Design Specification

Design Specification: Competition

Design a machine to complete the 2019 Stage Machine Design Competition Challenge
Choose the methods, materials, parts, and other elements of the solution based upon the requirements of the machine as detailed below
Team must function professionally, ethically, and within the honor code of their university
Produce a written proposal for the design by April 12
Develop a working prototype of the design to be tested May 4

Design Specification: Machine

Production Team/Stakeholders	Production	Context for Effect
Director	*Much Ado About Nothing*	Wedding scene
Design Team		
Producers		

Description of Effect (to be Interpreted)

Beautiful “rainfall” of flower petals over the lovers
Petals should fall “gently” and “slowly”

Effect Details

“Rainfall” of petals, to be referred to as Petal Rainfall
Petals used: silk flower petals, ~1½” by 1½”
Location of effect on stage: center stage
Time for effect, ⊗t = ~30 seconds
“Gentle and slow” fall, no further specifics
Max petal falling distance, ⊗x = 15’
Falling distance measured b/n stage level the lovers stand on to lowest masked place device can exist
Area covered by petal rainfall on stage floor: ~3’ diameter circle
Some “light and airy” musical scoring during the effect

Machine Details

Accomplish petal rainfall effect
Dimensions: footprint no greater than 20” by 20”, no height limit besides the grid (~50’ further up)
Able hang from 1½” Schedule 40 batten
Budget: $80 ($20/team member)
Load in time: ~20 minutes
After installation machine will be inaccessible to stage hands/crew, unable to be lowered
Reloadable from the ground without using a ladder or lift
Reload time: 10 minutes or less
Operated from 25’ offstage of the effect at stage level of the lovers (15’ below machine)
Relatively silent operation, some machine noise acceptable covered by musical scoring
Actors below effect during machine effect, safe operation
No explosives or pyrotechnics

Design Specification

Machine Wishlist
Reusable for other drop effects, including snow, confetti, and ping pong balls

Available Resources at Competition Site
15A, 110-120 VAC power
100 PSI air pressure via ¼" tube or quick-connect on request made prior to May 1
1½" Schedule 40 batten to elevate the machine

Competition Day
Provided with time prior to testing to calibrate and tune machine
~30 minutes total for load in, tune up, testing, repairs, and final test/presentation

Machine Disqualification
Machine design/prototype may not include explosives or pyrotechnics resulting in immediate disqualification
Machine prototypes deemed unsafe to operate or in violation of competition guidelines risk removal by competition hosts

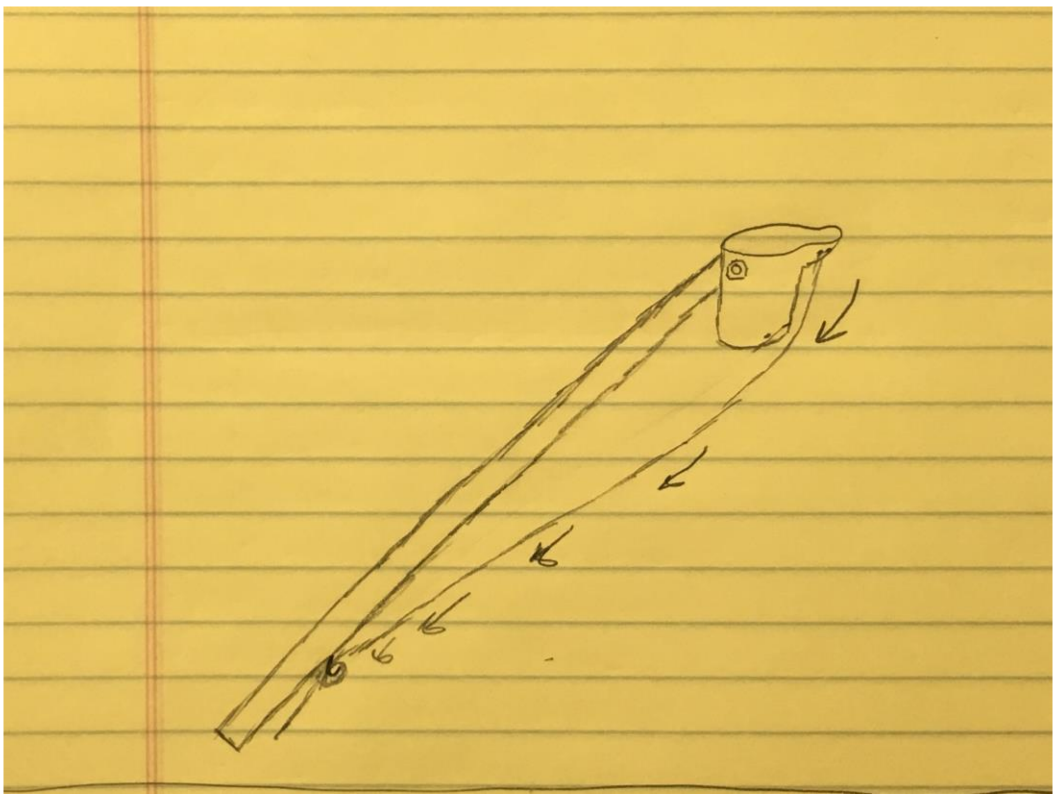
Concept Designs

Reloading Mechanism

Design One Fishing Pole Bucket

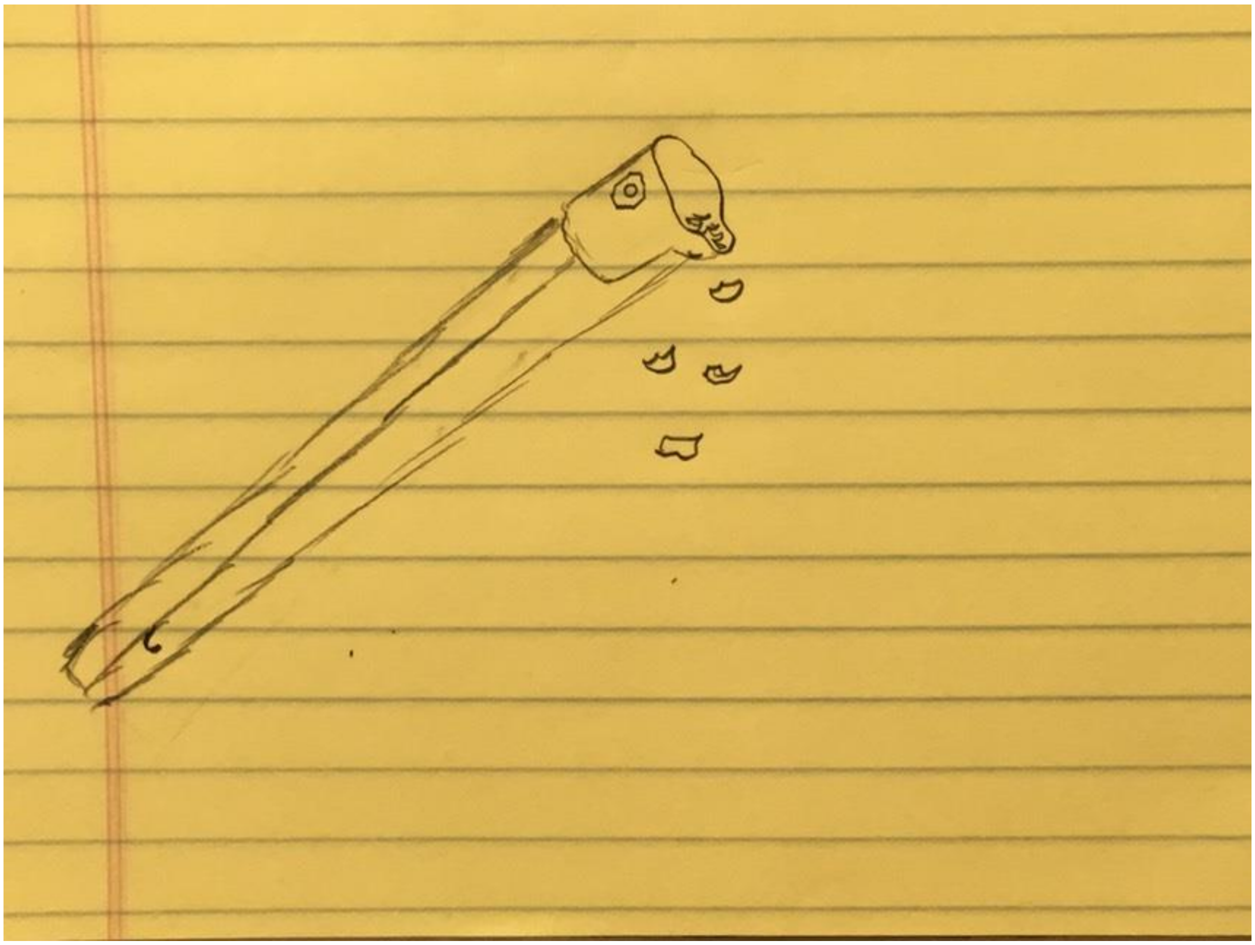
<u>Brief Description</u> A bucket is attached to the end of a pole on the side so as to allow full rotation of the bucket on a swivel bolt. Then, a string is attached to the spout of the bucket, so as to pull from the other end, and pour the petals out. There is also a hook near the end of the pole where the person holds, to avoid slipping when not in use.

<u>Sketches</u>



Concept Designs

Sketches



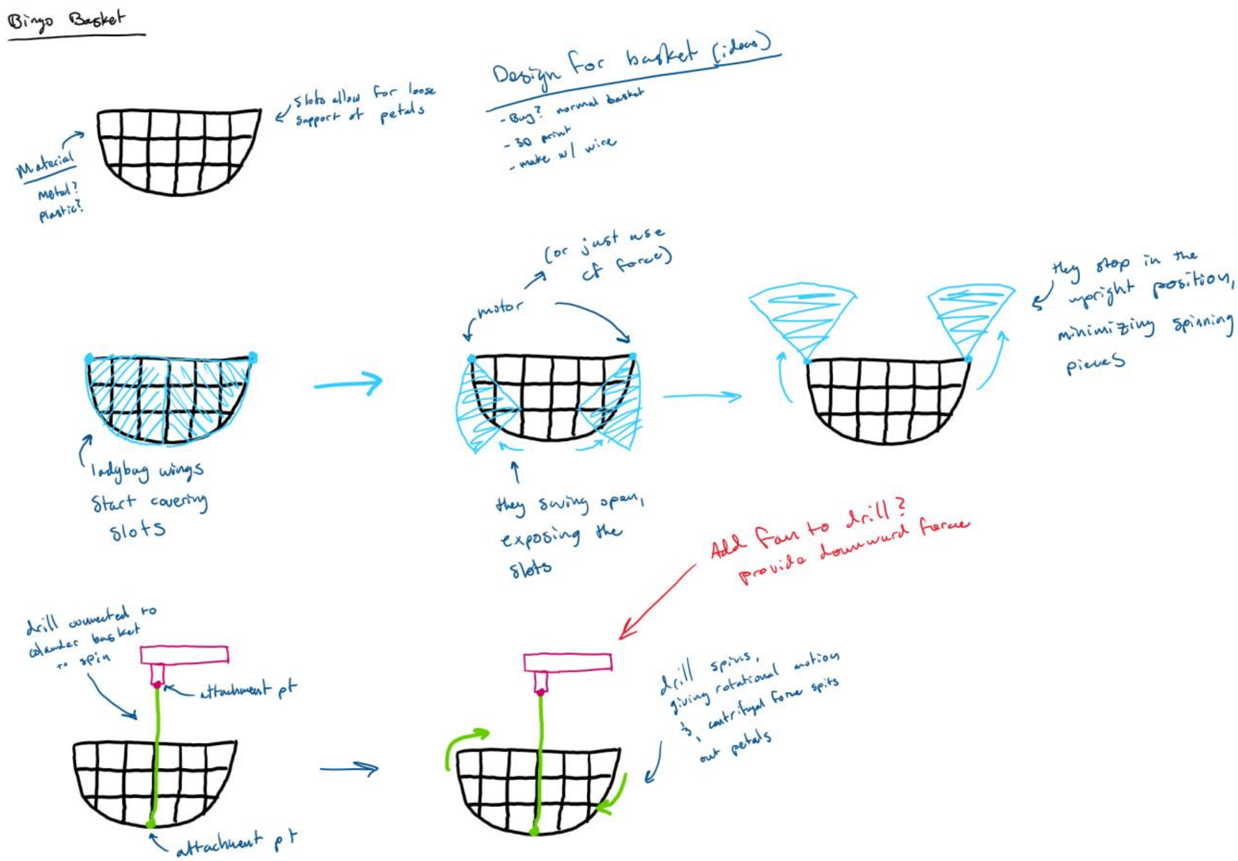
Concept Designs

Main Mechanism

Design One Basket

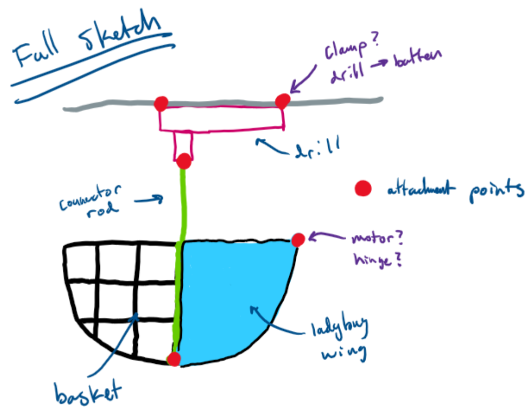
<u>Brief Description:</u> A wire hemisphere (“basket”) is covered by two halves of a solid hemisphere (“shell”), secured by hinges. The basket is connected from the bottom to a shaft, driven by a drill that is clamped to the batten. The basket is filled with petals and will not disperse until the shell is opened. The rotational motion of the drill will drive the shaft, causing the basket to evenly distribute petals throughout the grates.

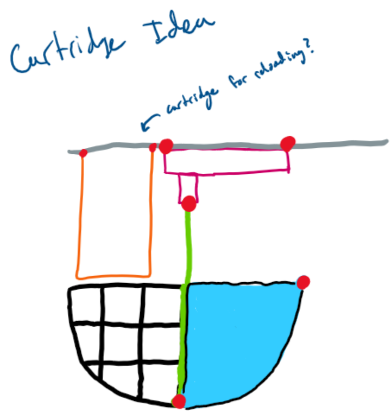
<u>Sketches</u>



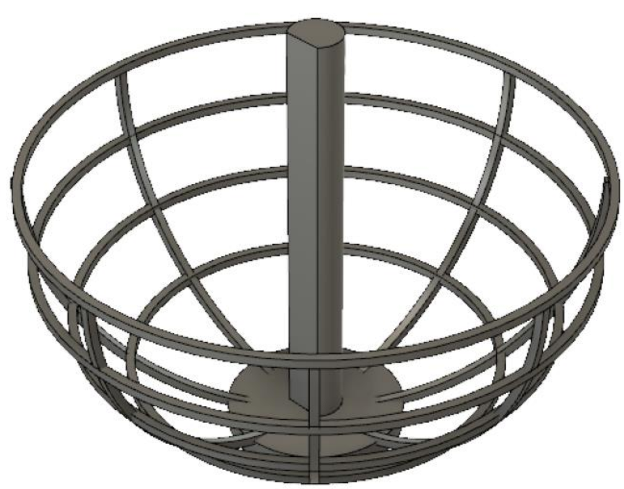
Concept Designs

<u>Sketches</u>





<u>3D Models</u>
Isometric



Concept Designs

<u>3D Models</u>
Side View

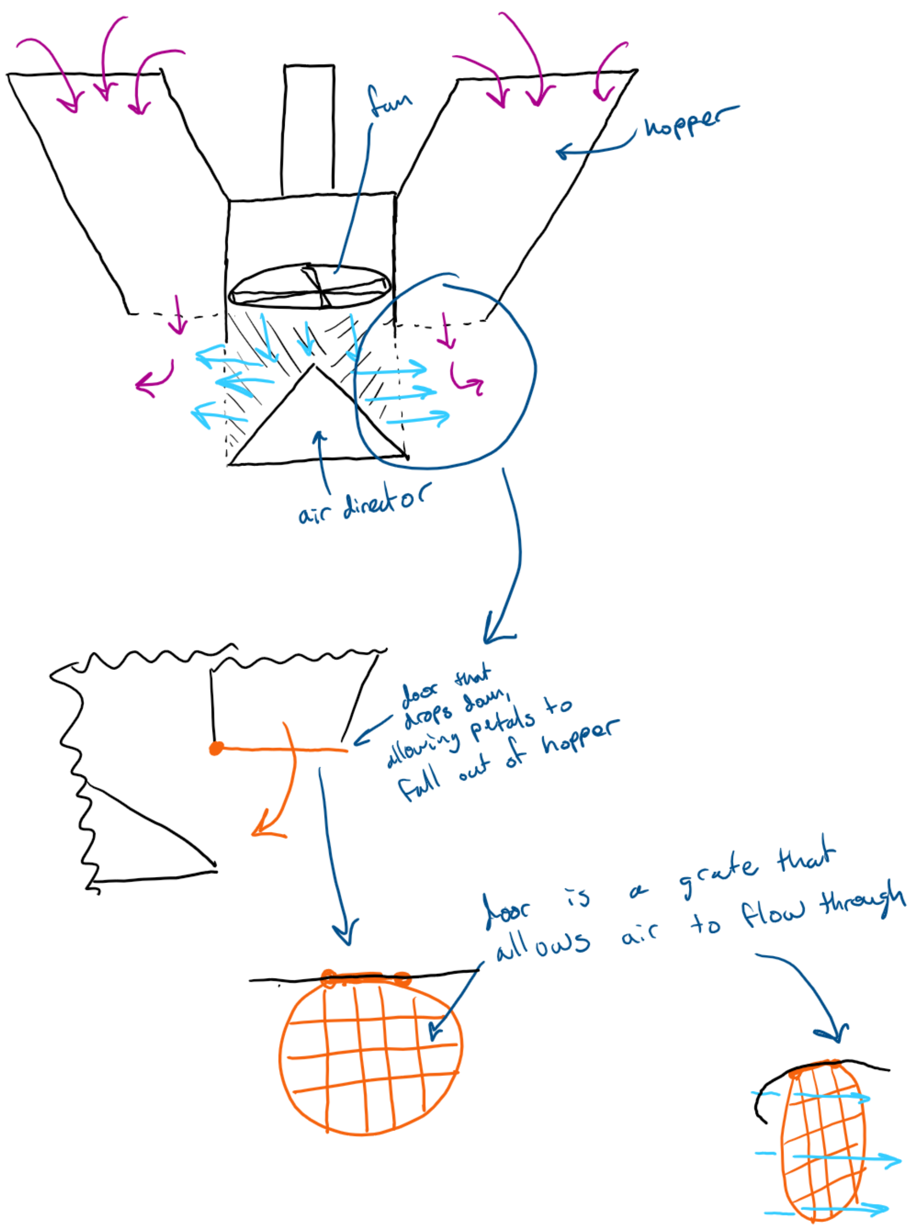
<u>3D Printed Prototype</u>

Concept Designs

Design Two Octagon

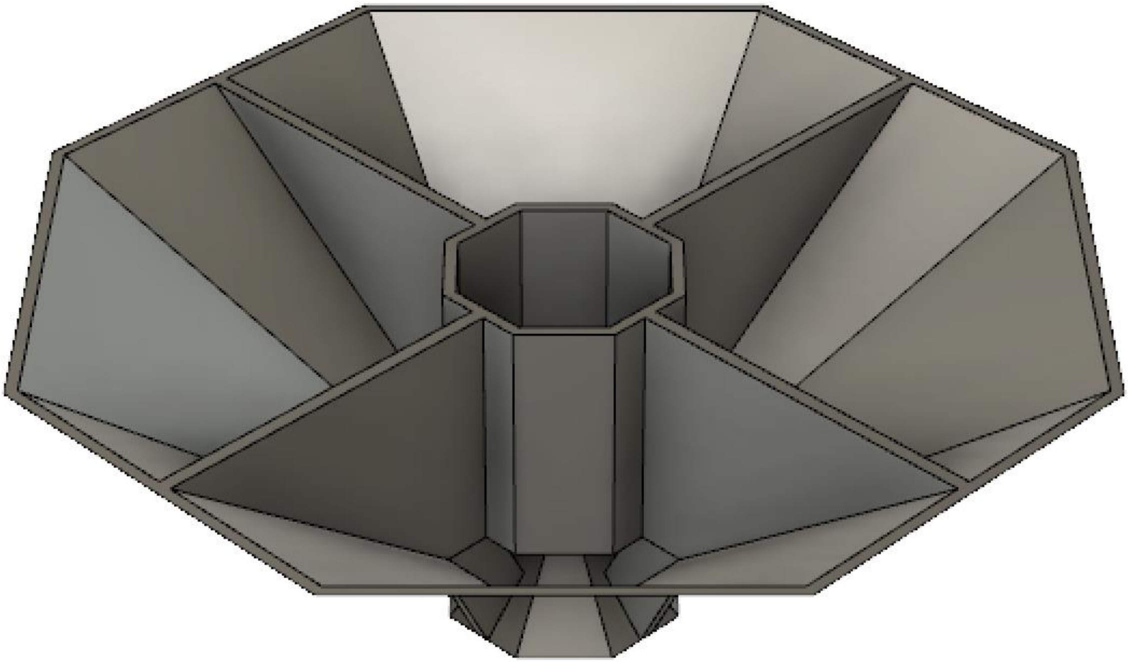
Brief Description An octagonal hopper holds petals, separated into four distinct sections. A fan housed in the middle, blows air into a cone that disperses the air down and out at an angle. Petals are loaded into the hopper, and stopped by small doors before they fall through the hole at the bottom. The doors are released, and the petals will begin falling through the bottom of the hopper into a circle via the airflow from the fan.

Sketches

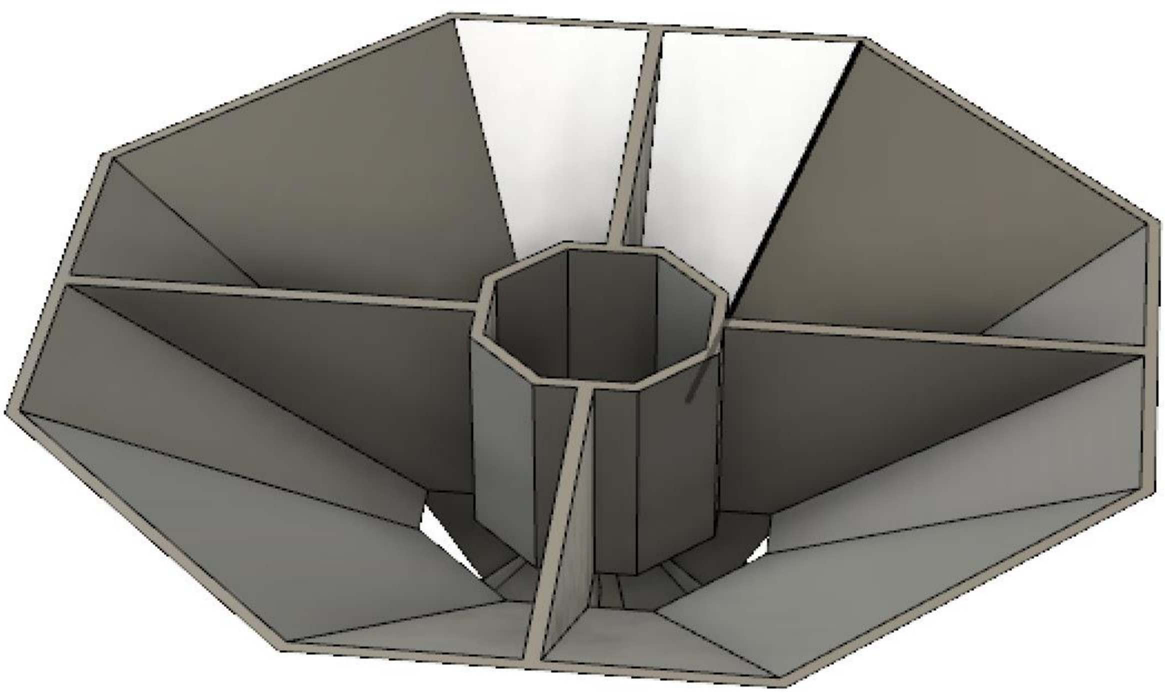


Concept Designs

<u>3D Models</u>
Isometric view

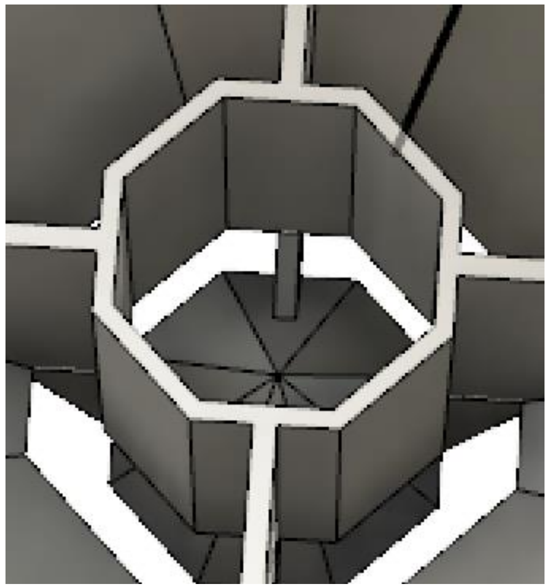


Four Sections



Concept Designs

<u>3D Models</u>
Fan Enclosure & Dispersion Cone



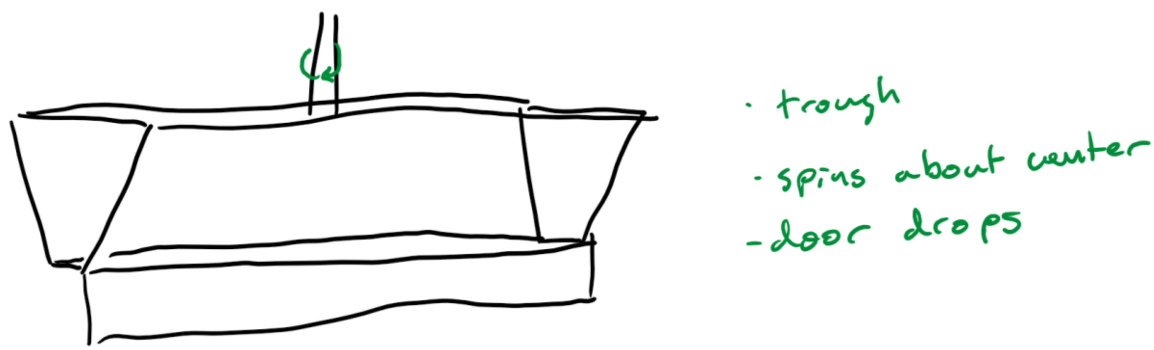
<u>3D Printed Prototype</u>

Concept Designs

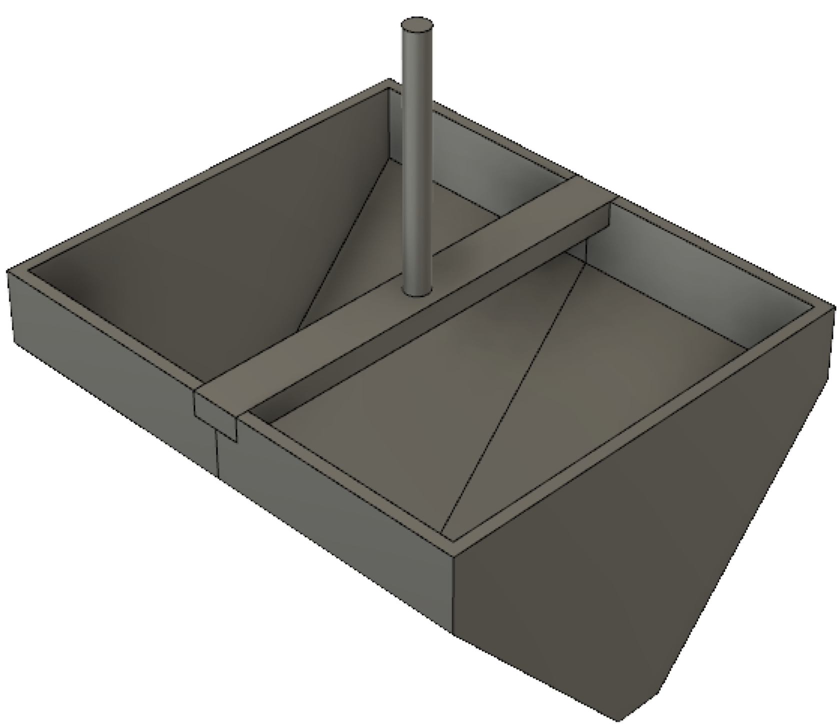
Design Three Trough

Brief Description A hollow trapezoidal pyramid connected to a drill and clamped to the batten as petals are loaded inside the trough. The door at the bottom is closed, covering up a slot running the length of the trough. The trough begins to slowly rotate when the drill is plugged in, and the door opens. Petals fall in a straight line from the bottom of the trough, and as the trough rotates, the constant flow of petals forms a circle.

Sketches



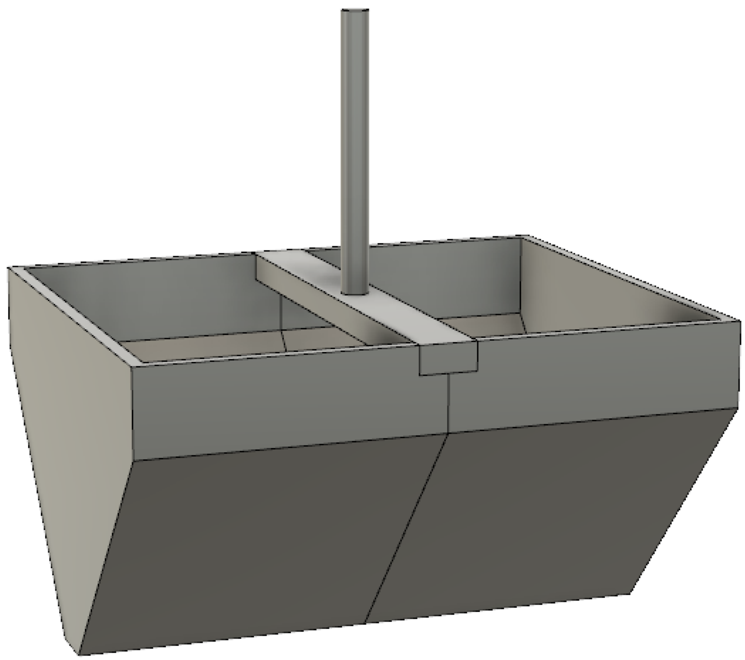
3D Models
Isometric



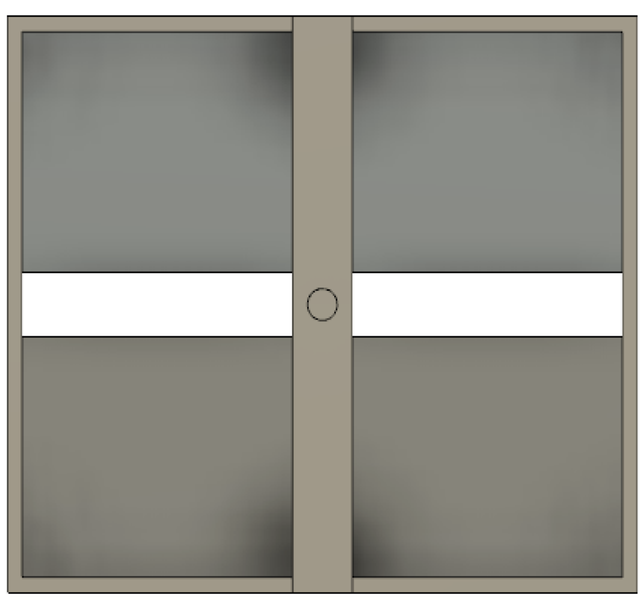
Concept Designs

<u>3D Models</u>

Isometric

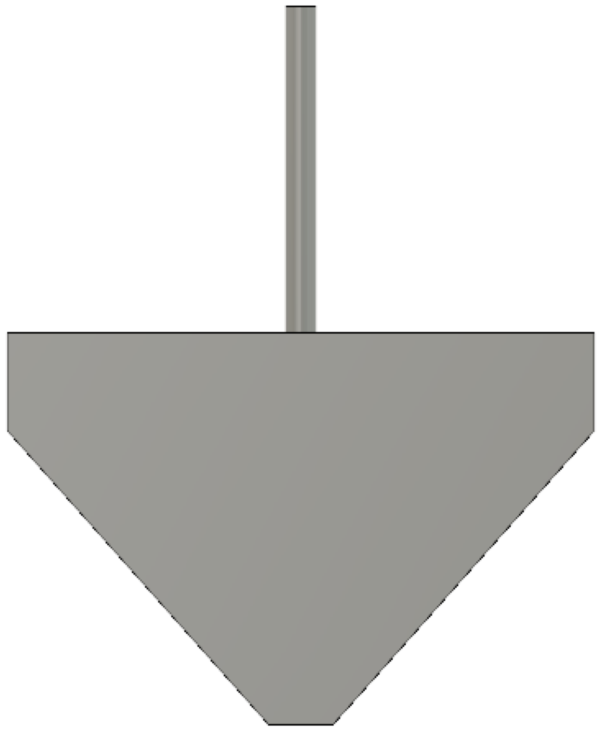


Top View



Concept Designs

<u>3D Models</u>
Side View



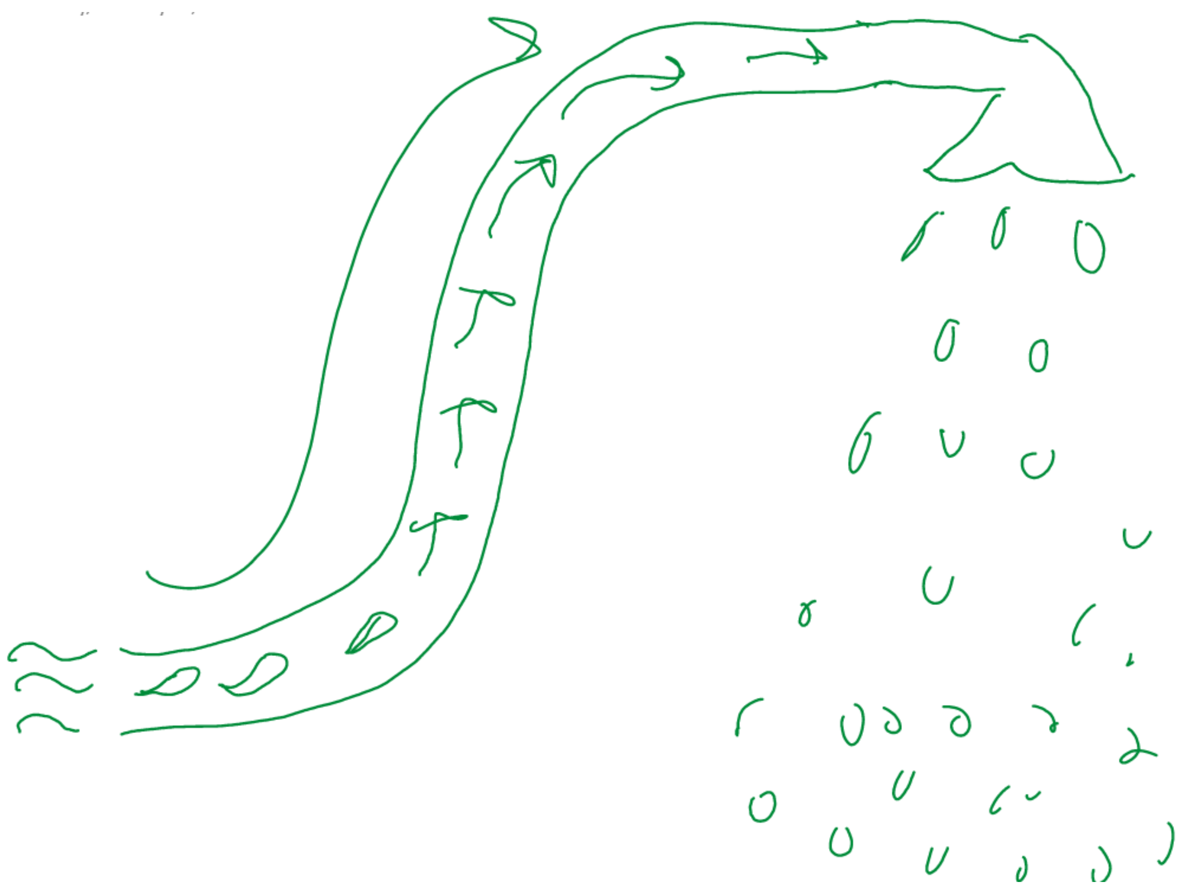
<u>3D Printed Prototype</u>

Concept Designs

Design Four Funnel Head

Brief Description Air is provided through a hose going into a funnel, connected to the batten, which disperses petals onto the floor in a circle.

Sketch

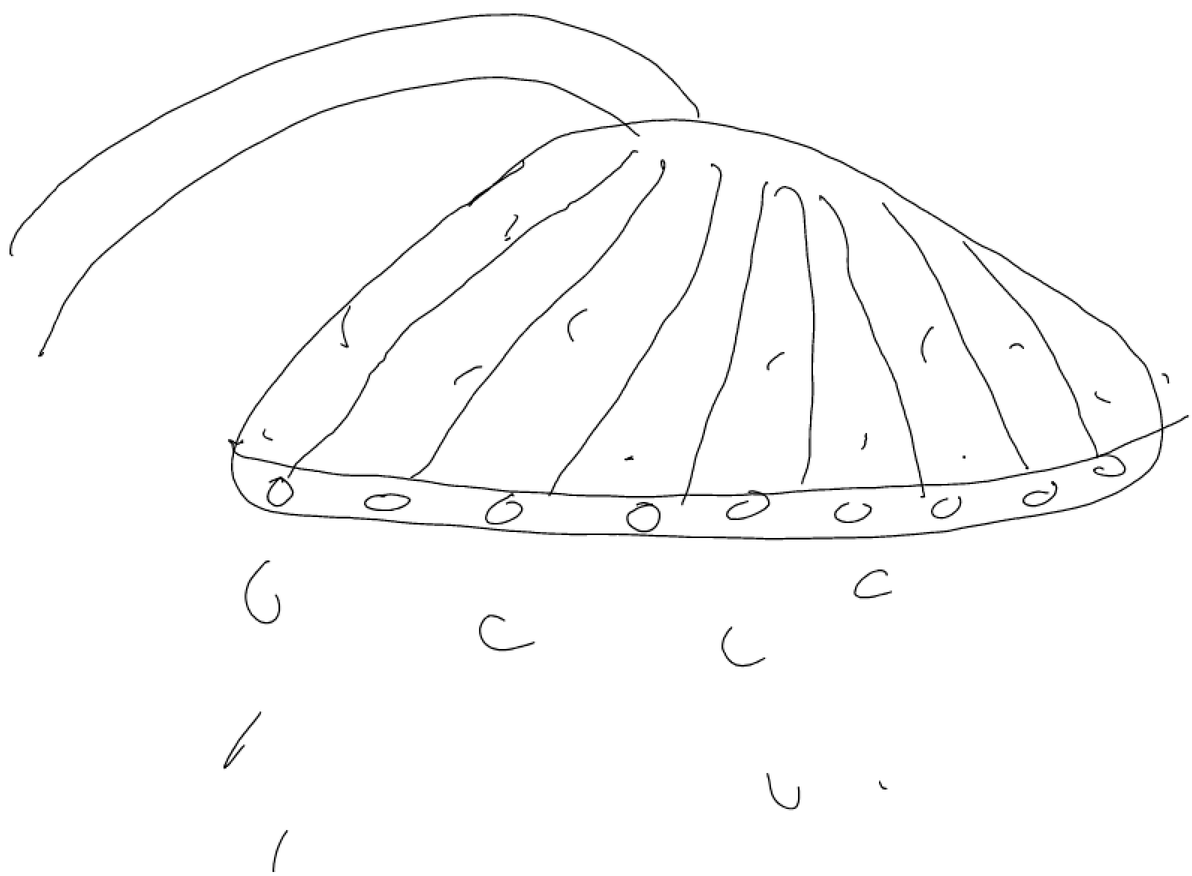


Concept Designs

Design Five Shower Head

Brief Description Air is provided through a hose going into a shower head shaped apparatus, connected to the batten, which disperses petals onto the floor through many 3” diameter holes. The different chambers within the showerhead apparatus go directly to the holes and will disperse the petals in a circle.

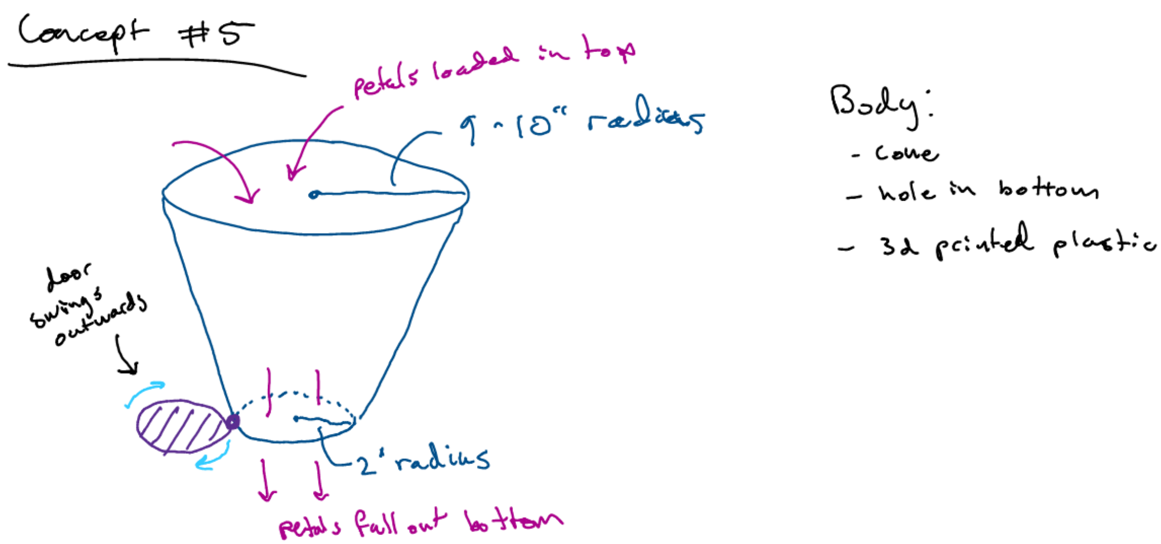
Sketch

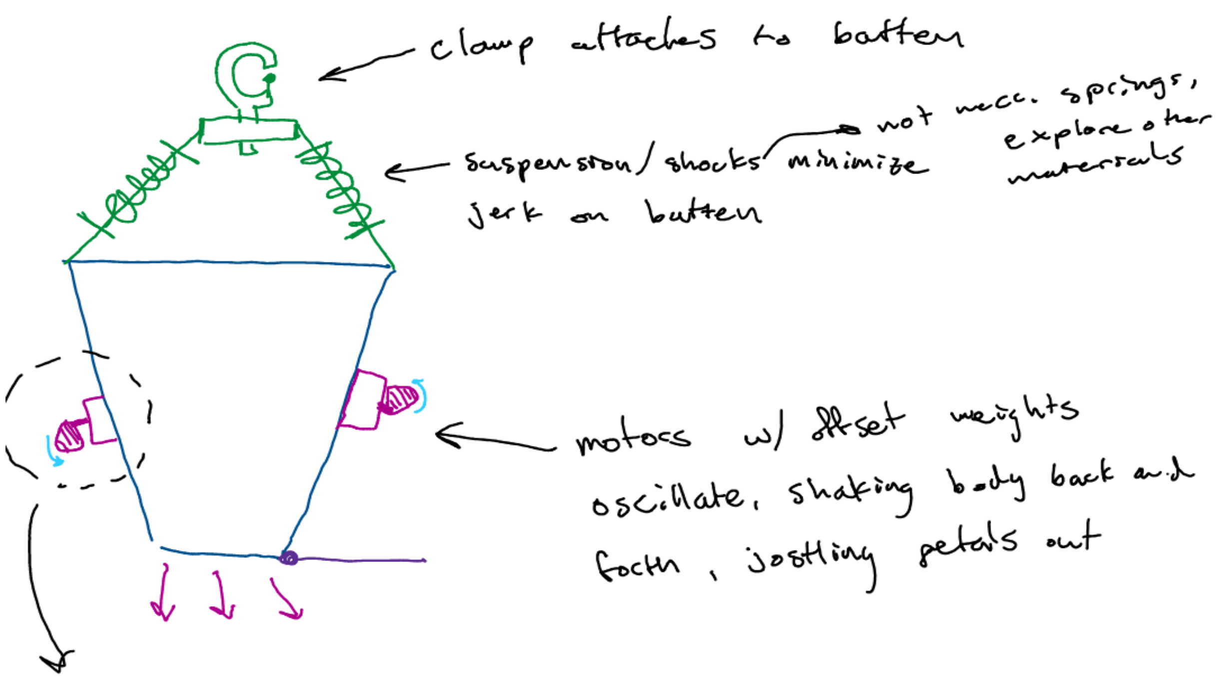


Design Six Oscillating Cone

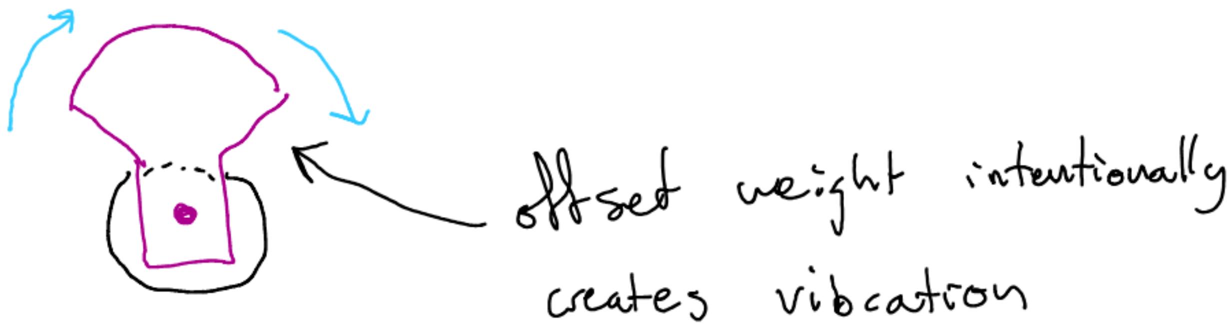
Brief Description The body of this design will be an inverted open cone with holes at both ends, and the radius of the bottom hole smaller than the top. The funnel is held up by four springs connected to one intersecting point which is attached to the batten. There are motors with offset weights that oscillate, shaking the body of the cone back and forth, jostling the petals loaded out onto the floor into a circle on the floor.

Sketches



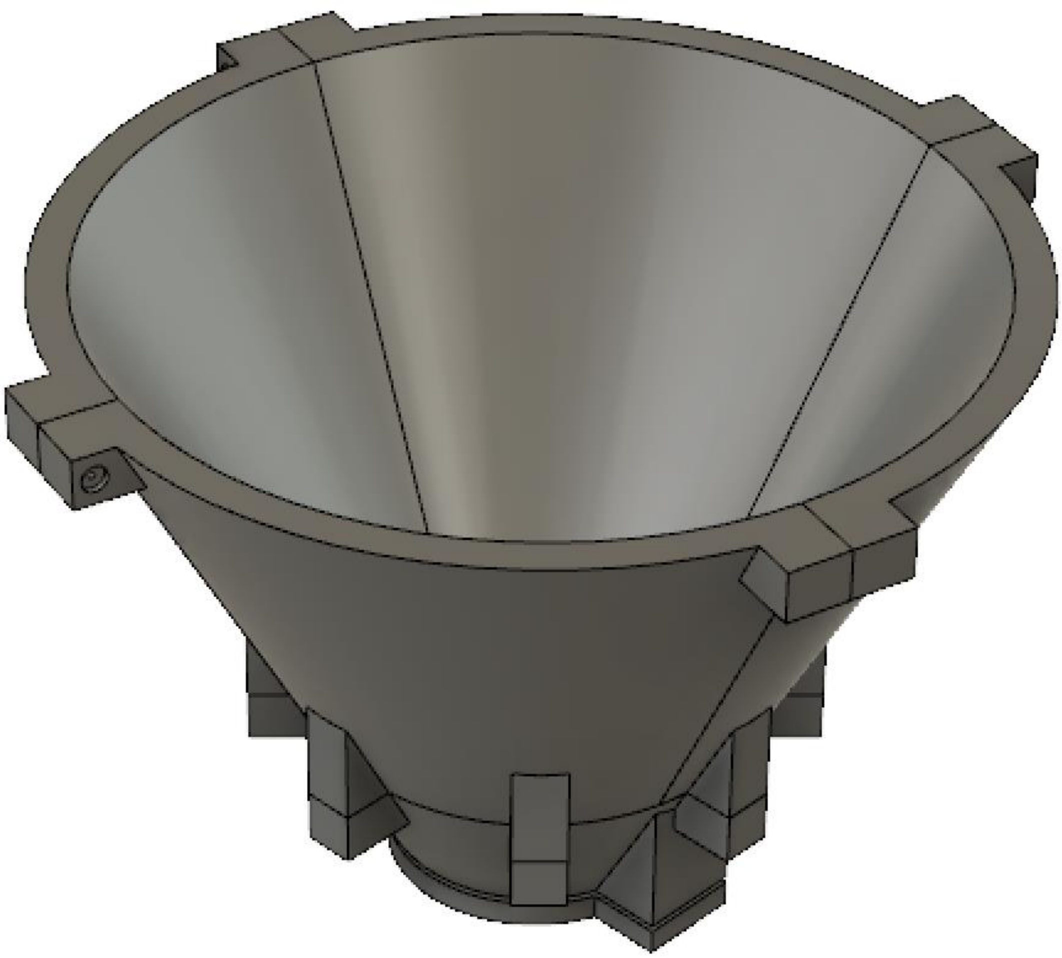


Sketches



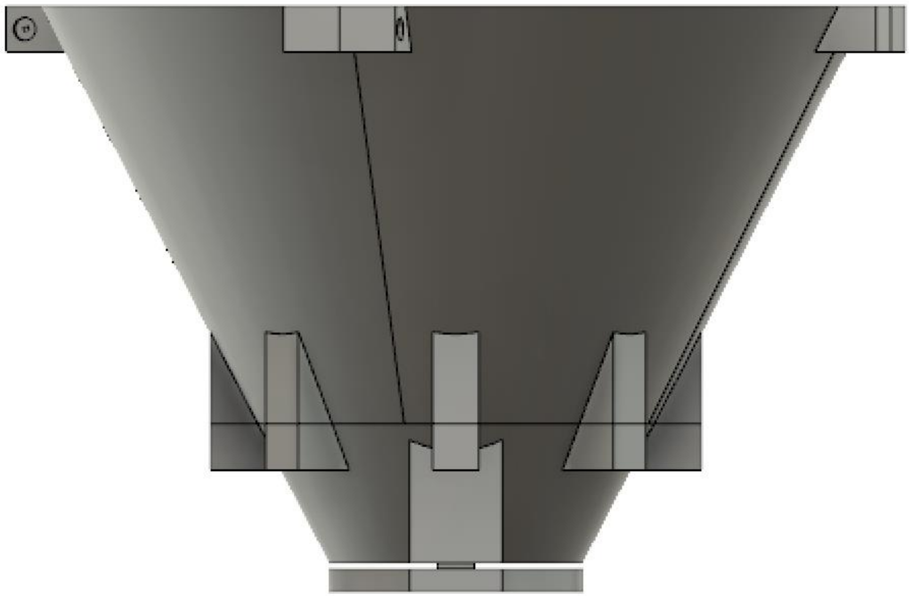
3D Models

Isometric

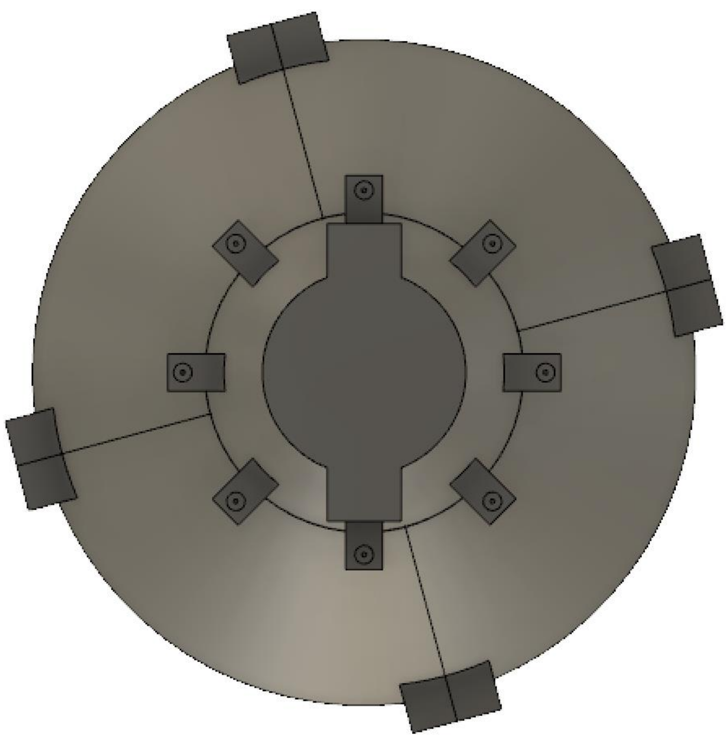


3D Models

Side View



Bottom View

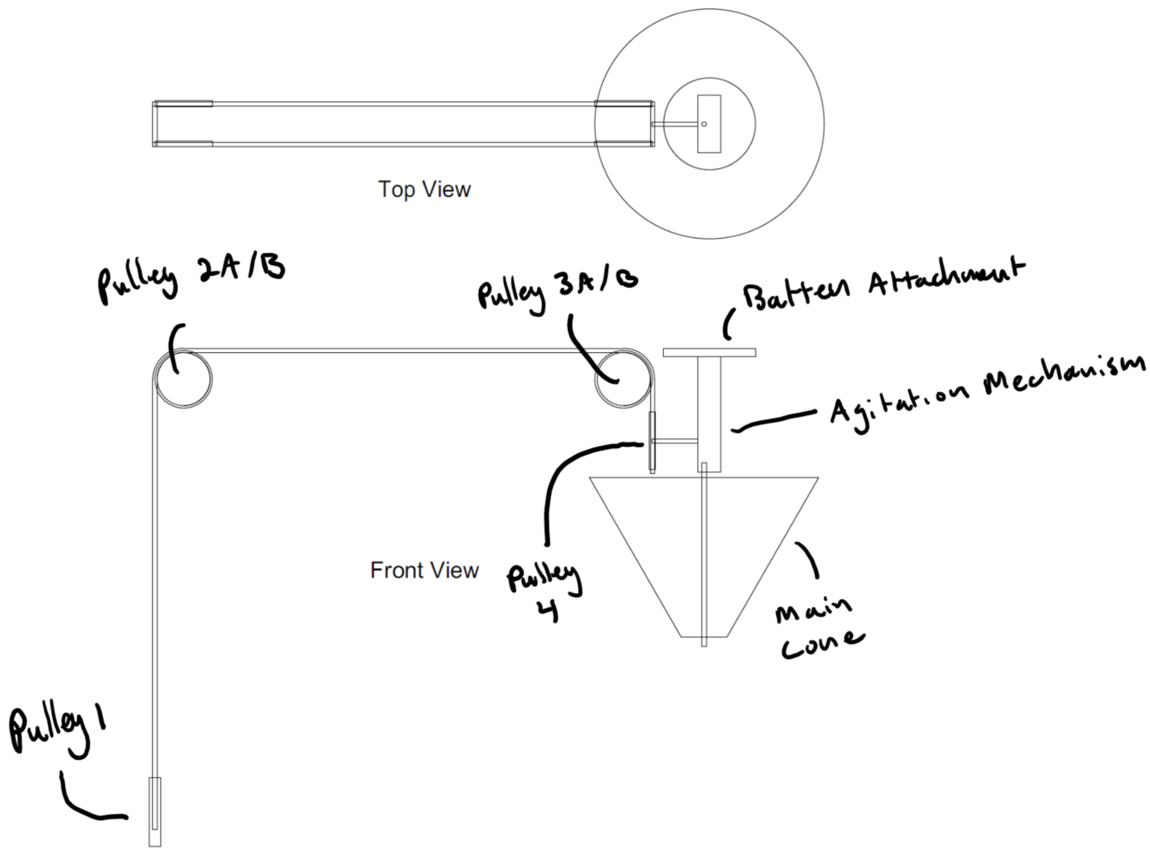


Final Decision

The final design chosen throughout this process was decided to be design six, the oscillating cone. The oscillating cone was the ultimate convergence of the ideas prior to which were tested for adequate completion of the design specifications required of the machine. Many of the concepts were focused on delivering the petals, but after physically testing the petals, it was observed that the focus of our design should not be based on solely delivering the petals to the floor, but to contain the petals within the targeted area. The physical concepts that were 3D printed and tested allowed room for recognition of this major design flaw and therefore led to the conclusive decision of design six. To where this design does not rely on air or rotational motion, which would spread the petals too far, but uses slight oscillation to jar the cone so as to jostle the petals at an appropriate rate. Ergo, design six adhered to the design specifications required and also resulted in the desired effect.

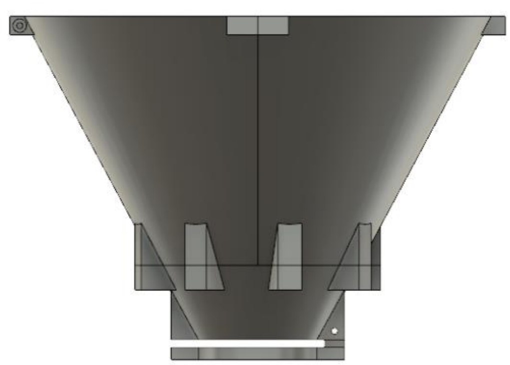
Physical Description

Overview Drawing



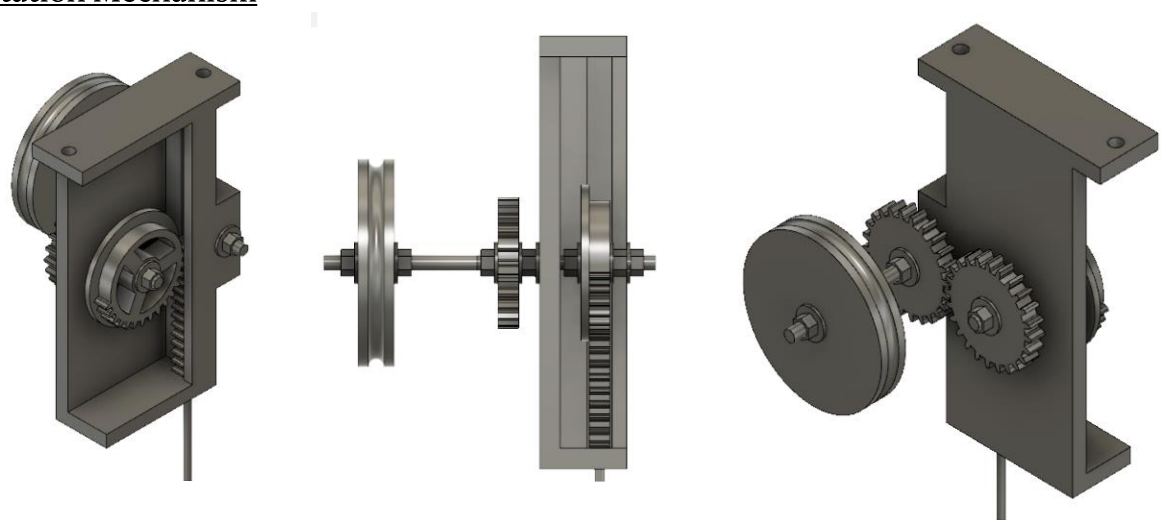
Component Drawings:

<u>Main Cone:</u>



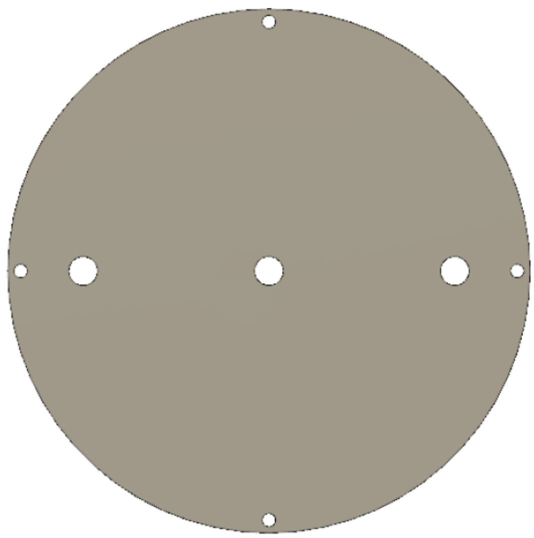
An upside-down hollow cone with a 19” diameter base formed at an angle of roughly 30^{O} off of vertical. A 4” diameter hole truncates the cone 13” below the base. The cone is split into five 3D printed components. All components are printable on a LulzBot TAZ 6. Protrusions with screw-holes allow the components to be assembled with glue and machine screws. The cone’s walls are 0.5” thick and printed from PLA plastic. Near the top, four holes are drilled in the sides of the cone that serve as attachment points for bungee cords that will attach the cone to the batten attachment.

Agitation Mechanism



The agitation mechanism is suspended above the main cone, affixed to the bottom of the batten attachment. A 16” agitator rod extends from the bottom of the mechanism through the inside of the main cone. Within the mechanism, the rod extends through a shaft. The part of the rod that lies inside the shaft is toothed to form the rack in a rack-and-pinion gear assembly. Only half of the pinion is toothed so that it interfaces with the rack only half of the time. When the pinion rotates and interfaces with the rack, the rod is lifted up through the inside of the cone. When the toothed section of the pinion stops moving the rack, the rod falls back to its original position as the pinion continues to rotate. To transfer power from the pulley system to the pinion, a system of gears is necessary. The pinion is connected to a shaft that is connected to a gear on the outside of the mechanism’s body. Another gear which is connected by another shaft to a sheave which is driven by the pulley system turns the gear connected to the pinion.

Batten Attachment:



An 8” diameter circle cut from 3/4” thick plywood. Four holes are drilled 90* apart from each other near the circumference. The bungee cords from the main cone attach to the four holes. The bottom of a c-clamp is bolted to the disk through a hole in the center, and clamps to a batten. Two more holes are drilled along the radius to bolt the attachment to the agitation mechanism.

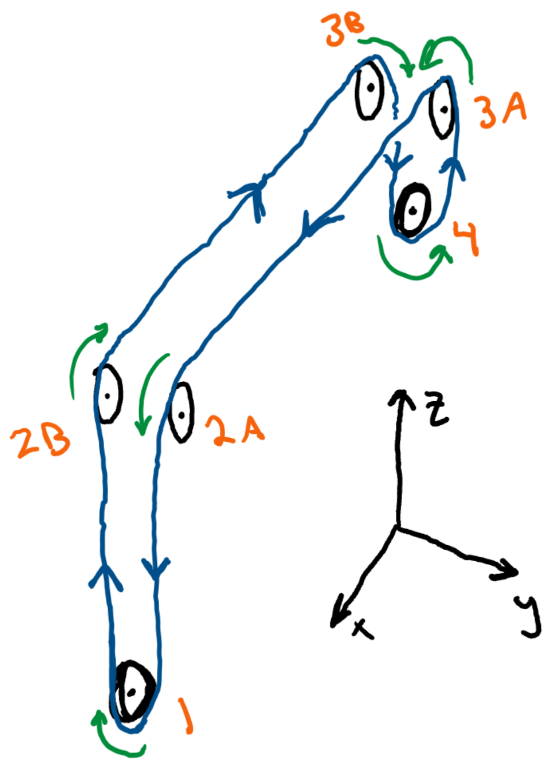
End Cap:

A circular end cap is attached to the bottom of a main cone on a hinge and covers the 4” diameter hole. The end cap is held in place by a magnet until the mechanism is activated and the agitator rod separates the magnets and the endcap swings down and out, uncovering the 4” hole.

Reloading Mechanism

A bucket is mounted on a ten foot PVC pipe so that it swivels about a bolt, by which it is connected to the pipe. There is a set of holes through the spout of the bucket so that string can be tied to them. The bucket will be filled with the desired volume of flower petals and lifted up to the top of the main cone. The string that is connected to the lip of the basket is used at the other end of the pole so that it may be tilted and the flower petals will pour from the bucket into the cone.

Pulley System



The pinion in the agitation mechanism is controlled by a system of pulleys. A tensioning pulley (Pulley 1) is screwed into the stage directly below the stage left edge of the batten. Directly above that tensioning pulley on the stage left edge of the batten is a set of up-and-down pulleys (Pulley 2A and Pulley 2B). Roughly 25’ along the batten is another set of up-and-down-pulleys (Pulley 3A and Pulley 3B). Below Pulleys 3A and 3B is a sheave (Pulley 4) which is connected to the shaft that drives the pinion in the agitation mechanism.

Functional Description

Reloading Mechanism

From the ground, the basket of the reloading mechanism is filled approximately 80% full (10 quarts) with flower petals. The pole is then lifted so the lip of the basket meets the brim of the main cone. The string is pulled to tilt the basket and the petals pour into the cone.

Main Cone

The main cone is designed to have a volume of roughly 1400 cubic inches (~24 quarts). Because flower petals do not pack cleanly, usage of this volume should not be maximized. The cone will hold the flower petals until their release.

Pulley System

The upstage rope extending from the batten to Pulley 1 will be pulled by a stagehand at a moderate rate of speed. This will begin the counter-clockwise rotation of the sheave that drives the agitation mechanism.

Agitation Mechanism

The counter-clockwise rotation of the sheave will be transferred by the gears to a clockwise rotation of the pinion, which raises the rack and piston approximately four inches. When the toothed portion of the pinion disengages, the rack and piston will fall. On the first revolution, this will force open the end cap. When the end cap is out of the way and the bottom of the main cone is open, further cycles of the piston rising and falling will agitate the petals, moving them to the hole on the upstroke and then forcing them through on the downstroke.

End Cap

When the piston strikes the end cap from within the cone, the magnetic seal is forced apart and the endcap will swing out and away from the bottom on a pivot, releasing the petals.

Design Narrative

We derived the idea that fuels our design from the many other concepts that were designed and tested. Components and concepts from previous designs, such as a petal-storing hopper as used in concept design #2, provided the base for what would become the final product. The original designs focused primarily on dispersing, or forcing the petals to the floor, but after physically testing the earlier ideas with the 3D-printed prototypes, it was determined that the focus of the mechanism should be on controlling the area covered by the petals rather than simply increasing it. After this discovery, the later concepts began incorporating a cone, or funnel, shaped apparatus with a small-diameter petal release hole to ensure this control. The desired effect was something close to that of a salt shaker, with the grains of salt being analogous to the petals, and the shaker being the agitation mechanism. Realizing an actual shaking motion would prove problematic as any movement of the cone would jostle the batten, we determined that an agitation of the actual petals rather than the entire assembly would be advantageous. This led to the development of a rack-and-pinion piston system to force the petals through the hole. This influenced idea behind the reloading mechanism which was inspired by a fruit-picker, and details the basket-on-a-stick reloading device which is designed to extend a stagehand's reach to pour petals directly into the machine.

Considering the different mechanisms detailed above, we believe that these diverse systems make this proposal the best overall design of all of the concepts we explored. When first attempting to develop the most efficient ways of producing the desired effect, our earlier concepts contained fewer moving parts and simpler designs. These designs executed the most basic requirements of the effect, but not in the precise, controlled way we were attempting to achieve. When we began introducing concepts that implemented funnels and cones to assist in regulating the distribution of the petals, we concluded that our design would need to incorporate some sort of motion to facilitate the consistent release of the petals. After including this new element into our thought process, our final design was generated, and ultimately accomplished what the other concepts could not. The final design was forged after many trials and many errors, and was the product of all of our prior innovations combined into one. Though the design utilizes multiple complex systems, along with a separate reloading mechanism, the final design was able to implement these systems in a way that allows for flexibility with room for error, reliability in the dispersion petals, and a long-lasting machine that can be used in future shows.

Overall, because of the flexibility, reliability, and longevity of this design it proves to be highly cost effective. The 3D printed parts used in the entire system can be easily and inexpensively replaced. We state this because PLA plastic costs just under two cents per gram, and 3D printing technology has recently become more and more widely available. Furthermore, the main machine and reloading mechanism are not only directly applicable to future shows and projects, but they can also be iterated and improved upon with different 3D printed components and repurposed for various other uses. This flexibility and adaptability greatly reduces long-run costs since several effects can be produced by this machine for multiple shows.

Instead of constructing the main cone and the entire agitation mechanism out of wood or metal, we 3D printed those specific parts which greatly reduced the costs that would have been incurred if we had used another material. Furthermore, using 3D modeling software allowed us to design geometric curves that would be quite difficult ,or near impossible, to create with wood or metalworking tools. The amount of money and time saved by 3D printing our components makes our design much more efficient and effective than a traditionally manufactured machine.

Given more time, a motor could be implemented to drive the mechanism instead of the pulley system, simply because the speed of the motor could be regulated by an inverter-driven brake motor rather than a possible variability of speed every performance because of various stagehands driving the design. Not only would replacing the pulley system with an electric motor increase efficiency by eliminating the necessity of gears to transfer power along an axis, it would also free up the setup time allocated to the installation and calibration of the pulleys. A twelve volt hobby motor would output the necessary power required to drive the mechanism and would cost around twenty-five dollars by itself.

However, the addition of electricity to the design would require the corresponding safety considerations to be included and provide an additional failure mode of the machine. While the voltage is reasonably low, heat dissipation would have to be taken into account if a resistor were used to control the speed of the motor. Furthermore, reasonably complex wiring would make the design more difficult to understand and manufacture. Despite these considerations, a motor that automates the control of the pinion would increase the effectiveness of the design to a point where it would outweigh the costs.

Overall, the flexibility of our design, the cost-reducing capacity of its 3D printed components, and the mechanism's ease of use result in this being the most efficient and practical design to implement.

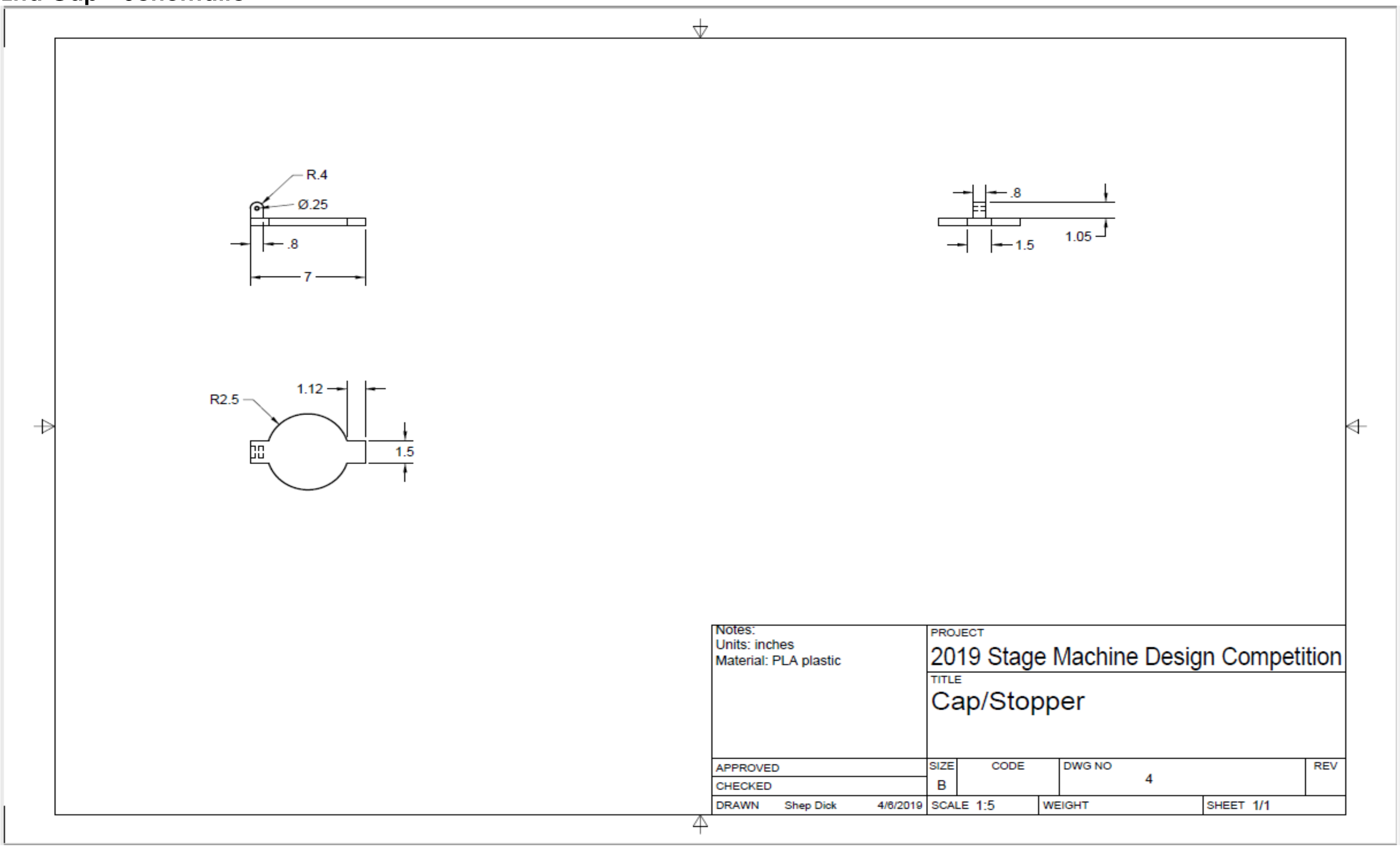
Materials and Costing Lists

Component	Amount	Part	Part Cost	Total Cost	Part #	Notes	Link/Source
Main Cone	1545 grams	PLA Plastic	$0.02 / g	$30.82			Amazon
	13	2" #5 Machine Screw	$0.37	$4.81	1557026		fmwfasteners.com
	5	#5 Nut	$0.05	$0.25	9195		boltdepot.com
	10	#5 Flat Washer	$3.60	$3.60	4DAR3	Price is for bag of 40	Grainger
Batten Attachment	1	8" Diameter Circle 3/4" Plywood	$9.96	$9.96	6.80141E+11		woodcrafter.com
	1	C-Clamp	$18.90	$18.90	7060A2009		newlighting.com
	2	2" - 3/8" Diameter Bolt	$2.00	$2.00	RTI2018737	Price is for a bag of 5	Home Depot
	2	3/8" Diameter Nut	$0.13	$0.26	801846		Home Depot
	4	3/8" Diameter Flat Washer	$0.08	$0.32	2949		Bolt Depot
	4	14" Bungee Cord	$12.99	$12.99	M600011	Price is for package of 10	Home Depot
Agitation Mechanism	460 grams	PLA Plastic	$0.02 / g	$9.18			Amazon
	1	8" 3/8" Diameter 16 TPI Threaded Rod	$0.87	$0.87	11007	Price is for 12"	Menards
	1	4" 3/8" Diameter 16 TPI Threaded Rod	$0.87	$0.87	11007	Price is for 12"	Menards
	9	3/8" Nut	$0.24	$2.16	804066		Home Depot
	11	3/8" Flat Washer	$0.24	$2.64	807296		Home Depot
	1	1/8" Diameter 16" Steel Rod	$2.21	$2.21	801547		Home Depot
Pulley System	1	Tensioning Pulley	$145.00	$145.00	1009		Truroll
	2	2-Sheave Vertical Pulley	$18.34	$36.68	852494		Home Depot
	1	Tension Block	$92.00	$92.00	1010		Truroll
	1	Idler Sheave	$14.25	$14.25	1014		Truroll
	1	82' 3/8" Rope	$11.90	$11.90	MFP8100		Amazon
Reloading Mechanism	1	10 Quart Bucket	$9.99	$9.99	622134		Amazon
	1	3/8" Bolt	$0.90	$0.90	805546		Home Depot
	2	3/8" Nut	$0.13	$0.26	801846		Home Depot
	2	3/8" Flat Washer	$0.08	$0.16	2949		Bolt Depot
	1	12' String	$4.97	$4.97	790525		Lowes
	1	Eye Screw	$0.93	$0.93	669510		Lowes
	1	10' 1" Diameter PVC Pipe	$9.32	$9.32	5AFJ4		Grainger
Other	1	Gorilla Glue	$4.78	$4.78	GG50003		Amazon
	1	Magnetic Strips/Tiles	$6.03	$6.03	23PA67		Grainger
Totals			**Total Cost**	$439.01	**Cost after borrowing materials**	$92.85	

Key
Bought
To be Bought
Borrowed

Technical Drawings

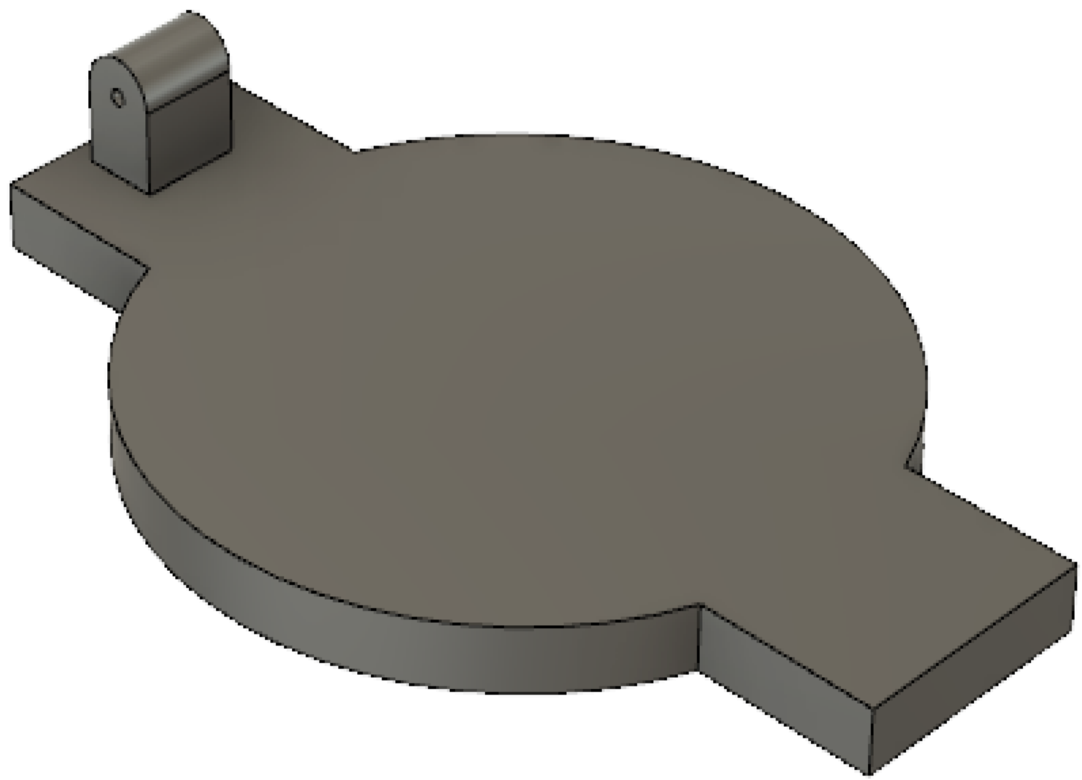
End Cap - Schematic



Technical Drawings

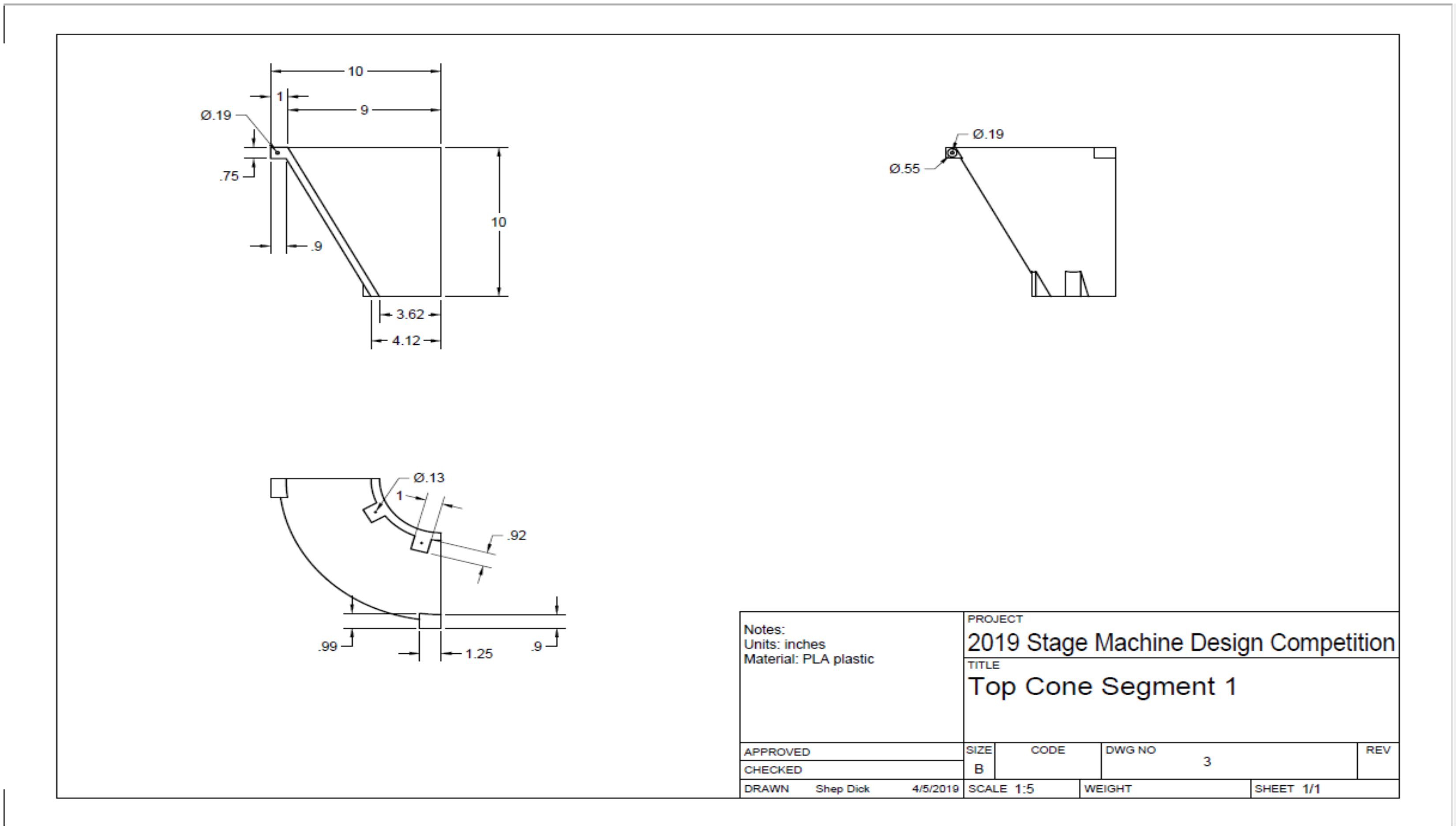
End Cap - Renderings

Isometric View



Technical Drawings

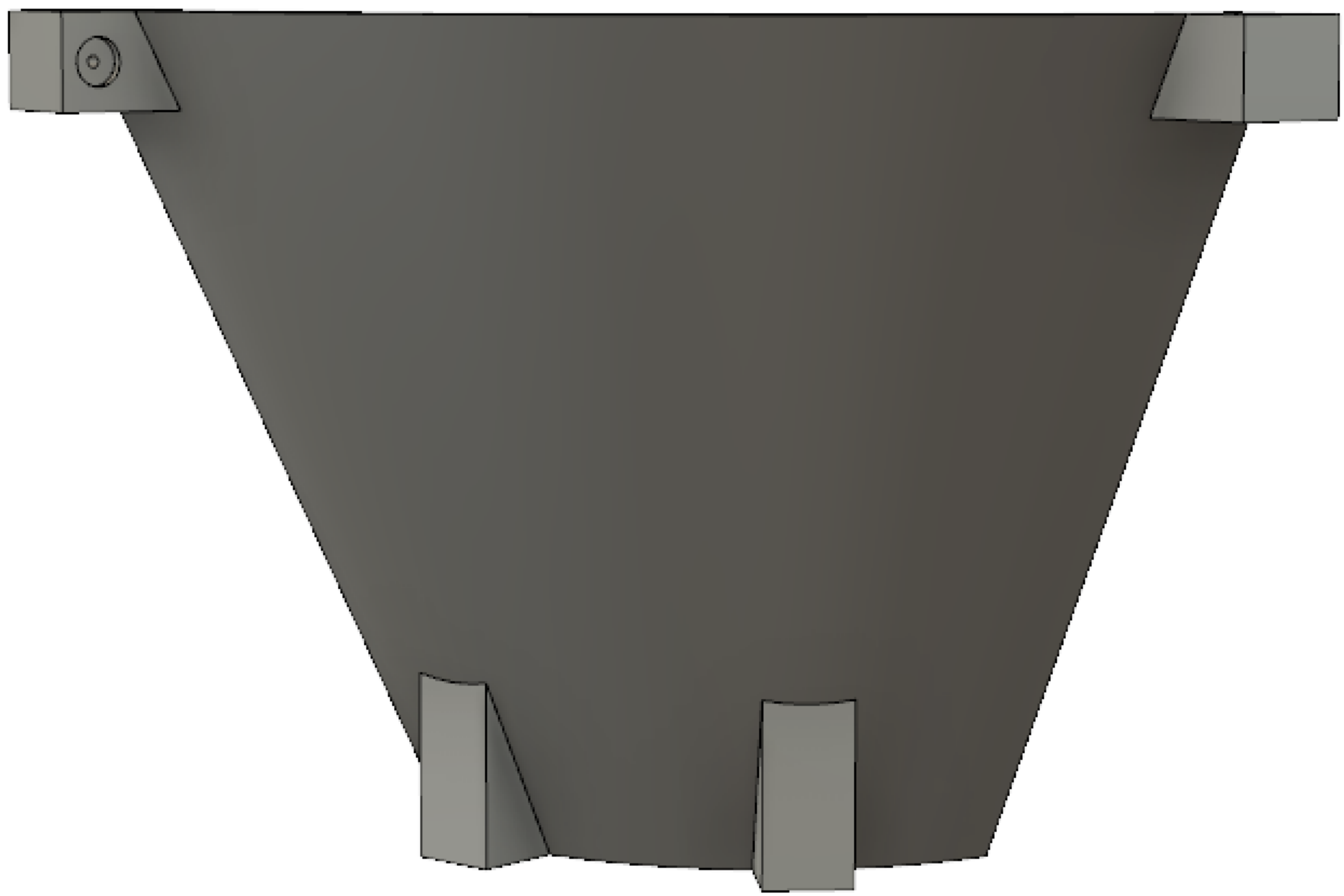
Upper Cone Segment - Schematic



Technical Drawings

Upper Cone Segment - Renderings

Front View

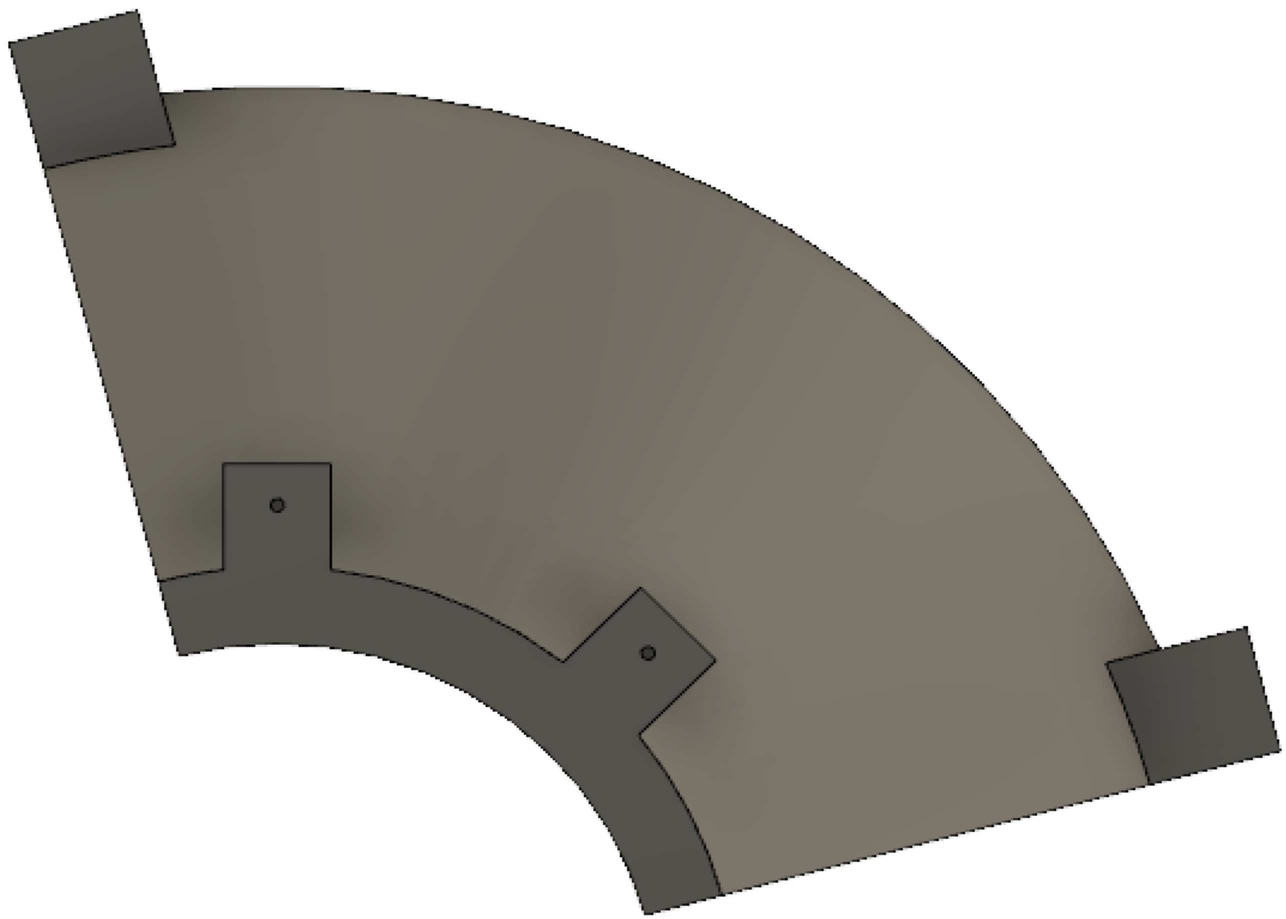


Technical Drawings

Side View

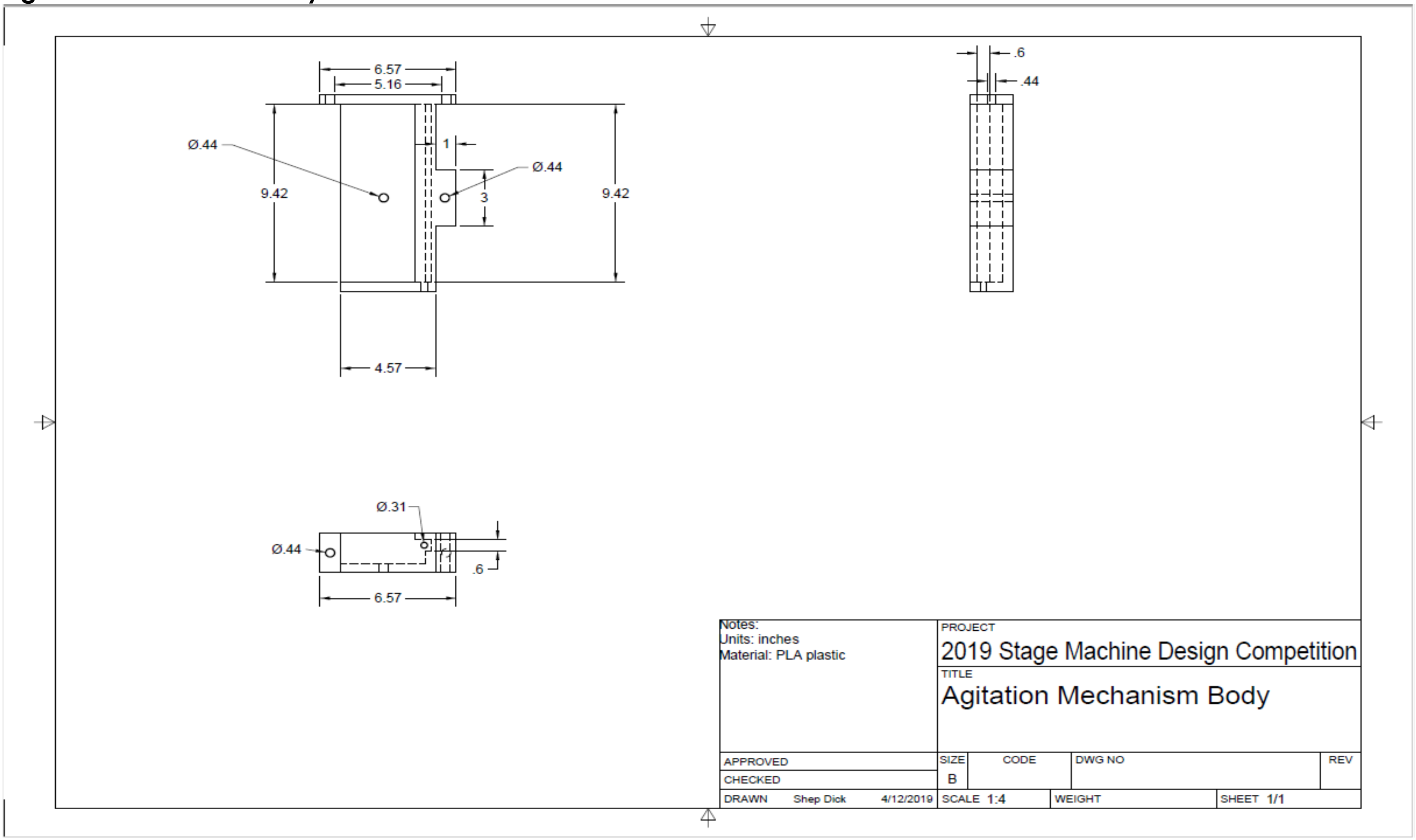
Technical Drawings

Bottom View



Technical Drawings

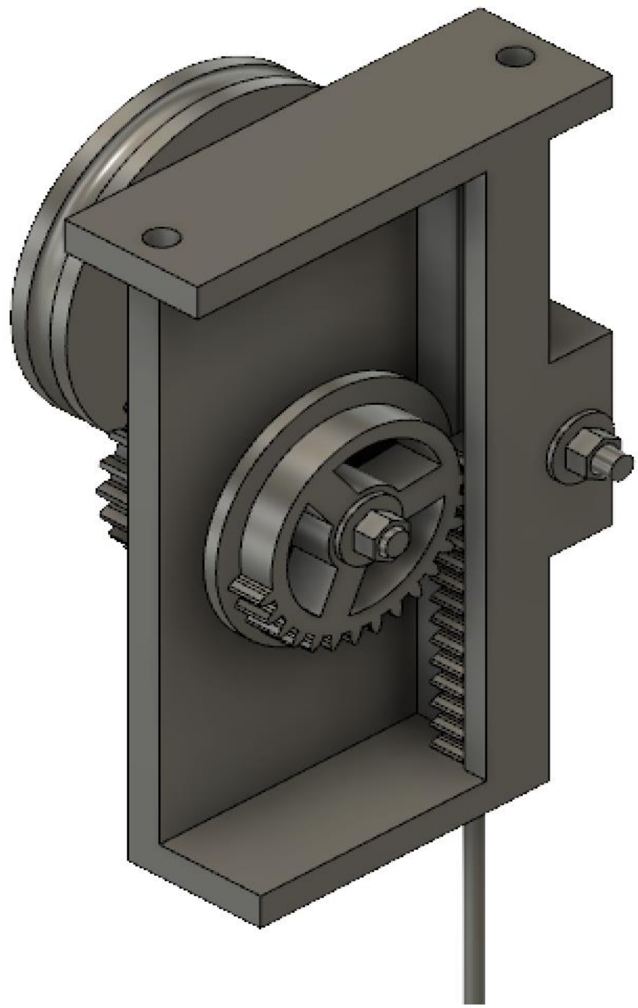
Agitation Mechanism Body - Schematic



Technical Drawings

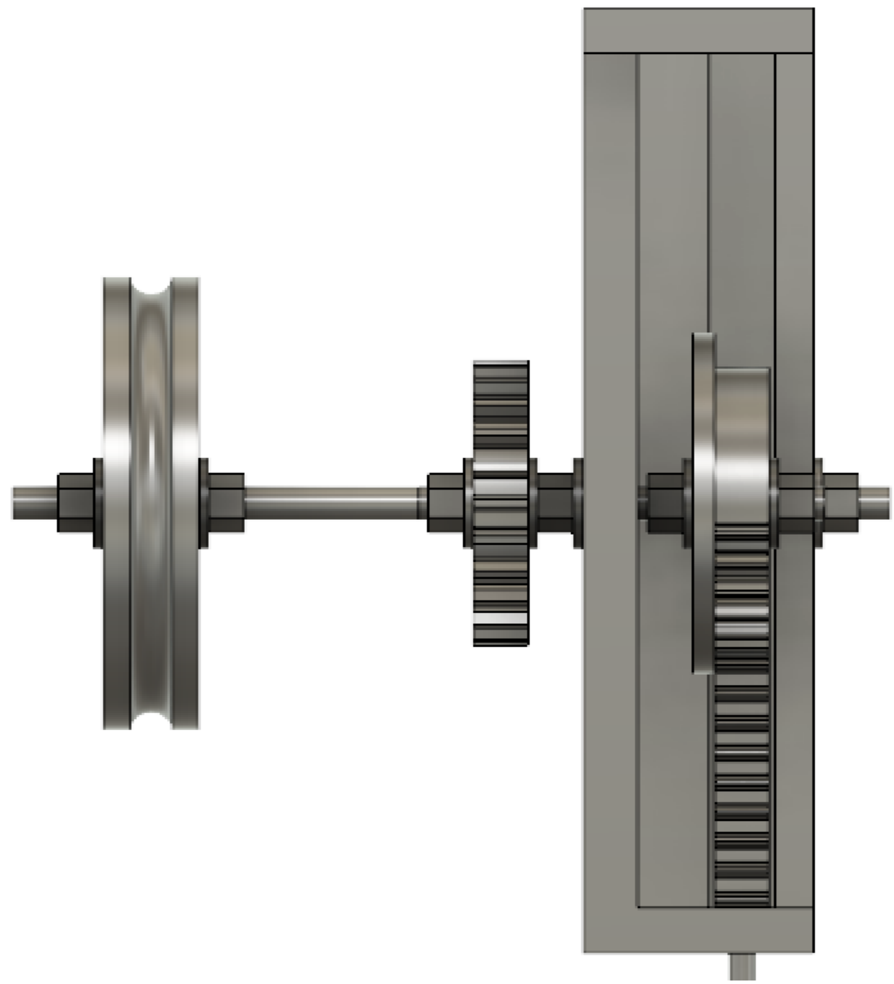
Agitation Mechanism Body - Renderings

Front Isometric View



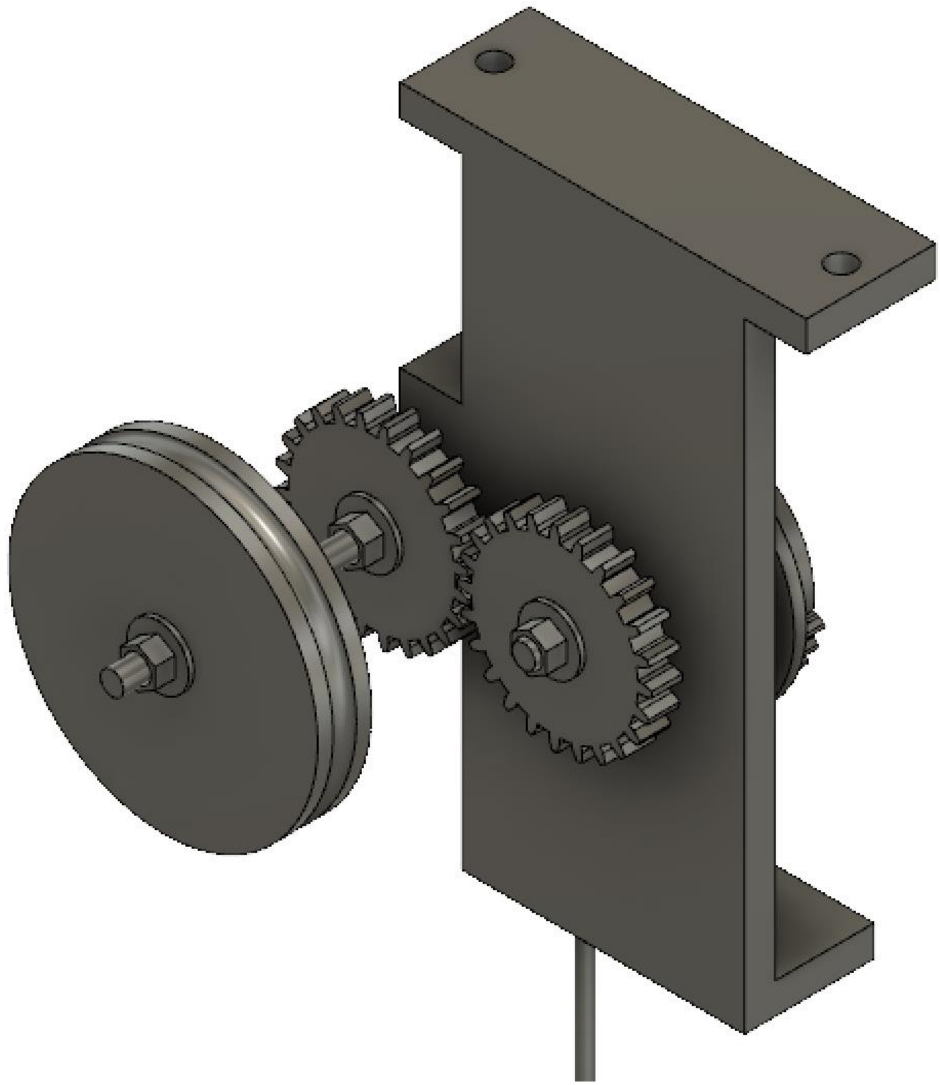
Technical Drawings

Top View



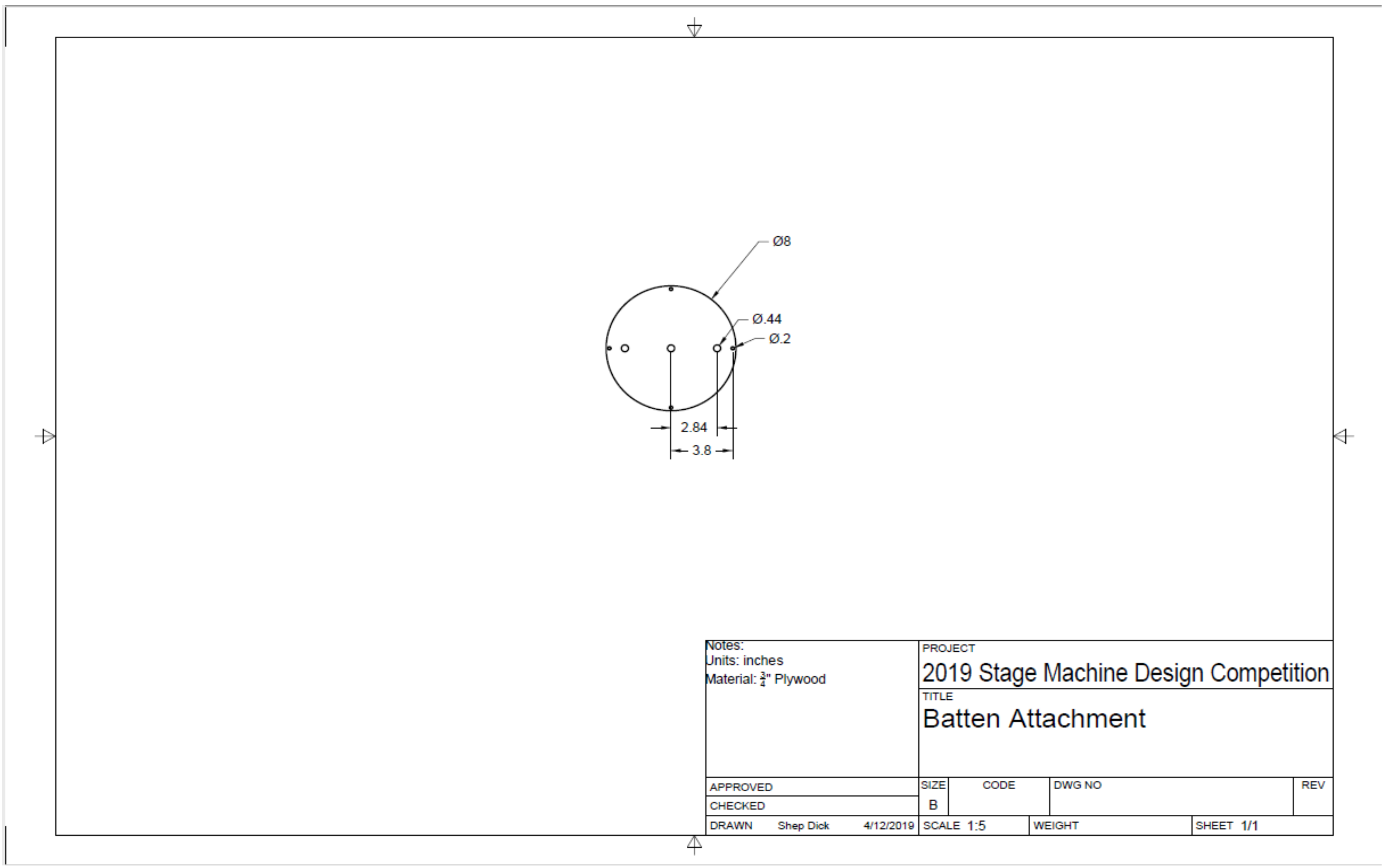
Technical Drawings

Back Isometric View



Technical Drawings

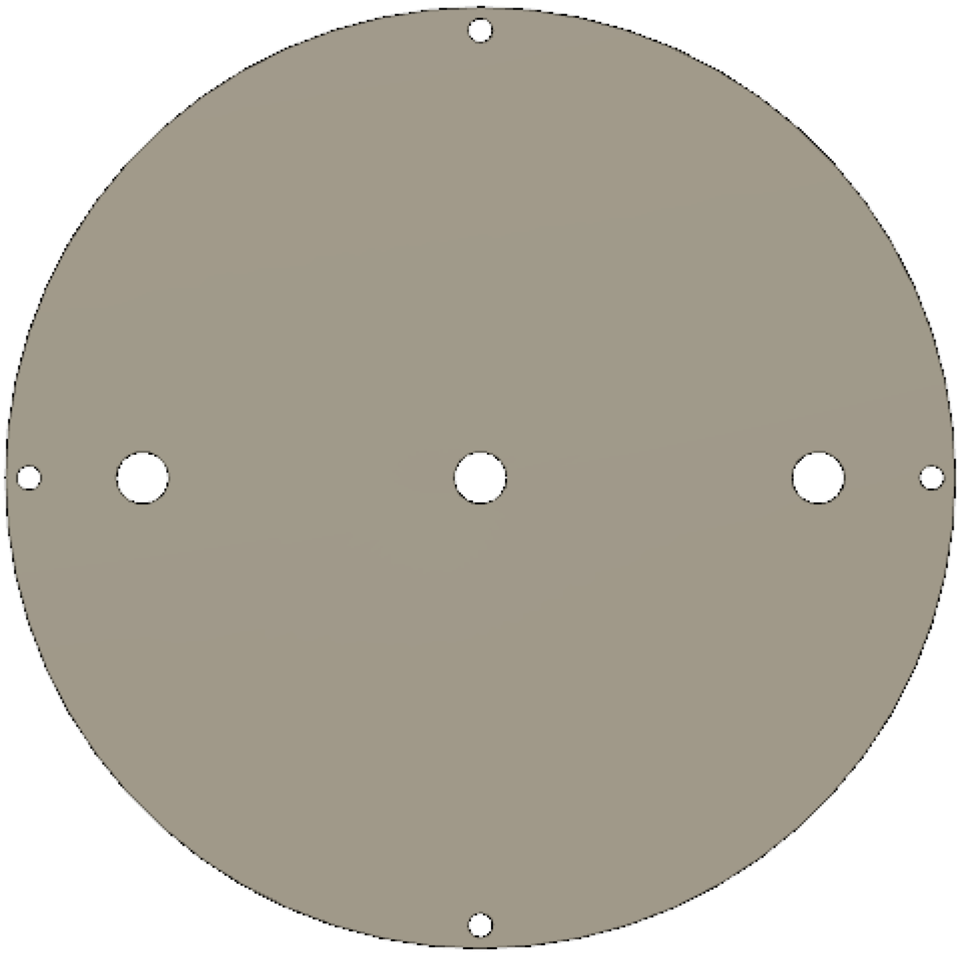
Batten Attachment - Schematic



Technical Drawings

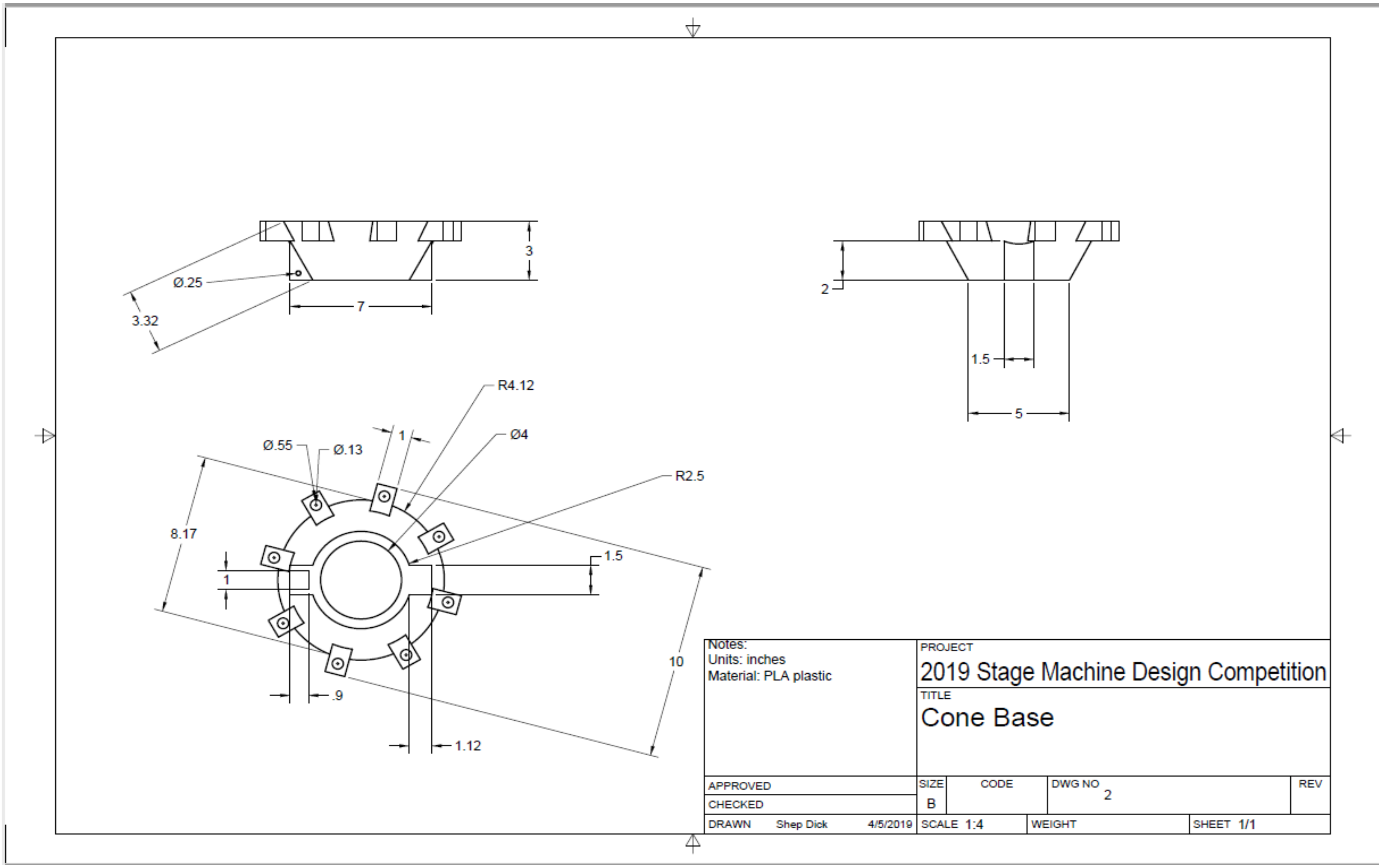
Batten Attachment - Renderings

Top View



Technical Drawings

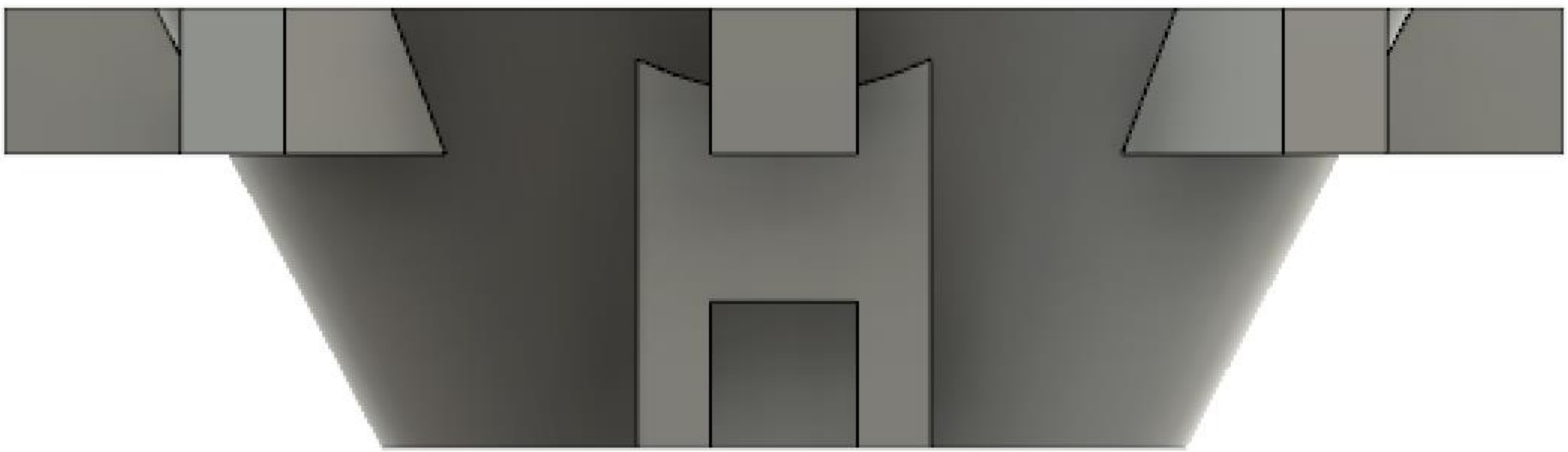
Cone Base - Schematic



Technical Drawings

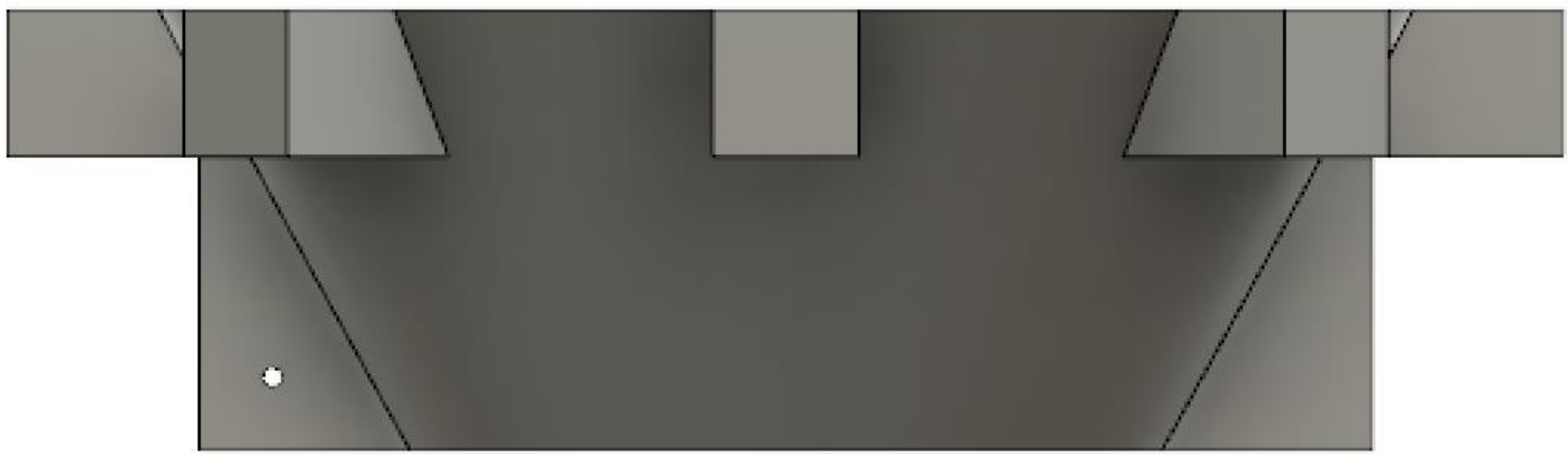
Cone Base - Renderings

Back View



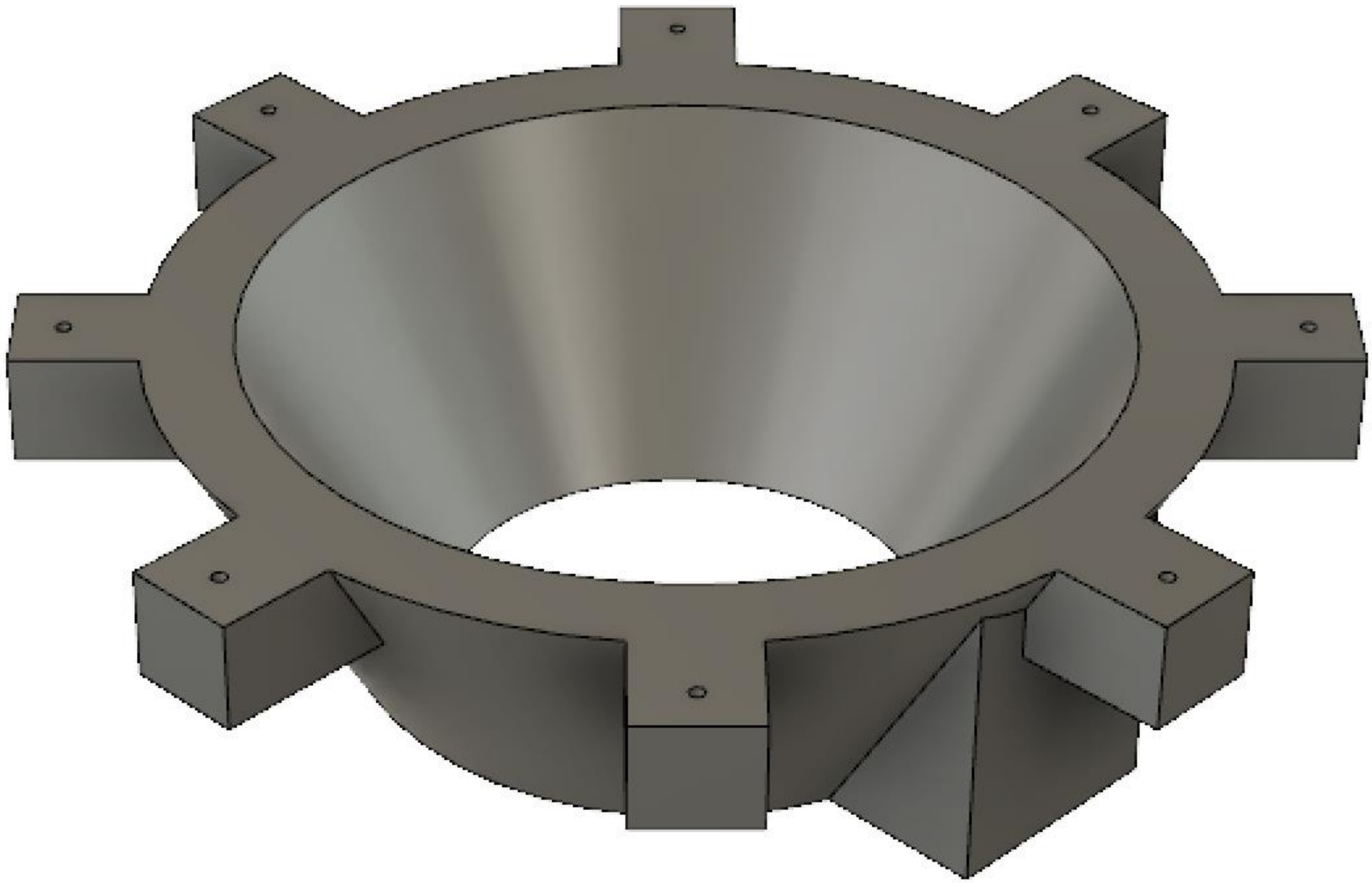
Technical Drawings

Side View



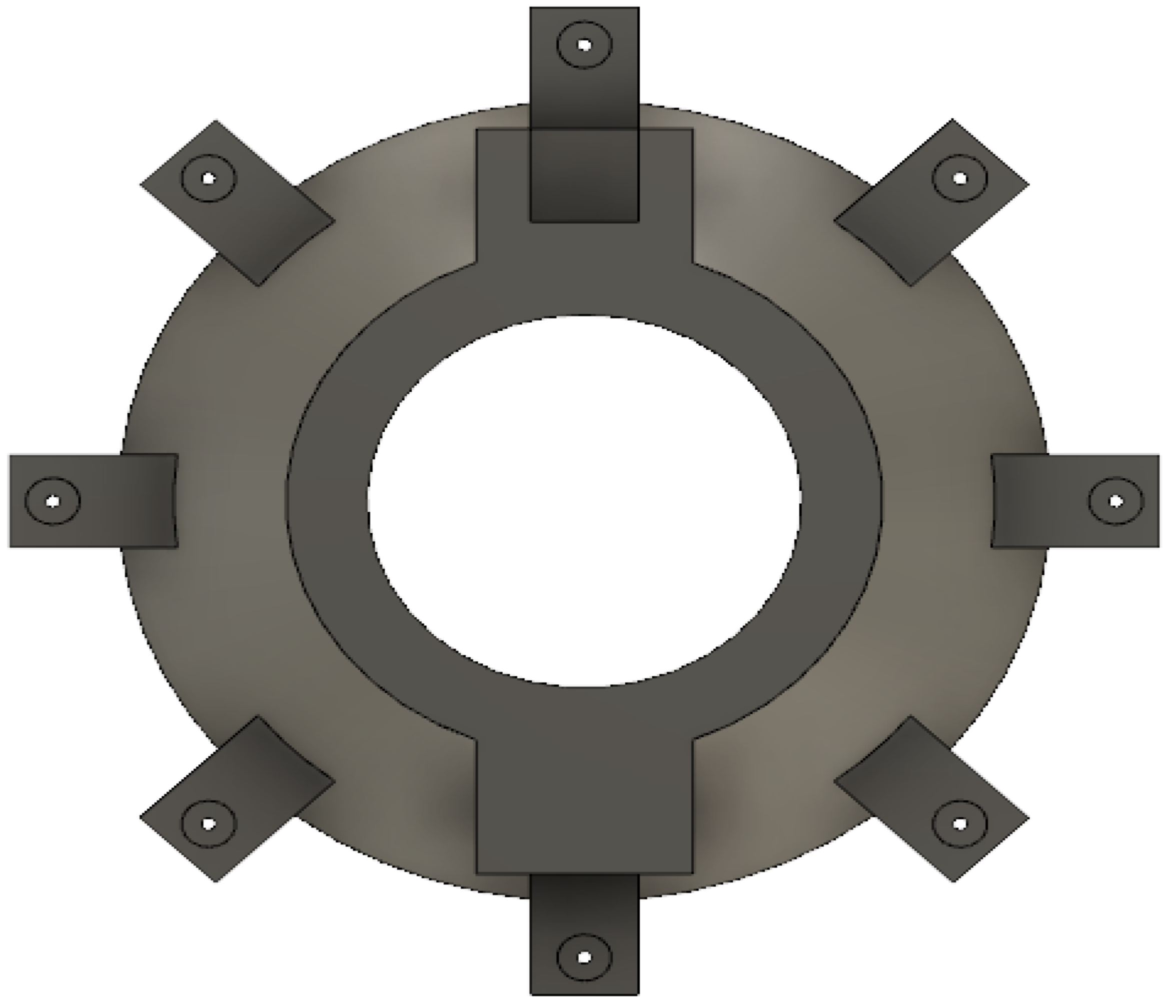
Technical Drawings

Isometric View



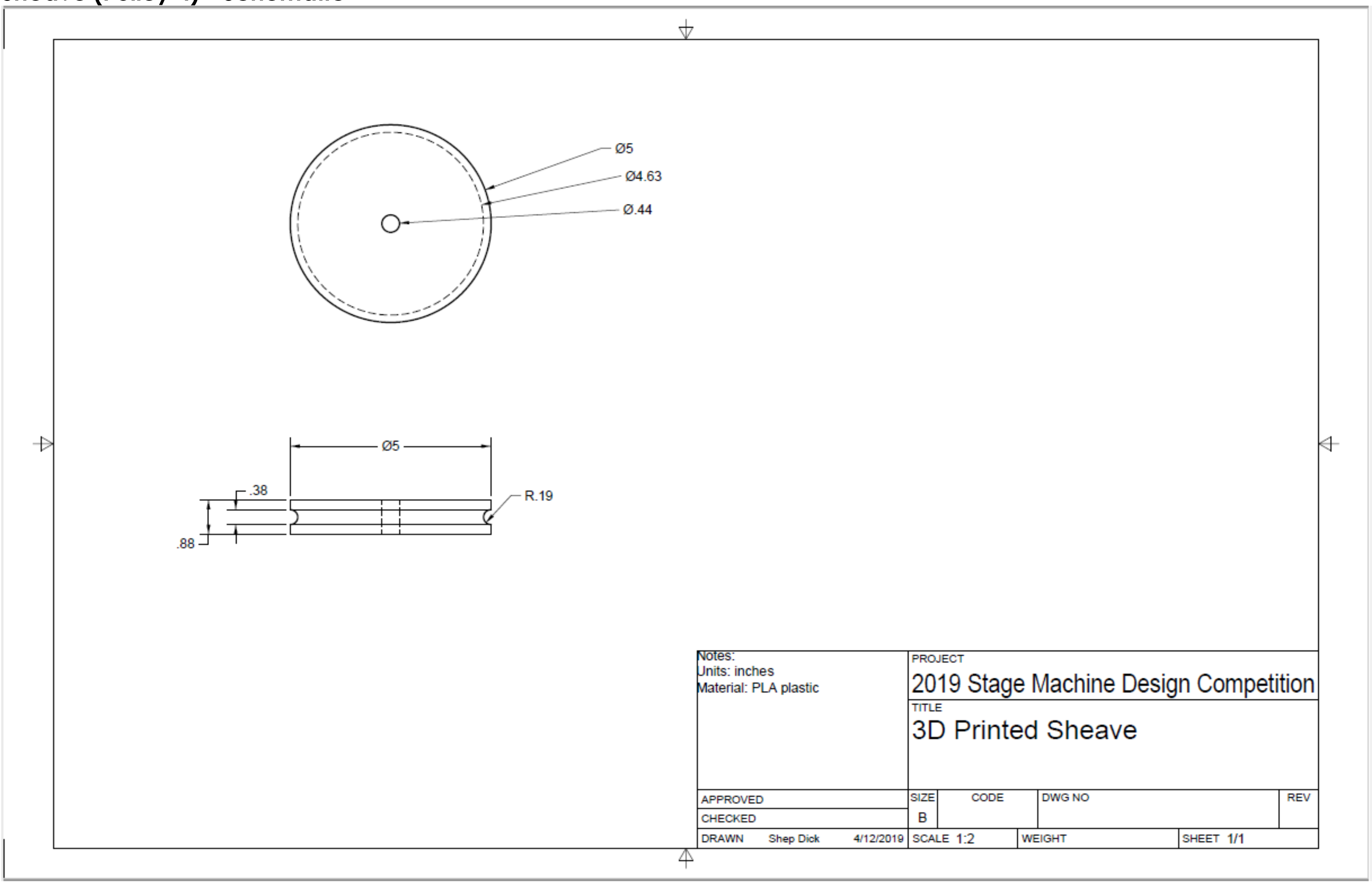
Technical Drawings

Bottom View



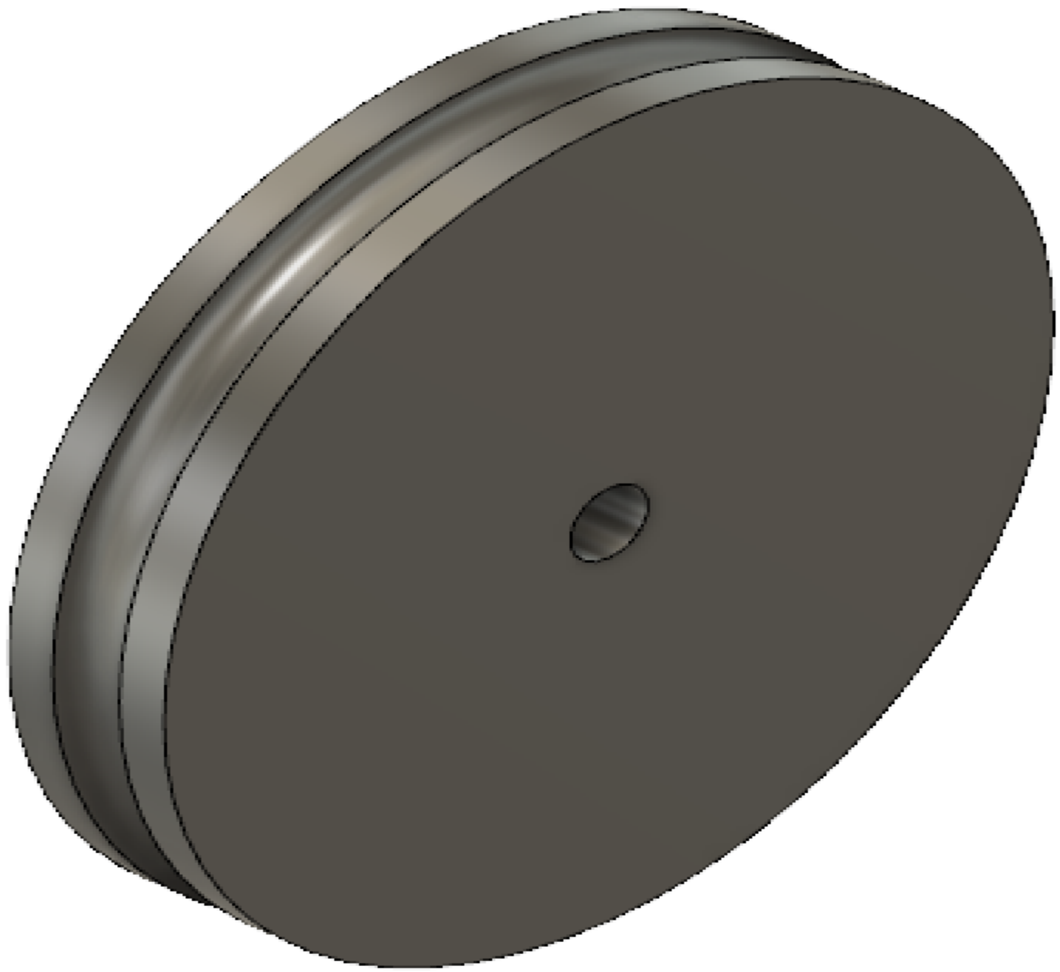
Technical Drawings

Sheave (Pulley 4) - Schematic



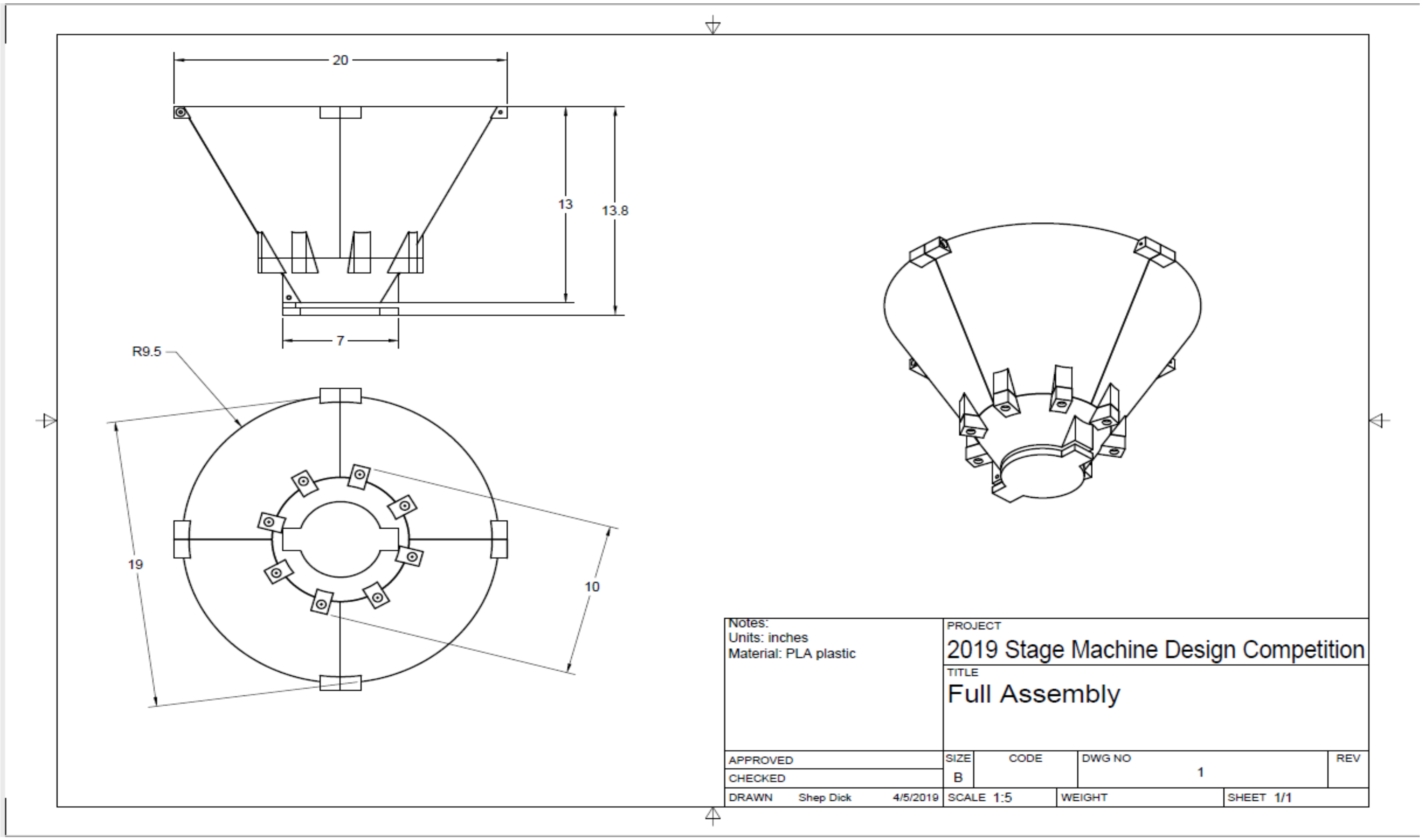
Technical Drawings

Sheave (Pulley 4) - Rendering



Technical Drawings

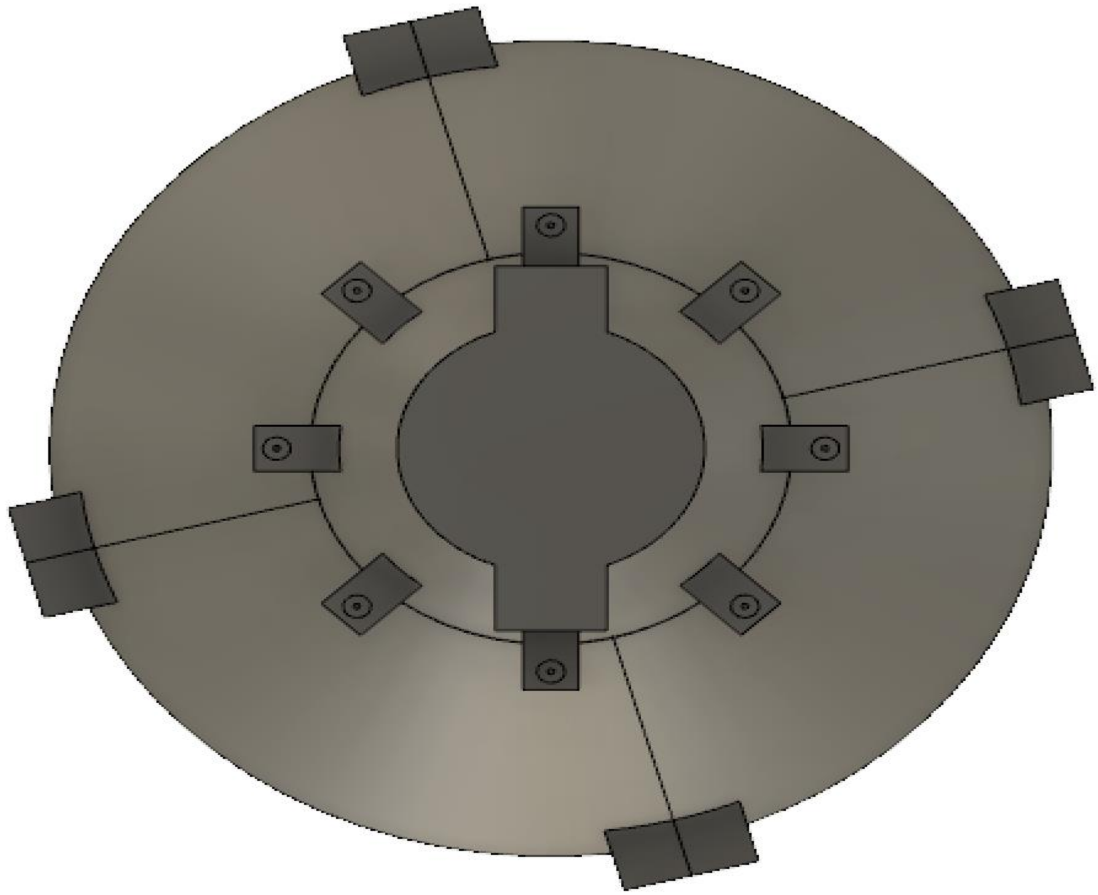
Main Cone Assembled Body - Schematic



Technical Drawings

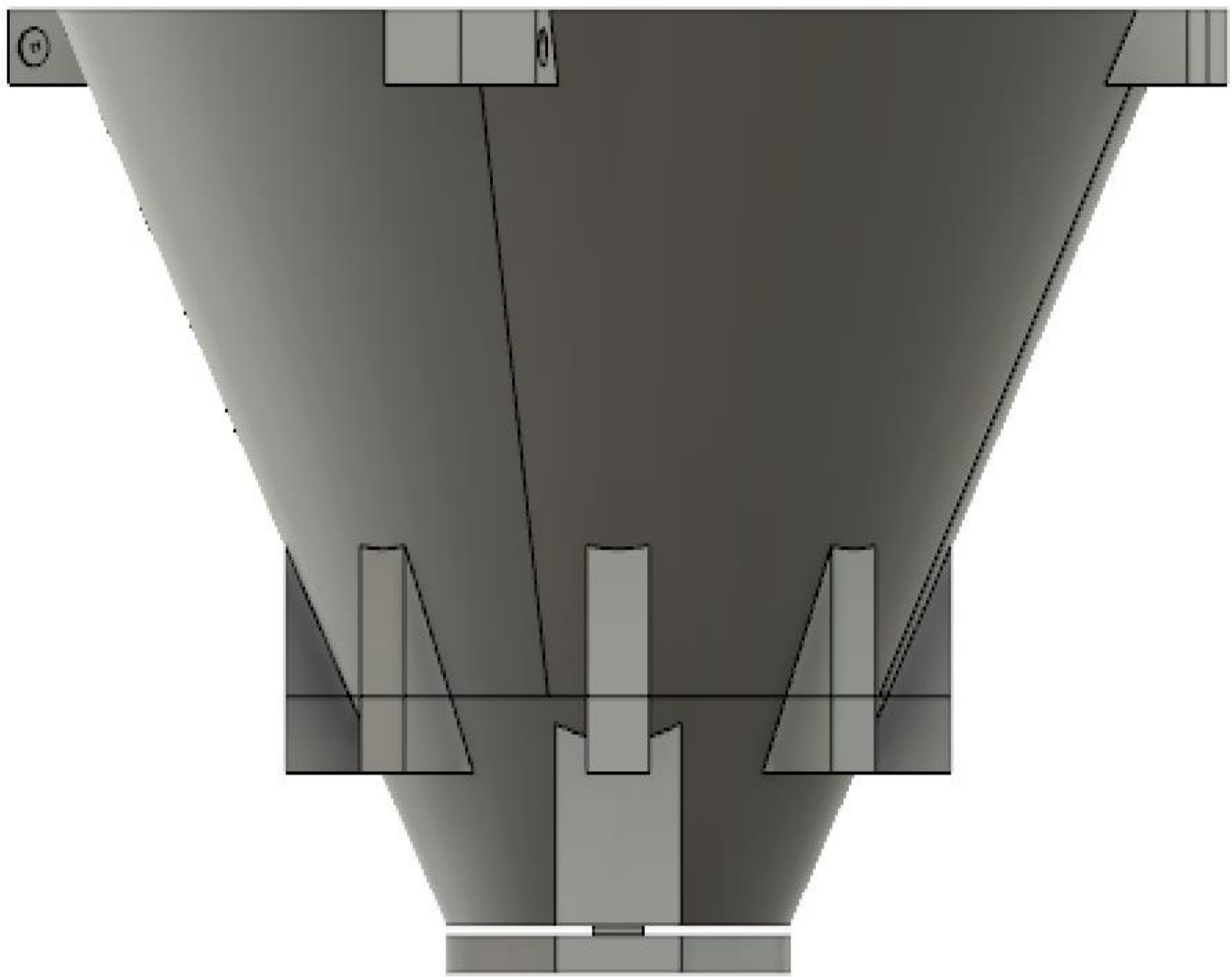
Main Cone Assembled Body - Rendering

Bottom View



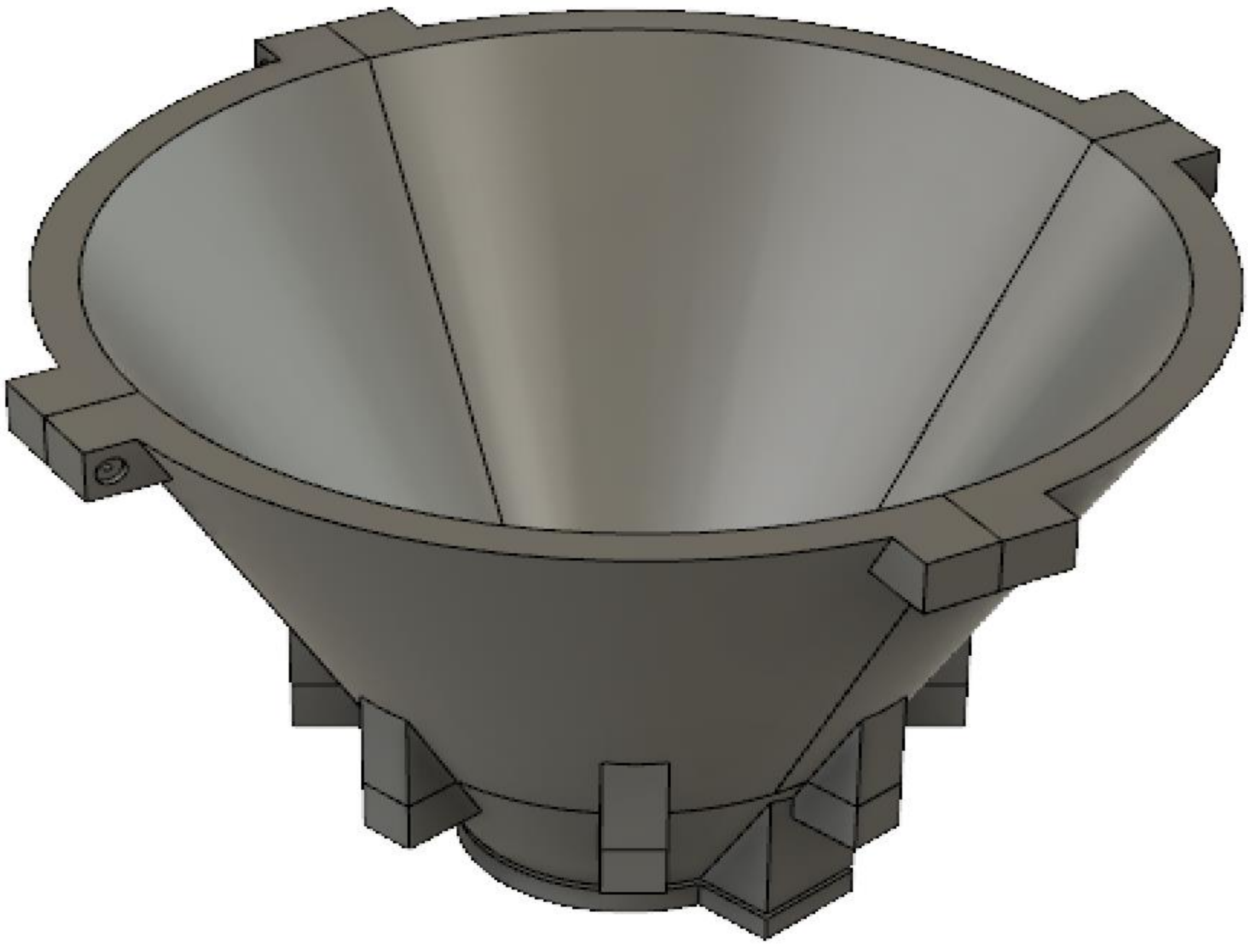
Technical Drawings

Side View



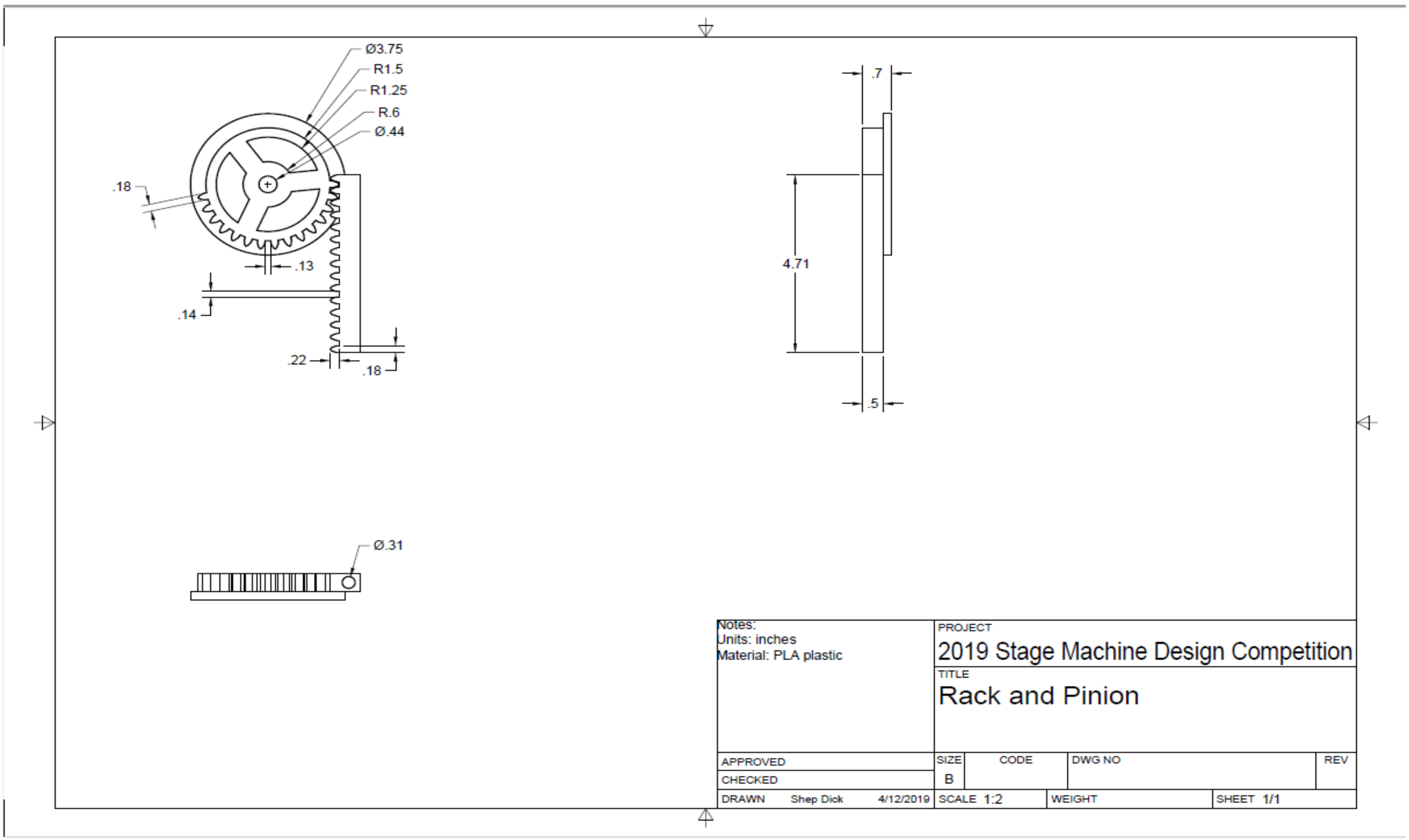
Technical Drawings

Isometric View



Technical Drawings

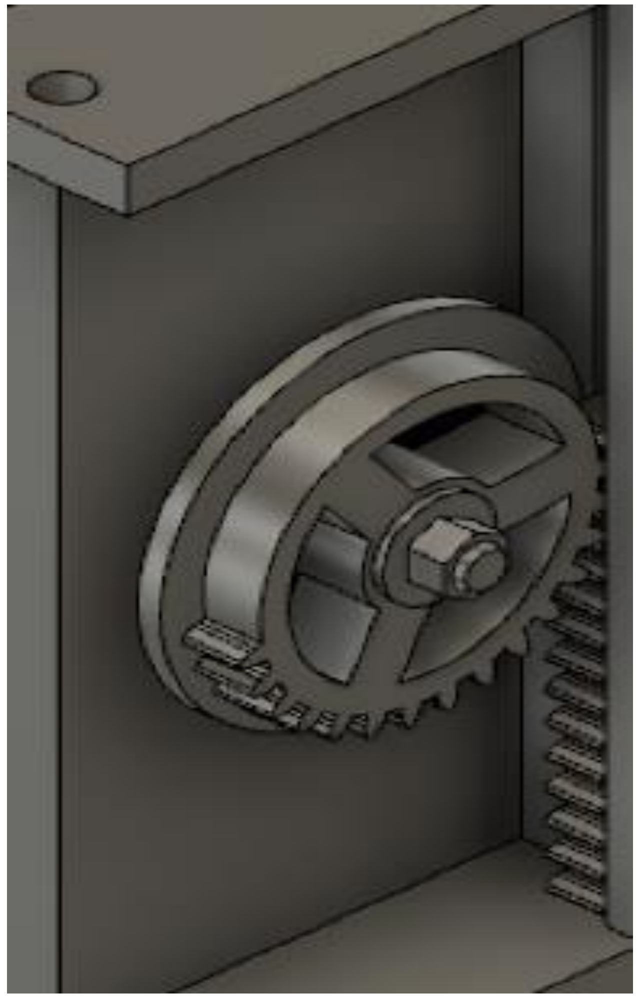
Agitation Mechanism Rack and Pinion - Schematic



Technical Drawings

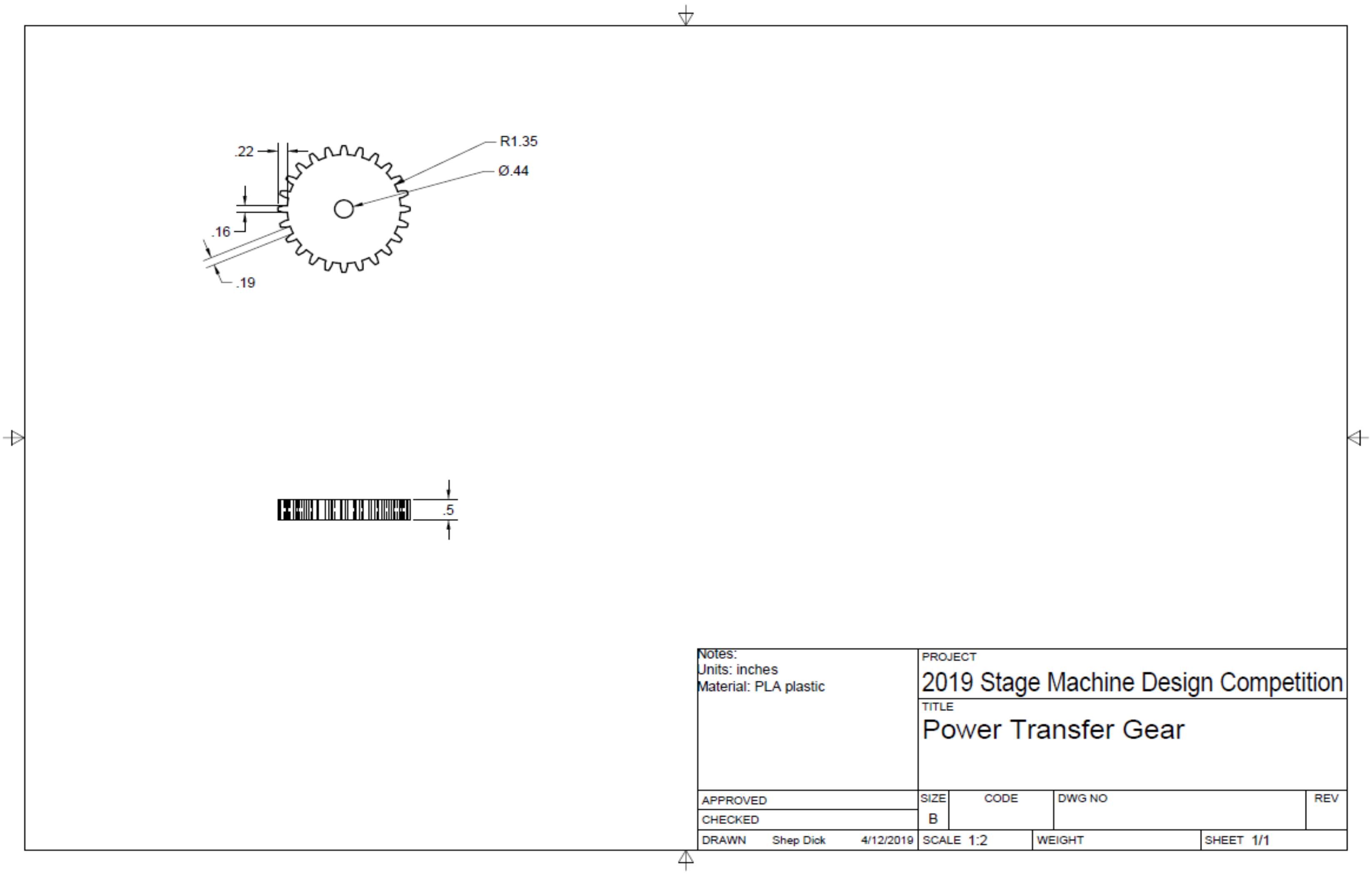
Rack and Pinion - Rendering

Isometric View



Technical Drawings

Agitation Mechanism Gear - Schematic



Technical Drawings

Agitation Mechanism Gear - Rendering

Isometric View

Mathematical/Engineering Analysis

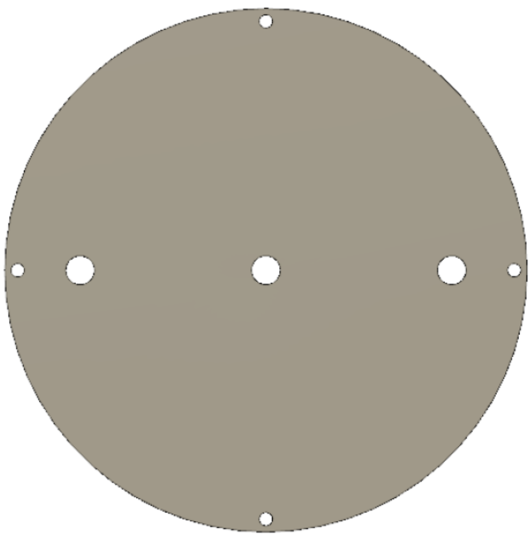
Component	Variable	Unit	Value	Given/Assumption/Formula
Mechanism	Time-total	seconds	30.0000	Given
Mechanism	Time-accel	seconds	4.0000	Assumption
Mechanism	Time-const	seconds	22.0000	Assumption
Mechanism	Time-decel	seconds	4.0000	Assumption
Mechanism	Time-cycle (avg)	seconds	2.0000	Assumption
Mechanism	Number of pinion cycles	N/A	15.0000	Time-total/Time-cycle (avg)
Partial Pinion	Radius-bottom of teeth	inches	1.5000	Given
Partial Pinion	Radius-bottom of teeth	feet	0.1250	Radius-bottom of teeth/12
Partial Pinion	Circumference	feet	0.7854	2*PI*Radius-bottom of teeth
Partial Pinion	Displacement-total	feet	11.7810	Number of pinion cycles*Circumference
Shaft Sheave	Radius-core	inches	2.3100	Given
Shaft Sheave	Radius-core	feet	0.1925	Radius-core/12
Shaft Sheave	Circumference	feet	1.2095	2*PI*Radius-core
Shaft Sheave	Displacement-total	feet	18.1427	Number of pinion cycles*Circumference
Mechanism	Displacement-total	feet	18.1427	Total Displacement of Rope during entire Move
Mechanism	Velocity-constant move	ft/sec	0.6048	Constant Velocity Move: Total Displacement/Total Time
Mechanism	Velocity-initial	ft/sec	0.0000	Given
Mechanism	Velocity-const	ft/sec	0.6978	Total Displacement of Rope/26 (Using Velocity Profile)
Mechanism	Velocity-final	ft/sec	0.0000	Given
Mechanism	Acceleration	ft/sec^2	0.1744	(2*Displacement-accel)/time-accel^2
Mechanism	Deceleration	ft/sec^2	-0.1744	(-2*Displacement-decel)/time-decel^2
Mechanism	Displacement-accel	feet	1.3956	Velocity-const*Time-accel*1/2 (Using Trap. Velocity Profile)
Mechanism	Displacement-const	feet	15.3515	Velocity-const*Time-const (Using Trap. Velocity Profile)
Mechanism	Displacement-decel	feet	1.3956	Velocity-const*Time-decel*1/2 (Using Trap. Velocity Profile)
Rack and piston	Force-weight	pounds	0.1000	Given
Rack and piston	Mass	slugs	0.0031	Force-weight/Acceleration-gravity
Rack and piston	Force-accel	pounds	0.0003	Mass*Acceleration
Rack and piston	Force-lift	pounds	0.1000	
Partial Pinion	Displacement-angular-cycle	radians	6.2832	
Partial Pinion	Angular velocity	rad/sec^2	1.5708	
Partial Pinion	Moment of Inertia	slugft-ft^2	0.0125	
Partial Pinion	Torque-accel	inch-pounds	0.0196	
Shaft Sheave	Angular velocity	rad/sec^2	0.6048	
Shaft Sheave	Moment of Inertia	slugft-ft^2	0.0172	
Shaft Sheave	Torque-accel	inch-pounds	0.0104	

MANUAL AND USER INSTRUCTIONS

PART 1

- Install the main cone mechanism and the agitation mechanism to the bottom of the batten using the batten attachment.
    - Bolt the agitation mechanism to the underside of the batten attachment using 3/8” bolts, washers, and nuts.
    - Clamp the c-clamp to the batten.
    - Hook 4 bungee cords to the holes on the circumference of the batten attachment.
    - Hook the other side of each bungee cord to the holes in the main cone.

Figure 1 Batten Attachment



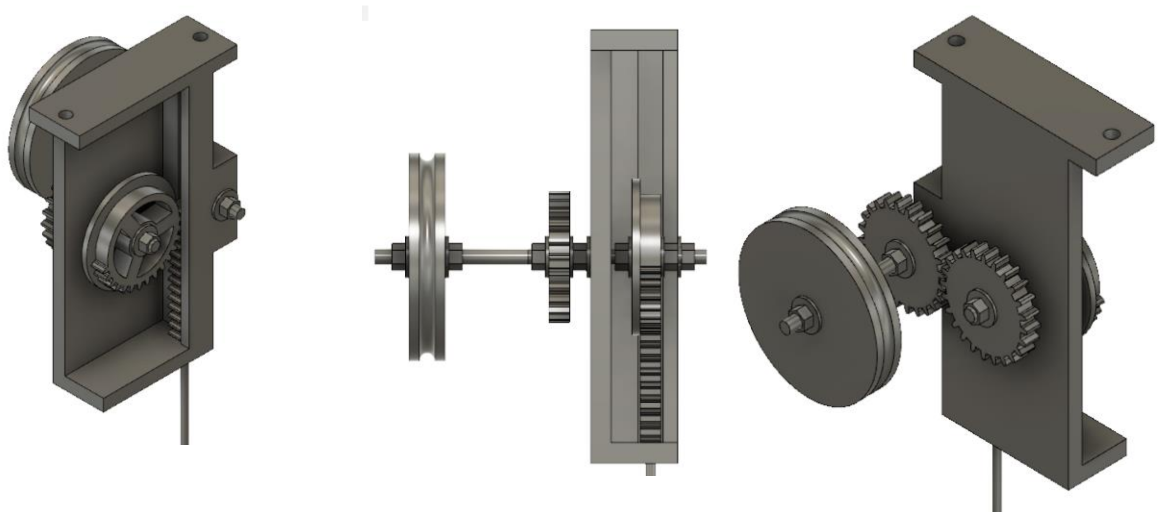
The bottom of a c-clamp is bolted to the disk through a hole in the center, and clamps to a batten. Two more holes are drilled along the radius to bolt the attachment to the agitation mechanism. This is also connected to the end cap of the main cone below.

Figure 2 Main Cone

An upside-down hollow cone with a 19” diameter base formed at an angle of roughly 30° off of vertical. A 4” diameter hole truncates the cone 13” below the base.Near the top, four holes are drilled in the sides of the cone that serve as attachment points for bungee cords that will attach the cone to the batten attachment.

Figure 3 Agitation Mechanism

MANUAL AND USER INSTRUCTIONS



The agitation mechanism is suspended above the main cone, affixed to the bottom of the batten attachment. A 16” agitator rod extends from the bottom of the mechanism through the inside of the main cone.

PART 2

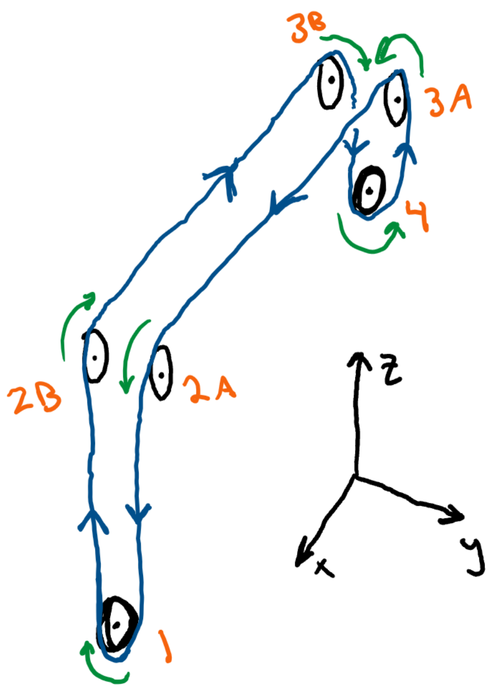
- Connect the pulleys and sheaves in the order of this diagram starting from pulley 1 to pulley 4 using ⅜” rope.
- First, screw in pulley 1 directly into the stage below the stage left edge of the batten,
- Then, connect pulleys 2B and 2A vertically above pulley 1, using the aforementioned rope.
- Afterwards, travel approximately 25’ across the batten with the rope an install pulleys 3B and 3A.
- Later, use the sheave (or pulley 4, as seen in figure 5) that is connected to the agitation mechanism, along with the rope, to the agitation mechanism to the rest of the pulley system.
- Finally, leave rope at the end of pulley 1, so that one will be able to pull the rope later in the process to drive the mechanism.

Figure 5 Sheave of Agitation Mechanism

MANUAL AND USER INSTRUCTIONS

The sheave of the agitation mechanism that has an outer radius of 2-½ " and an inner radius of 2-⁵⁄₁₆ . The indention around the sheave allows for the ⅜ " rope to continuously run through the pulley system and drive the agitation mechanism.

Figure 6 Completed Pulley System



Pulley system containing a total of 4 pulleys , and 1 sheave acting as a pulley, that assists in driving the rack-and-pinion system inside of the agitation mechanism to cause the effect.

PART 3

MANUAL AND USER INSTRUCTIONS

Figure 7 Reloading Mechanism

The bucket will be filled with the desired volume of flower petals and lifted up to the top of the main cone. The string that is connected to the lip of the basket is used at the other end of the pole so that it may be tilted.

- Use the reloading mechanism to load the main cone from the ground.
  - Fill the bucket with approximately 10 quarts of flower petals.
  - Lift the lip of the bucket to the lip of the main cone.
  - Pull the string to pour the flower petals from the reloading mechanism's bucket into the main cone.

PART 4

- Pull the rope at the end of pulley 1 to drive the agitation mechanism, allowing the petals loaded to fall accordingly for the desired effect.
  - Pull at a moderate rate of speed, watching the end of the piston to assure a smooth and controlled released

MANUAL AND USER INSTRUCTIONS

SAFETY PROTOCOLS

In the preceding steps, ensure that the main cone, agitation mechanism, and pulley system do not collapse from the batten. The user must secure all systems properly and consistently . Inspect separate mechanisms for unstable components or fasteners before use.

If the rope used is too long, then the rope could be a tripping hazard, and should be cut accordingly. As for the reloading mechanism, make certain that the bucket is properly secured to the PVC pipe. This is to guarantee the bucket will not break and fall from the pole when lifted and injure those below the reloading mechanism.

To accommodate this, confirm that no persons are located under the batten where the main mechanisms are when utilizing the reloading mechanism. Consistently monitor for stress-based failures of systems used, and be aware of the relative sturdiness/reliability factors of materials used when constructing the various mechanisms mentioned above.