Low-Cost Multifunctional Heating Device

ME 1670 *Introduction to Engineering Graphics and Visualization*

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Fall 2021

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Contents

Chapter 1

Project Ideation

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Project Title: Low-Cost Multifunctional Heating Device	Tejas Gururaj	tejasgururaj@gatech.edu
Number of Components: 48	Stanisław Kowalski	skowalski3@gatech.edu

Description of Low-Cost Multifunctional Heating Device:

A sustainable, low-cost, solar heating device that concentrates solar radiation to power or simplify common household items or chores in a non-toxic and healthy manner.

Sustainable Development Goal:

"Ensure access to affordable, reliable, sustainable, and modern energy for all" (Goal 7 | Department of Economic and Social Affairs (un.org)).

Context and Design Details:

A sustainable, low-cost, solar heating device would be greatly beneficial to communities receiving sufficient sunlight and having coal/wood-powered sources of heat, as burning coal/wood generates smoke with toxic chemicals, harming the cook's health, especially the lungs. Several initiatives are in place to attempt to solve the problem using solar stoves, but we believe our solution is more cost-effective and more utilitarian in terms of functionality. By building a low-cost solar stove, we can provide a sustainable and healthy (non-toxic) way of generating heat to power various components. To generate heat from the sun, our device uses a large truss-framed concave reflector to concentrate heat radiation reflected to a smaller area inside the reflector.

Our multifunctional heating device enables users to cook food using a cooking attachment, purify water by distillation, dry clothes, towels, and dishes using the drying rack attachment, and power a stirling engine for power generation. Our solution aids socially by providing an affordable and healthy solution for cooking food and performing other tasks with lesser effort, electricity consumption, and accessibility in areas lacking electrification. The heating device is powered solely by the solar radiation, which makes

our solution sustainable from an environmental perspective. Our solution is economical due to the easier manufacturability of our product, use of cheaper materials and simpler structures, lack of electronic components (except the generator), and bulk efficiency allowed by its large size.

Product Sustainability and Necessity:

1) The product is produced using commonly found industrial materials. The product also does not release noxious elements when used. The product solely utilizes solar energy to power its components.
2) The machine is targeted for impoverished areas in sub-Saharan Africa where households continue using coal or wood stoves. Constraints for households include allocation for a large amount of space: the width is 1000 mm to allow the reflector to reflect a sufficient amount of energy to heat components/tools efficiently.
3) The product helps prevent the toxic environment by assisting households in shifting from the burning of non-renewable energy sources.
4) The product speeds up people's ability to complete tasks through easy access to energy and an efficient heating device.
5) The product will also abate carbon emissions since the machine utilizes only the renewable sources of energy to complete household tasks.

Description of Geometric Features/Modules:

- Solar Reflector (Siva Appana): This modular component consists of a reflector that will concentrate the heat energy to a small region. The frame will allow for rotation to permit the user to revolve the reflector to point towards the sun. The frame will also allow the following attachments to clip on. The reflector will follow a catenary curve to optimally concentrate heat to a single point.
- Cooking Rack (Siva Appana): The cooking rack resembles the structure of a stove to permit pots and pans to be placed. This promotes the movement from traditional petroleum/coal burning stoves to solar stoves. The cooking rack is constructed from thin ceramic pipes to create a stove-like environment. The cooking rack can easily be placed on top of the frame and held in place by gravity.
- Pots/Pans (Akash Chennuri): The kit includes several compatible pots and pans to promote healthy cooking for an individual or a community. The cast iron pots and pans are designed to fit on the cooking rack.
- Drying Rack (Akash Chennuri): This attachment allows various materials to dry when placed on top of it, serving functions such as clothes-drying or dish-drying. The drying rack fits on top of the solar reflector frame similar to the cooking rack. The cooking rack attachment must be removed to place the drying rack.

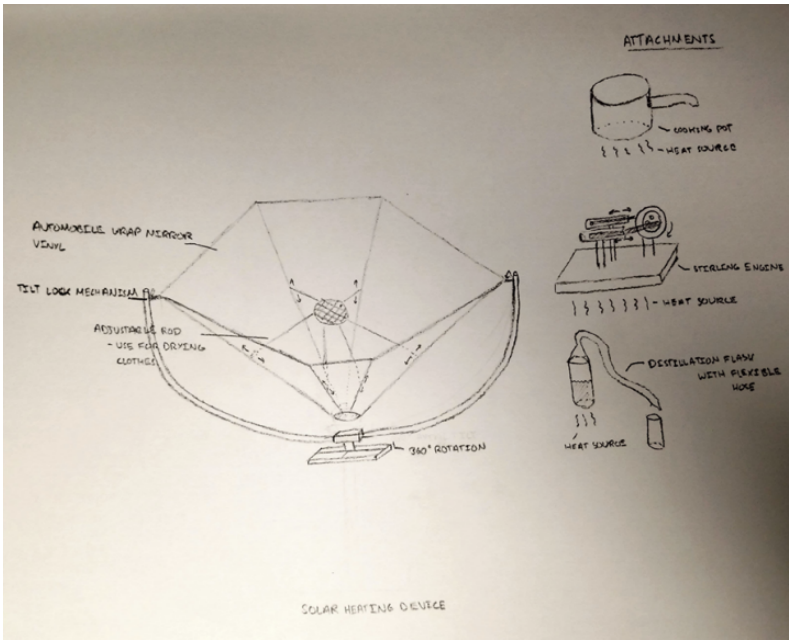
- Shelves (Tejas Gururaj): The small shelves fit around the solar reflector frame. The shelves hold utensils, non-perishable foods, and pots/pans. The interior design of these shelves is optimized to store jars, utensils, pots, and other cooking-related supplies.
- Distillation Grid (Tejas Gururaj): This component allows users to distill water to increase access to clean water despite the lack of clean water surrounding the community. The water is purified by evaporating and collecting the evaporated water in a separate jug.
- Stirling Engine (Stanisław Kowalski): The device produces electricity by converting the heat to rotational mechanical energy which then converts to electrical energy with the use of a turbine. This can power a lightbulb for a small household or store energy in a generator. The stirling engine is designed similar to a crankshaft.

Moving Parts

The subassemblies, as listed above, each consist of moving components. The solar reflector frame includes rotational motion and a swinging motion, thus allowing the frame to rotate in all three dimensions. The cooking rack, being an attachment, will have translational movement when placed on the frame and removed from the frame. The drying rack will also have a similar movement. The pots/pans have translational movement, moving from the shelves to the cooking rack or drying rack. The shelves will have sliding doors and drawers. The distillation grid will move from the storage to the cooking rack, occupying two segments of the cooking rack. The stirling engine will have a rotating crankshaft and a piston to generate electricity over time.

Each component in each subassembly will be modeled individually; then, the subassemblies will be assembled and animated using the SolidWorks 3D Rendering. The animation will consist of all the moving components displayed sequentially.

Initial Sketch/Idea of Proposed System:



Project Management, Planning, Timeline:

Tasks	23-Sep	24-Sep	30-Sep	6-Oct	7-Oct	8-Oct	9-Oct	14-Oct	21-Oct	28-Oct	29-Oct	30-Oct	31-Oct	4-Nov	5-Nov	11-Nov	12-Nov	13-Nov	15-Nov	16-Nov	17-Nov	18-Nov	19-Nov	20-Nov	21-Nov	24-Nov	2-Dec	5-Dec	6-Dec	10-Dec	15-Dec
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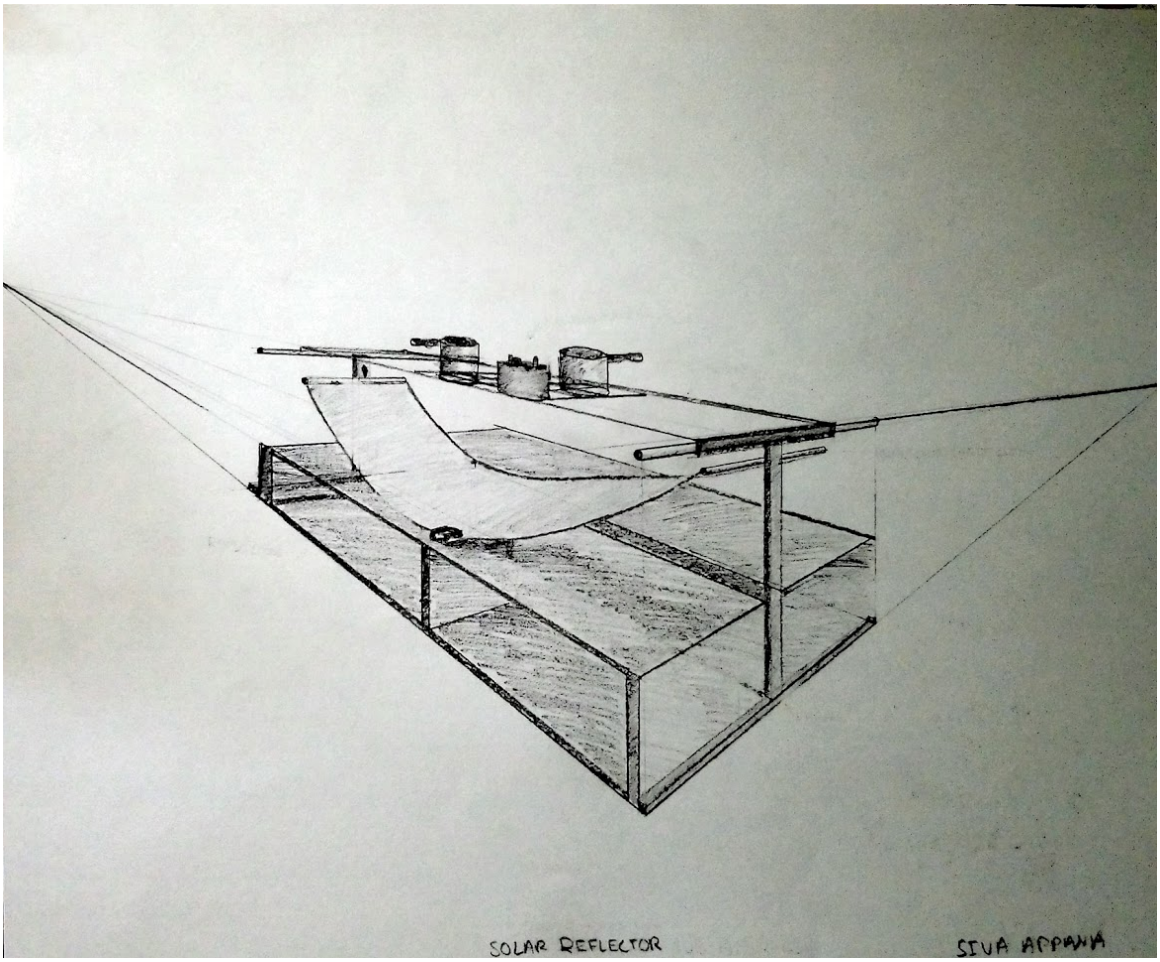
Labs																															
Meetings (Meeting Minutes)																															
Sketch Parts																															
Submit Sketches																															
Model Parts																															
Submit Part Models																															
Align Part Dimensions																															
Assemble Sub-Assemblies																															
Assemble/Revise Parts																															
Submit Assembly																															
Prepare Assembly Instructions																															
Generate Assembly Instructions Views																															
Compile Assembly Instructions																															
Submit Report																															
Prepare Presentation																															
Complete Rendering																															
Present Presentation																															

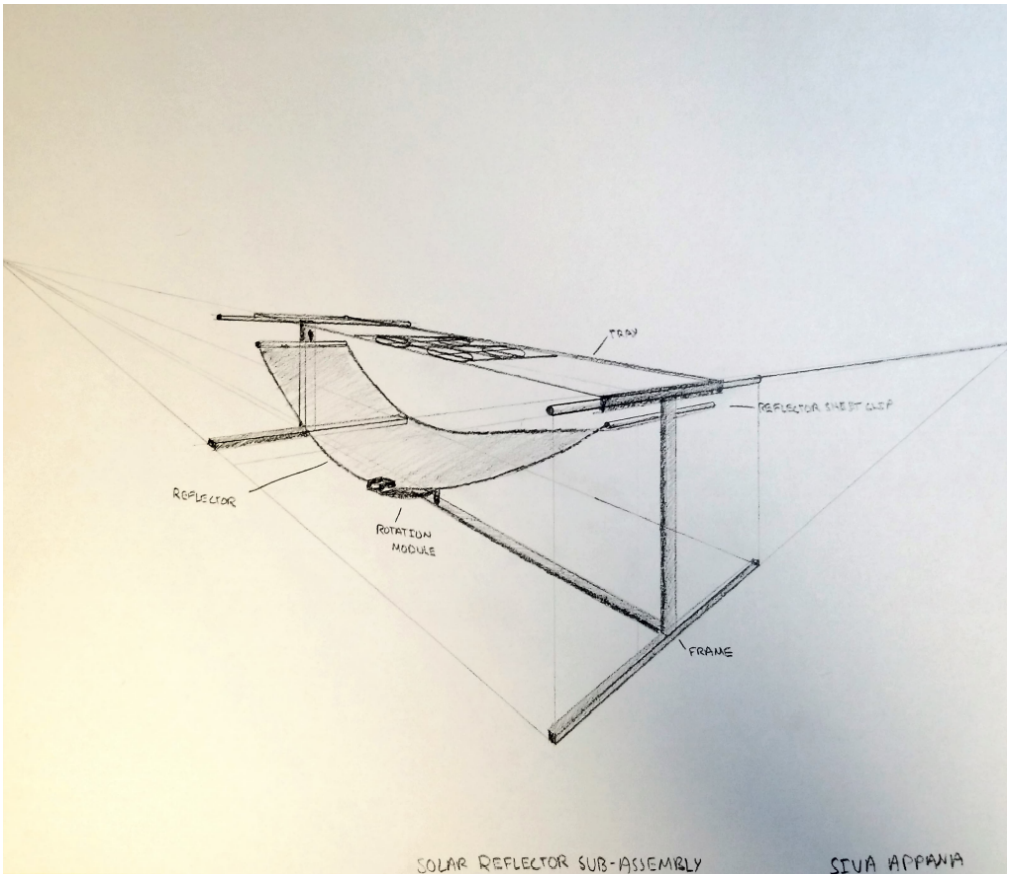
Chapter 2

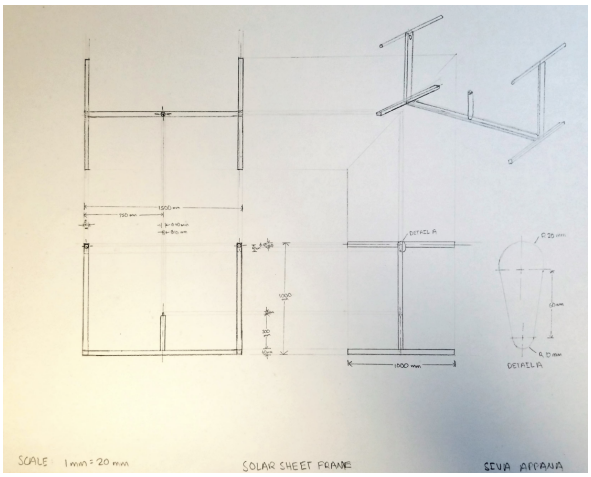
Preliminary Design

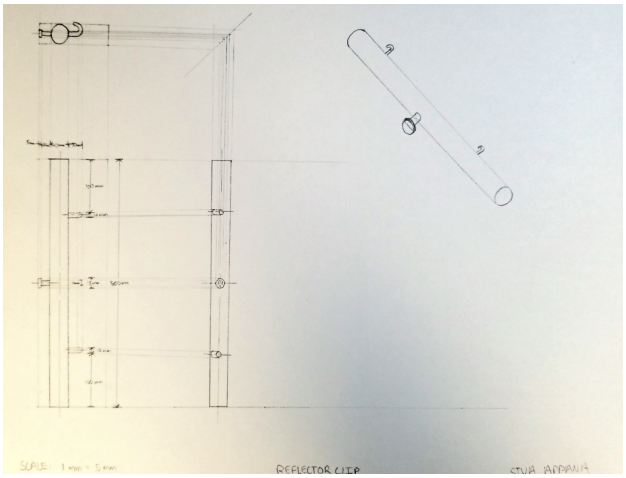
Complete Perspective Sketch - Siva Appana



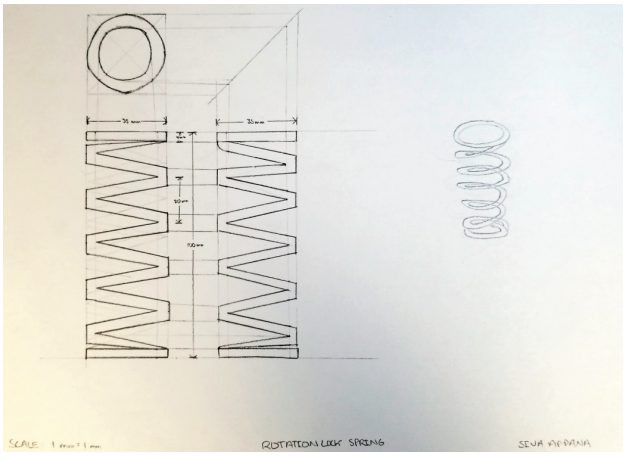
Hand Sketches - Siva Appana

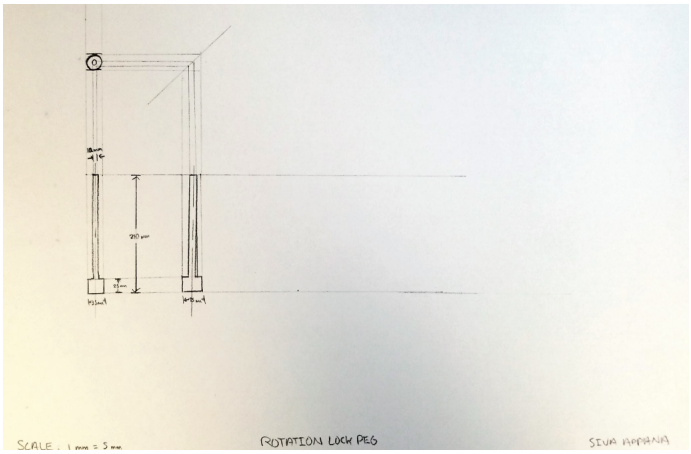


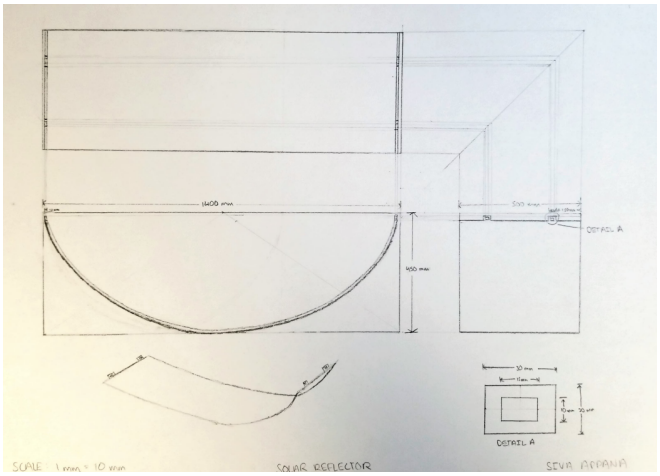


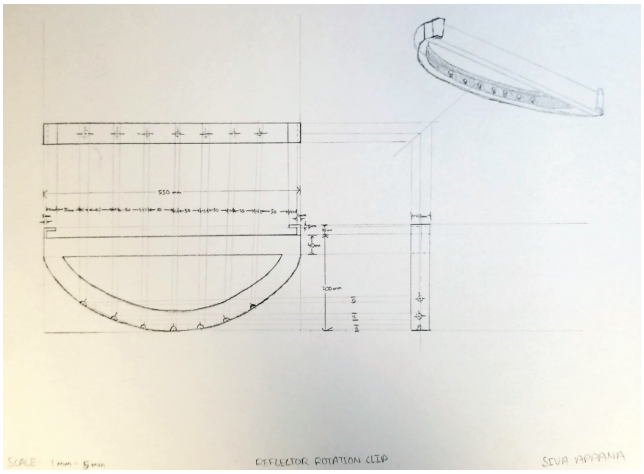


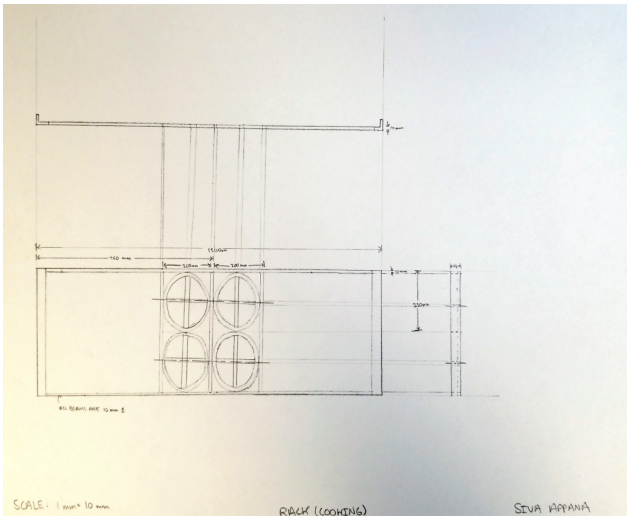
Hand Sketches - Siva Appana



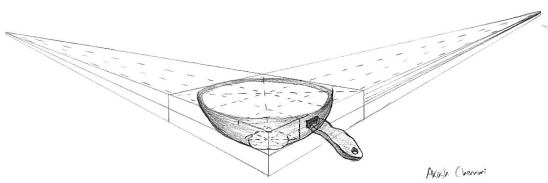


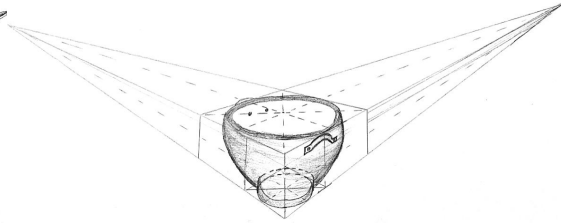


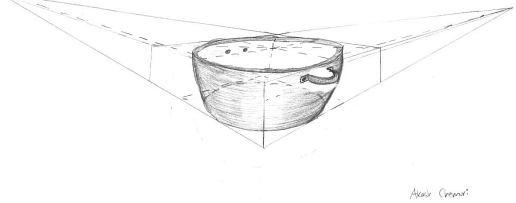


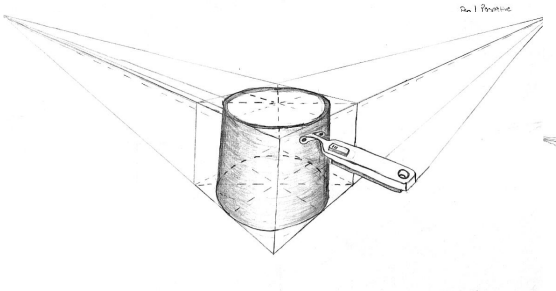


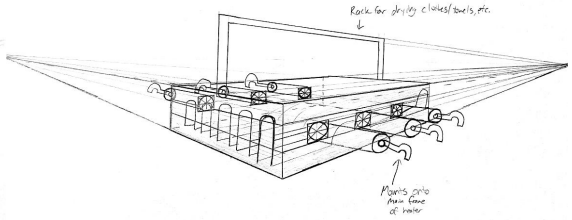
Hand Sketches - Akash Chennuri

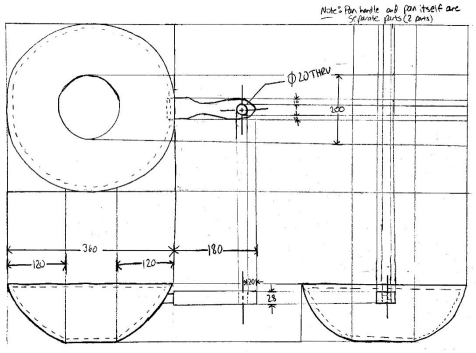


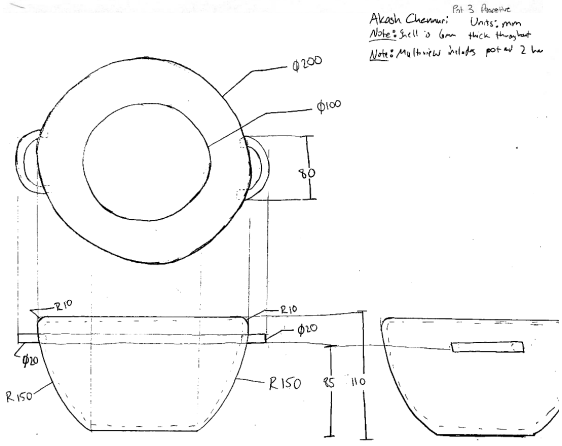


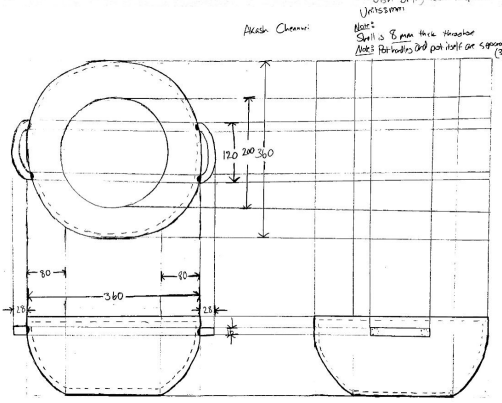


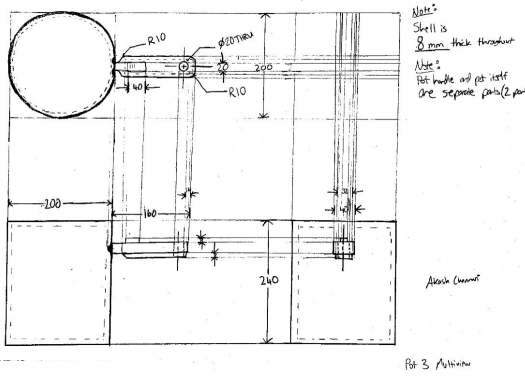












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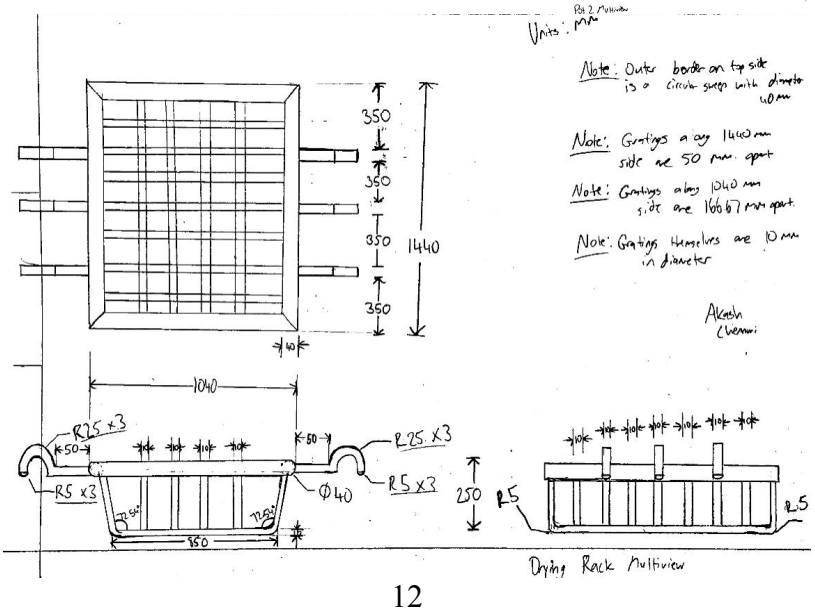
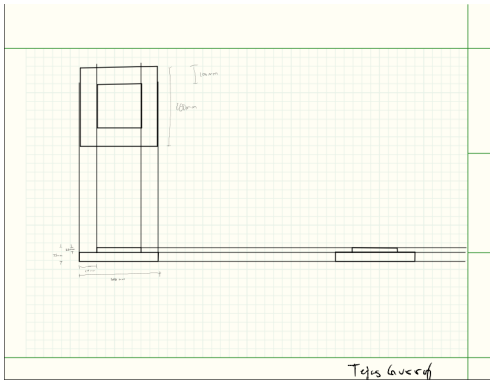
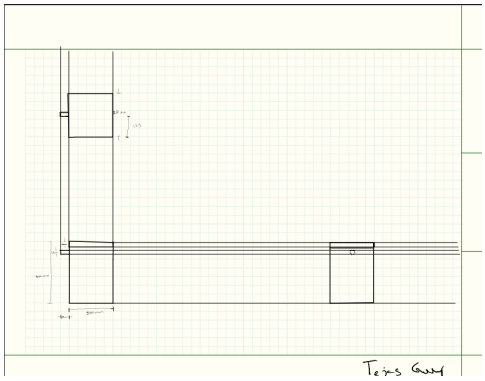
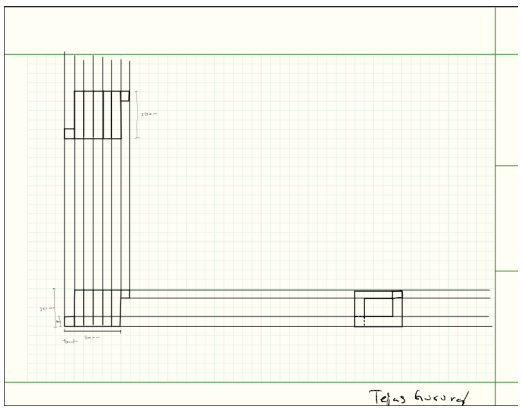
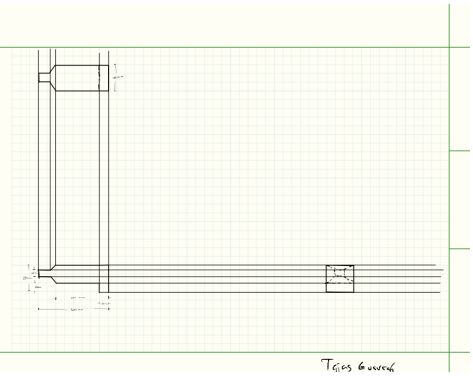


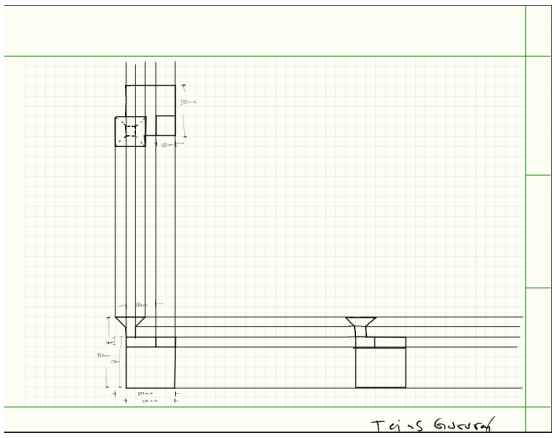
Hand Sketches - Tejas Gururaj

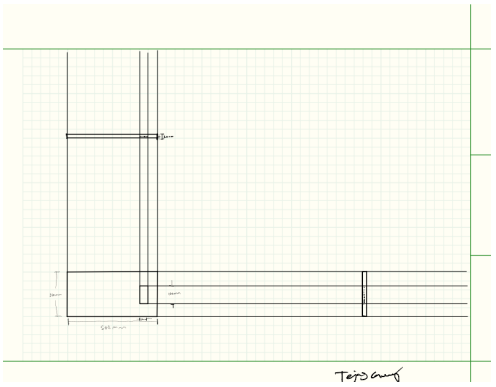


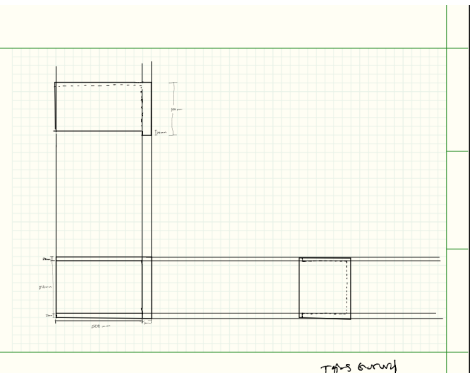


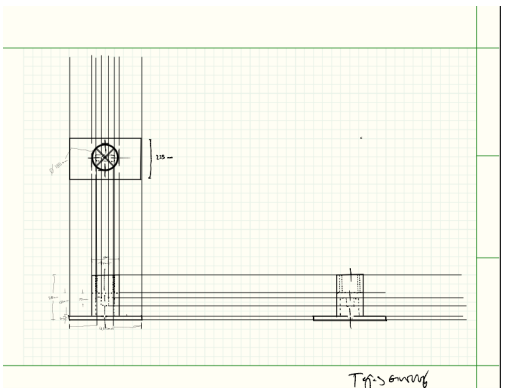


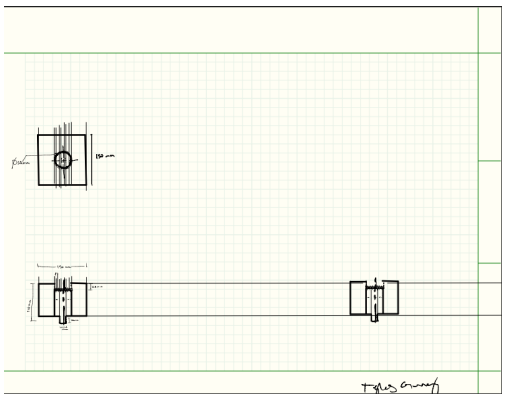


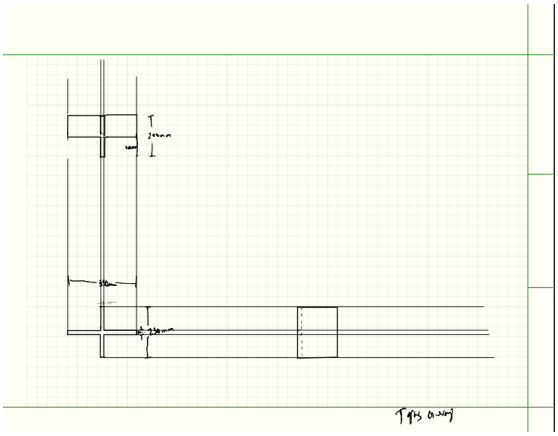


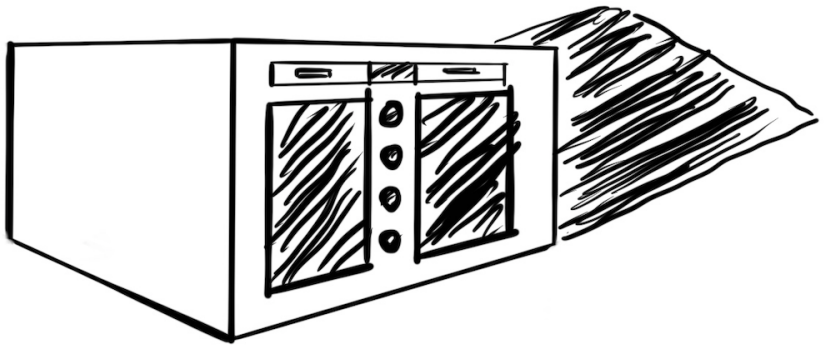




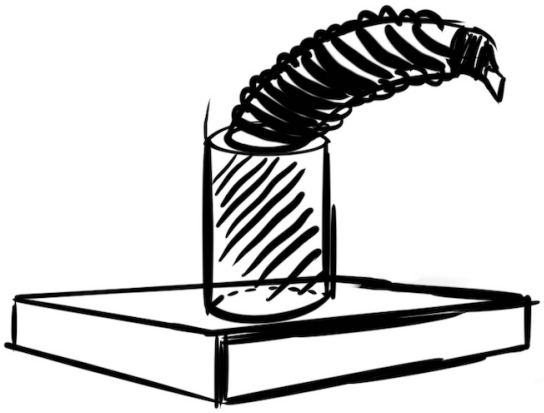






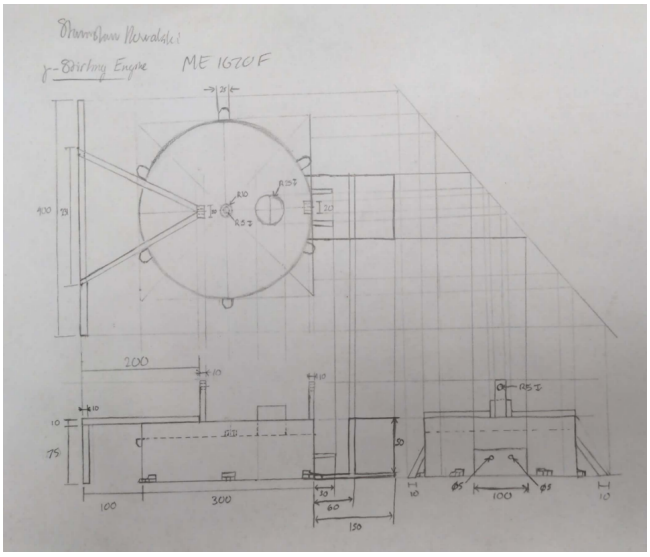


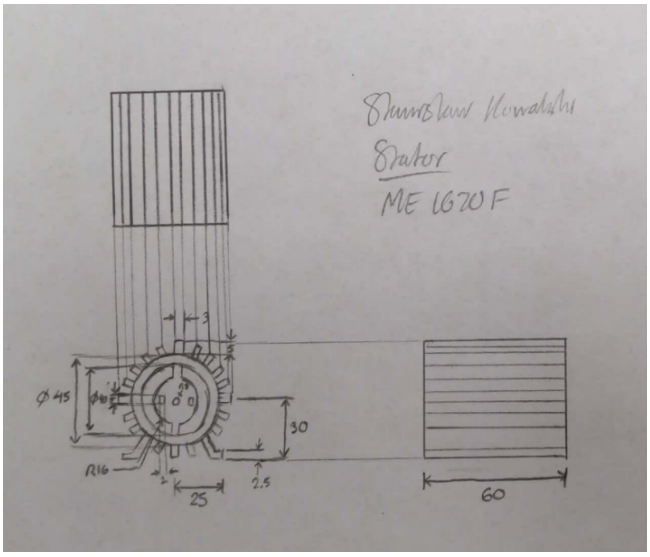
Tejas Gururaj

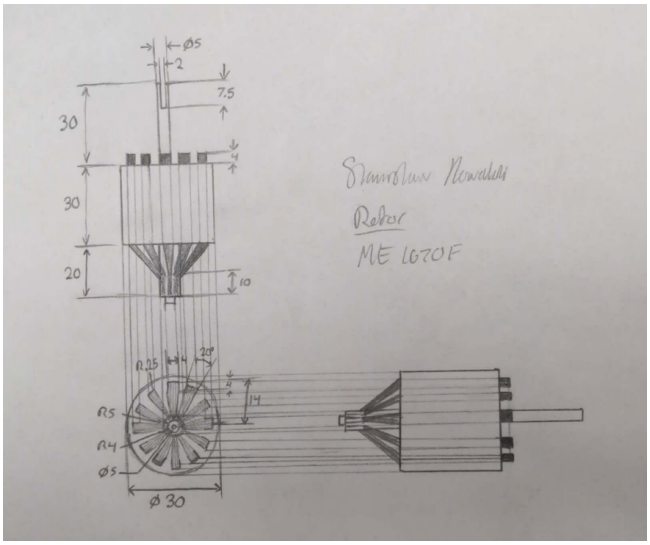


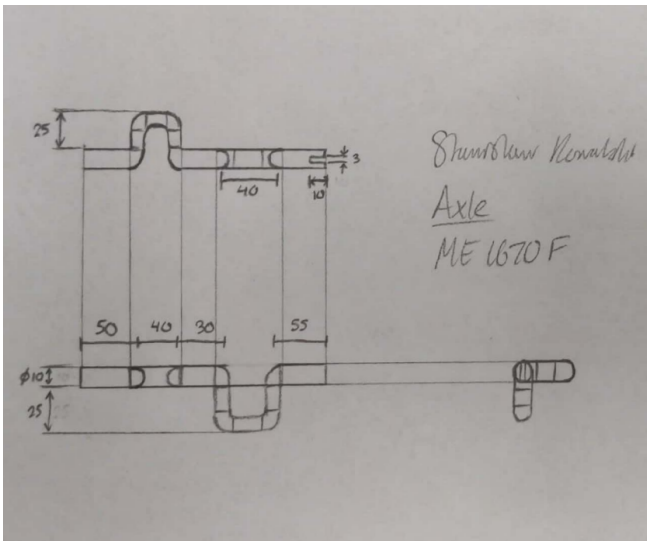
Tejas Gururaj

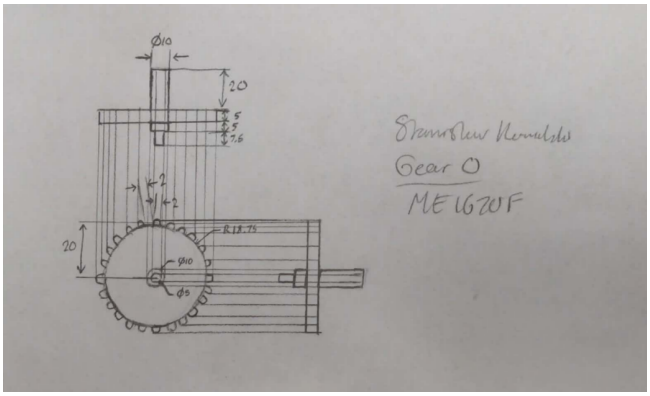
Hand Sketches - Stanislaw Kowalski

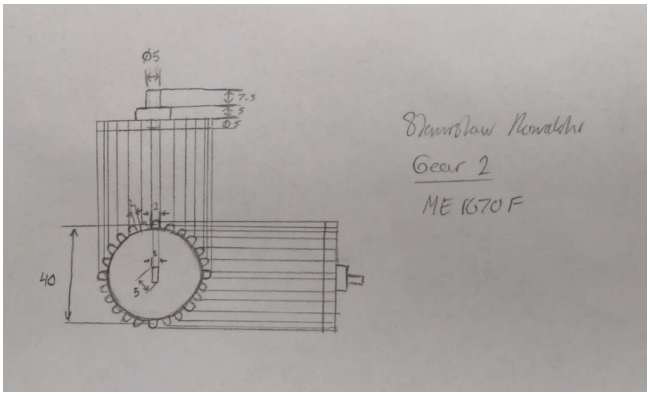




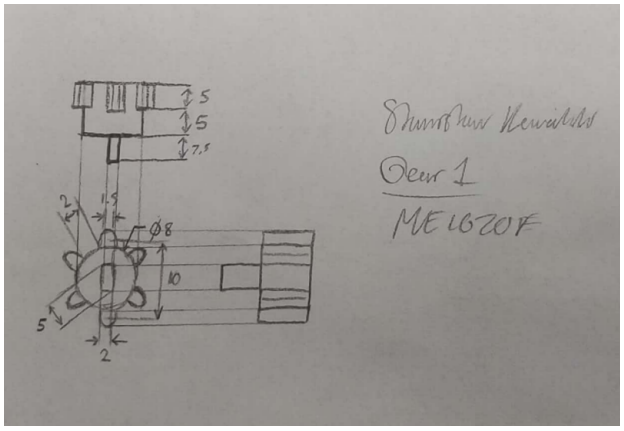


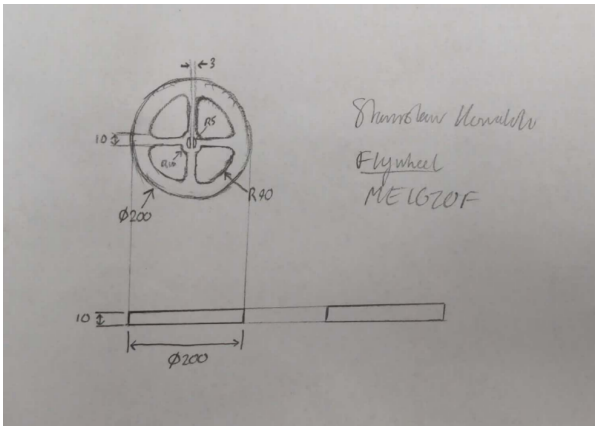


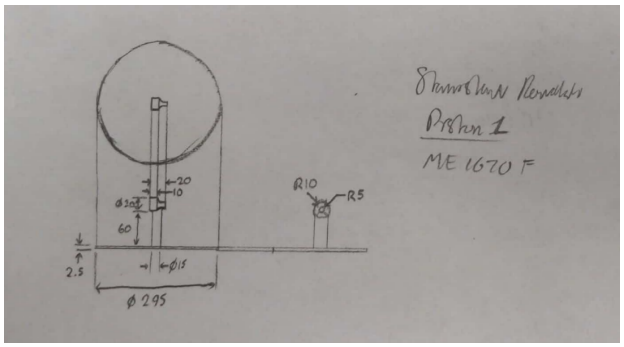


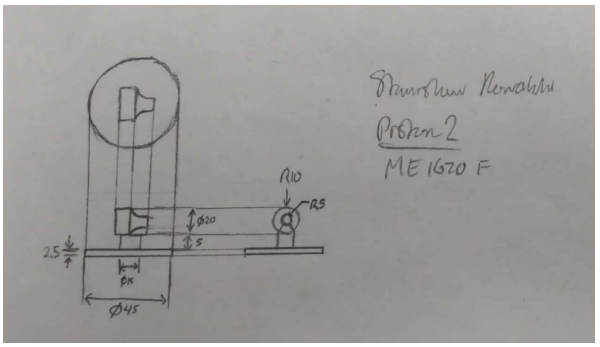


Hand Sketches - Stanislaw Kowalski

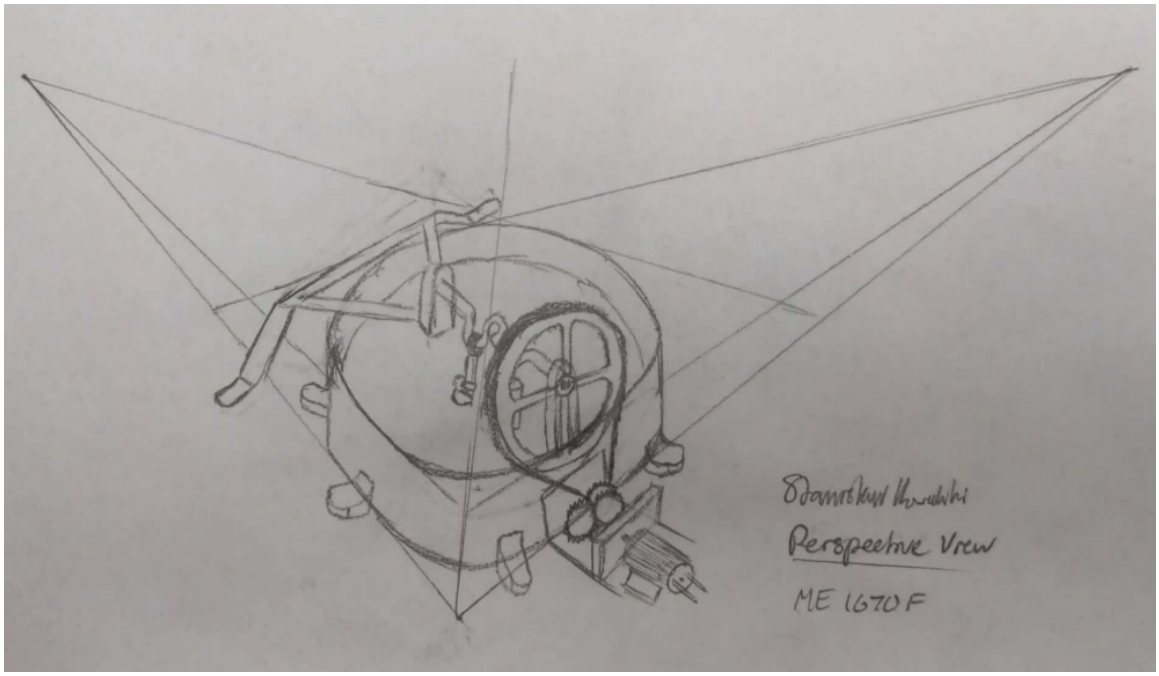


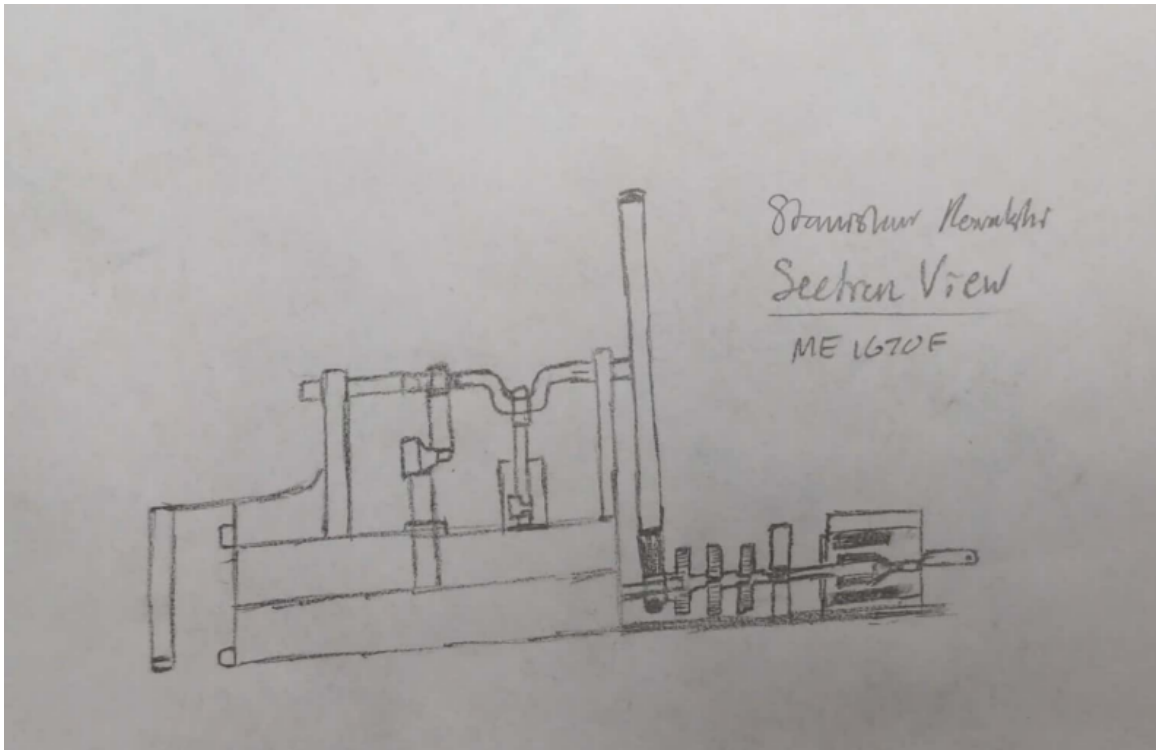






Hand Sketches - Stanislaw Kowalski

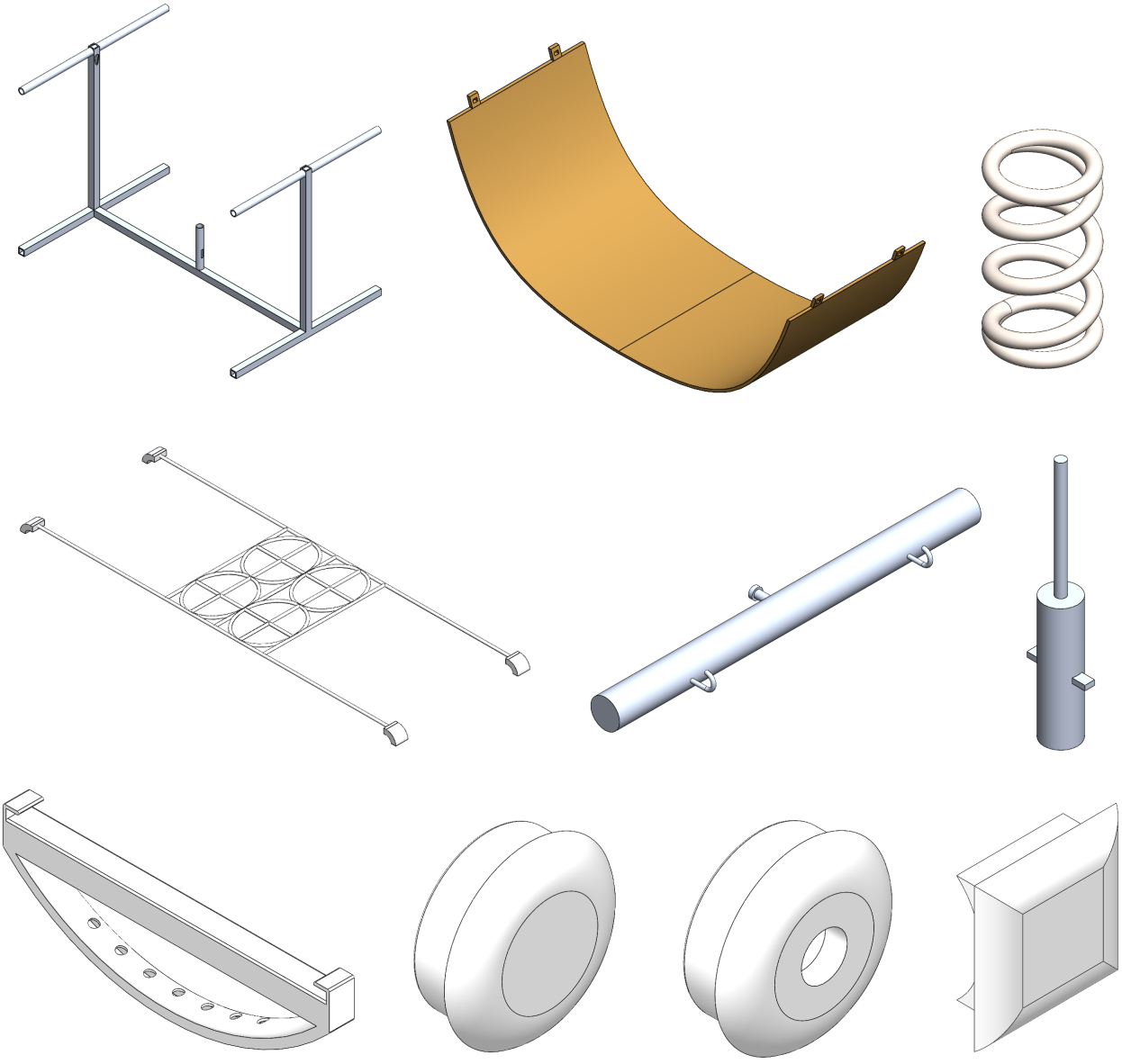




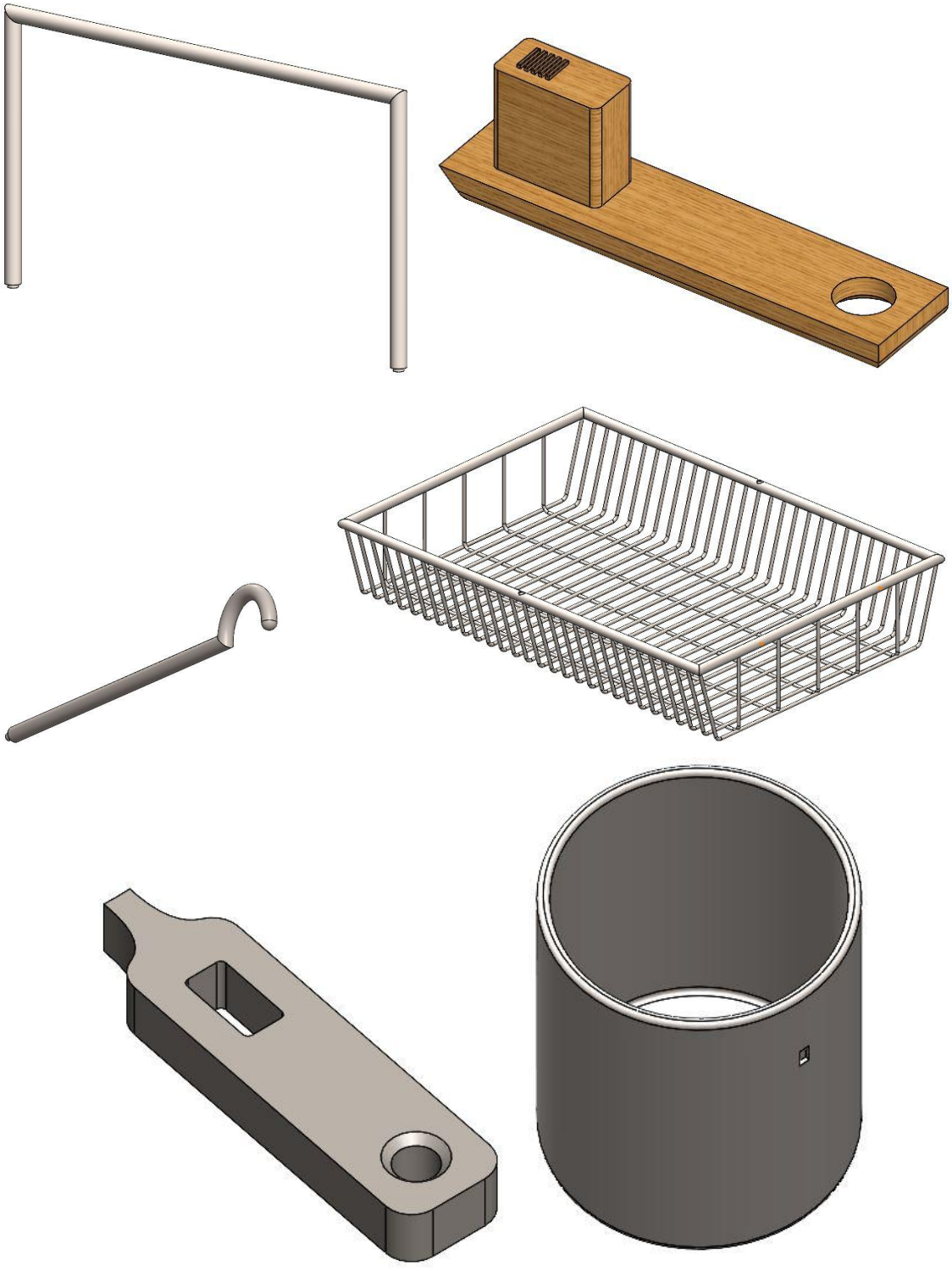
Chapter 3

Detail Design

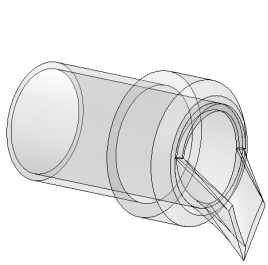
Part Models - Siva Appana

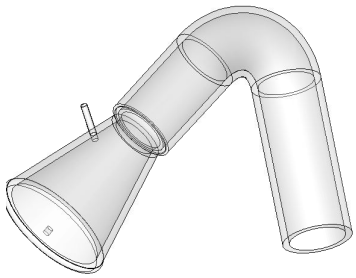


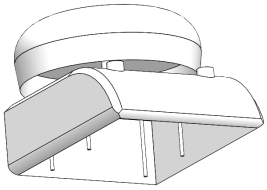
Part Models - Akash Chennuri

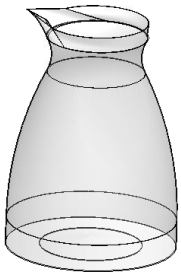


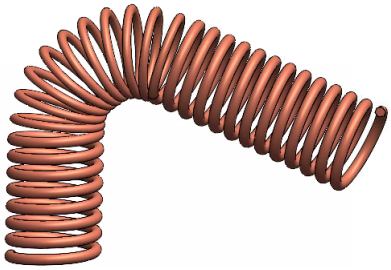
Part Models- Tejas Gururaj

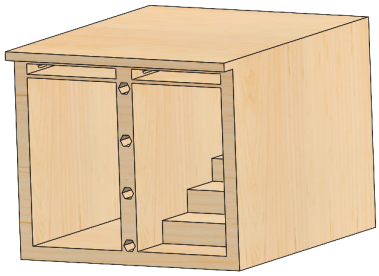


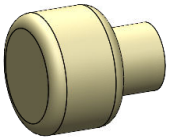


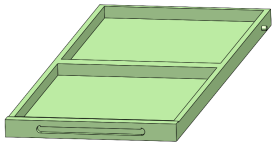




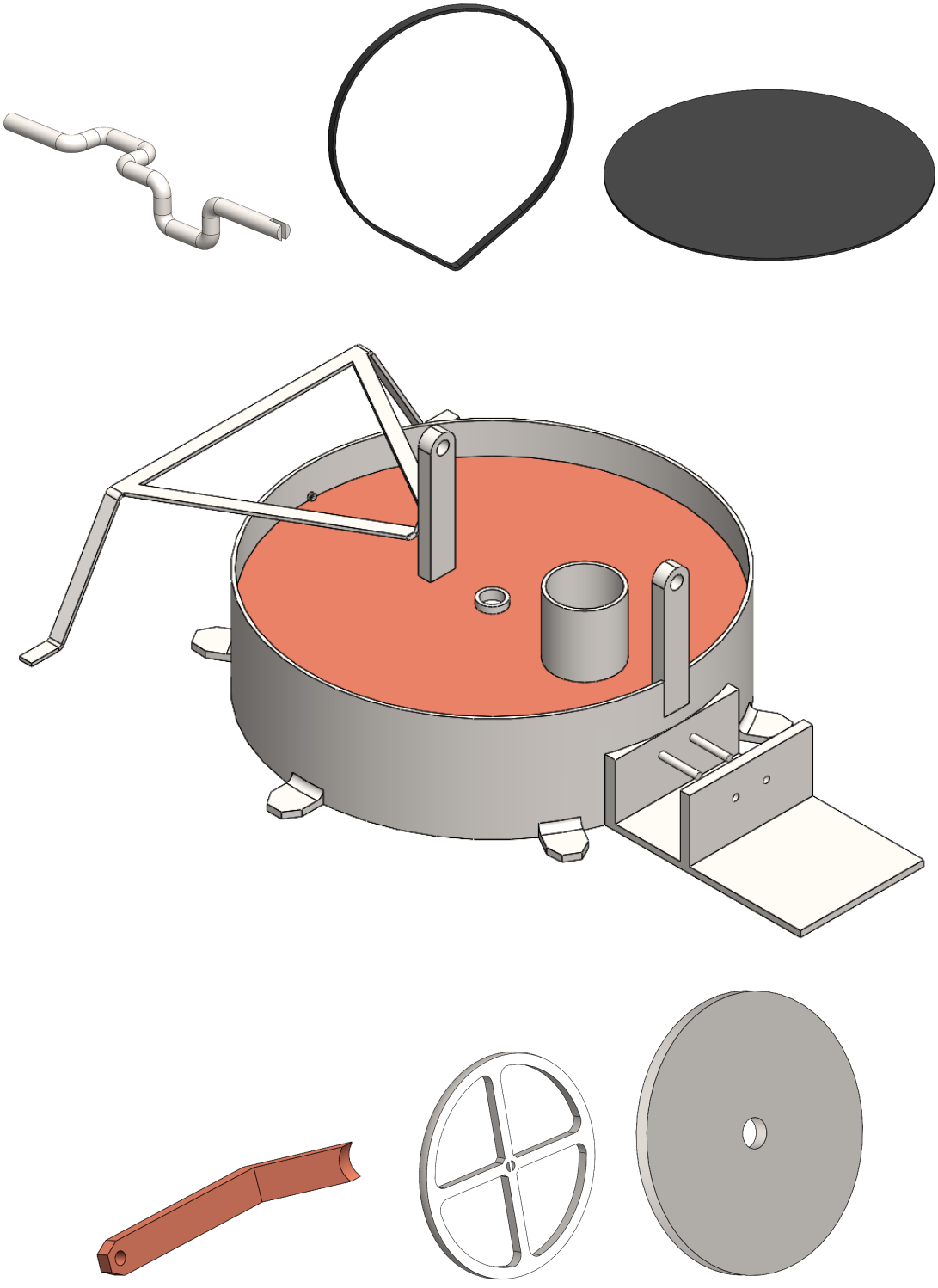


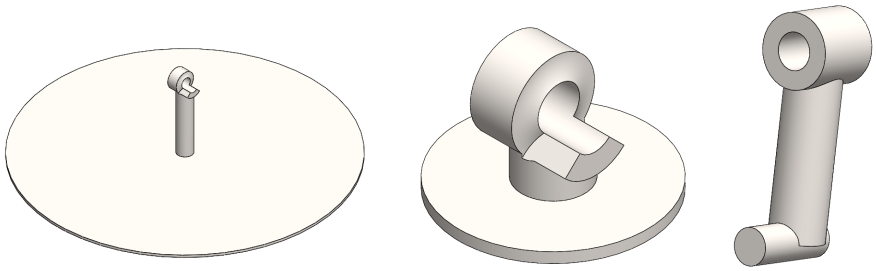


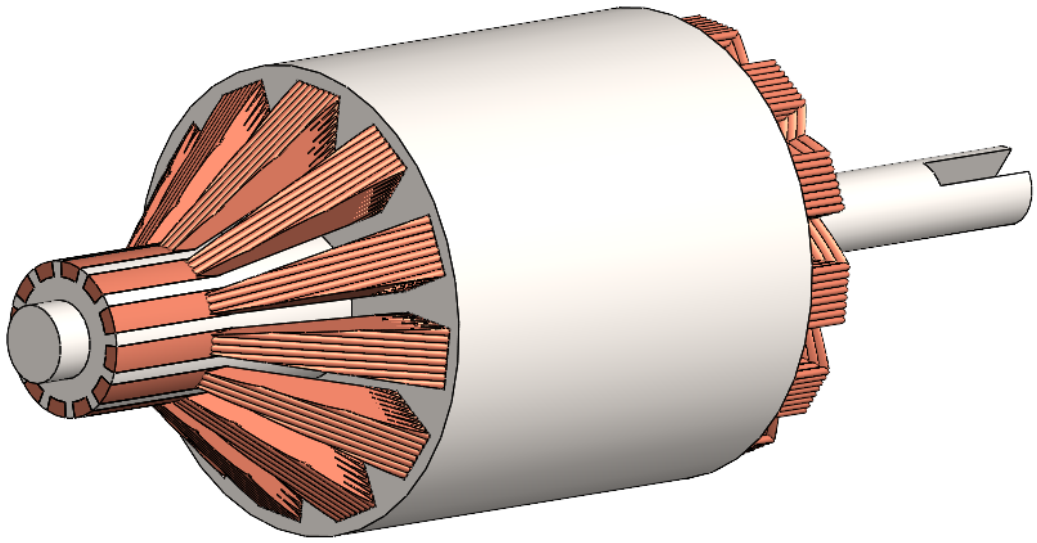


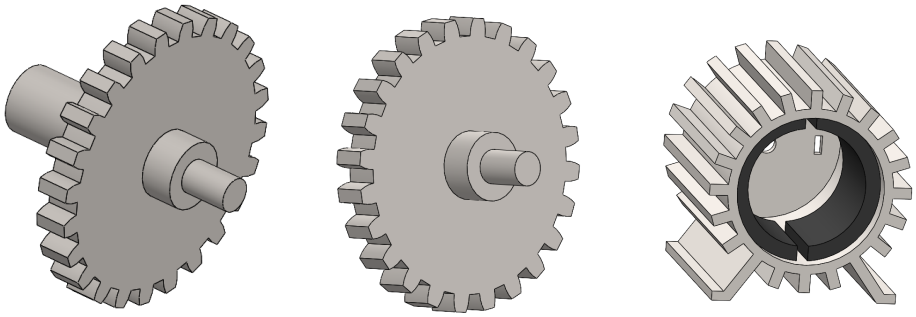


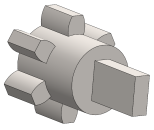
Part Models - Stanislaw Kowalski



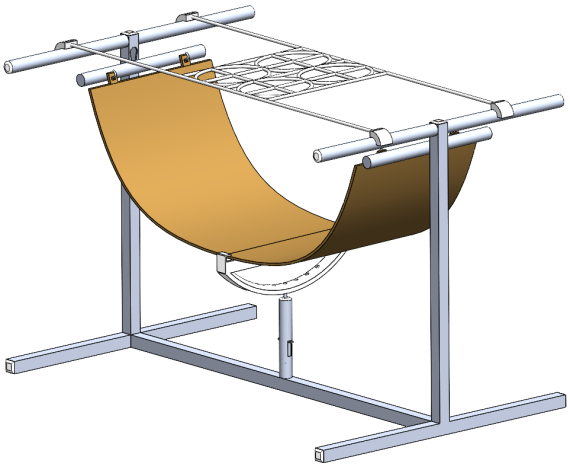


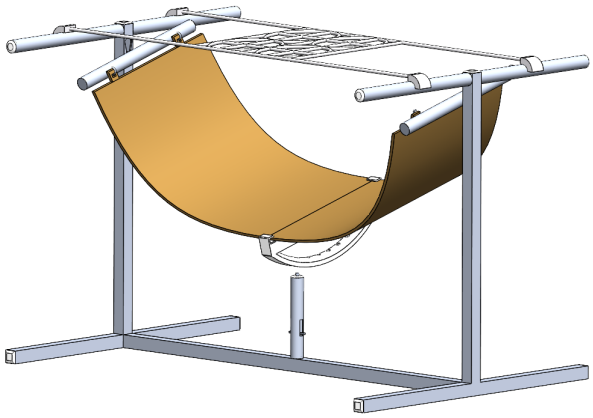


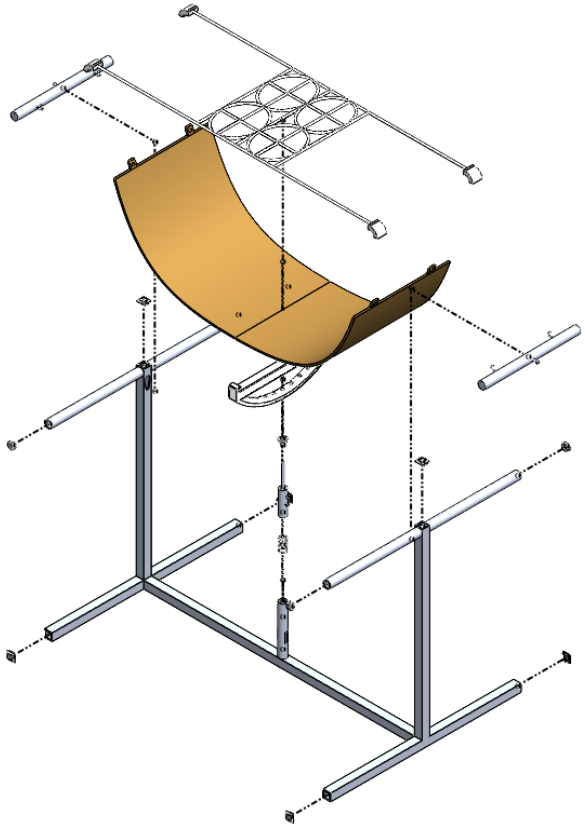




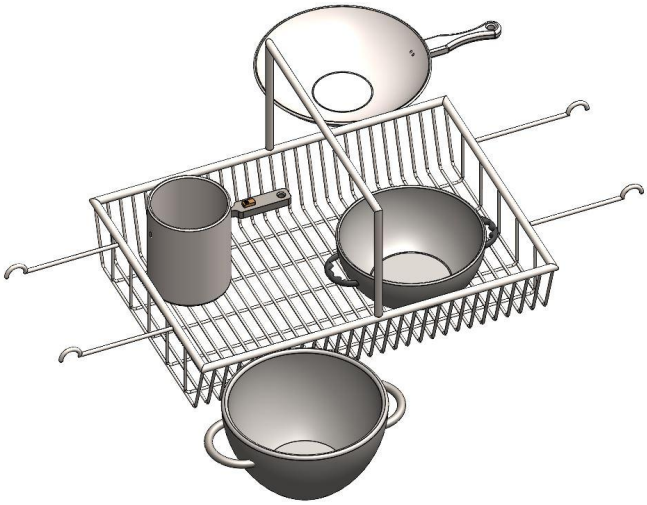
Subassembly - Siva Appana

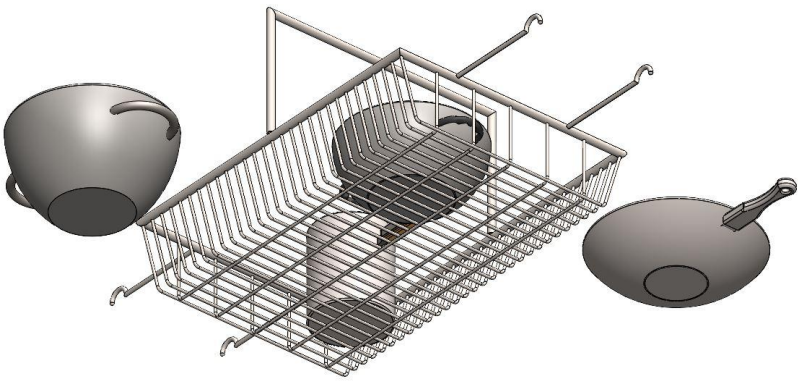


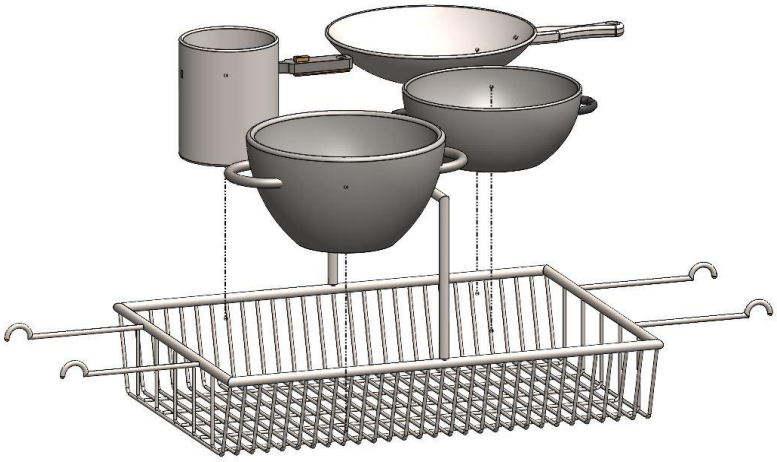


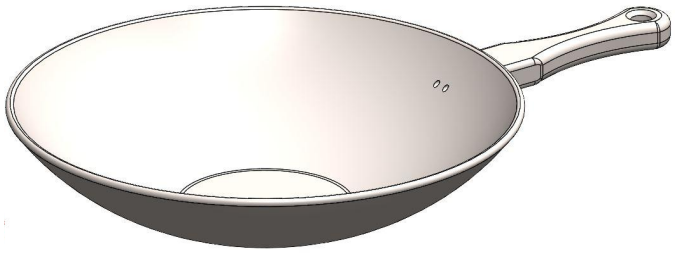


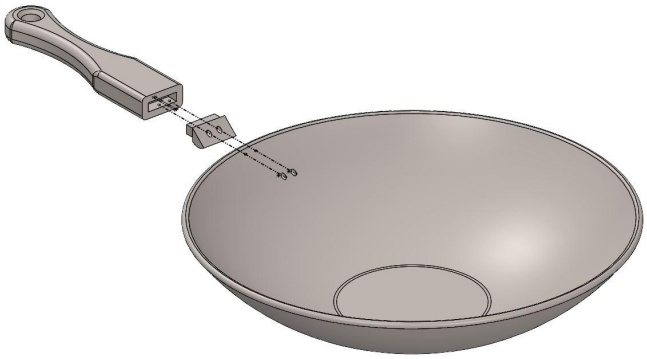
Subassembly - Akash Chennuri

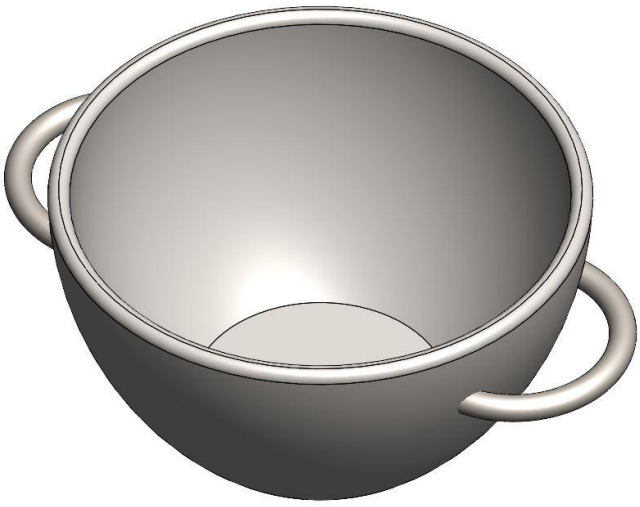


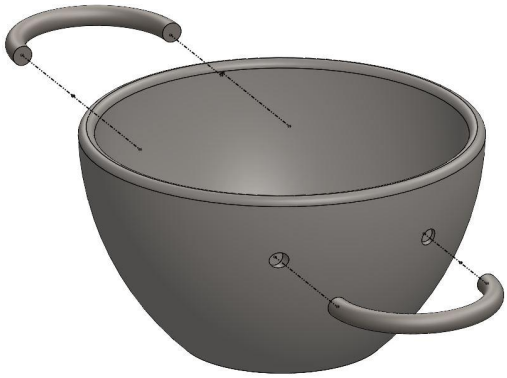


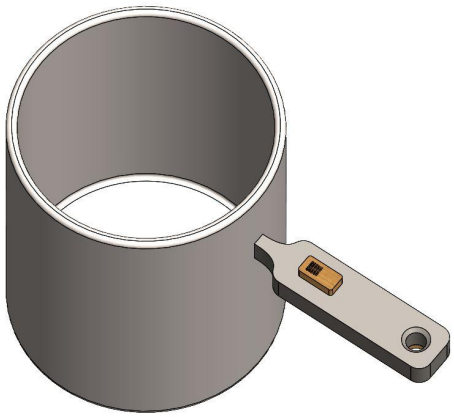


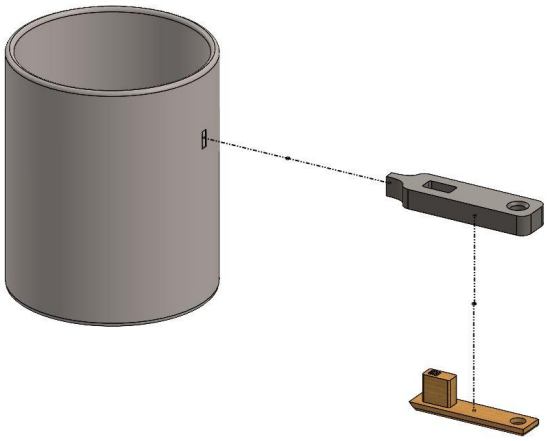


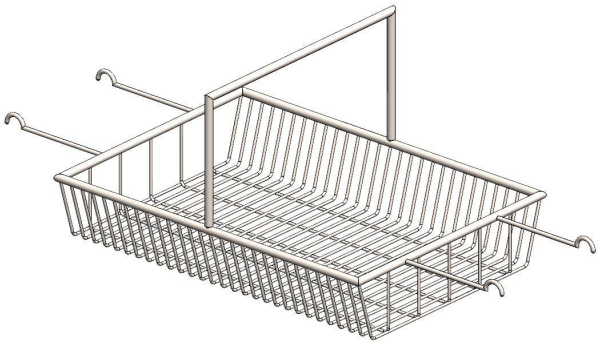


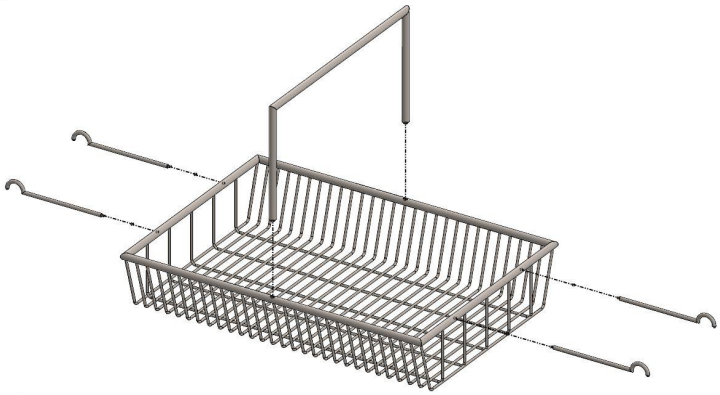




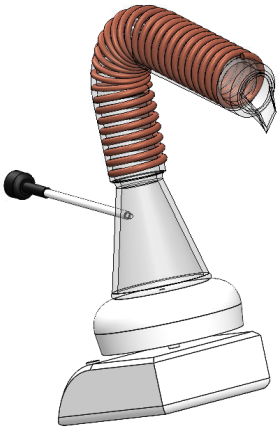


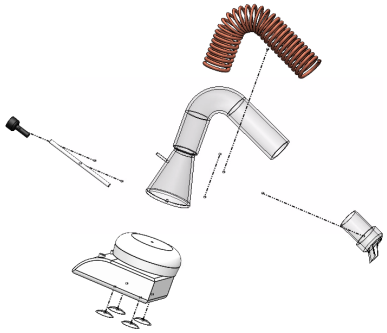


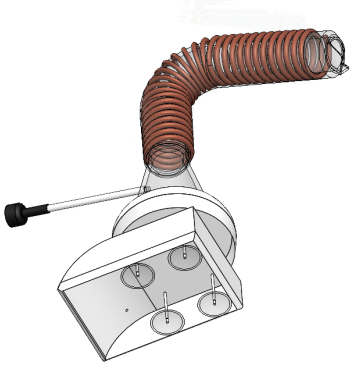


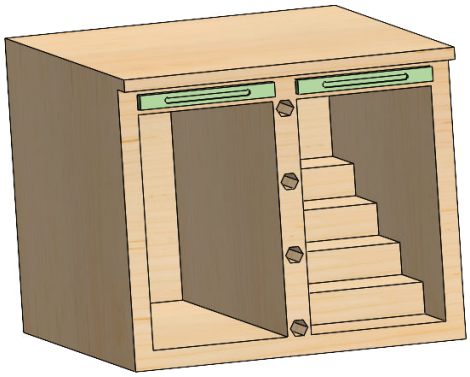


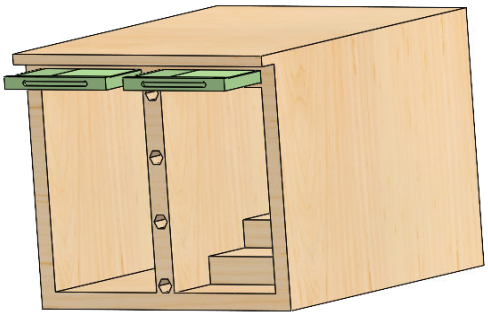
Subassembly - Tejas Gururaj

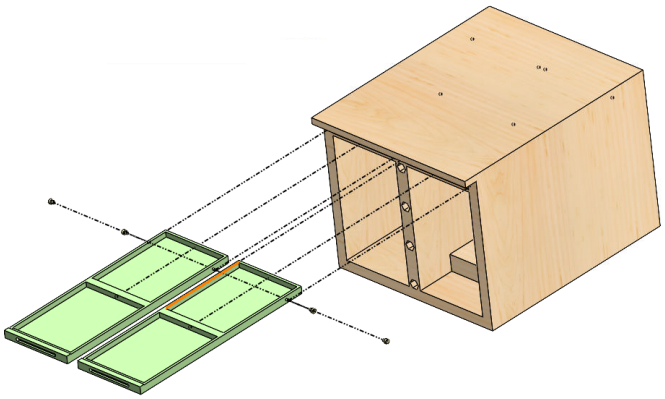




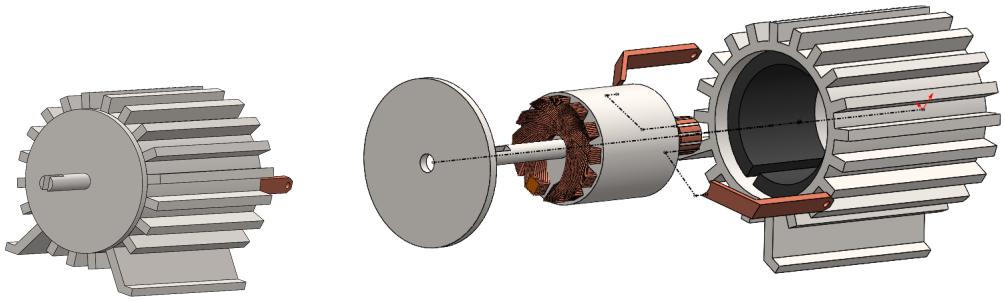


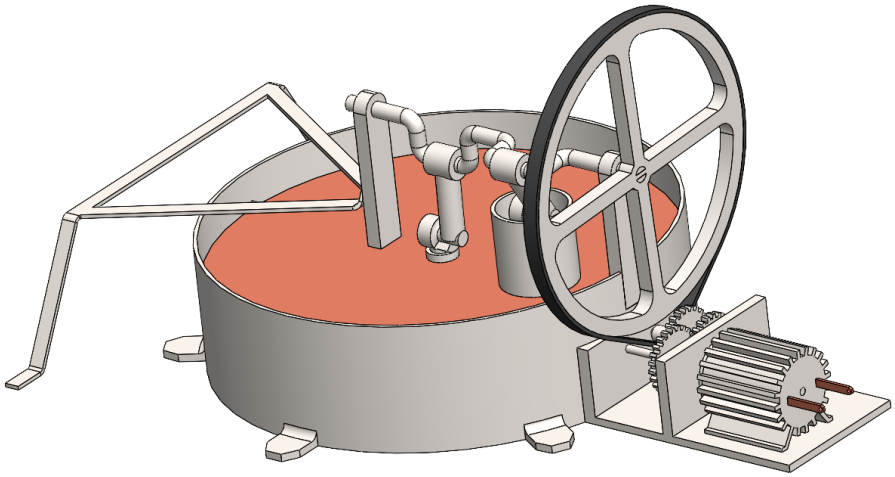


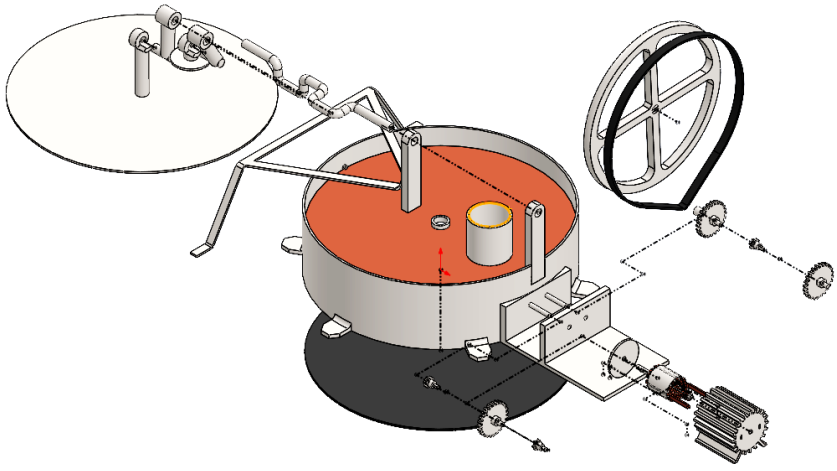




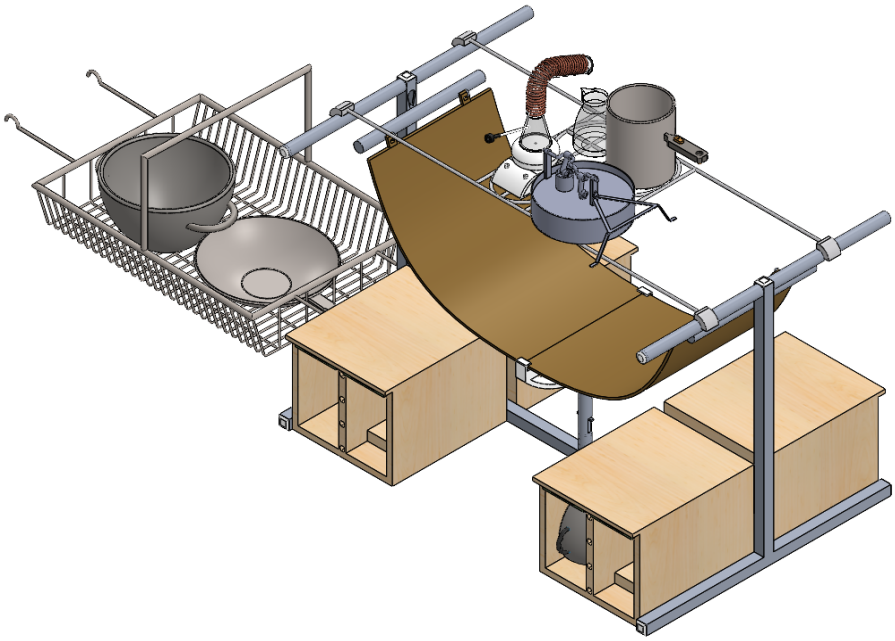
Subassembly - Stanislaw Kowalski

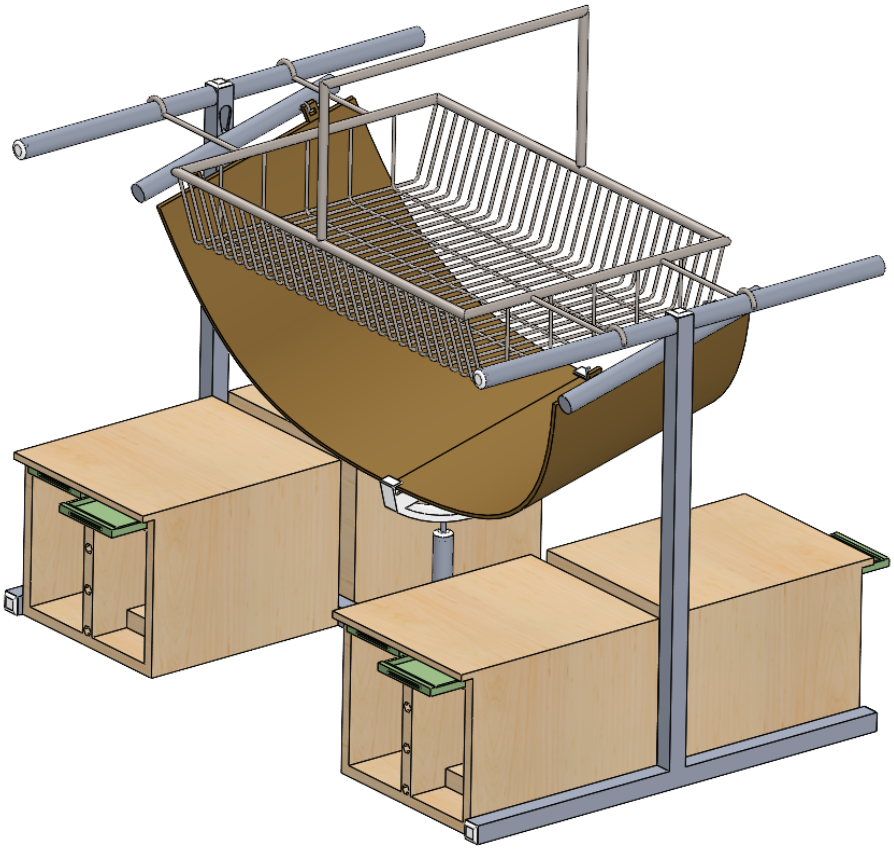






Final Assembly

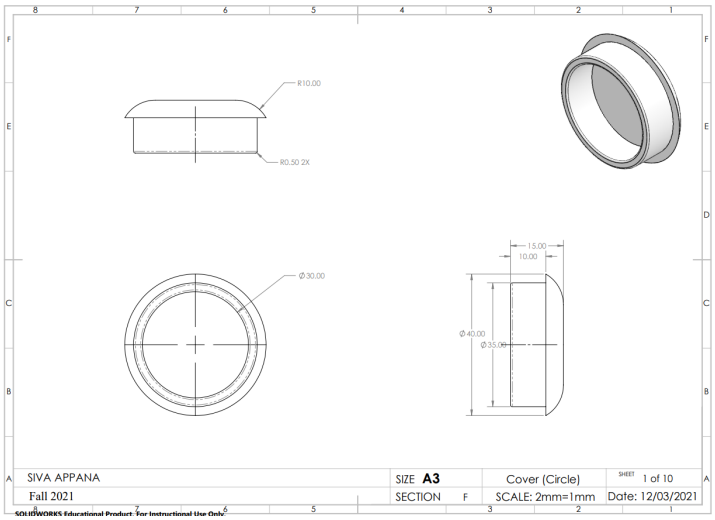


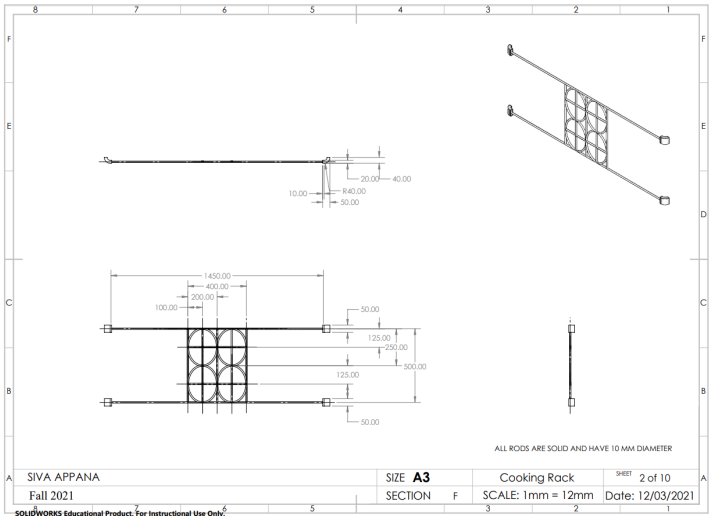


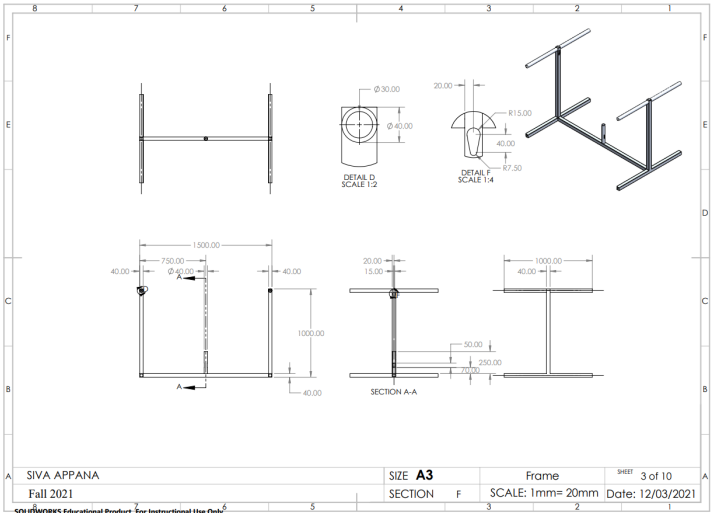
Chapter 4

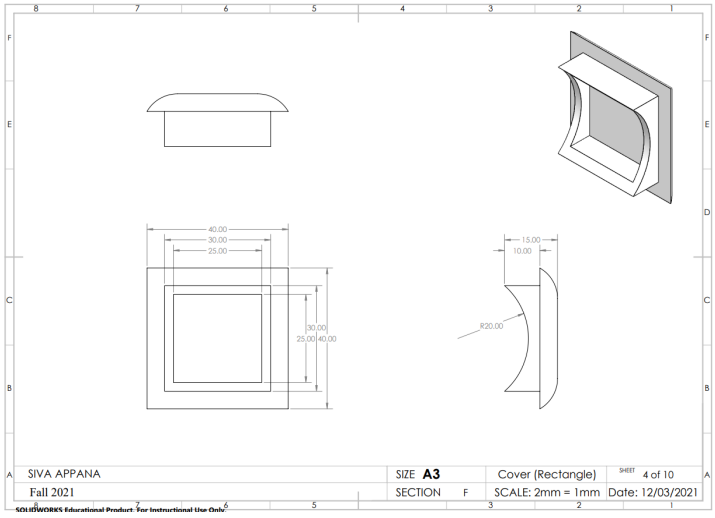
Manufacturing Working Drawings

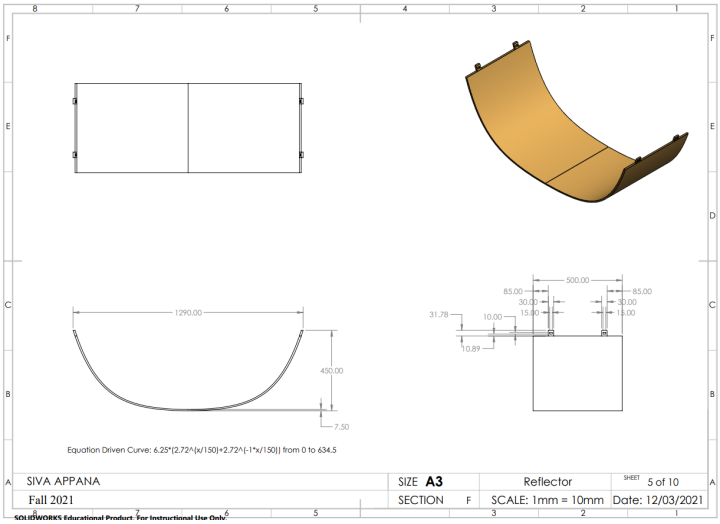
Working Drawings - Siva Appana

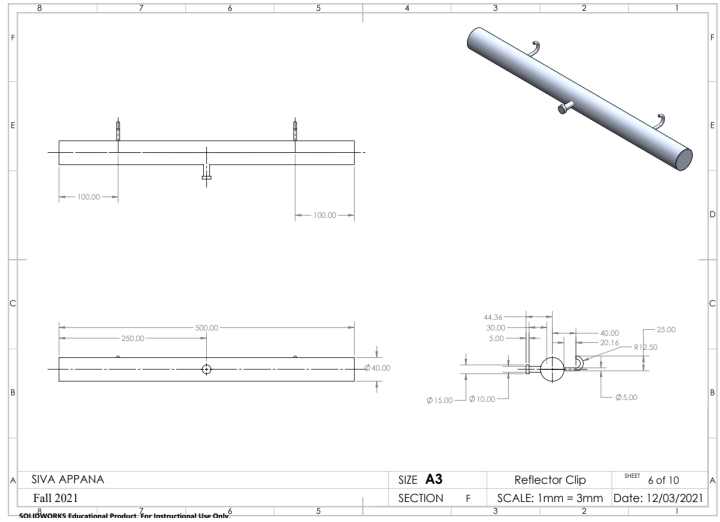


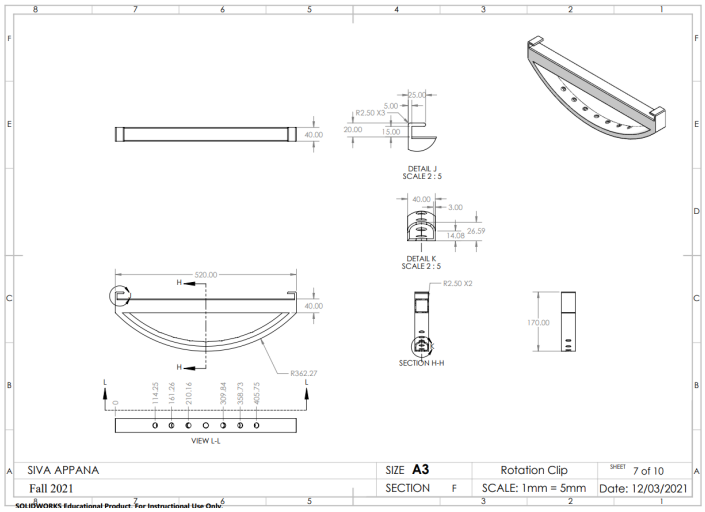




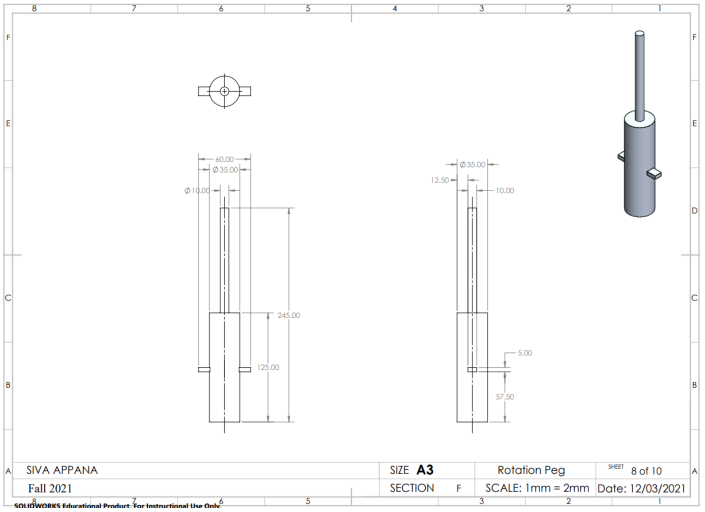




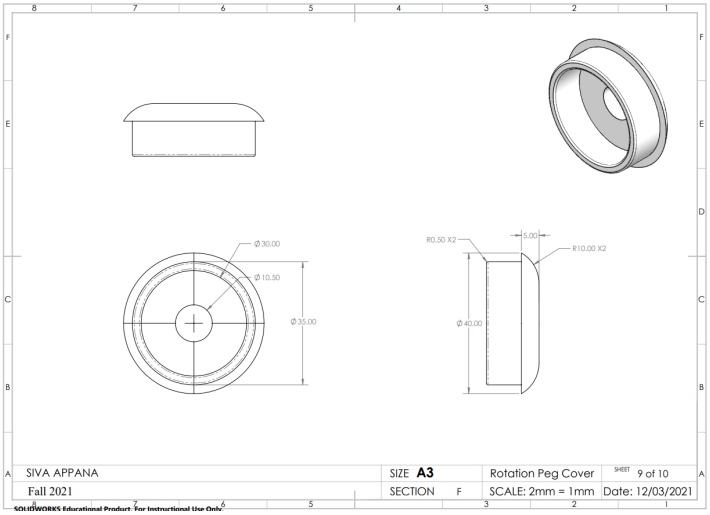




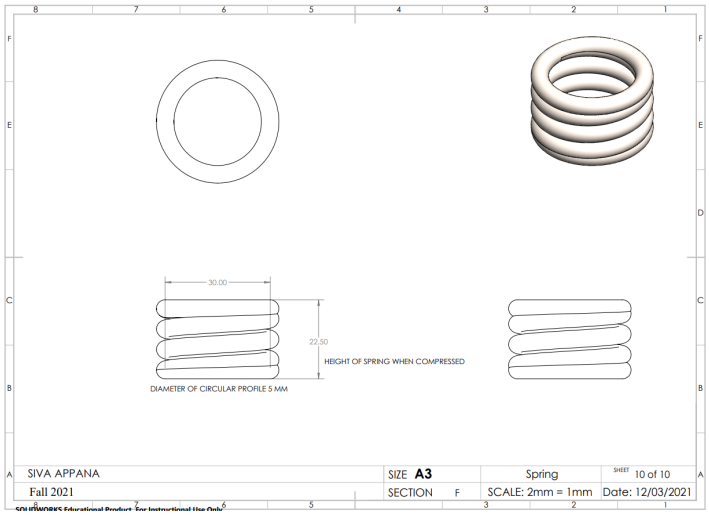
SIVA APPANA	SIZE A3	Rotation Clip	SHEET 7 of 10
Fall 2021	SECTION F	SCALE: 1mm = 5mm	Date: 12/03/2021



SIVA APPANA	SIZE A3	Rotation Peg	SHEET 8 of 10
Fall 2021	SECTION F	SCALE: 1mm = 2mm	Date: 12/03/2021

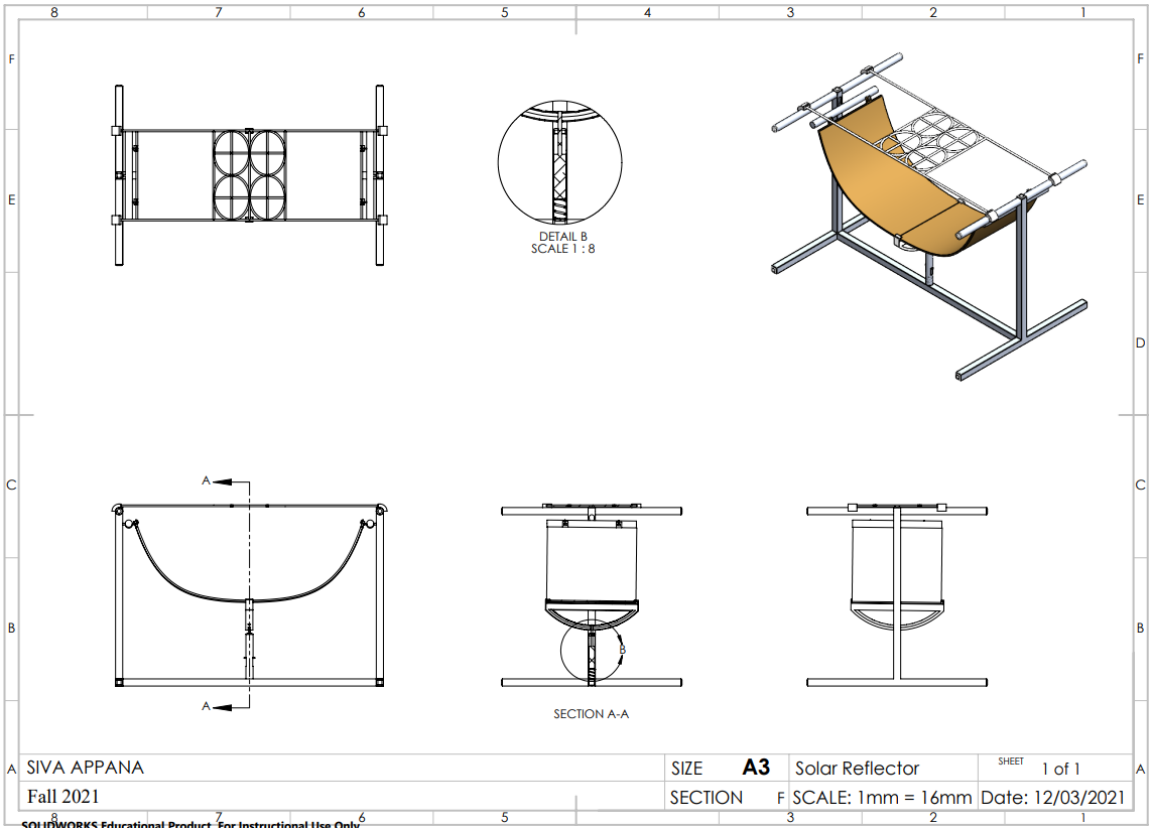


SIVA APPANA	SIZE A3	Rotation Peg Cover	SHEET 9 of 10
Fall 2021	SECTION F	SCALE: 2mm = 1mm	Date: 12/03/2021

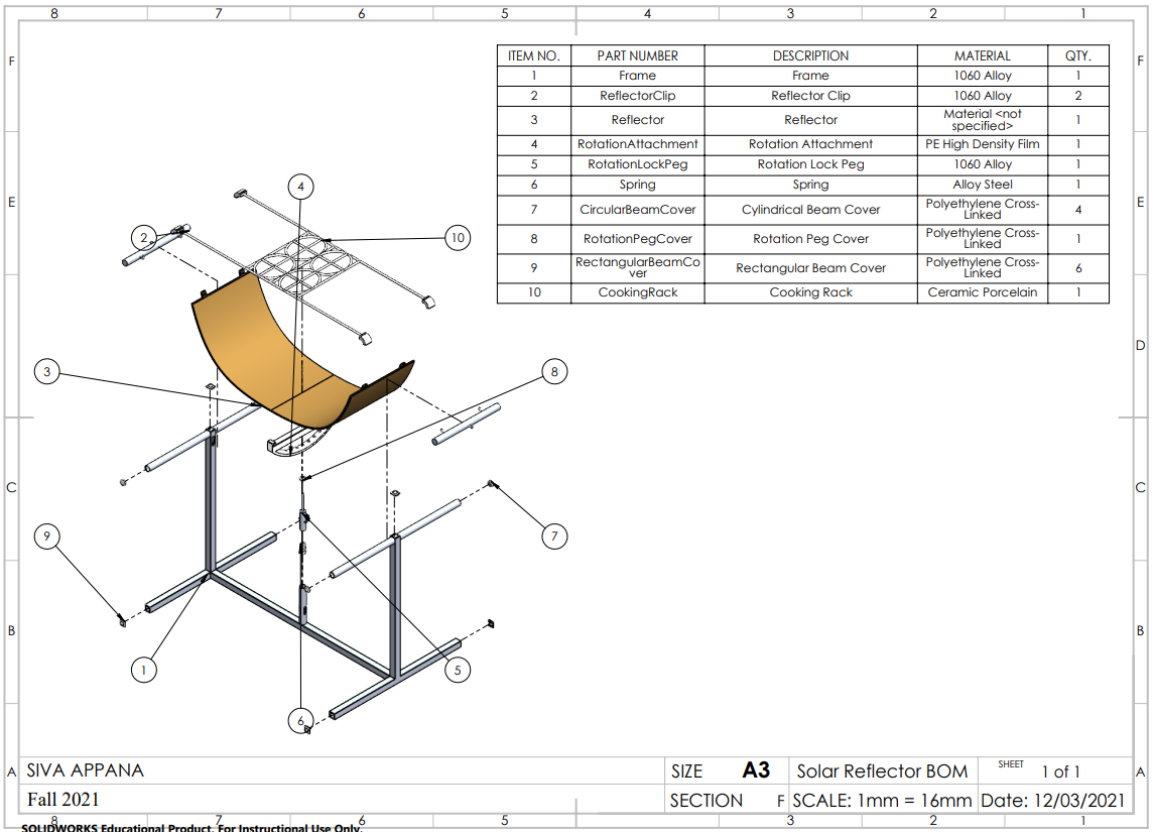


SIVA APPANA	SIZE A3	Spring	SHEET 10 of 10
Fall 2021	SECTION F	SCALE: 2mm = 1mm	Date: 12/03/2021

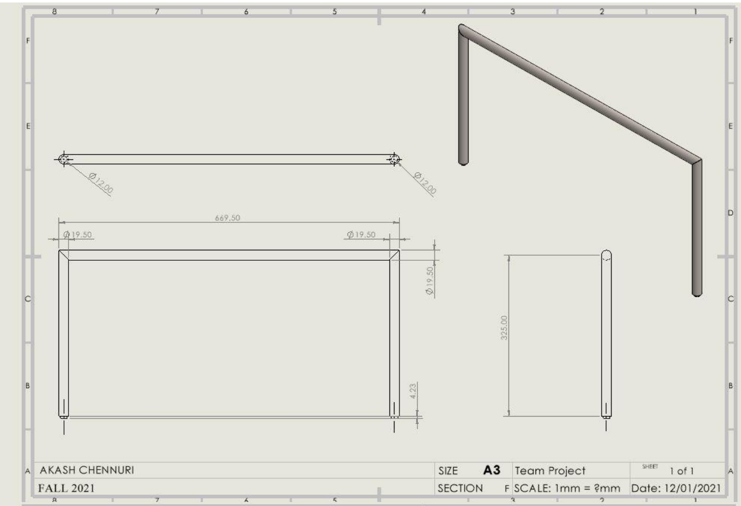
Assembly Views - Siva Appana

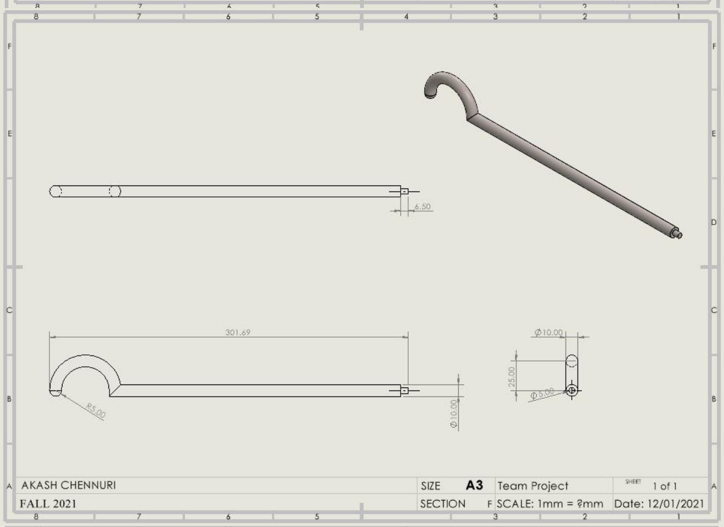


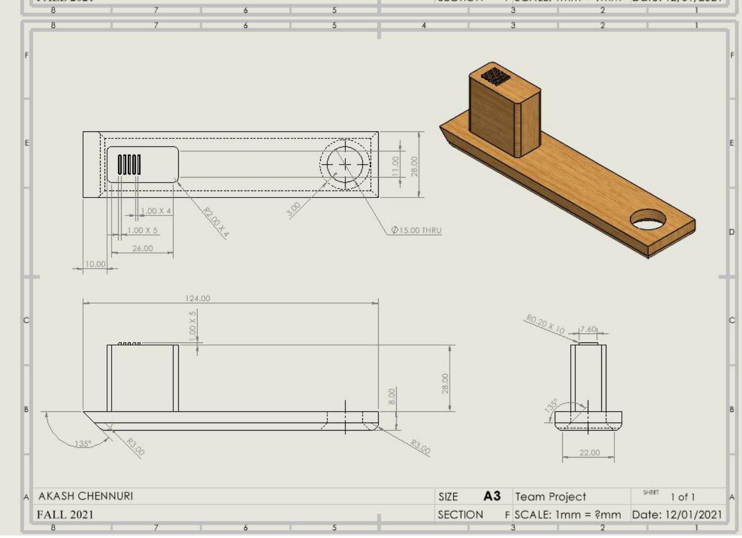
ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	QTY.
1	Frame	Frame	1060 Alloy	1
2	ReflectorClip	Reflector Clip	1060 Alloy	2
3	Reflector	Reflector	Material <not specified>	1
4	RotationAttachment	Rotation Attachment	PE High Density Film	1
5	RotationLockPeg	Rotation Lock Peg	1060 Alloy	1
6	Spring	Spring	Alloy Steel	1
7	CircularBeamCover	Cylindrical Beam Cover	Polyethylene Cross-Linked	4
8	RotationPegCover	Rotation Peg Cover	Polyethylene Cross-Linked	1
9	RectangularBeamCover	Rectangular Beam Cover	Polyethylene Cross-Linked	6
10	CookingRack	Cooking Rack	Ceramic Porcelain	1

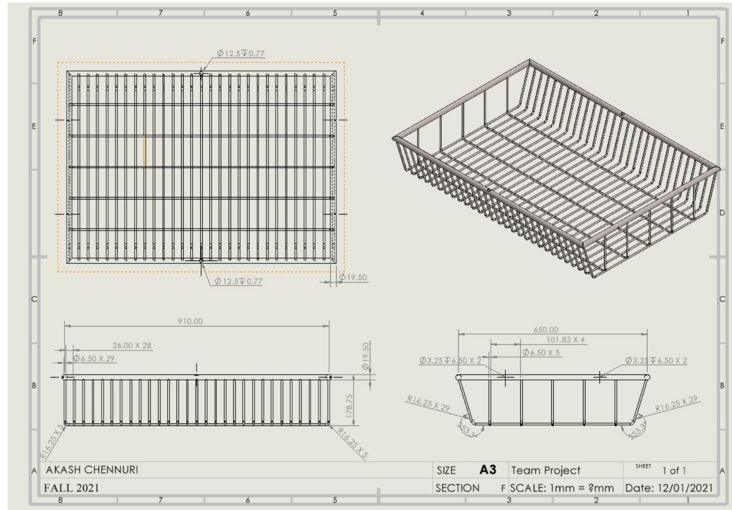


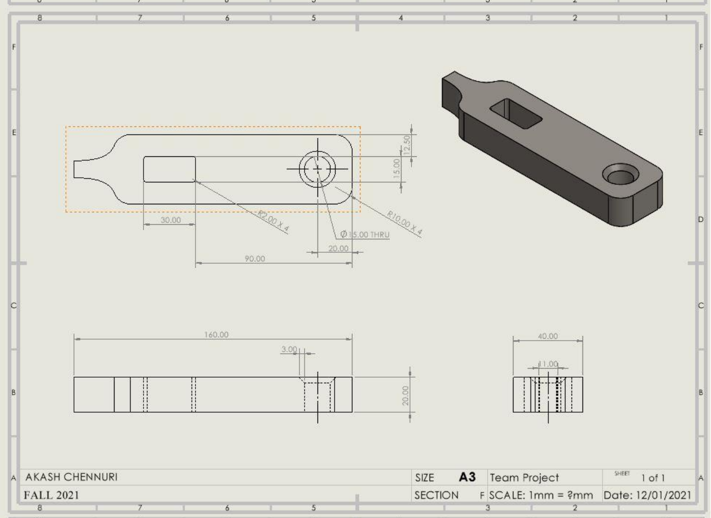
Working Drawings - Akash Chennuri

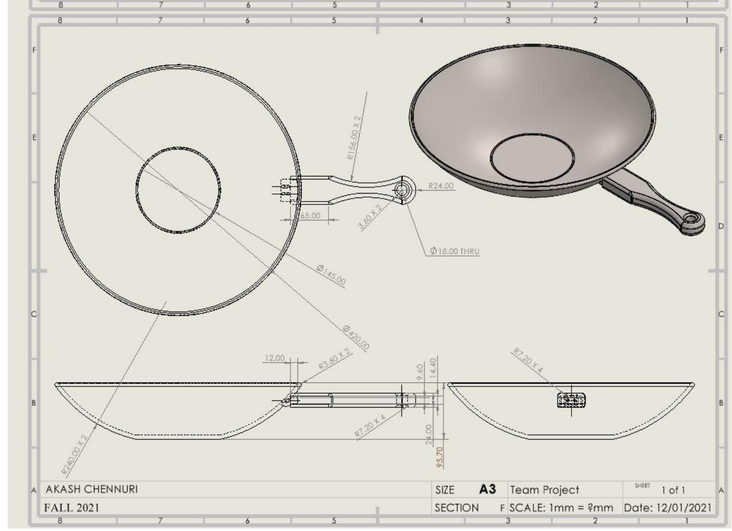


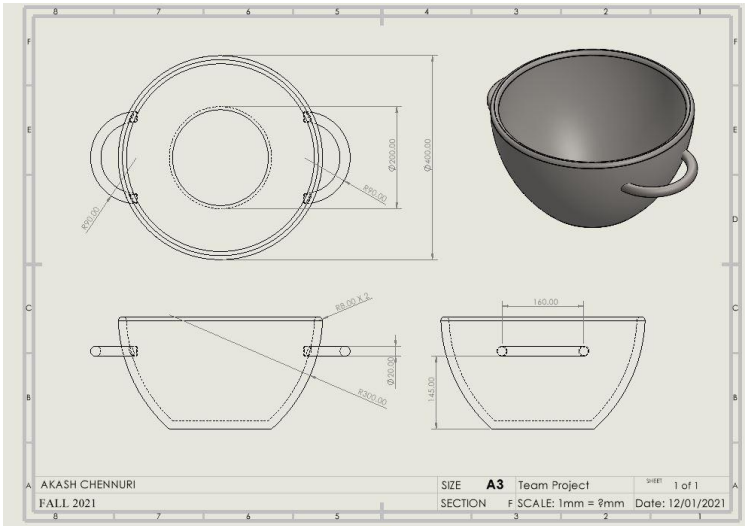




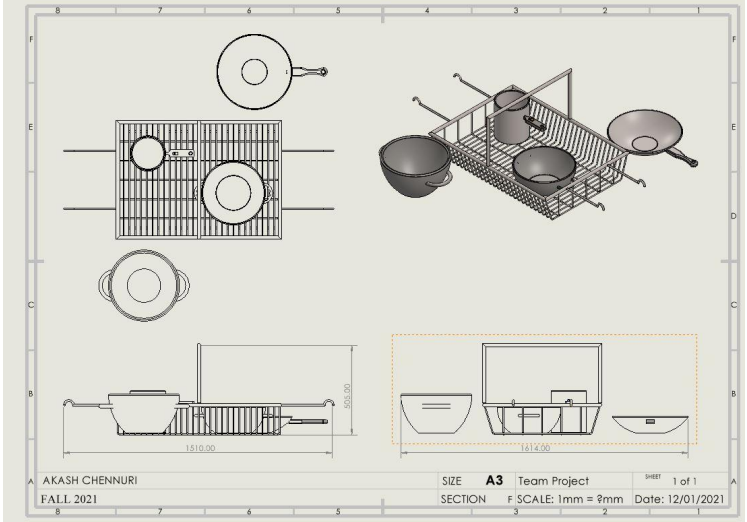






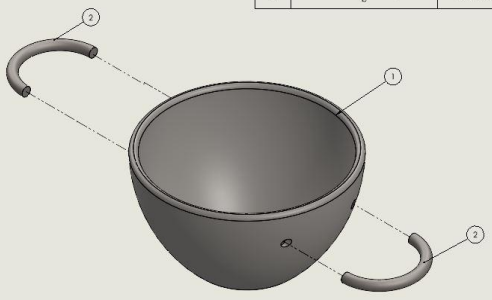


AKASH CHENNURI	SIZE A3	Team Project	SHEET 1 of 1	
FALL 2021	SECTION F	SCALE: 1mm = ?mm	Date: 12/01/2021	

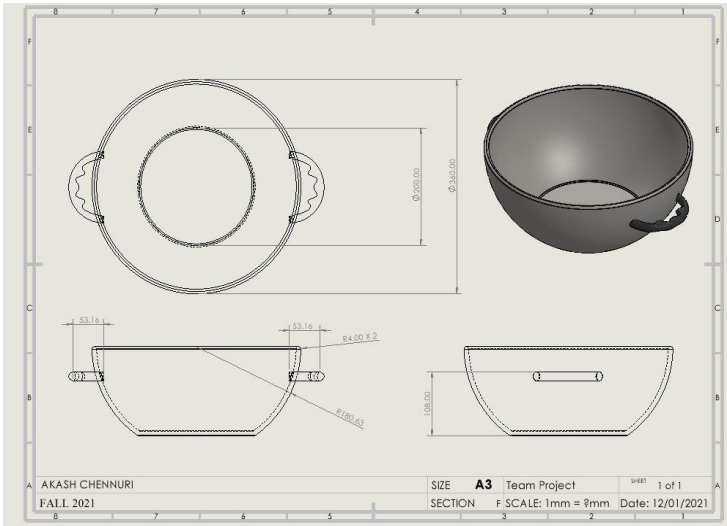


AKASH CHENNURI	SIZE A3	Team Project	SHEET 1 of 1	
FALL 2021	SECTION F	SCALE: 1mm = ?mm	Date: 12/01/2021	

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	QTY.
1	Chennuri_Akash_TeamProject_Pot1a	Pot 1	Cast Stainless Steel	1
2	Chennuri_Akash_TeamProject_Pot1b	Handles for Pot 1	AISI 1035 Steel (SS)	2

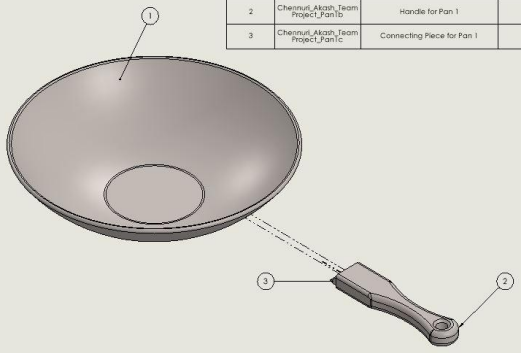


AKASH CHENNURI	SIZE A3	Team Project	SHEET 1 of 1	
FALL 2021	SECTION F	SCALE: 1mm = ?mm	Date: 12/02/2021	



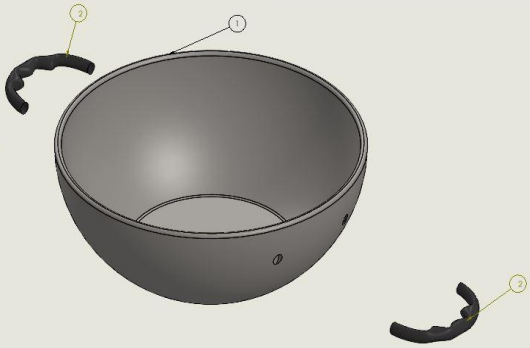
AKASH CHENNURI	SIZE A3	Team Project	SHEET 1 of 1	
FALL 2021	SECTION F	SCALE: 1mm = ?mm	Date: 12/01/2021	

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	QTY.
1	Chennuri_Akash_TeamProject_Pan1a	Pan 1	Titanium	1
2	Chennuri_Akash_TeamProject_Pan1b	Handle for Pan 1	Titanium	1
3	Chennuri_Akash_TeamProject_Pan1c	Connecting Piece for Pan 1	Titanium	1

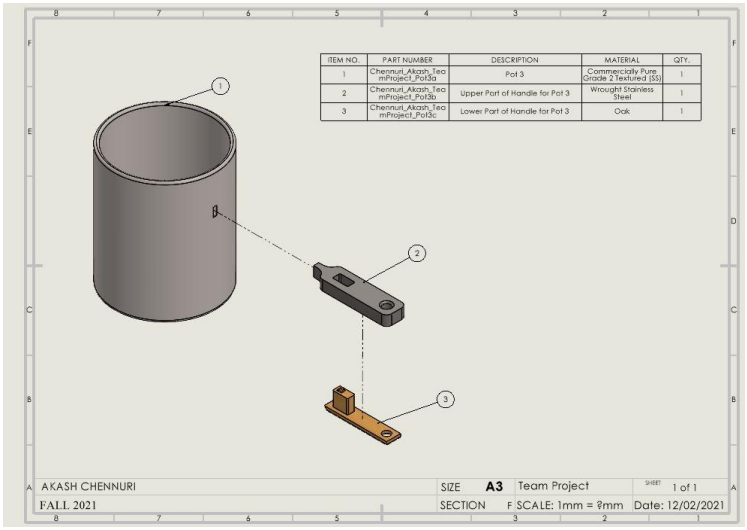


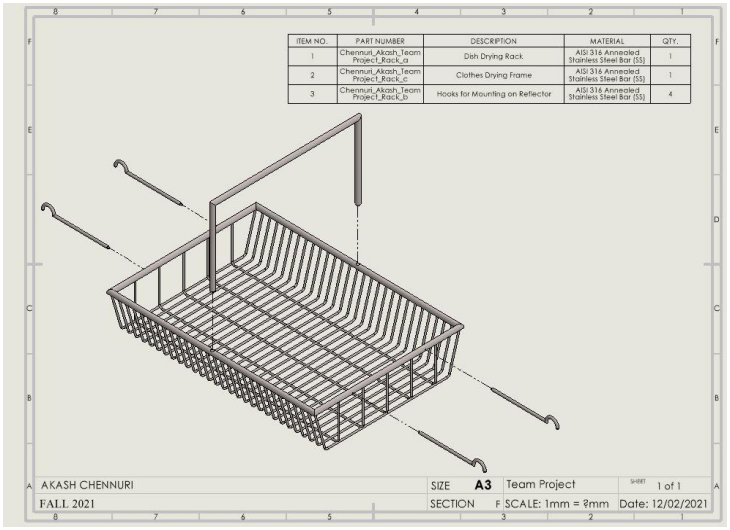
AKASH CHENNURI	SIZE A3	Team Project	SHEET 1 of 1	
FALL 2021	SECTION F	SCALE: 1mm = ?mm	Date: 12/02/2021	

ITEM NO.	PART NUMBER	DESCRIPTION	MATERIAL	QTY.
1	Chennuri_Akash_TeamProject_Pot2a	Pot 2	Cast Carbon Steel	1
2	Chennuri_Akash_TeamProject_Pot2b	Handle for Pot 2	Silicon Rubber	2

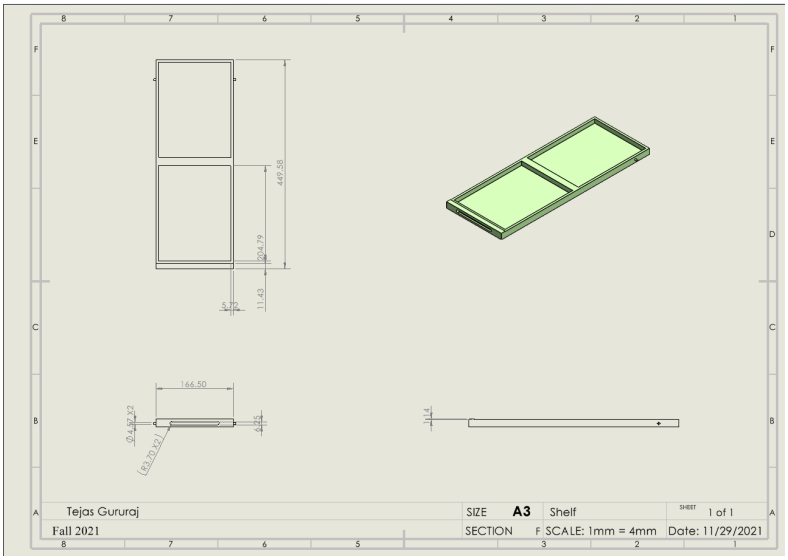


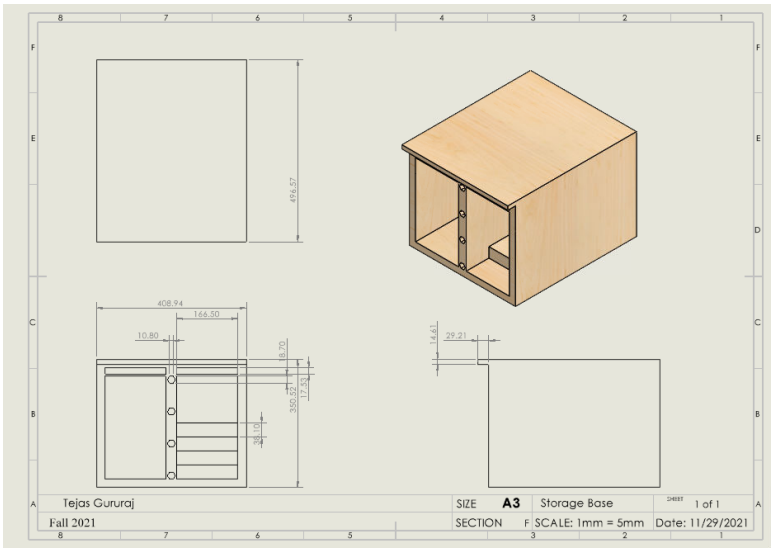
AKASH CHENNURI	SIZE A3	Team Project	SHEET 1 of 1	
FALL 2021	SECTION F	SCALE: 1mm = ?mm	Date: 12/02/2021	

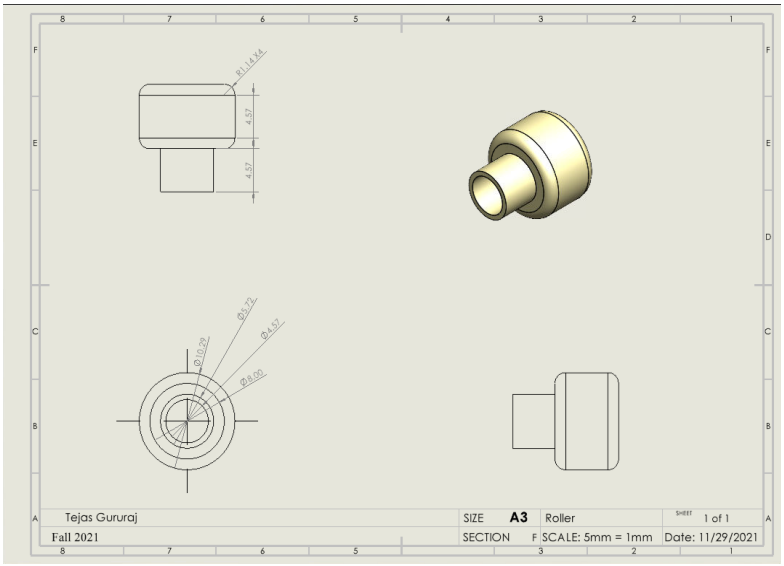

ITEM NO. | PART NUMBER | DESCRIPTION | MATERIAL | QTY.
1 | Chennuri_Akash_TeamProject_Pot3a | Pot 3 | Commercially Pure, Grade 2 Textured (SS) | 1
2 | Chennuri_Akash_TeamProject_Pot3b | Upper Part of Handle for Pot 3 | Wrought Stainless Steel | 1
3 | Chennuri_Akash_TeamProject_Pot3c | Lower Part of Handle for Pot 3 | Oak | 1
AKASH CHENNURI
FALL 2021
SIZE A3
SECTION
F
Team Project
SCALE: 1mm = ?mm
SHEET 1 of 1
Date: 12/02/2021

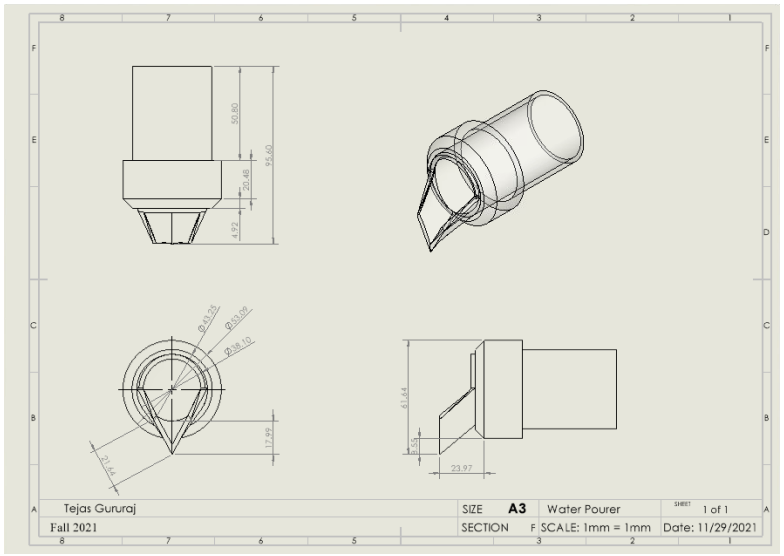

ITEM NO. | PART NUMBER | DESCRIPTION | MATERIAL | QTY.
1 | Chennuri_Akash_TeamProject_Rack_a | Dish Drying Rack | AISI 316 Annealed Stainless Steel Bar (SS) | 1
2 | Chennuri_Akash_TeamProject_Rack_c | Clothes Drying Frame | AISI 316 Annealed Stainless Steel Bar (SS) | 1
3 | Chennuri_Akash_TeamProject_Rack_b | Hooks for Mounting on Reflector | AISI 316 Annealed Stainless Steel Bar (SS) | 4
AKASH CHENNURI
FALL 2021
SIZE A3
SECTION
F
Team Project
SCALE: 1mm = ?mm
SHEET 1 of 1
Date: 12/02/2021

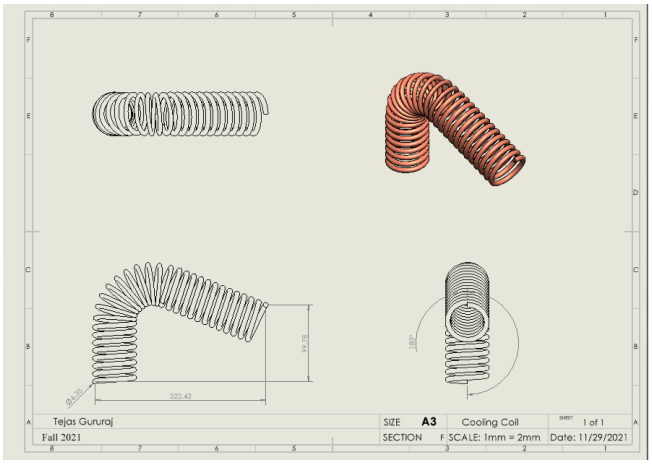
Working Drawings - Tejas Gururaj

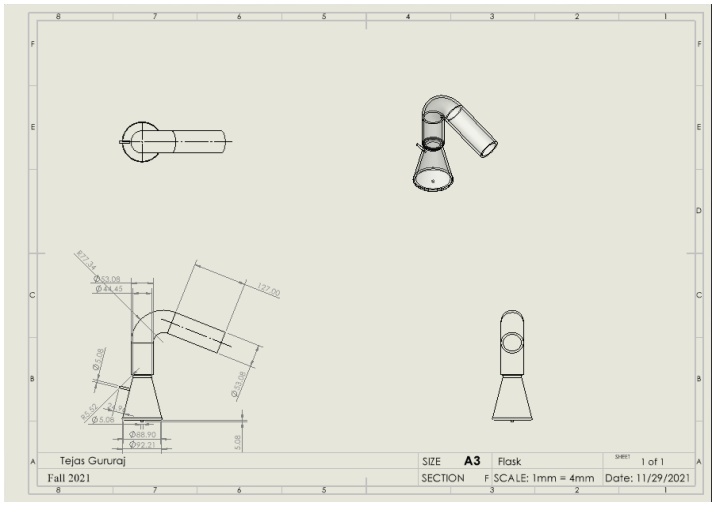


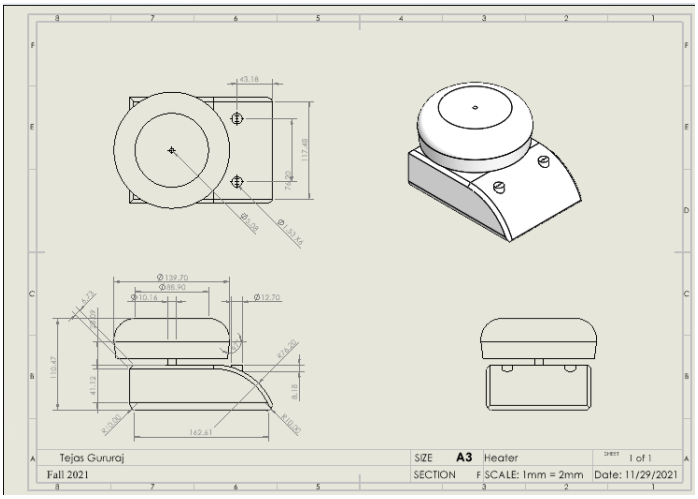


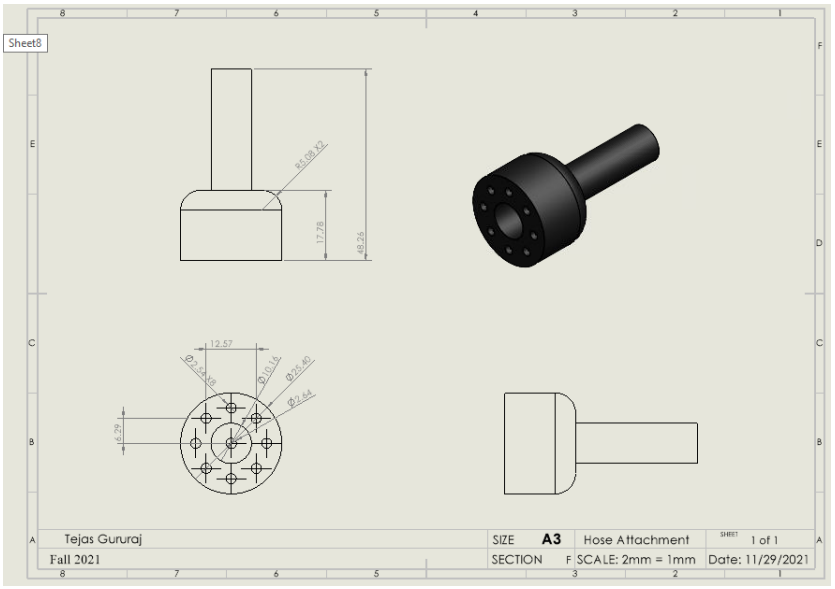


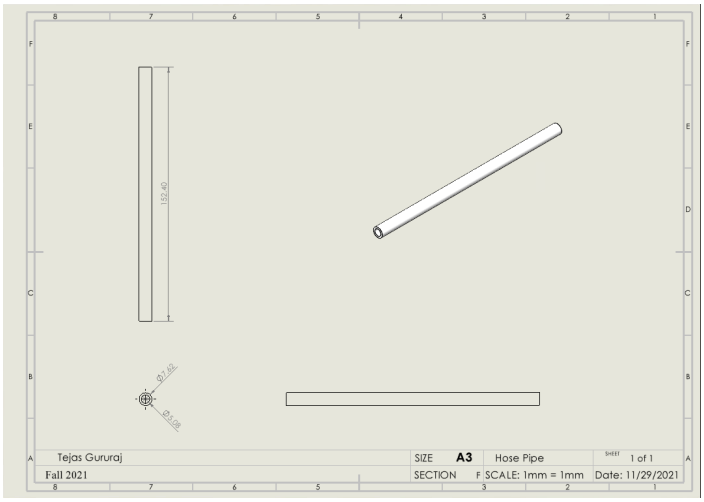


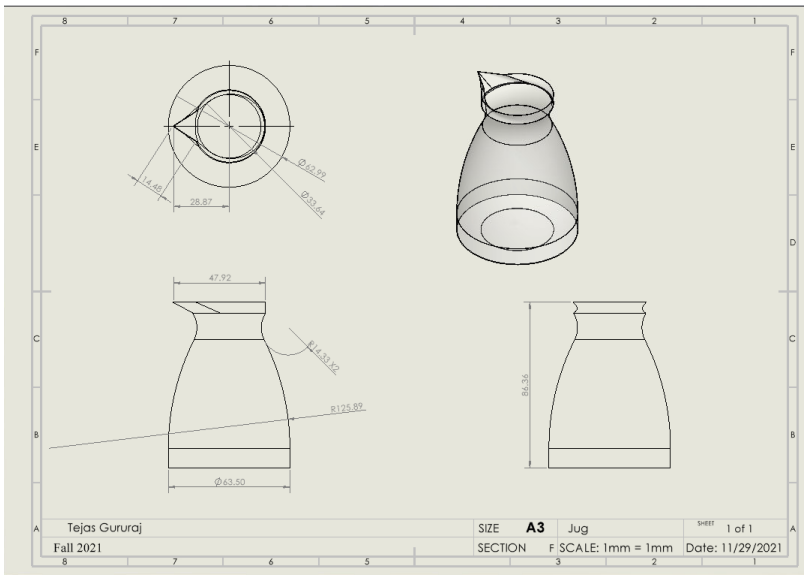




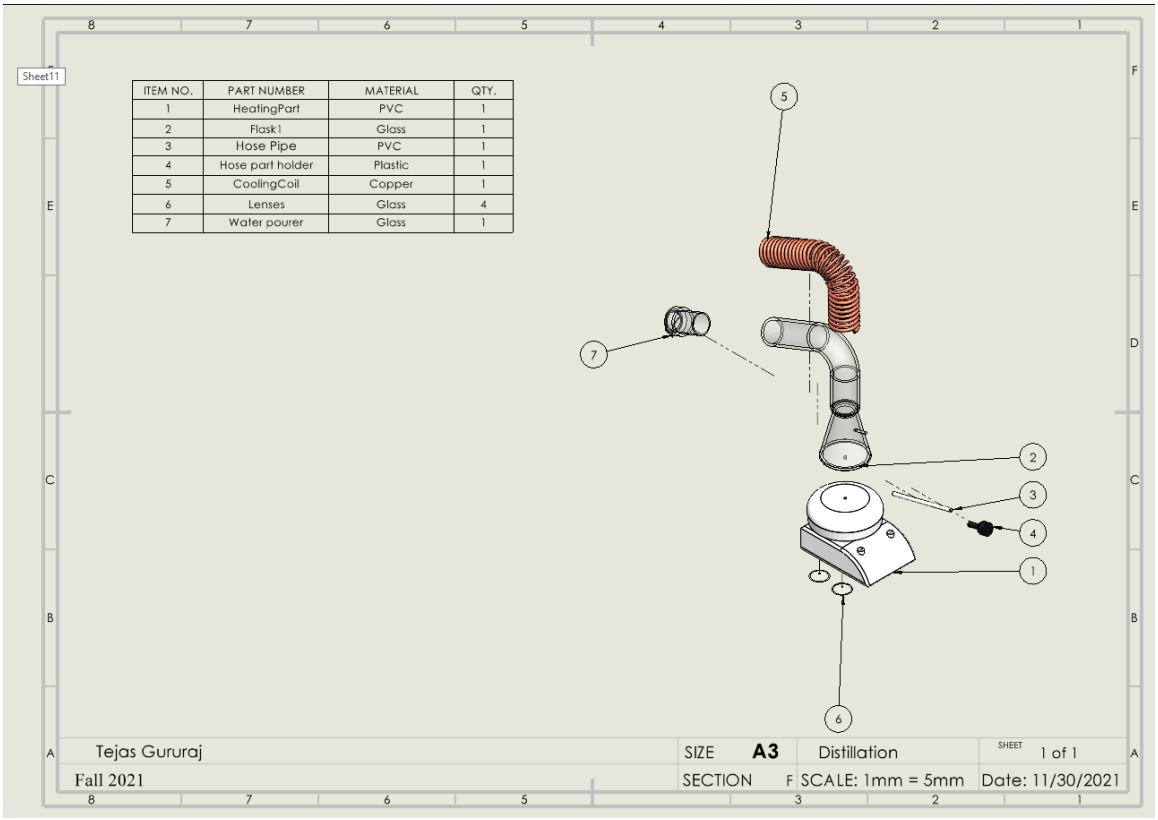

Tejas Gururaj
Fall 2021
SIZE A3 Heater
SECTION F SCALE: 1mm = 2mm
Date: 11/29/2021

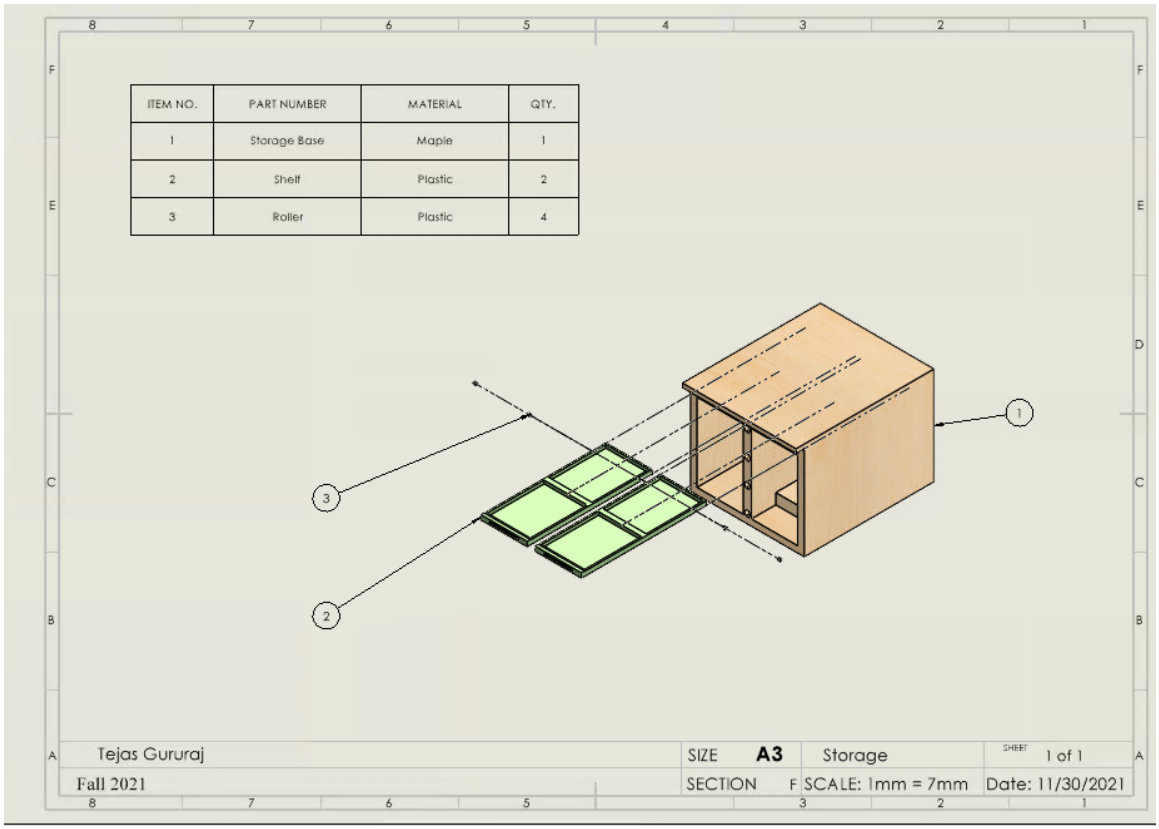

Sheet8
Tejas Gururaj
Fall 2021
SIZE A3 Hose Attachment
SECTION F SCALE: 2mm = 1mm
Date: 11/29/2021


Tejas Gururaj
Fall 2021
SIZE A3 Hose Pipe
SECTION F SCALE: 1mm = 1mm
Date: 11/29/2021

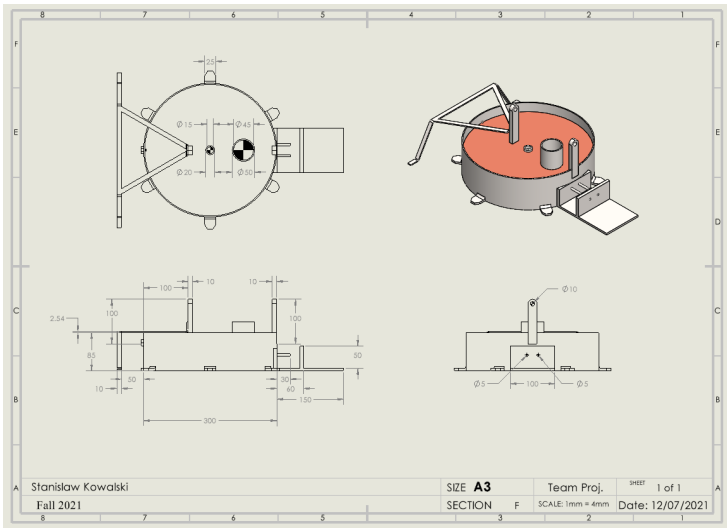

Tejas Gururaj
Fall 2021
SIZE A3 Jug
SECTION F SCALE: 1mm = 1mm
Date: 11/29/2021

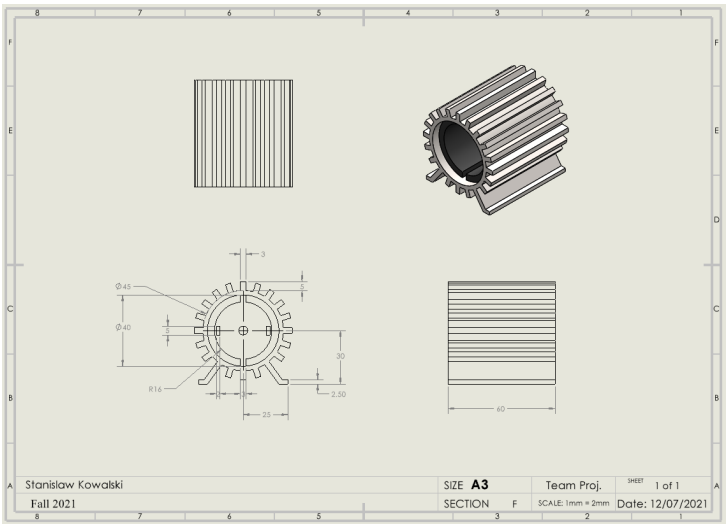
Assembly Views - Tejas Gururaj

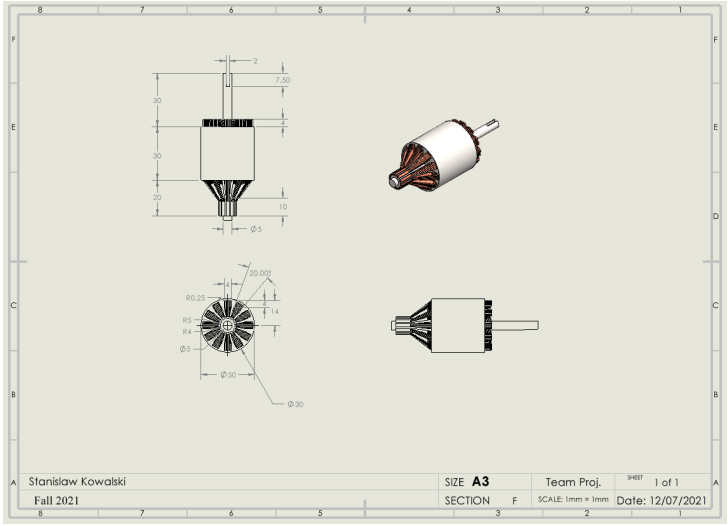


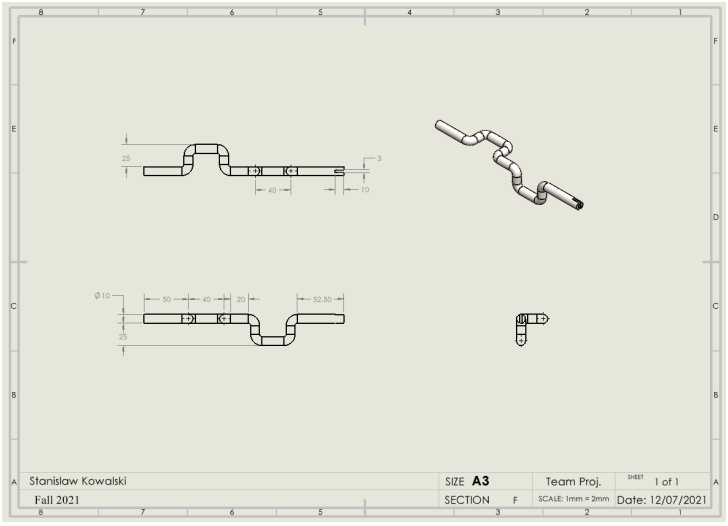


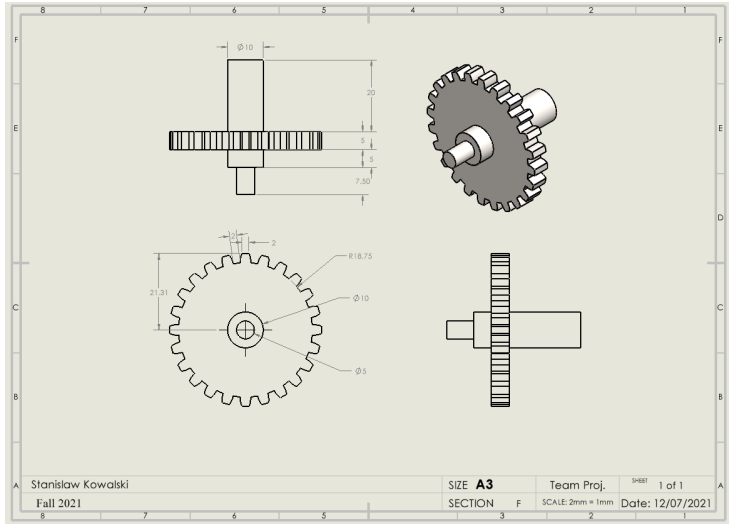
Working Drawings - Stanislaw Kowalski

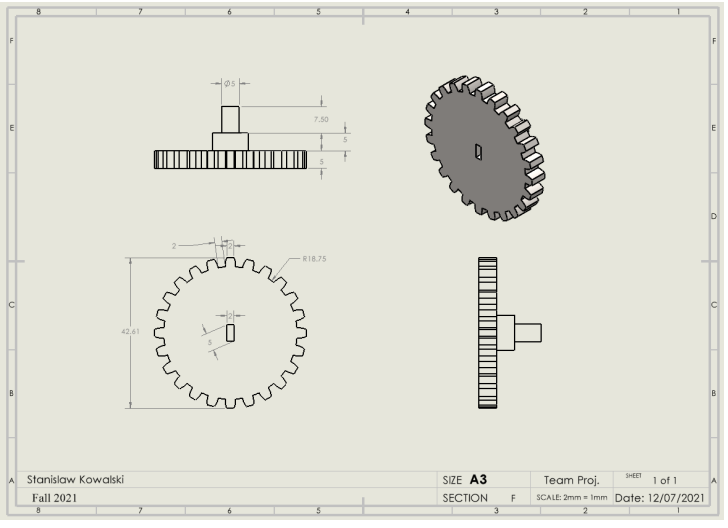


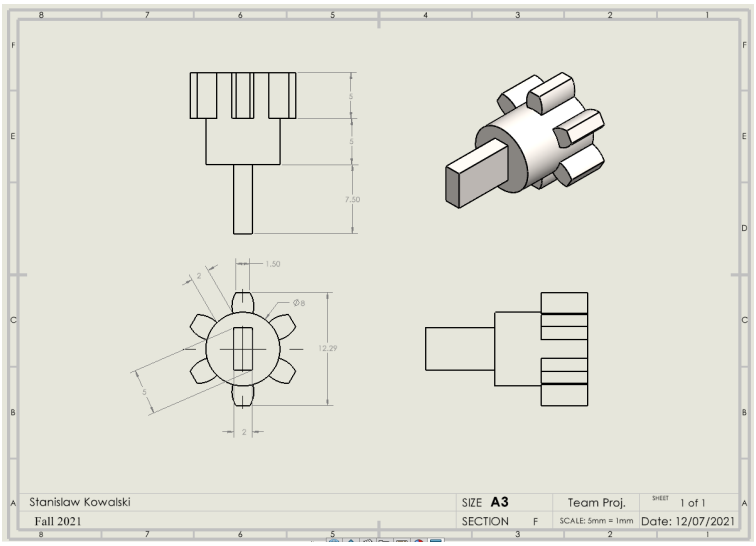


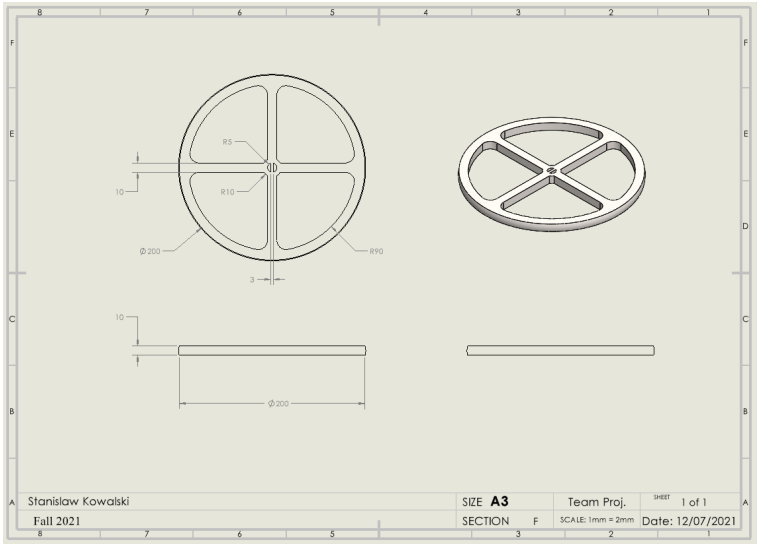


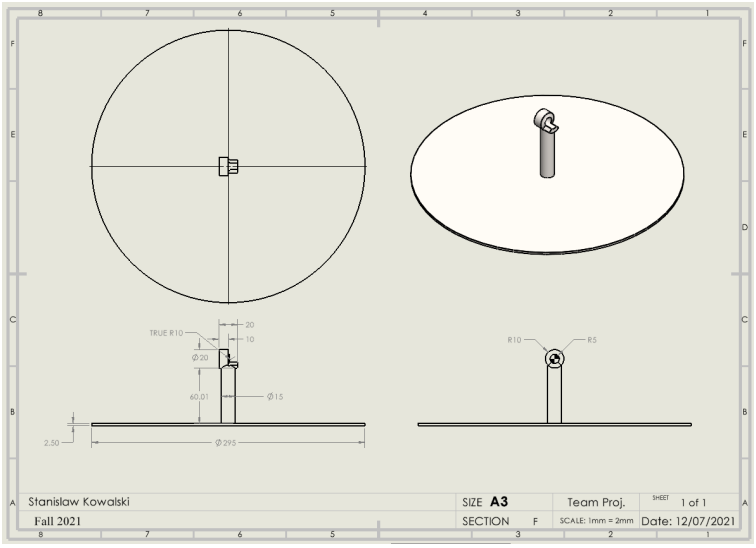


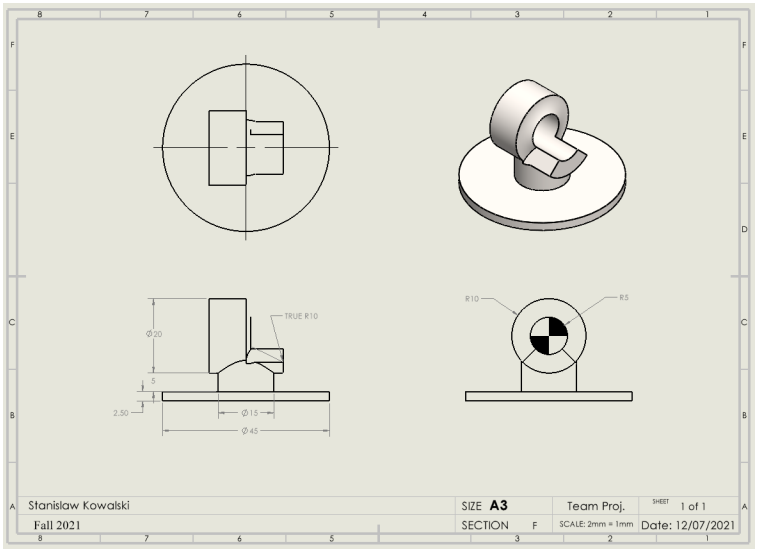




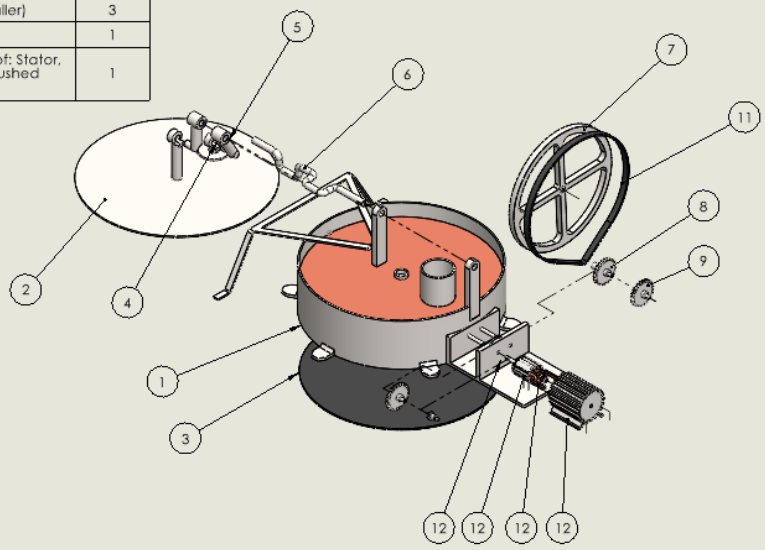

Stanislaw Kowalski
SIZE A3
Team Proj.
SHEET 1 of 1
Fall 2021
SECTION F
SCALE: 5mm = 1mm
Date: 12/07/2021


Stanislaw Kowalski
SIZE A3
Team Proj.
SHEET 1 of 1
Fall 2021
SECTION F
SCALE: 1mm = 2mm
Date: 12/07/2021


Stanislaw Kowalski
SIZE A3
Team Proj.
SHEET 1 of 1
Fall 2021
SECTION F
SCALE: 1mm = 2mm
Date: 12/07/2021

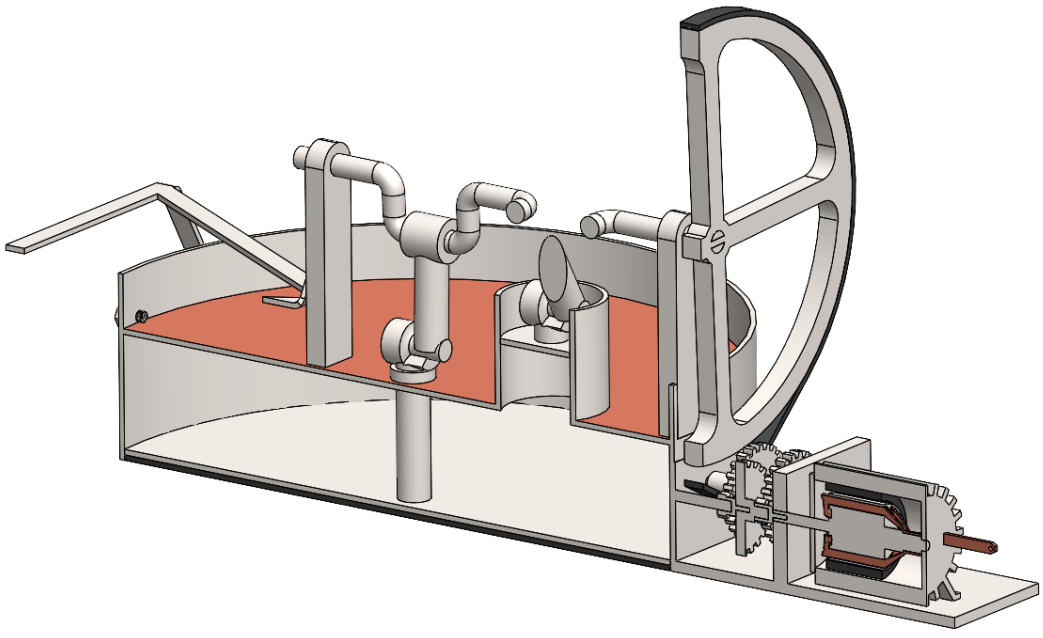

Stanislaw Kowalski
SIZE A3
Team Proj.
SHEET 1 of 1
Fall 2021
SECTION F
SCALE: 2mm = 1mm
Date: 12/07/2021

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Main	Main Body of Stirling Engine	1
2	Piston1	Large Piston	1
3	Bottom	Bottom of Engine, Black for Solar Absorbition	1
4	Piston2	Small Piston	1
5	Lever1	Connection between Pistons & Axle	2
6	Axle	Main Axle	1
7	Flywheel	Flywheel & Flexible Belt Wheel	1
8	Gear 0	Belt-Powered Gear	1
9	Gear 1	Large Gear (Same size as Gear 0)	2
10	Gear 2	Small Gear (4x smaller)	3
11	Belt	Flexible Belt	1
12	Generator	Generator, composed of: Stator, Rotor, Motor Cap, Brushed Contacts	1

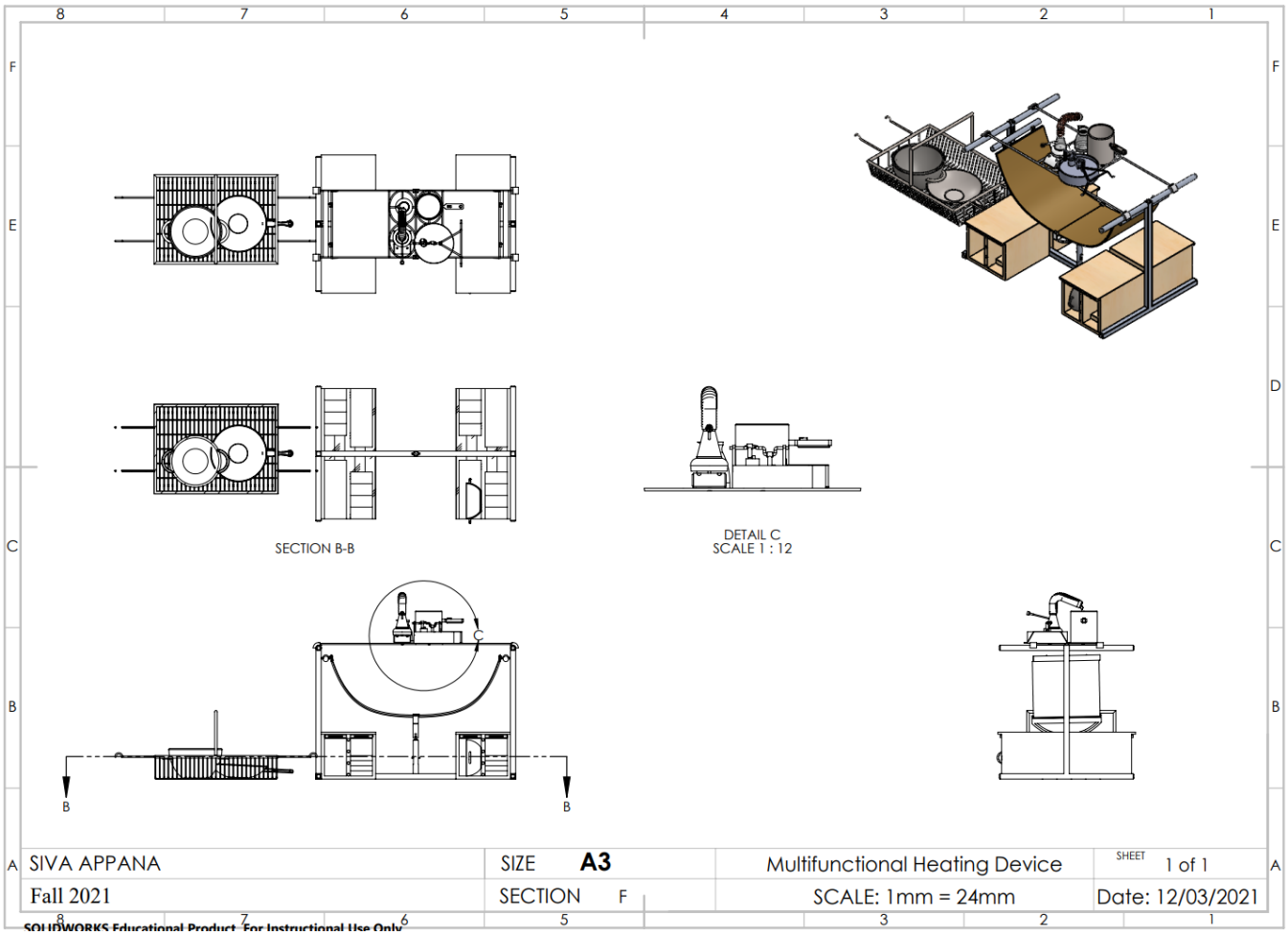


Stanislaw Kowalski | SIZE A3 | Team Proj. | SHEET 1 of 1

Fall 2021 | SECTION F | SCALE: 2mm = 1mm | Date: 12/07/2021



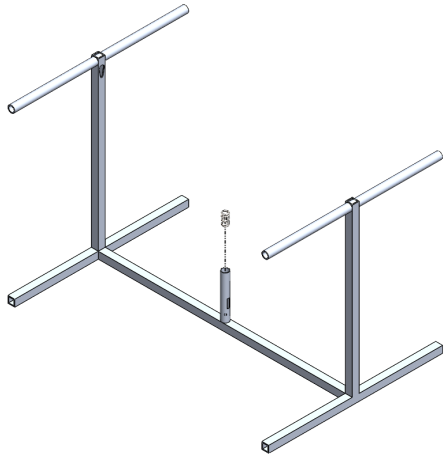
Final Assembly



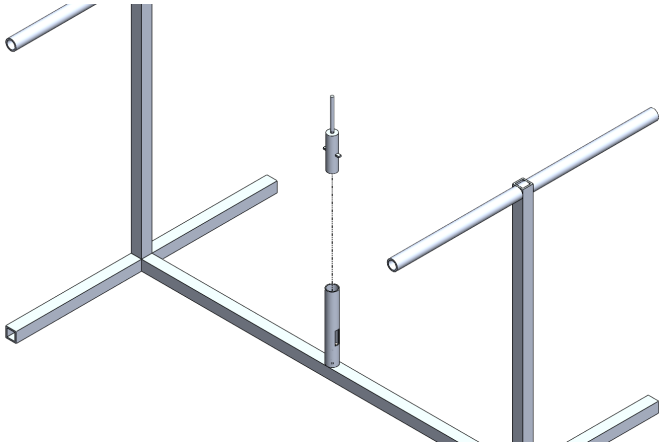
ASSEMBLY INSTRUCTION MANUAL

SOLAR REFLECTOR ASSEMBLY INSTRUCTIONS:

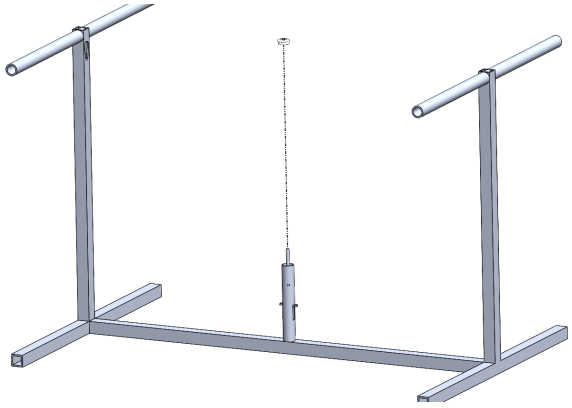
STEP 1: Start with the frame. Insert the spring into the vertical pipe on the frame's center beam.



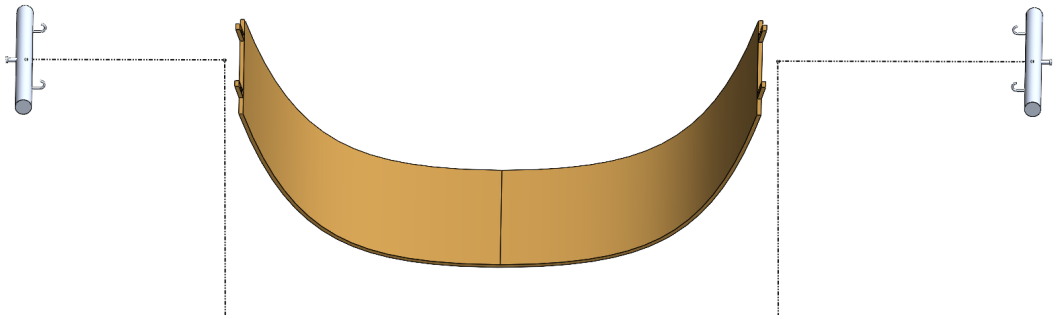
STEP 2: Insert the Rotation Lock Peg into the vertical pipe on the frame's center beam.



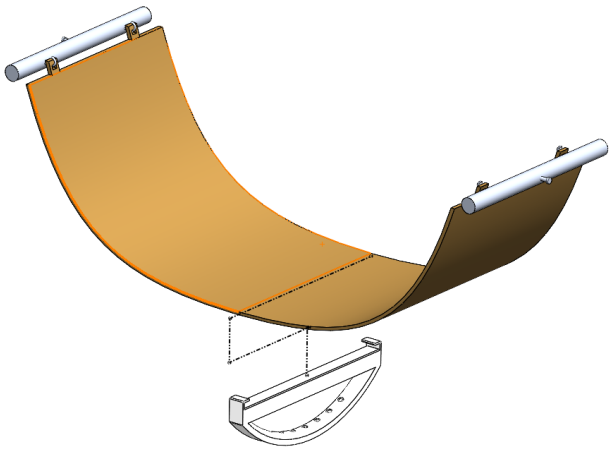
STEP 3: Place the Rotation Peg Cover on the vertical pipe on the frame's center beam so that the Rotation Lock Peg protrudes from the Rotation Peg Cover.



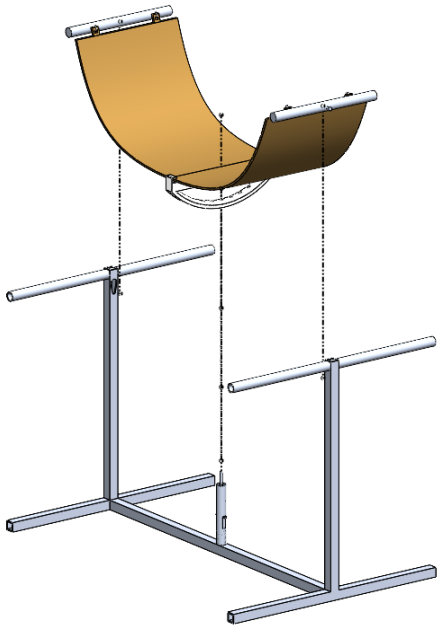
STEP 4: Hook the Reflector onto the Left and Right Reflector Clips.



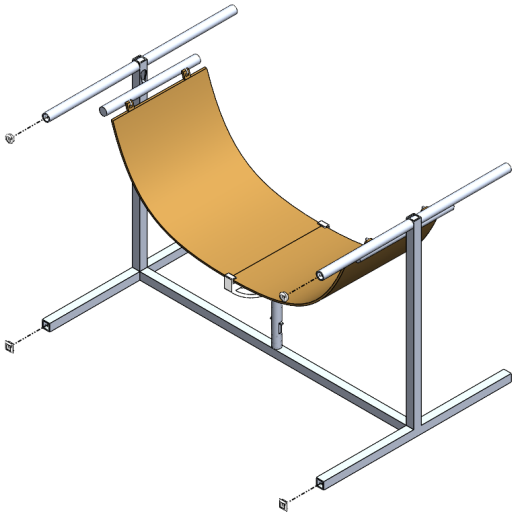
STEP 5: Slide the Rotation Attachment onto the Reflector by slightly bending the Reflector sheet.



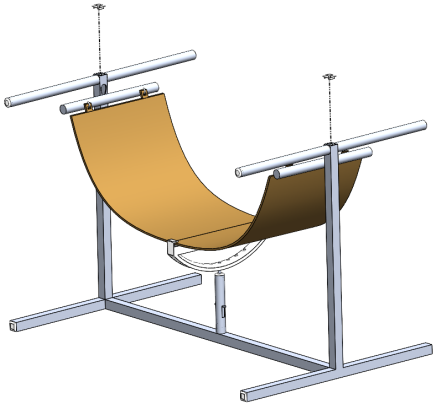
STEP 6: Insert the ends of the Reflector Clips into the Frame. Make sure the Rotation Peg is inserted in one of the holes in the Rotation Attachment.



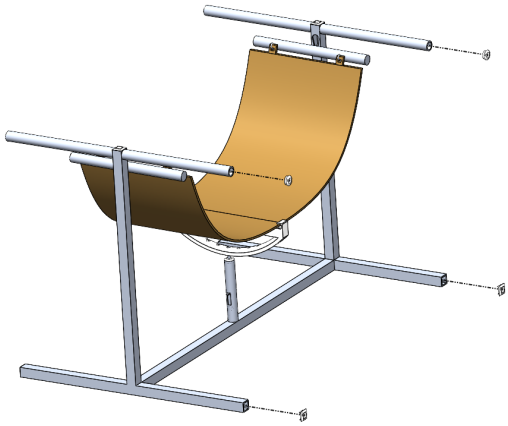
STEP 7: Place 2 Rectangular Covers on the left side of the bottom rectangular beams. Place 2 Circular Covers on the left side of the top cylindrical beams.



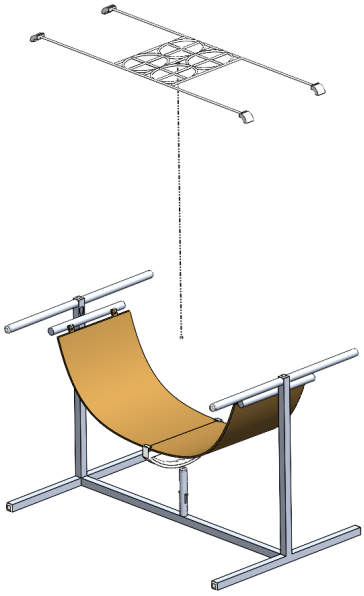
STEP 8: Place 2 Rectangular Covers on top of the 2 vertical square beams.



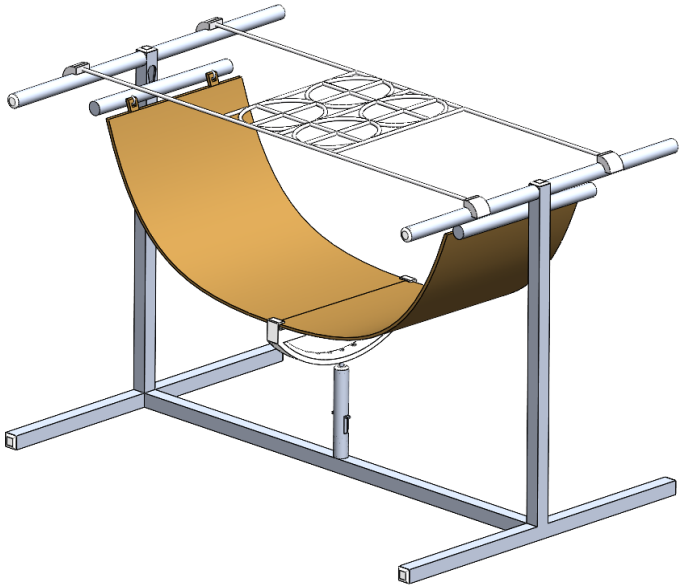
STEP 9: Place 2 Rectangular Covers on the right side of the bottom rectangular beams. Place 2 Circular Covers on the right side of the top cylindrical beams.



STEP 10: Place the Cooking Rack on top of the frame so that the ends of the rack are tangent to the horizontal cylindrical beams. Center the Cooking Rack.



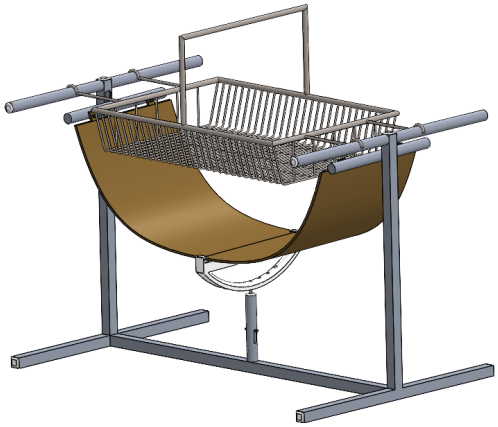
STEP 11: End of Solar Reflector Assembly with Cooking Rack



OR

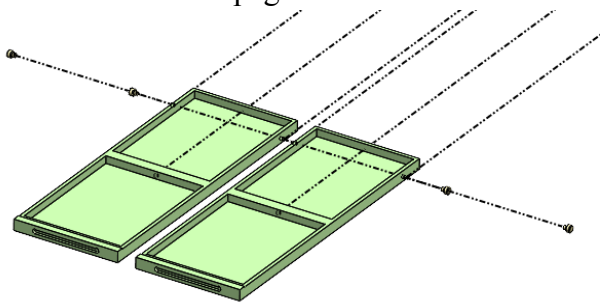
STEP 10: Place the Drying Rack on top of the frame so that the ends of the rack are tangent to the horizontal cylindrical beams. Center the Drying Rack.

STEP 11: End of Solar Reflector Assembly with Drying Rack

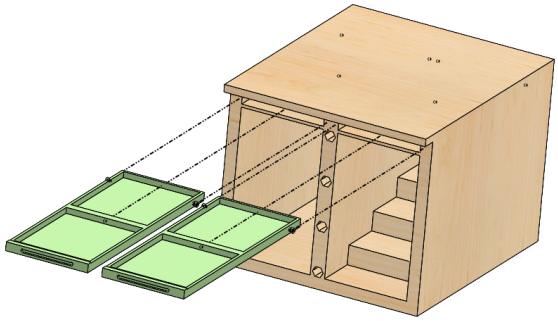


STORAGE ASSEMBLY INSTRUCTIONS:

STEP 1: Attach Rollers to Shelfs on all 4 pegs



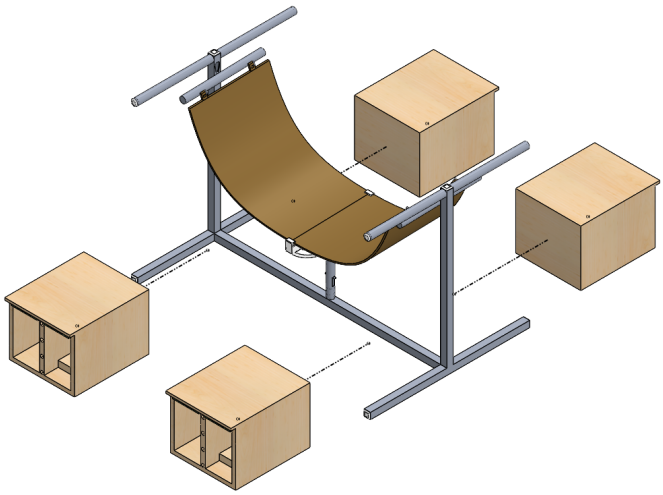
STEP 2: Slide the Shelf, Roller Assembly into the Storage Base so that the rollers rest in the groove



STEP 3: Repeat Steps 1 and 2 for each of the four storages

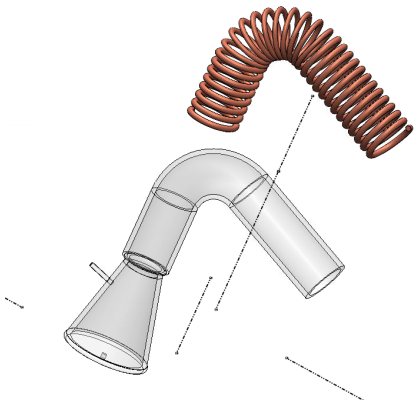
STORAGE INSTALLATION INSTRUCTIONS:

STEP 1: Place 1 storage container in each of the four corners as shown below.

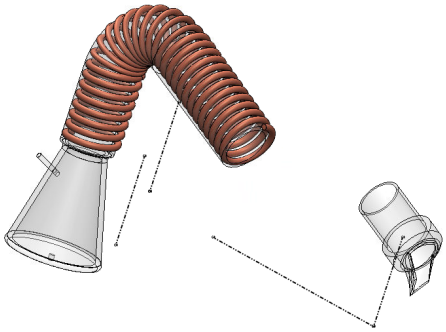


DISTILLATION ASSEMBLY INSTRUCTIONS:

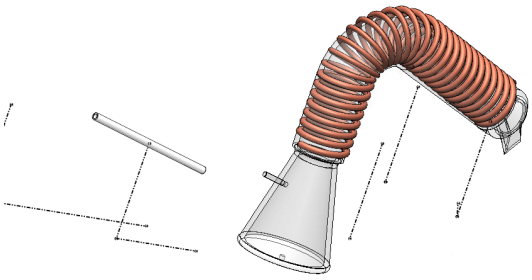
STEP 1: Attach the Cooling Coil to the Flask



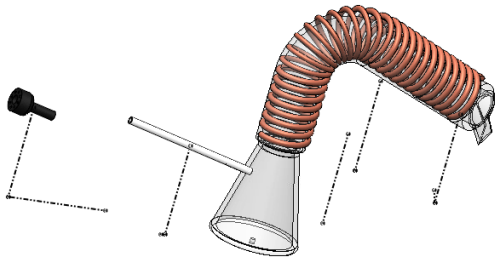
STEP 2: Attach the Water Pourer to the Flask



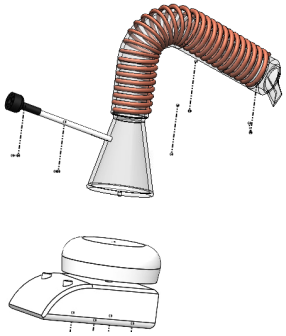
STEP 3: Attach the Hose Pipe to the Flask



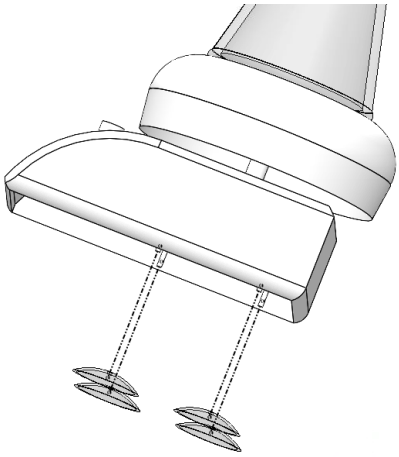
STEP 4: Attach the Hose Part Holder to the Hose Pipe



STEP 6: Attach the Flask to the Heating Part

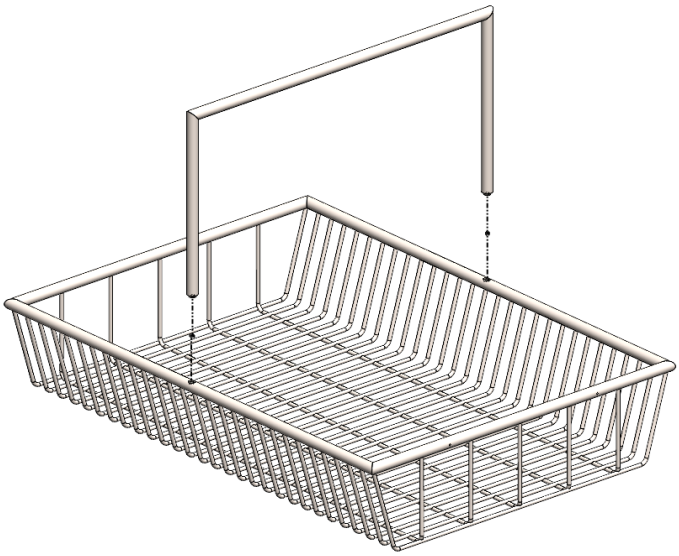


STEP 7: Attach the Lenses to the Bottom of the Heating Part

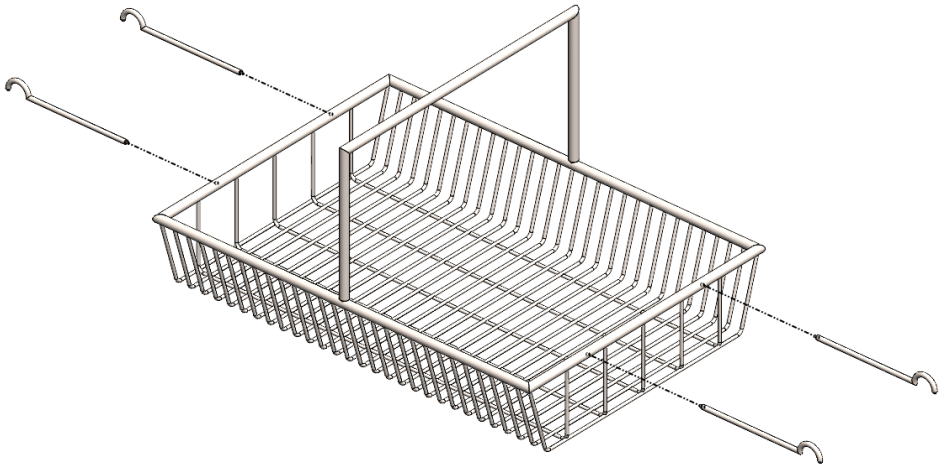


DRYING RACK ASSEMBLY INSTRUCTIONS:

STEP 1: Insert frame for drying clothes or other garments into main frame of drying rack

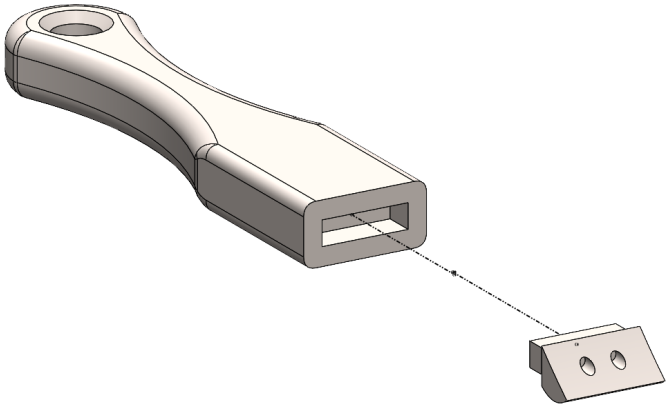


STEP 2: Insert four hooks for mounting onto solar reflector into provided holes of main frame of drying rack

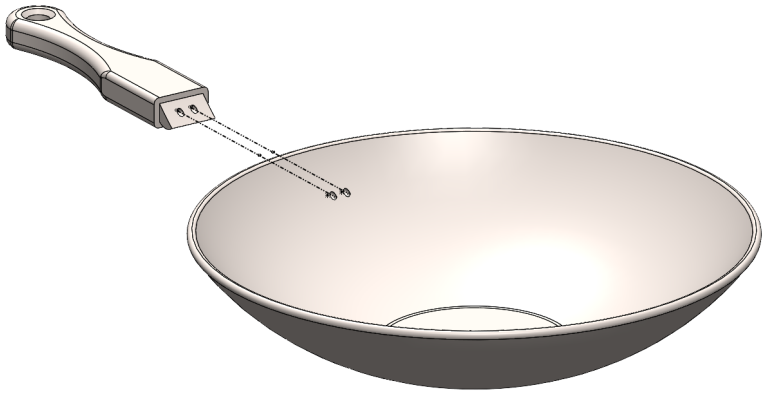


POTS AND PANS ASSEMBLY INSTRUCTIONS:

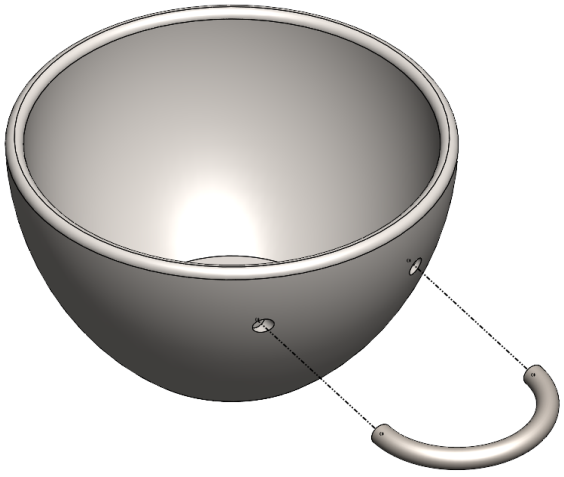
STEP 1: Press the connecting piece for Pan 1 into the main handle of Pan 1



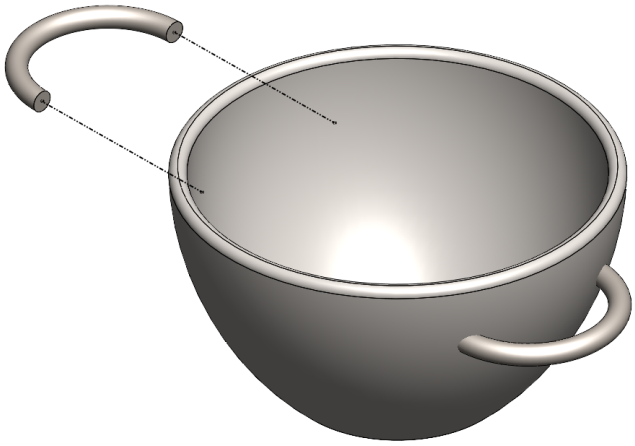
STEP 2: Align the resulting assembly and press onto the face of Pan 1



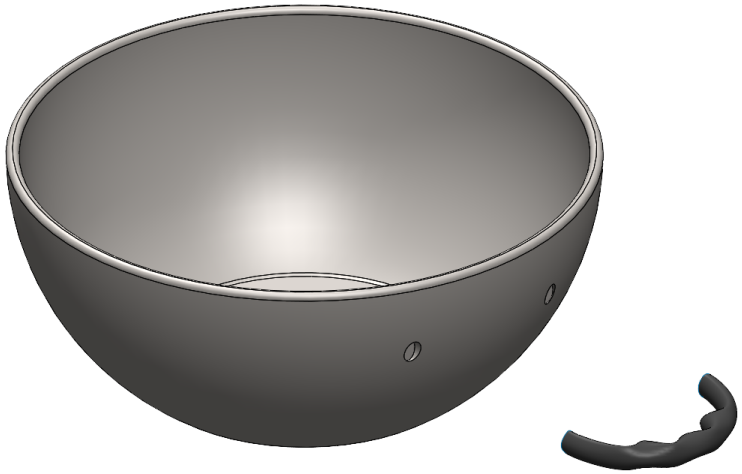
STEP 3: Insert one handle into the holes located on the face of Pot 1



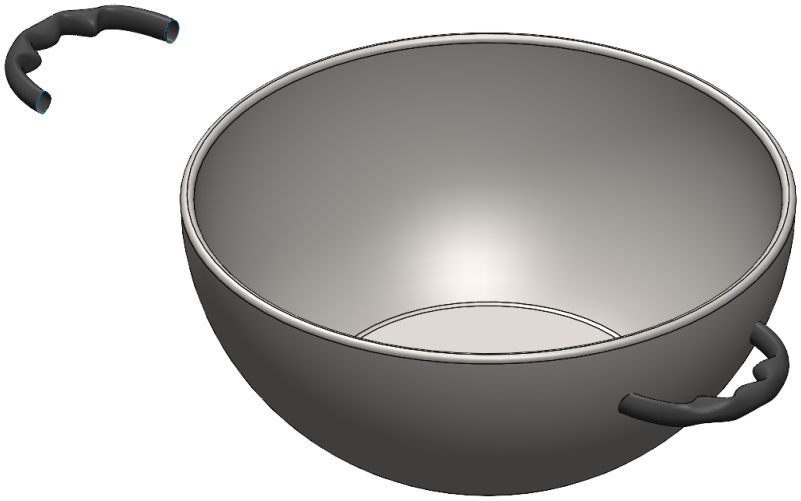
STEP 4: Insert the other handle into the holes located on the opposite facebook of Pot 1



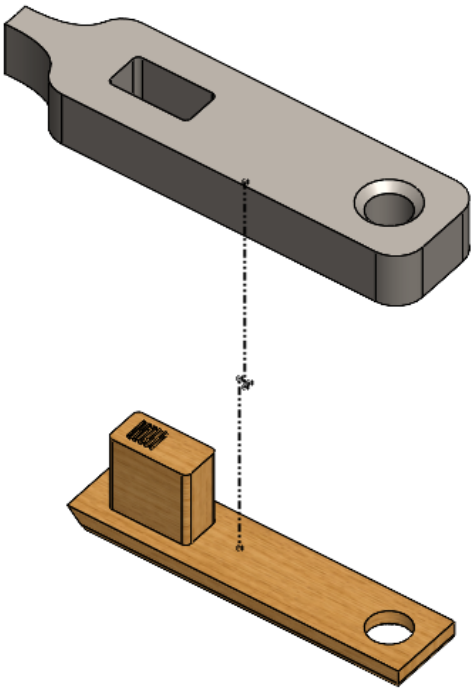
STEP 5: Insert one handle into the holes located on the face of Pot 2



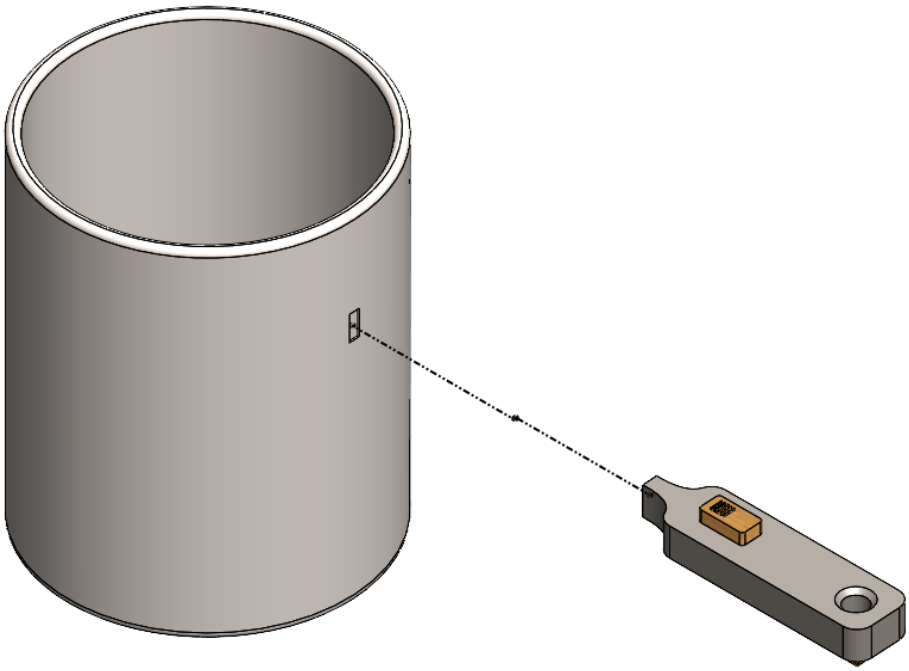
STEP 6: Insert the other handle into the holes located on the opposite facebook of Pot 2



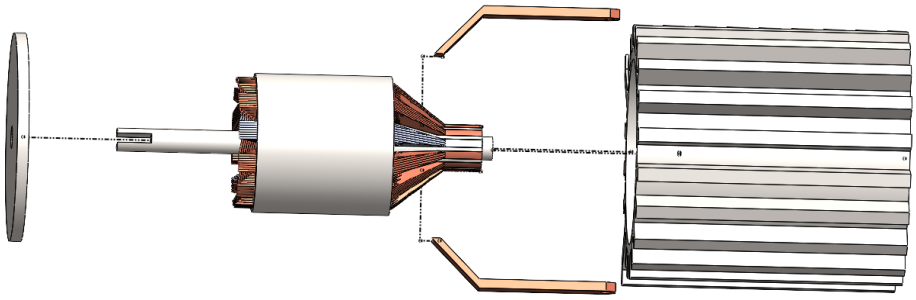
STEP 7: Press fit the lower wooden portion of the handle for Pot 3 into the upper metallic portion of the handle for Pot 3



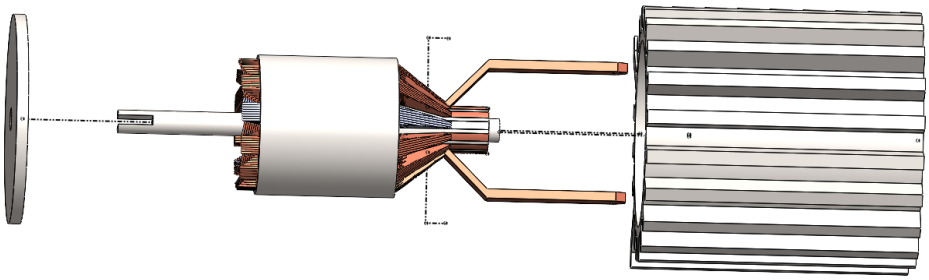
STEP 8: Press the upper portion of the handle for Pot 3 into the hole present on the face of Pot 3



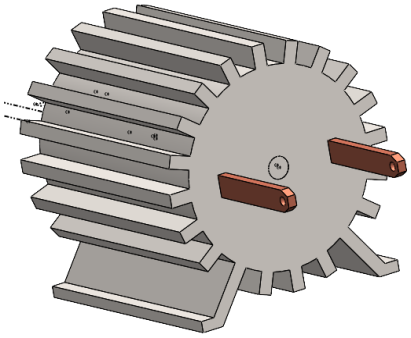
GENERATOR ASSEMBLY INSTRUCTIONS:



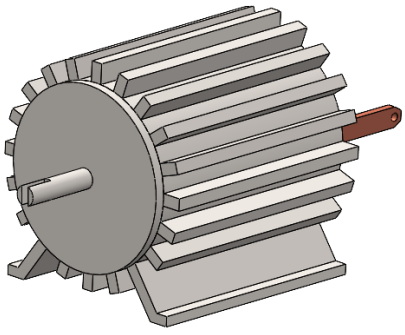
STEP 1: Put brushes in contact with the commutator on the rotor.



STEP 2: Insert rotor / brush combination into appropriate slots in stator.

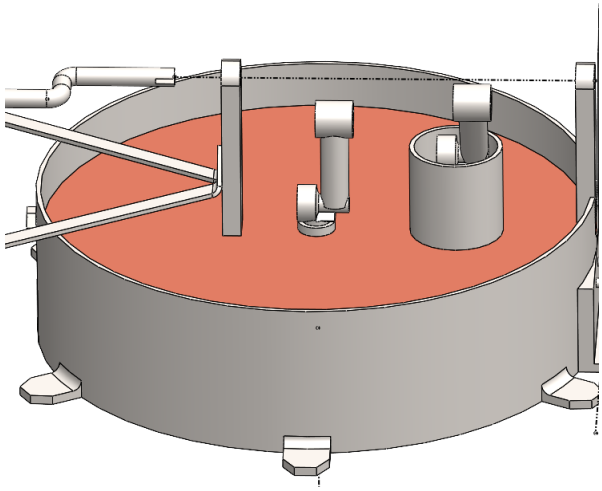


STEP 3: Weld rotor cap on.

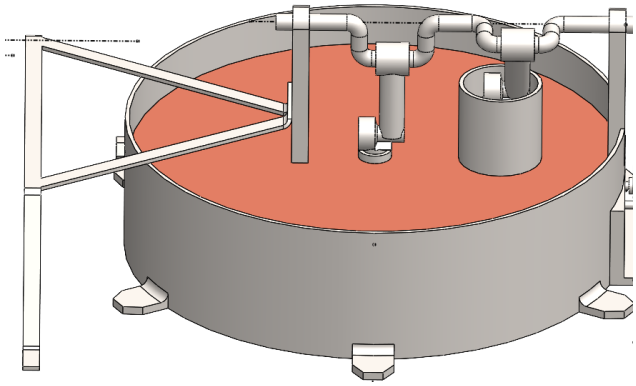


STIRLING ENGINE ASSEMBLY INSTRUCTIONS:

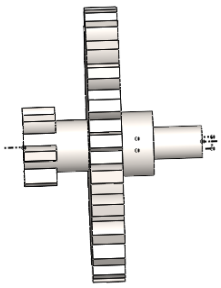
STEP 1: Insert pistons into main body of stirling engine, lever arm into piston upper receivers, and weld bottom to main body of stirling engine:

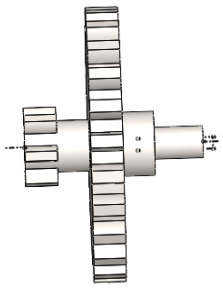


STEP 2: Insert axle into appropriate holes and levers, using pipe-bender to bend into shape.

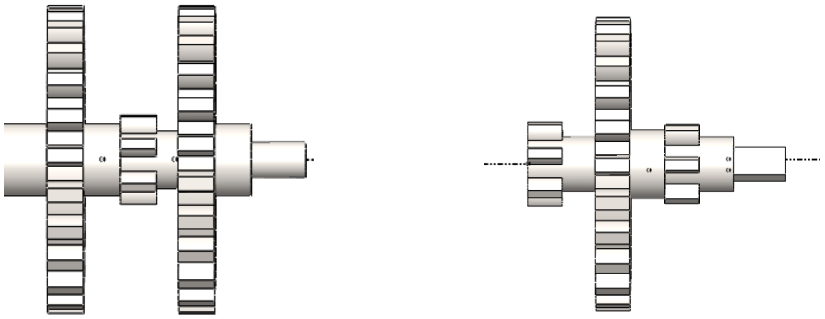


STEP 3: Fit Gear 2 into Gear 1 (x2):

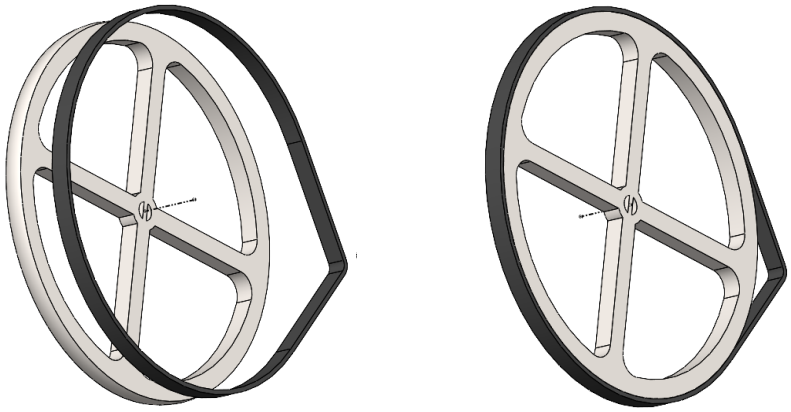




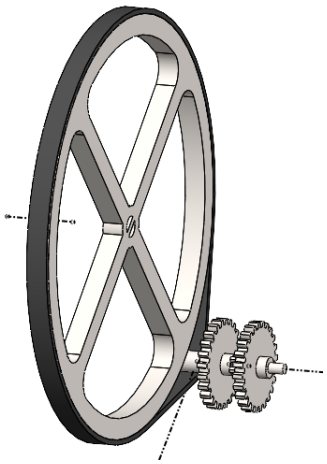
STEP 4: Fit Gear 0 into Gear 2 and Gear 1 into Gear 2:



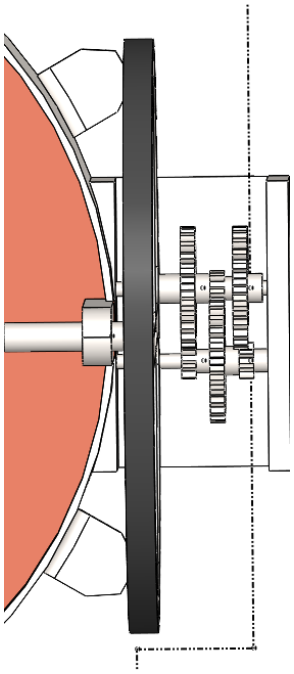
STEP 5: Fit flexible belt onto flywheel:



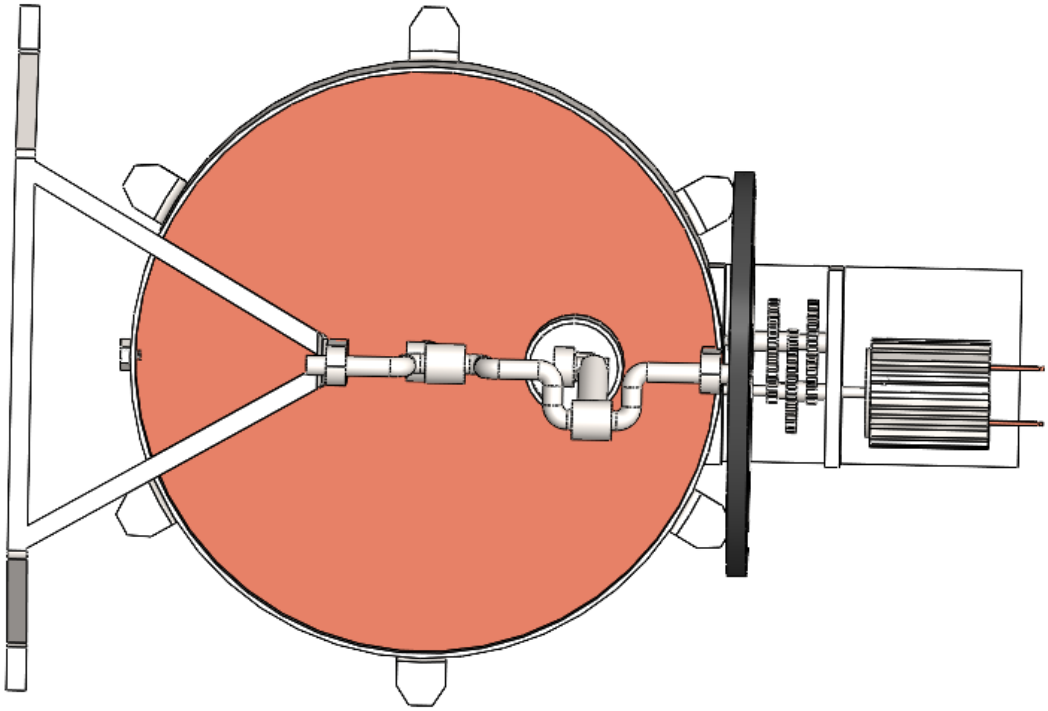
STEP 6: Fit flexible belt onto Gear 0:



STEP 7: Fit gears into gearbox, flywheel onto axle

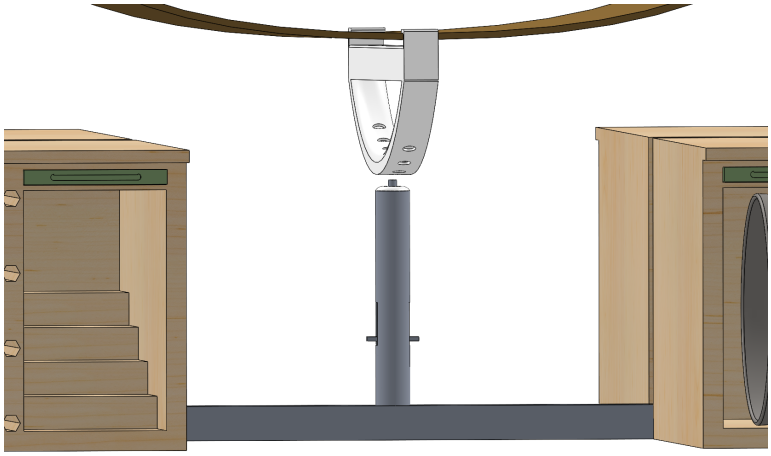


STEP 8: Fit generator rotor into gear 2, attaching stator to platform:

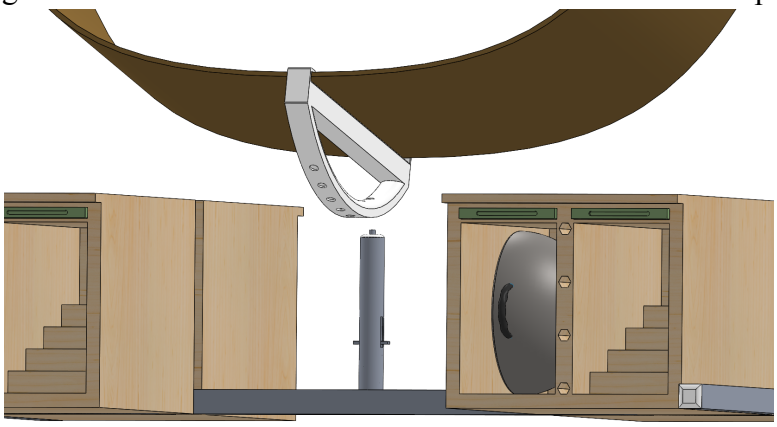


USING ROTATION MODULE INSTRUCTIONS:

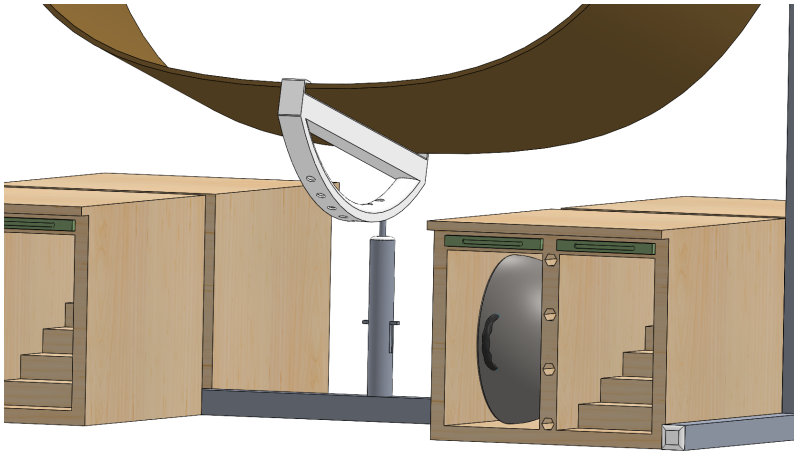
STEP 1: Push down the sliding peg with one hand.



STEP 2: Grip and move the Rotation Clip to the desired position with your other hand so that the peg aligns with one of the holes on the bottom of the Rotation Clip.



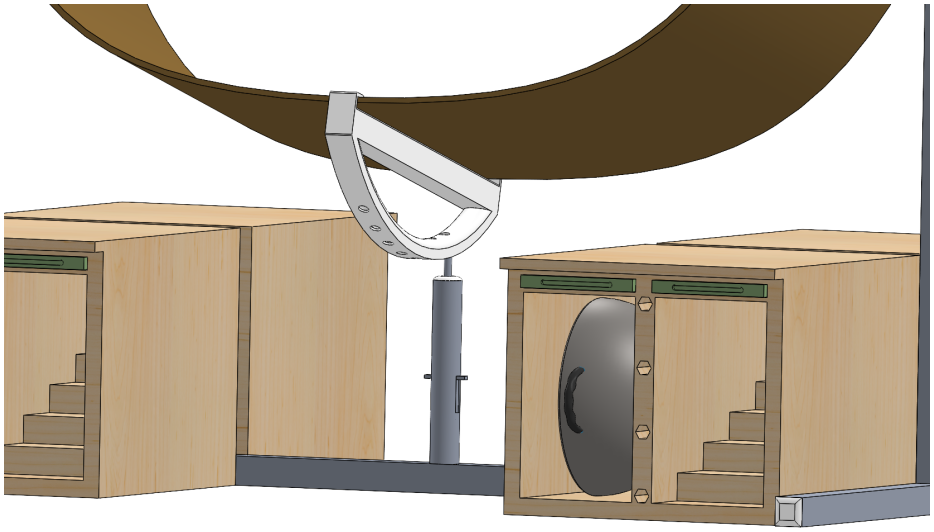
STEP 3: Release the peg.



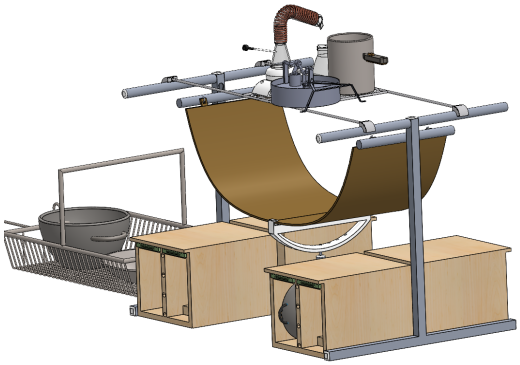
Chapter 5

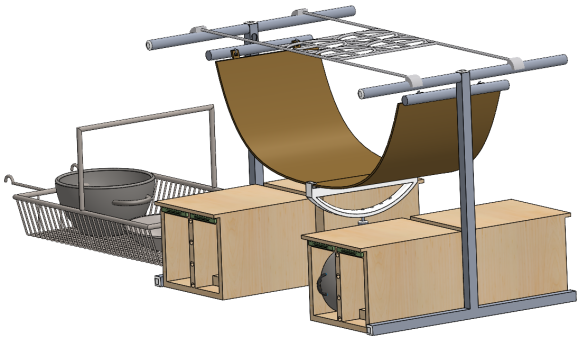
Check for Functionality

The reflector and the rotation module will rotate during the animation. First, the peg will be pushed down, and then the reflector and rotation attachment will rotate 20 degrees in both directions. Finally, the rotation peg will be released and the rotation will be locked, depicting the ability to rotate the reflector.

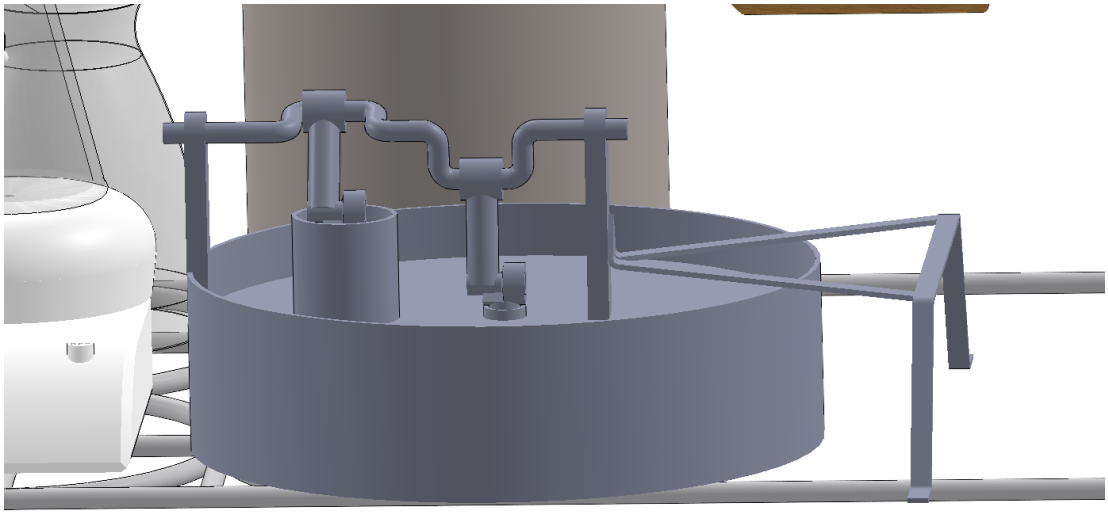


The supplies on the cooking rack will be moved into or out of the storages, and the cooking rack will move to the ground. Then, the drying rack will move on top of the frame, portraying the two primary configurations of the device: cooking rack and drying rack.

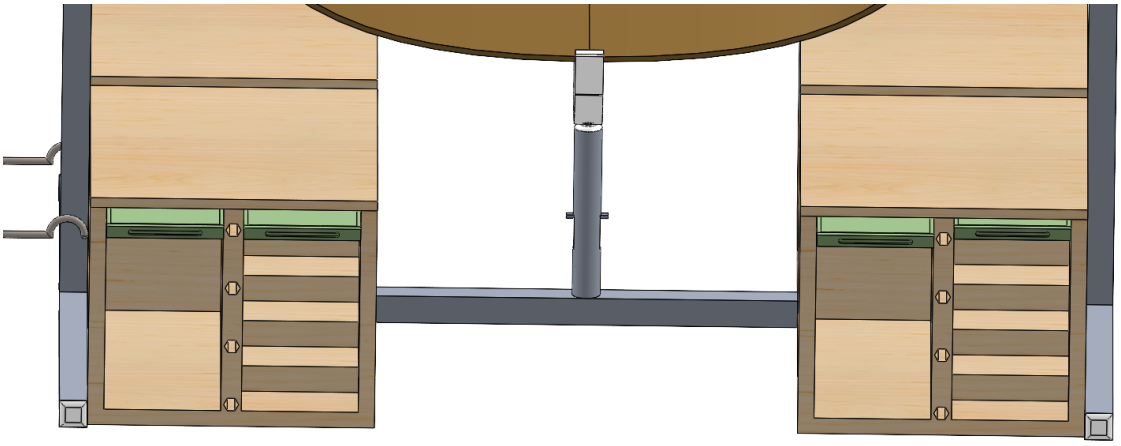




The crankshaft on the Stirling engine will begin to rotate and slowly speed up and then slow down. This represents the function of the Stirling engine during the day when the sun is out.



Simultaneously, the shelves on the storage slide in and out to present the concealed storage space.



Chapter 6

Summary and Concluding Remarks

The goal of the project is to produce a three-dimensional representation of a multi-functional apparatus that utilizes solar energy to serve various functions in an impoverished community or household in sub-Saharan Africa. Some of the functions include non-toxic cooking, distilling water, drying appliances or clothes, storing materials, and generating power. With our sustainable design, households will no longer need to suffer from the consequences of burning nonrenewable energy sources in the kitchen, including diseases that could have lasting impacts. The various modules on our design permitted each team member to independently develop a creative solution to accomplish the assigned function, inherently promoting each member's ideas and visualizations. For instance, one of our team members was assigned to design the storage which led to the unique storage feature seen in the assembly. By dividing the various tasks, our team was able to successfully construct the Low-Cost Multifunctional Heating Device which utilizes common industrial materials while serving a highly utilitarian purpose. Some areas that require development include proper communication regarding overall measurements and the unit system.

As mentioned above, our team had occasional issues with communication, including crucial aspects such as measurements and due date of deliverables. This inadequate communication resulted in several parts being completed at the very last second. Despite the communication issues, we are mostly pleased with our final product. We are certain that the quality of our product would have been significantly better if we increased the frequency of our meetings and incorporated more group work periods.

Our experience in this course has certainly been enjoyable. The chronological order of the lessons and interconnectedness of the manufacturing aspects has provided us with a great understanding of the general design for manufacturing process. We also enjoyed learning about the tools helping us to design, and we found the LinkedIn Learning videos particularly helpful for learning SolidWorks. We certainly found the lab activities and weekly lectures very helpful in enhancing our learning, but we also think the CAD-related lab activities can be more complex. We also believe the CAD was slightly rushed since we did not find enough time to practice all the various concepts we learned on LinkedIn learning. We have certainly learned a lot from this class, and we look forward to our future design and manufacturing classes.

Appendix 1: Meeting Minutes

DATE	NOTES	DELIVERABLES

SEP 5	• Began ideation to solve a sustainability problem
	• Decided to solve clean energy problem
	  ○ Assist those being affected by burning nonrenewable energy sources
	• Chose to utilize energy from the sun: concentrating solar radiation using a reflector
	  ○ Started with solar cooking
		• Generate ideas and concept sketches for each component.
		• Find real-world resemblances for the chosen ideas.
		• Find more applications for heating

SEP 23	• Finalized concepts and attachments/functions that require heating
	  ○ Distillation, Stirling Engine, Cooking, and Drying
	• Divided parts for heating device
	  ○ Siva: Solar Frame, Reflector, Cooking Rack
	  ○ Akash: Various Pots and Pans, Drying Rack
	  ○ Tejas: Distillation Grid, Storage for Pots/Pans
	  ○ Stas: Stirling Engine and related components
	• Decided on using the metric system
	• Decided to let the owner of the parts design the parts
		• Finish ideation for each sub-assembly
		• Finish perspective and multiview sketching
		• Upload sketches to google drive

SEP 30	• Finish any additional ideation sketching- Tejas, Stas • Peer Review components and make changes as necessary • Increase the complexity of sketches and dimension multiviews in relation to agreed dimensions: ○ 1500mm Width, 1000mm Height, 1000mm Depth	• Finish the sketches and perspective drawings • Finish dimensioning all the drawings • Complete final assembly perspective drawing based on Frame perspective view
OCT 7	• Continue Peer Reviewing components and making changes as necessary • Finished sketching and figuring out full	• Begin thinking about the part modeling • Watch LinkedIn

	assembly after making parts in the future • Compiled drawings in one file to submit for Review 1	Learning videos on topics that we should improve on

OCT 14	• Started modeling our parts from the ideation sketches
	• Made new parts when needed: Tejas, Stas
	• Discussed areas to increase complexity on particular parts
	  ○ This became a particular problem when attempting to accomplish the idea of "Low-Cost" while completing the requirements for the project.
	• Discussed potentially conflicting dimensions, and adjusted some parts to fit the frame.
	• Stas researched properties of a proper Stirling Engine.
	• Siva discovered the most effective curve is the catenary curve.
		• Model parts and dimension according to discussed dimensions
		• Ensure parts within a sub-assembly fit together in a proper way
		  ○ Use screws, bolts, and hooks when needed
		  ○ Ensure that the sub-assembly can be properly assembled
		• Increase complexity of models as necessary

OCT 28	• Made any final edits to the parts.
	• Peer Reviewed the parts and suggested alternate approaches to modeling
	  ○ Ex. Siva used a series of pipes and beams for the frame, so he explored the routing tool
	• Create Google Doc
	  ○ Compile all the images to submit Review 2
	  ○ Format pictures neatly and in the necessary manner
		• Inform Siva after finishing your portion of Review 2
		• Submit Review 2

NOV 11	• Worked on sub-assemblies and brainstormed how parts would fit
	• Learned about potential mates that could be used for assembling different parts on LinkedIn Learning
	• Reworked some parts and increased complexity: feedback from Dr. Pucha in Review 2
	  ○ Siva increase the complexity of the covers for the beams: filleted to reduce the sharpness of the edges and cut out the center to reduce material
		• Work on subassemblies
		  ○ Consider Design for manufacturing
		• Upload subassemblies as you finish to the Google Drive

	○ Akash: increased the complexity of the handles for the pots and pans, increased the comfort from holding the pot's handle ○ Tejas: lessened the "boxy" look of some of the containers and storage ○ Stas: completed the Stirling engine	
NOV 18	• Assembled the subassemblies, and transferred subassemblies, with all the parts, to the Google Drive folder. • Assembled the final assembly ○ Fixed dimension-mismatch errors ○ Scaled parts as necessary ○ Edited parts to make assembly more appealing • Began working on compiling images for Review 3	• Edit parts or assemblies as necessary • Finish full assembly • Create Exploded Views • Submit Review 2 to Dr. Pucha for feedback
DEC 2	• Started animating after finalizing assembly mates and subassembly • Tried to time the animation so we can properly run animations • Worked on report and final presentation	• Submit Final Report • Finish animation and prepare for presentation