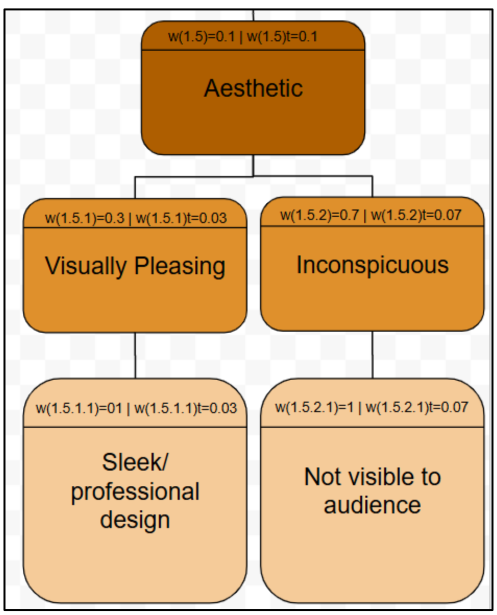

Figure 6

3. Sketches

Agitator Sketch

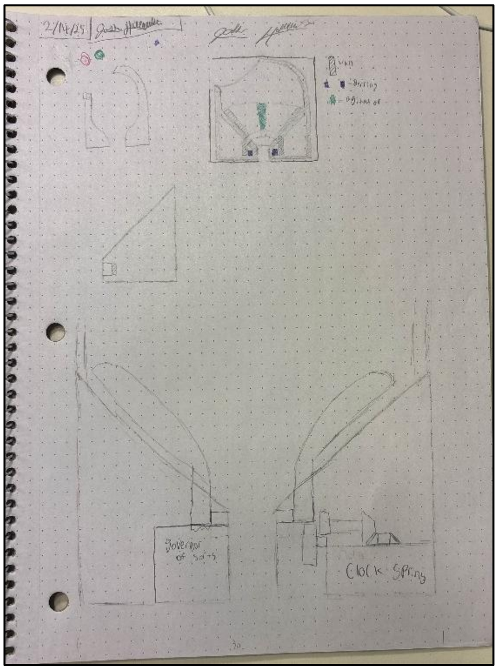

Figure 7

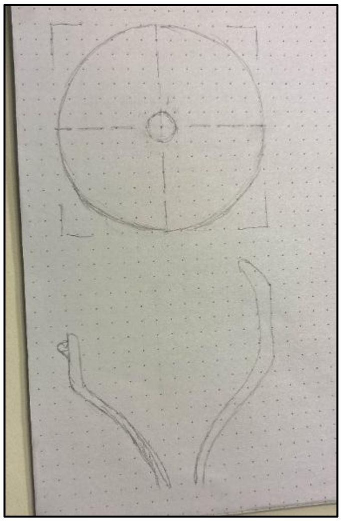

Figure 8

Figure 7 and Figure 8 are part of a design that includes a slow-spinning spindle being powered by a clockwork mechanism and strong governor. There is a hole in the center of the device for the petals to flow into to disperse onto the stage below. With this design, there were issues with the complexity of the mechanism. This would violate the “simplicity of use” requirement we had previously established in the objective tree as the ease of maintenance and ease of resetting would be more difficult to accomplish with this design.

<u>Reloading Device Sketch</u>

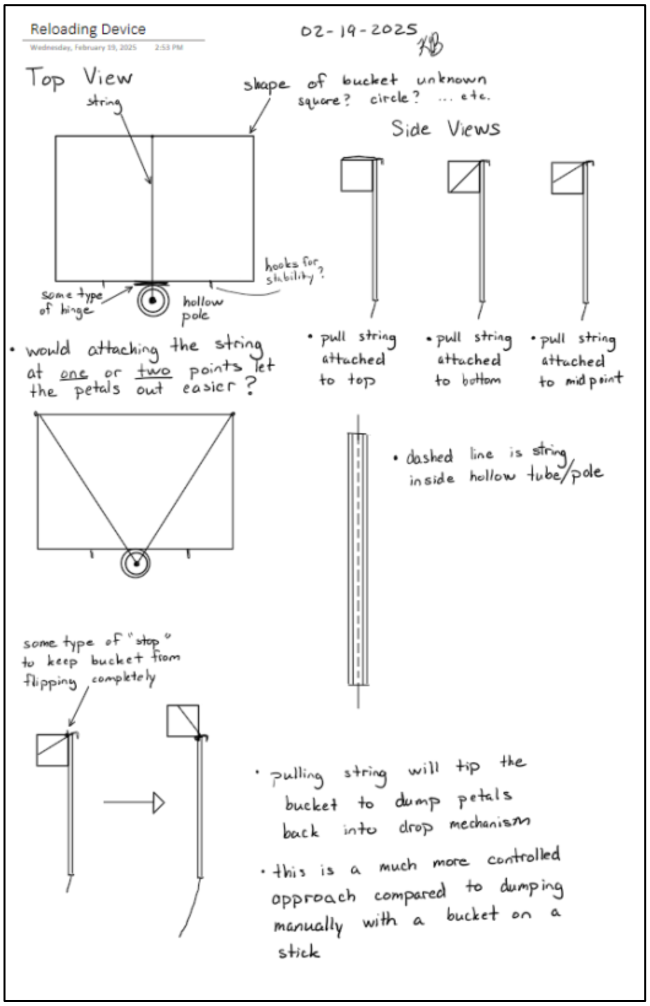

Figure 9

Figure 9 includes our initial design to reload the device after dispensing the flower petals or other material. It is a modified bucket on a long PVC pipe with a rope on a pulley connected inside the bucket and running through the pipe to dump the contents of the bucket back into the device. The pipe has a connection in the middle to separate it for ease of transport and a hook on the edge of the bucket for more precise reloading.

<u>Trough Sketch</u>

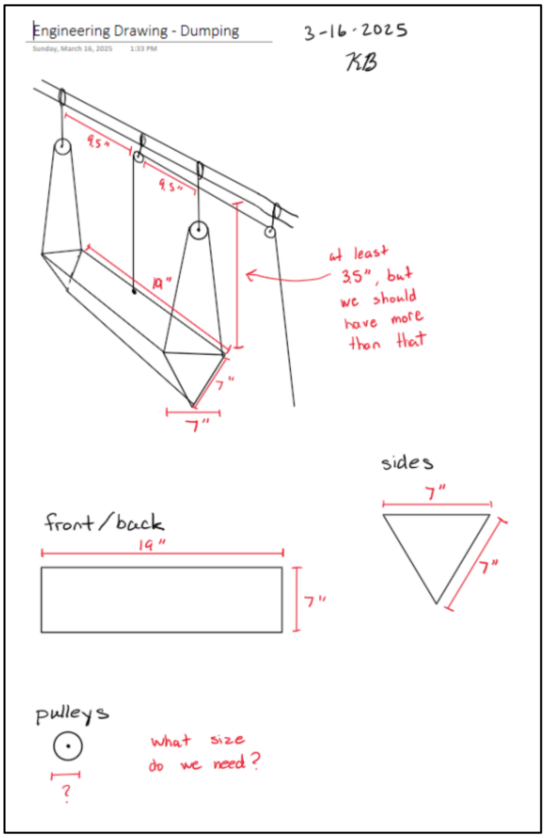

Figure 10

In Figure 10, our conceptual design was a trough that was able to rock to allow petals to spill out. The device would be tilted from side to side by a rope attached to a pulley system. We chose to discard of this design due to the issues with the large disposal area and the inconsistency with the dispersal of materials.

Fly Wheel Sketch

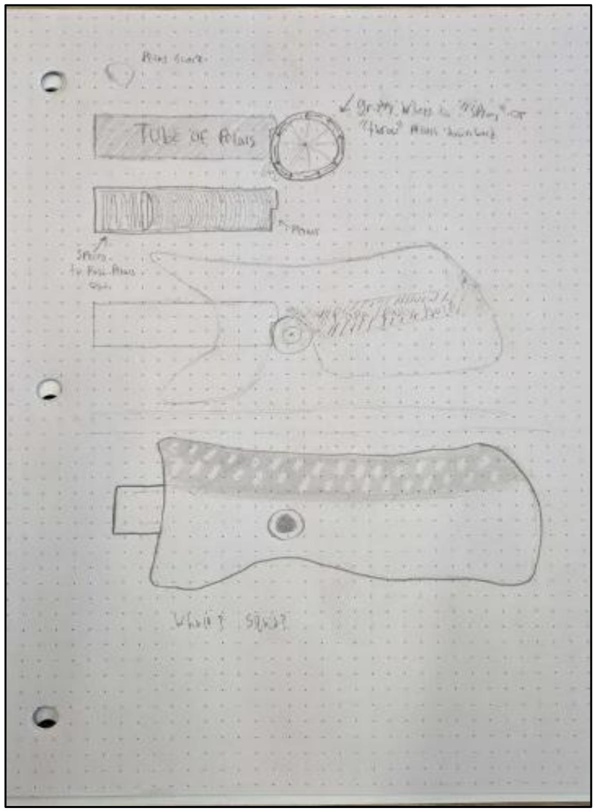

Figure 11

Figure 11 shows one of our “out of the box” ideas. This design utilized a spring-powered magazine to feed petals to a pulley-powered fly wheel that would pull the petals out and down to the stage. The issues with this design included difficulty reloading the device, difficulty reloading the magazine, and rate of petals dropped since it was solely based on the pulley speed.

Cradle Sketch

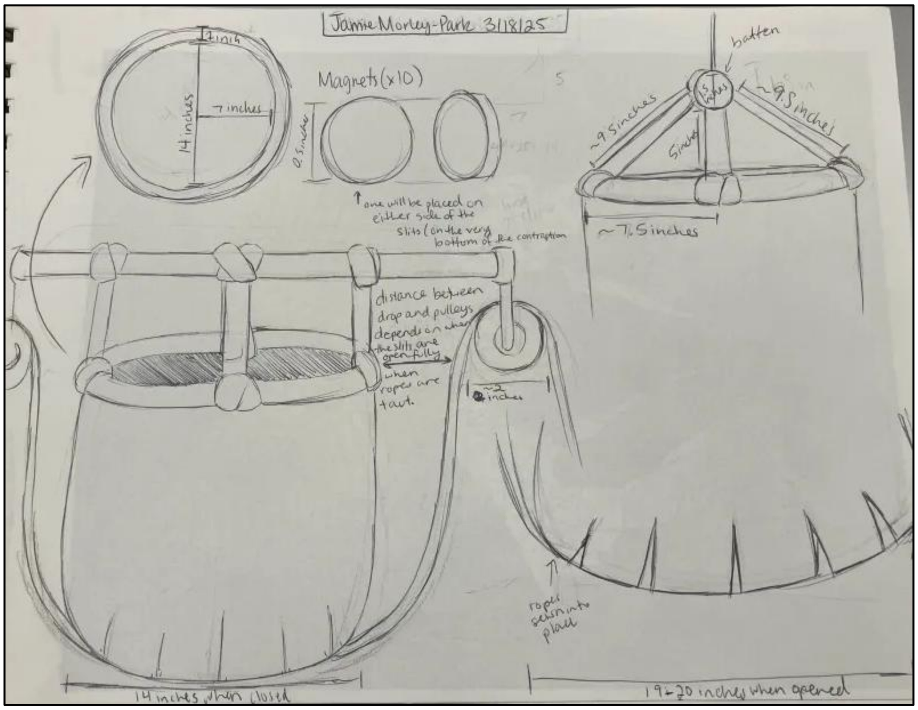

Figure 12

Figure 12 above shows the polished conceptual sketch of the “cradle” design. Inspired by a snow cradle, the device could dispense flower petals, ping pong balls, confetti, or snow through 5 large slits along the bottom slide of the cradle. These slits would be kept closed using 10 circular magnets embedded into the fabric. When the device was pulled on, using a pulley system on both sides of the cradle, the magnets would separate. This would allow the slits to open, and the contents inside of the cradle to fall through the bottom. There were some issues with consistency of the materials dispensing and confusion on how to load the device, resulting in the abandonment of this design.

Air Funnel Sketch

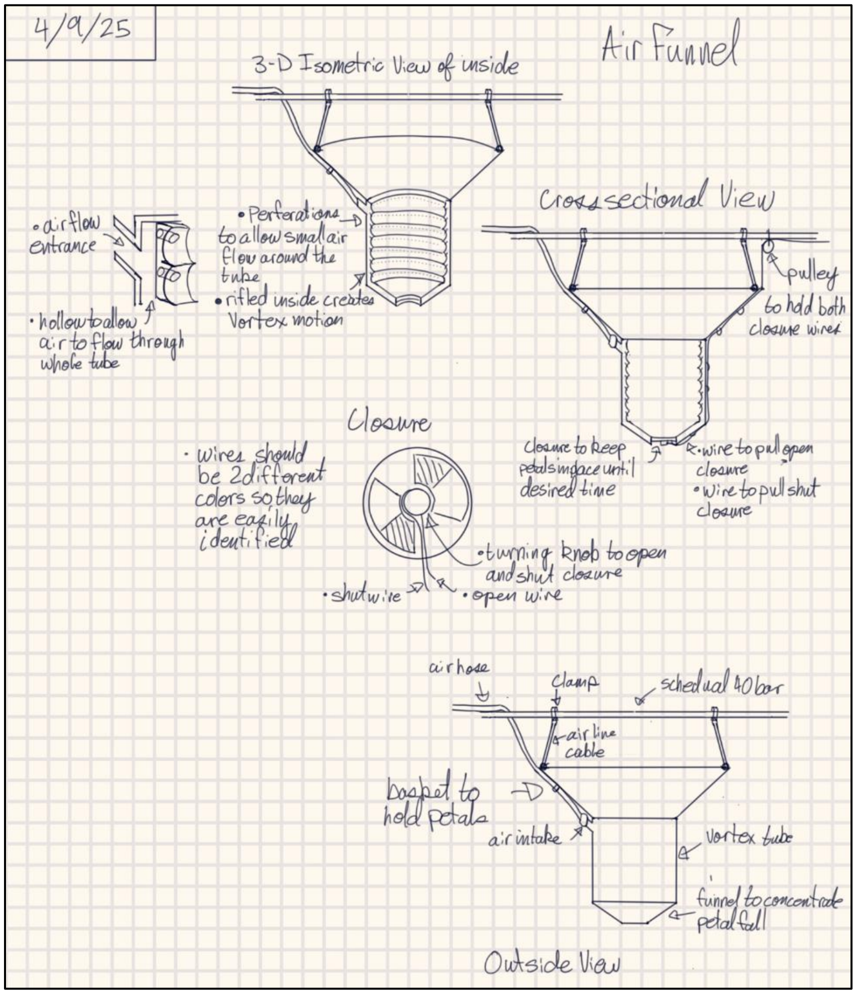

Figure 13

The air funnel sketch uses pressurized air to condense the petals into a controlled spiral in a smaller diameter circle. Petals will drop down into the tube from the basket and be pushed into a descending spiral by small perforations inside the mechanism. The rifling design allows the airflow to be continually pushed into a downward spiral along with the petals. A closure at the bottom of the mechanism is controlled by a wire from the side of the stage to open and close the mechanism when desired. There are two walls of the tube, a solid outer shell and a rifled inside shell with the perforations. Between these two walls is a hollow space to allow airflow all around the tube. Attached to the bar with clamps and airline wire, the mechanism can be raised and lowered to any height.

4. Design Matrix

With the evaluation criteria determined from the objective tree shown in Figures 1-6, we compiled a design matrix to judge each concept and see how each evaluation criteria were met. The Design Matrix Requirements Table outlines how each criterion was weighed using the Scale Table as a reference. We measured each aspect based on a scale of 0 to 5 and multiplied it by our weighted value to determine the best design. The weighted value of each criterion was then summed for one concept to determine its total weighted value.

Design Matrix Requirements Table							
	Evaluation Criteria		Parameters	Unit	Prototype Name		
					Magn.	Value	Wt. Value
NO		wt.			M_{il}	V_{il}	WV_{il}
1	**Minimize Inputs**	0.12	**Number of Inputs**	-			
2	**Minimal Mechanical Hazards**	0.18	**Expected Mechanical Hazards**	-			
3	**Low Complexity of Components**	0.09	**Expected Complexity of Components**	-			
4	**Low Cost Material**	0.05	**Expected Cost**	$			
5	**Minimization of Waste**	0.05	**Unused materials**	-			
6	**Quick and Efficient Reloading**	0.06	**Time to Complete Reloading**	min.			
7	**Obvious and Simple Directions**	0.09	**Expected Manual Complexity**	-			
8	**Ease of Accessing Components**	0.06	**Accessible locations**	-			
9	**Compatible With Different Materials**	0.08	**Number of Possible Dropped Materials**	-			
10	**Few Points For Mechanical Failure**	0.12	**Number of Ways for Mechanical Failure**	-			
10	**Sleek/Professional Design**	0.03	**Expected Level of Professionalism**	-			
10	**Not Visible/Audible From Audience**	0.07	**Expected Lack of Visibility/Sound**	-			
	Σw_i =	**1**	Expected =		OWV_1=		

Table 1

Scale Table			
#	Description		
0	Solution is not useful	3	Solution is satisfactory
1	Solution hardly useful	4	Solution is good

Scale Table			
2	Solution somewhat useful	5	Solution is perfect

Table 2

Tables 3 and 4 below show how well each concept performed in relation to the evaluation criteria. Both the Agitator and Fly Wheel scored low due to their complexity and mechanical hazards. The material cost and possible dropped material scored highly for each concept except the Fly Wheel due to its loading mechanism being designed specifically for petals. While the Trough and Air Funnel both performed well, the Air Funnel was objectively better due to the fewer inputs (users) needed to make it function. In the end, the Air Funnel was chosen as our prototype although some aspects from the other designs were implemented into the preliminary design.

Agitator			**Trough**			**Fly Wheel**		
Magn.	**Value**	**Wt. Value**	**Magn.**	**Value**	**Wt. Value**	**Magn.**	**Value**	**Wt. Value**
M_{il}	V_{il}	WV_{il}	M_{il}	V_{il}	WV_{il}	M_{il}	V_{il}	WV_{il}
Avg	3	0.36	High-Avg	2	0.24	Low	4	0.48
High	2	0.36	Avg	3	0.54	High	2	0.36
High	2	0.18	Low	4	0.36	High-Avg	2	0.18
High	3	0.15	Low	4	0.2	Avg	3	0.15
Avg	3	0.15	Low	4	0.2	Avg	3	0.15
Low	5	0.3	High-Avg	2	0.12	High	2	0.12
High-Avg	4	0.36	Low	4	0.36	Avg	3	0.27
Avg	3	0.18	High	4	0.24	Low	2	0.12
High	5	0.4	Avg	4	0.32	Low	1	0.08
High	2	0.24	Low	4	0.48	High	2	0.24
High-Avg	4	0.12	Low-Avg	2	0.06	Avg	2	0.06
Low	2	0.14	Avg	3	0.21	Avg	3	0.21
OWV_1=		2.94	OWV_1=		3.33	OWV_1=		2.42

Table 3

Cradle			Air Funnel		
Magn.	**Value**	**Wt. Value**	**Magn.**	**Value**	**Wt. Value**
M_{il}	V_{il}	WV_{il}	M_{il}	V_{il}	WV_{il}
High	2	0.24	Avg	3	0.36
High	2	0.36	Low	3	0.54
Avg	3	0.27	High-Avg	4	0.36
Low	4	0.2	Avg	4	0.2
Low	4	0.2	Low	4	0.2
Low	4	0.24	Low	5	0.3
High	2	0.18	Avg	3	0.27
High	4	0.24	High	5	0.3
High	5	0.4	High	5	0.4
Avg	3	0.36	Avg	3	0.36
Low	2	0.06	High	4	0.12
High	4	0.28	Avg	4	0.28
OWV_1=		3.03	OWV_1=		3.69

Table 4

5. Preliminary Design Sketches

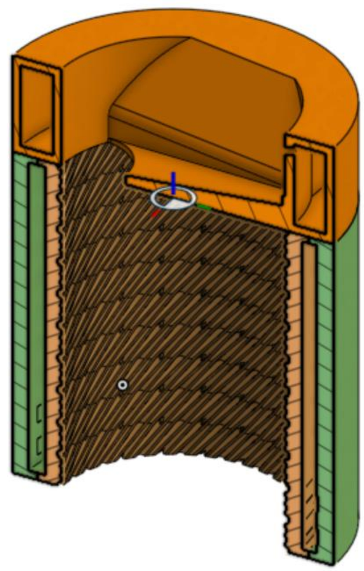

Figure 13

Figure 13 is a preliminary design CAD model. We plan on channeling pressurized air through the hollowed body. As the petals are dispensed via a bucket into the upper chamber, they will move down a short ramp and into the next chamber. Once in the lower chamber, pressurized air comes out at an angle from each part of the rifling causing a spiraling motion to move the petals downward, mimicking a tornado-like air pattern.

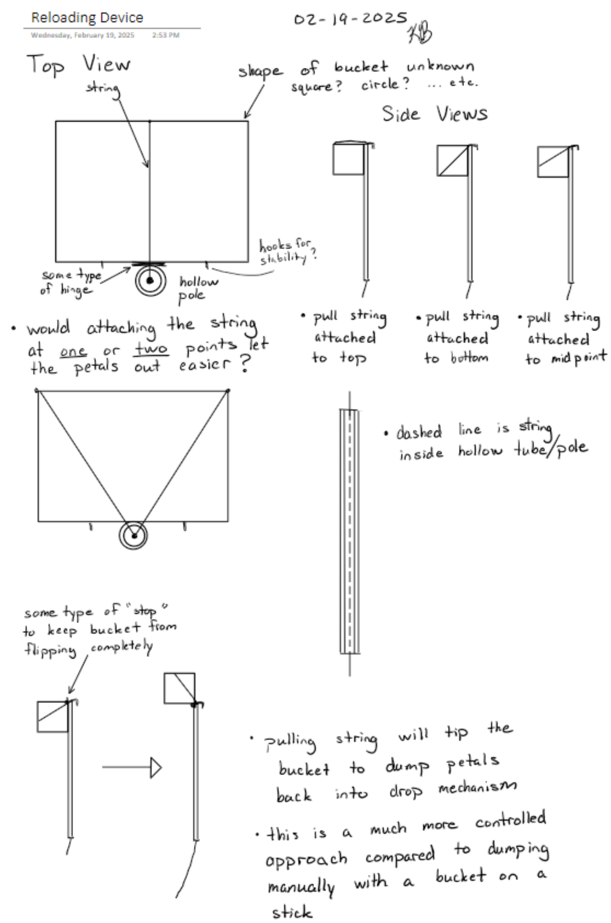

Figure 14

Figure 14 is the preliminary design of our reloading device. Our reloading device consists of a conduit pipe long enough to reach out device from the ground, a modified bucket to hold the reloading materials, a hooking attachment to securely hold onto out device, a hinging piece to allow the bucket to swivel over the top, and a rope that runs through the center of the pipe down to the operator. The rope is pulled to tip the contents of the bucket into the device to reset it from the ground.

Conclusion

Having chosen to proceed with the pressurized air-powered design to serve as out petal drop, the next tasks moving forward will be deciding the final materials all future physical models will be built from and completing a budget for these model materials. Once the budget is submitted and materials are purchased and received, a test model can be built for both the upper and lower chamber. Testing the lower chamber will help confirm the pressurized air will move the petals in a spiral motion as intended to keep the petals in within a 3 ft. diameter circle once they reach the ground. Testing the upper chamber will highlight any issues that must be addressed when the petals are received by the device to allow a smooth dispersal.