

**GEORGIA INSTITUTE OF TECHNOLOGY**  
**PROJECT REPORT**

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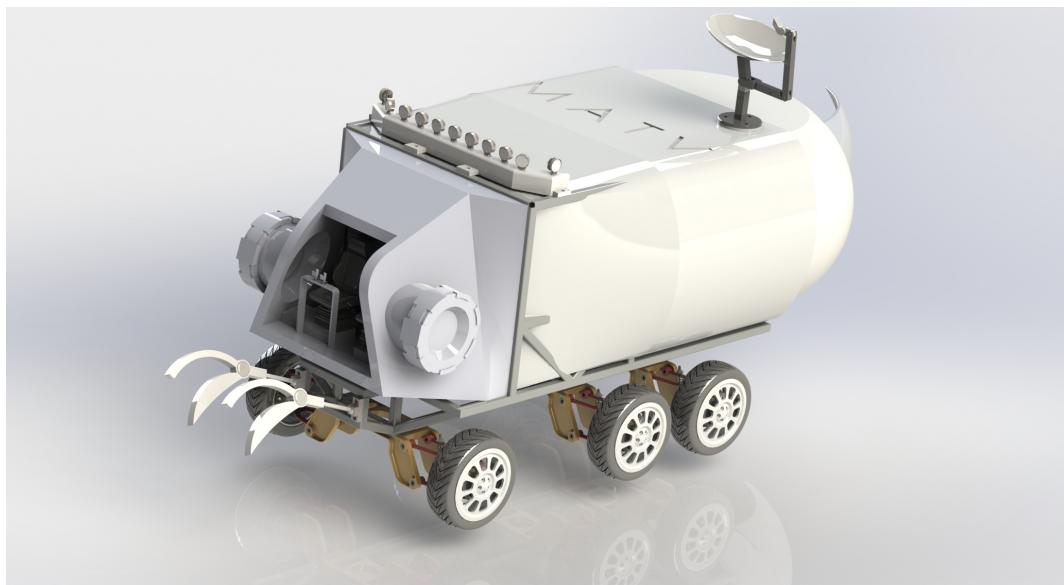
**Mars ATV**

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*A report submitted in fulfillment of the requirements  
for the team project of ME 1770*



# Contents

<b>Contents</b>	<b>iii</b>
<b>List of Figures</b>	<b>vii</b>
<b>1 Project Ideation</b>	<b>1</b>
1.1 Project Proposal . . . . .	1
1.1.1 Description of Product / Structure: Describe the creative ideation and what is new? . . . . .	1
1.1.2 Description of subsystem . . . . .	1
1.1.3 Subassembly Functionality . . . . .	2
1.1.4 Allocation for each member . . . . .	2
1.1.5 Briefly explain what new functionalities (system and sub-system ) you are planning to add. How your product is different from existing products: . . . . .	2
1.1.6 Picture of the Proposed System (or Similar System): (please include a reference if you are using pictures from internet). You can also include conceptual sketch. . . . .	3
1.2 Project Management . . . . .	4
1.2.1 Part Distribution . . . . .	4
Allocating subsystems among team members . . . . .	4
1.2.2 Timeline . . . . .	4
<b>2 Preliminary Design</b>	<b>7</b>
2.1 Conceptual Sketches . . . . .	8
2.2 Perspective Sketches . . . . .	12
2.3 Multiview Sketches . . . . .	19
<b>3 Detail Design</b>	<b>27</b>
3.1 Seat . . . . .	27
3.2 Bed . . . . .	30
3.3 DoorandExterior . . . . .	32
3.4 Cockpit . . . . .	35
3.5 Joystick . . . . .	39
3.6 Dial . . . . .	43
3.7 CabinetDoor . . . . .	44
3.8 EmergencySwitch . . . . .	45
3.9 MechanicalDisplay . . . . .	56
3.10 3DPrinter . . . . .	58
3.11 Chassis . . . . .	62

3.12 Helmet . . . . .	63
3.13 Suspension . . . . .	66
3.14 Antenna . . . . .	72
<b>4 Manufacturing Working Drawing</b>	<b>77</b>
<b>4.1 Working Drawings . . . . .</b>	<b>78</b>
4.1.1 Joystick . . . . .	78
4.1.2 Emergency Switch . . . . .	79
4.1.3 Seat . . . . .	83
4.1.4 Mechanical Display . . . . .	84
4.1.5 Antenna . . . . .	85
4.1.6 Chassis . . . . .	93
4.1.7 Cabinet Drawer . . . . .	94
4.1.8 Door and Hinge . . . . .	95
4.1.9 Exterior Shell . . . . .	97
4.1.10 Helmet . . . . .	99
4.1.11 Grabber . . . . .	103
4.1.12 Suspension . . . . .	112
4.1.13 3D Printer . . . . .	121
4.1.14 Bed . . . . .	127
<b>4.2 Assembly Instruction Manual . . . . .</b>	<b>132</b>
<b>4.2.1 Antenna . . . . .</b>	<b>132</b>
Step 1 . . . . .	132
Step 2 . . . . .	133
Step 3 . . . . .	134
Step 4 . . . . .	135
Step 5 . . . . .	136
<b>4.2.2 Grabber . . . . .</b>	<b>137</b>
Step 1 . . . . .	137
Step 2 . . . . .	138
Step 3 . . . . .	139
Step 4 . . . . .	140
Step 5 . . . . .	141
<b>4.2.3 Lights . . . . .</b>	<b>142</b>
Step 1 . . . . .	142
Step 2 . . . . .	142
Step 3 . . . . .	143
<b>4.2.4 Suspension . . . . .</b>	<b>144</b>
Step 1 . . . . .	144
Step 2 . . . . .	145
Step 3 . . . . .	146
Step 4 . . . . .	147
Step 5 . . . . .	148
<b>4.2.5 3DPrinter . . . . .</b>	<b>149</b>
Step 1 . . . . .	149
Step 2 . . . . .	150
Step 3 . . . . .	151

4.2.6	FlexBed . . . . .	152
Step 1 . . . . .	152	
Step 2 . . . . .	152	
4.2.7	Helmet . . . . .	154
Step 1 . . . . .	154	
Step 2 . . . . .	155	
4.2.8	Hinge . . . . .	156
Step 1 . . . . .	156	
Step 2 . . . . .	157	
4.3	Exploded View . . . . .	158
4.3.1	Antenna . . . . .	158
4.3.2	Grabber . . . . .	159
4.3.3	Light . . . . .	160
4.3.4	Suspension . . . . .	161
4.3.5	MechanicalDisplay . . . . .	162
4.3.6	EmergencyButton . . . . .	163
4.4	Part List . . . . .	164
4.4.1	Antenna . . . . .	164
4.4.2	Lights . . . . .	165
4.4.3	Suspension . . . . .	166
4.4.4	Grabbers . . . . .	167
4.4.5	Emergency Button . . . . .	168
4.4.6	Mechanical Display . . . . .	169
<b>5</b>	<b>Check For Functionality</b>	<b>171</b>
5.1	Mechanical Display . . . . .	171
5.2	Antenna . . . . .	172
5.3	Grabbers . . . . .	173
5.4	Emergency Button . . . . .	174
<b>6</b>	<b>Summary And Concluding Remarks</b>	<b>175</b>
6.1	Objective And Goal . . . . .	175
6.2	Course Comment . . . . .	175
6.3	Team Experience . . . . .	176
6.4	Course Suggestions . . . . .	176
<b>A</b>	<b>Meeting Minutes</b>	<b>177</b>



# List of Figures

1.1 Daybreak Games: Planetside 2 ANT Vehicle Concept . . . . .	3
1.2 BAJA SAE India Team . . . . .	3
1.3 Gantt Chart . . . . .	5
2.1 Hirani, Asimm: Suspension . . . . .	8
2.2 Hirani, Asimm: Powertrain . . . . .	8
2.3 Hirani, Asimm: Scientific Storage . . . . .	9
2.4 Kumar, Vishakh: Exterior . . . . .	9
2.5 Rodriguez, Juan: Overview . . . . .	10
2.6 Sackett, Justin: Grabber . . . . .	10
2.7 Sackett, Justin: Lights . . . . .	11
2.8 Sackett, Justin: Light Assembly . . . . .	11
2.9 Hirani, Asimm: Suspension . . . . .	12
2.10 Ferrarer, Auston: Exterior . . . . .	12
2.11 Rodriguez, Juan: Chassis . . . . .	13
2.12 Rodriguez, Juan: Antenna . . . . .	13
2.13 Kumar, Vishakh: Cockpit . . . . .	14
2.14 Kumar, Vishakh: Seat . . . . .	15
2.15 Kumar, Vishakh: Joystick . . . . .	16
2.16 Kumar, Vishakh: Emergency . . . . .	17
2.17 Kumar, Vishakh: Mechanical Dials . . . . .	18
2.18 Hirani, Asimm: Gear One . . . . .	19
2.19 Hirani, Asimm: Disc Brake . . . . .	19
2.20 Hirani, Asimm: Upright . . . . .	20
2.21 Hirani, Asimm: Motor . . . . .	20
2.22 Ferrarer, Auston: 3D Printer . . . . .	21
2.23 Ferrarer, Auston: Bed . . . . .	21
2.24 Ferrarer, Auston: Helmet . . . . .	22
2.25 Ferrarer, Auston: Rear Hatch . . . . .	22
2.26 Rodriguez, Juan: Antenna . . . . .	23
2.27 Rodriguez, Juan: Antenna . . . . .	23
2.28 Rodriguez, Juan: Antenna . . . . .	24
2.29 Rodriguez, Juan: Chassis . . . . .	25
2.30 Rodriguez, Juan: Chassis . . . . .	25
2.31 Rodriguez, Juan: Chassis . . . . .	26
2.32 Kumar, Vishakh: Joystick . . . . .	26
3.1 Kumar, Vishakh: Seat View 1 . . . . .	27
3.2 Kumar, Vishakh: Seat View 2 . . . . .	28

3.3	Kumar, Vishakh: Seat View 3 . . . . .	29
3.4	Ferrarer, Auston: Mattress . . . . .	30
3.5	Ferrarer, Auston: Slide Bracket . . . . .	30
3.6	Ferrarer, Auston: Sliding Bolt . . . . .	31
3.7	Ferrarer, Auston: Top Bed Bracket . . . . .	31
3.8	Ferrarer, Auston: Exterior Structure . . . . .	32
3.9	Ferrarer, Auston: Hinge Right Side . . . . .	32
3.10	Ferrarer, Auston: Hinge Left Side . . . . .	33
3.11	Ferrarer, Auston: Pin . . . . .	33
3.12	Ferrarer, Auston: Rear Door . . . . .	34
3.13	Kumar, Vishakh: Cockpit View 1 . . . . .	35
3.14	Kumar, Vishakh: Cockpit View 2 . . . . .	36
3.15	Kumar, Vishakh: Cockpit View 3 . . . . .	37
3.16	Kumar, Vishakh: Cockpit View 4 . . . . .	38
3.17	Kumar, Vishakh: Cockpit View 4 . . . . .	38
3.18	Kumar, Vishakh: Joystick View 1 . . . . .	39
3.19	Kumar, Vishakh: Joystick View 2 . . . . .	40
3.20	Kumar, Vishakh: Joystick View 3 . . . . .	41
3.21	Kumar, Vishakh: Joystick View 4 . . . . .	42
3.22	Kumar, Vishakh: Dial . . . . .	43
3.23	Ferrarer, Auston: Cabinet Door . . . . .	44
3.24	Kumar, Vishakh: Emergency Switch View 1 . . . . .	45
3.25	Kumar, Vishakh: Emergency Switch View 2 . . . . .	46
3.26	Kumar, Vishakh: Emergency Button Top . . . . .	46
3.27	Kumar, Vishakh: Emergency Switch Spring . . . . .	47
3.28	Kumar, Vishakh: Emergency Switch Main Casing . . . . .	48
3.29	Kumar, Vishakh: Emergency Switch Pod Casing . . . . .	49
3.30	Kumar, Vishakh: Stecker . . . . .	50
3.31	Kumar, Vishakh: Buckle Axis . . . . .	51
3.32	Kumar, Vishakh: Switch Base . . . . .	51
3.33	Kumar, Vishakh: Buckle . . . . .	52
3.34	Kumar, Vishakh: Nut . . . . .	53
3.35	Kumar, Vishakh: Plastic Axis . . . . .	54
3.36	Kumar, Vishakh: Emergency Dial Top . . . . .	55
3.37	Kumar, Vishakh: Emergency Dial Bottom . . . . .	55
3.38	Kumar, Vishakh: Mechanical Display View 1 . . . . .	56
3.39	Kumar, Vishakh: Mechanical DisplayView 2 . . . . .	56
3.40	Kumar, Vishakh: Mechanical Display View 3 . . . . .	57
3.41	Ferrarer, Auston: Basic Cut Extrude . . . . .	58
3.42	Ferrarer, Auston: Extruder . . . . .	59
3.43	Ferrarer, Auston: Extruder Housing . . . . .	60
3.44	Ferrarer, Auston: Printing Plate . . . . .	60
3.45	Ferrarer, Auston: Slide Bar . . . . .	61
3.46	Rodriguez, Juan: Chasis Render . . . . .	62
3.47	Ferrarer, Auston: Helmet Shell . . . . .	63
3.48	Ferrarer, Auston: Helmet Visor . . . . .	63
3.49	Ferrarer, Auston: Left light . . . . .	64

3.50 Ferrarer, Auston: Right light . . . . .	65
3.51 Hirani, Asimm: 25 Tooth Gear . . . . .	66
3.52 Hirani, Asimm: 60 Tooth Gear . . . . .	67
3.53 Hirani, Asimm: Brake Caliper . . . . .	67
3.54 Hirani, Asimm: Brake Disk . . . . .	68
3.55 Hirani, Asimm: Center Frame . . . . .	68
3.56 Hirani, Asimm: Coilover . . . . .	69
3.57 Hirani, Asimm: Gearbox Drive Shaft . . . . .	69
3.58 Hirani, Asimm: Gearbox Idler Shaft . . . . .	69
3.59 Hirani, Asimm: Gearbox Output Shaft . . . . .	70
3.60 Hirani, Asimm: Gearbox Steel Plate . . . . .	70
3.61 Hirani, Asimm: Hub . . . . .	71
3.62 Hirani, Asimm: Gearbox Drive Shaft . . . . .	71
3.63 Rodriguez, Juan: Antenna Rendering . . . . .	72
3.64 Rodriguez, Juan: Antenna Base . . . . .	73
3.65 Rodriguez, Juan: pin A . . . . .	73
3.66 Rodriguez, Juan: pin B . . . . .	74
3.67 Rodriguez, Juan: Antenna . . . . .	75
3.68 Rodriguez, Juan: Receiver . . . . .	76
4.1 Kumar, Vishakh: JoyStick Full Assembly . . . . .	78
4.2 Kumar, Vishakh: Top . . . . .	79
4.3 Kumar, Vishakh: Main Casing . . . . .	80
4.4 Kumar, Vishakh: Pod Casing . . . . .	81
4.5 Kumar, Vishakh: Spring . . . . .	82
4.6 Kumar, Vishakh: Seat Full Assembly . . . . .	83
4.7 Kumar, Vishakh: Mechanical Display . . . . .	84
4.8 Signal Bar . . . . .	85
4.9 Swivel Link . . . . .	86
4.10 Antenna Assembly . . . . .	87
4.11 Antenna Base . . . . .	88
4.12 Antenna Exploded . . . . .	89
4.13 Antenna Support . . . . .	90
4.14 Crossbar . . . . .	91
4.15 Pin A . . . . .	92
4.16 Rodriguez, Juan: Chassis . . . . .	93
4.17 Rodriguez, Juan: Cabinet Drawer . . . . .	94
4.18 Ferrarer, Auston: Complete Hinge . . . . .	95
4.19 Ferrarer, Auston: Exterior Door . . . . .	96
4.20 Ferrarer, Auston: Assembly . . . . .	97
4.21 Ferrarer, Auston: Full Shell . . . . .	98
4.22 Ferrarer, Auston: Helmet Full Assembly . . . . .	99
4.23 Ferrarer, Auston: Helmet Shell . . . . .	100
4.24 Ferrarer, Auston: Helmet Visor . . . . .	101
4.25 Ferrarer, Auston: Side Lights . . . . .	102
4.26 Sackett, Justin: Ball Rod . . . . .	103
4.27 Sackett, Justin: Ball Socket . . . . .	104

4.28 Sackett, Justin: Grabber Exploded . . . . .	105
4.29 Sackett, Justin: Grabber Pin . . . . .	106
4.30 Sackett, Justin: Lights Exploded Part List . . . . .	107
4.31 Sackett, Justin: Light . . . . .	108
4.32 Sackett, Justin: Light Base . . . . .	109
4.33 Sackett, Justin: Lower Arm . . . . .	110
4.34 Sackett, Justin: Upper Pincer . . . . .	111
4.35 Hirani, Asimm: 25 Tooth Gear . . . . .	112
4.36 Hirani, Asimm: 60 Tooth Gear . . . . .	113
4.37 Hirani, Asimm: Center Frame . . . . .	114
4.38 Hirani, Asimm: Gearbox Idler Shaft . . . . .	115
4.39 Hirani, Asimm: Gearbox Plate . . . . .	116
4.40 Hirani, Asimm: LCA . . . . .	117
4.41 Hirani, Asimm: Suspension Assembly . . . . .	118
4.42 Hirani, Asimm: Upright . . . . .	119
4.43 Hirani, Asimm: Wheel . . . . .	120
4.44 Ferrarer, Auston: Base Extrusion . . . . .	121
4.45 Ferrarer, Auston: Full 3D Printer . . . . .	122
4.46 Ferrarer, Auston: Printing Nozel . . . . .	123
4.47 Ferrarer, Auston: Printing Nozel Casing . . . . .	124
4.48 Ferrarer, Auston: Printing Pad . . . . .	125
4.49 Ferrarer, Auston: Sidebar for Nozel . . . . .	126
4.50 Ferrarer, Auston: Connecting Side Bracket . . . . .	127
4.51 Ferrarer, Auston: Full Bed . . . . .	128
4.52 Ferrarer, Auston: Mattress . . . . .	129
4.53 Ferrarer, Auston: Slide Bolt For Brackets . . . . .	130
4.54 Ferrarer, Auston: Top Brackets . . . . .	131
4.55 Rodriguez, Juan: Assembly Step 1 . . . . .	132
4.56 Rodriguez, Juan: Assembly Step 2 . . . . .	133
4.57 Rodriguez, Juan: Assembly Step 3 . . . . .	134
4.58 Rodriguez, Juan: Assembly Step 4 . . . . .	135
4.59 Rodriguez, Juan: Assembly Step 5 . . . . .	136
4.60 Sackett, Justin: Assembly Step 1 . . . . .	137
4.61 Sackett, Justin: Assembly Step 2 . . . . .	138
4.62 Sackett, Justin: Assembly Step 3 . . . . .	139
4.63 Sackett, Justin: Assembly Step 4 . . . . .	140
4.64 Sackett, Justin: Assembly Step 5 . . . . .	141
4.65 Sackett, Justin: Assembly Step 1 . . . . .	142
4.66 Sackett, Justin: Assembly Step 2 . . . . .	142
4.67 Sackett, Justin: Assembly Step 3 . . . . .	143
4.68 Hirani, Asimm: Assembly Step 1 . . . . .	144
4.69 Hirani, Asimm: Assembly Step 2 . . . . .	145
4.70 Hirani, Asimm: Assembly Step 3 . . . . .	146
4.71 Hirani, Asimm: Assembly Step 4 . . . . .	147
4.72 Hirani, Asimm: Assembly Step 5 . . . . .	148
4.73 Ferrarer, Auston: Assembly Step 1 . . . . .	149
4.74 Ferrarer, Auston: Assembly Step 2 . . . . .	150

4.75 Ferrarer, Auston: Assembly Step 3 . . . . .	151
4.76 Ferrarer, Auston: Assembly Step 1 . . . . .	152
4.77 Ferrarer, Auston: Assembly Step 2 . . . . .	153
4.78 Ferrarer, Auston: Assembly Step 1 . . . . .	154
4.79 Ferrarer, Auston: Assembly Step 2 . . . . .	155
4.80 Ferrarer, Auston: Assembly Step 1 . . . . .	156
4.81 Ferrarer, Auston: Assembly Step 2 . . . . .	157
4.82 Rodriguez, Juan: Exploded View of Antenna Assembly . . . . .	158
4.83 Sackett, Justin: Exploded View of Grabber Assembly . . . . .	159
4.84 Sackett, Justin: Exploded View of Light Assembly . . . . .	160
4.85 Hirani, Asimm: Exploded View of Suspension Assembly . . . . .	161
4.86 Kumar, Vishakh: Exploded View of Mechanical Display . . . . .	162
4.87 Kumar, Vishakh: Exploded View of Emergency Button . . . . .	163
4.88 Rodriguez, Juan: Antenna . . . . .	164
4.89 Sackett, Justin: Lights . . . . .	165
4.90 Hirani, Asimm: Suspension . . . . .	166
4.91 Sackett, Justin: Grabbers . . . . .	167
4.92 Kumar, Vishakh: Emergency Button . . . . .	168
4.93 Kumar, Vishakh: MechanicalDisplay . . . . .	169



## Chapter 1

# Project Ideation

### 1.1 Project Proposal

#### 1.1.1 Description of Product / Structure: Describe the creative ideation and what is new?

Our product is a Mars capable ATV. We began with the idea of the standard ATV, coupled with the idea of a manned Mars rover. By combining these two concepts, we were able to create a more agile vehicle capable of handling Mars' low gravity and dusty environment. The combination of a pressurized capsule in an off-road vehicle can be challenging but the benefits would be immense in creating robust vehicles for a manned colony on Mars.

#### 1.1.2 Description of subsystem

Subsystem	Description
Orbital Deployment	Circular parachute and coiled spring shocks.
Grabbers	Pivoting arm with ball socket and grabbing hands.
Suspension	Coil spring shocks, double A-frame suspension and tire rods.
Chassis	Triangular truss support frame.
Tires	Cylindrical tires with embossed treads.
Controls	Joystick, Displays, Plexiglas encased w/ rectangular control panel.
Cockpit	Oblong shaped cockpit
Powertrain	Circular Motor with chain drive to rear axle with rear diff.
Charging	Rectangular solar cells on roof.
Science/Storage	Large prisms storage area in back of ATV.
Communication System	Conic Satellite Dish.
Lighting	Semi-Paraboloid lights mounted on front of ATV.

### 1.1.3 Subassembly Functionality

Subsystem	Functionality
Orbital Deployment	Landing Gear when ATV is dropped from orbit.
Grabbers	Grabs materials for data inspection.
Suspension	Absorbs shocks from planetary terrain.
Chassis	Beefy frame for surviving rough conditions.
Tires	Extreme grip to handle unexpected terrain.
Controls	Steering, cockpit, seating, etc.
Cockpit	Location of Controls
Powertrain	Electric drivetrain, differential.
Charging	Solar cells from roof to charge batteries behind cockpit.
Science/Storage	Large storage area in back of ATV to collect data/samples.
Communication System	Antenna to communicate with base.
Lighting	To maintain visibility once night falls or in sandstorms.

### 1.1.4 Allocation for each member

Subsystem	Member	Complexity
Orbital Deployment	Vishakh Kumar	Medium
Grabbers	Justin Sackett	Hard
Suspension	Asimm Hirani	Medium
Chassis	Juan Rodriguez	Hard
Tires	Auston Ferrarer	Easy
Controls	Vishakh Kumar	Hard
Cockpit	Vishakh Kumar	Easy
Powertrain	Asimm Hirani	Hard
Charging	Vishakh Kumar	Easy
Science/Storage	Auston Ferrarer	Medium
Communication System	Juan Rodriguez	Medium
Lighting	Justin Sackett	Easy

### 1.1.5 Briefly explain what new functionalities (system and sub-system ) you are planning to add. How your product is different from existing products:

This design differs from the traditional ATV because it has a improved suspension system for travel along Martian terrain. The ATV will be able to withstand orbital entry into the Martian landscape through its improved suspension and parachute for controlled descent. Additionally for increased driver visibility the pressurized cabin is built with GT-Superglass® which has the material strength of hardened steel and the weight of titanium. With this glass our vehicle will be able to withstand sandstorms containing heavy debris.

**1.1.6 Picture of the Proposed System (or Similar System):** (please include a reference if you are using pictures from internet). You can also include conceptual sketch.



FIGURE 1.1: Daybreak Games: Planetside 2 ANT Vehicle Concept



FIGURE 1.2: BAJA SAE India Team

## 1.2 Project Management

With a project as complex as ours, we needed to propose a schedule for each team member to turn their parts in, a system for sharing files and method of team communication.

- Timeline - Gantt Chart using Excel More about the Gantt Chart is explained in the section [1.2.2](#)
- Data management - Google Drive and Github Although Github was more suited to collaborative work, we opted to use Google Drive in order to use a platform accessible to all team members. However, Google Drive proved to be a problem as it synced temporary files as well as permanent files, which caused issues with references inside an assembly. We would not recommend using Google Drive in the future for said reason. At the end of the project, we used Github to sync Solidworks files together and to create our report. We have two repositories for the project and the report.
  - ME1770 files - <https://github.com/vishakhkumar/ME1770>
  - ME1770 report - <https://github.com/vishakhkumar/ME1770Report>

### 1.2.1 Part Distribution

#### Allocating subsystems among team members

An important element of team success lies in allocating tasks to team members equitably. We kept in mind two factors while allocating tasks:

- The set of tasks that has to be completed (which may be one task or it may be several.)
- The set of individuals (the team members) able to complete them.

Given each team member's skill level and complexity of the part, we assigned tasks as shown in the table [1.1.4](#)

Further notes: Since the cockpit and the controls were interrelated task, it was decided to allocate both tasks to the same person.

### 1.2.2 Timeline

Planning our project was simple using Gantt chart created in an Excel sheet. We opted to finish our tasks earlier than suggested by the Gantt chart provided to us by our instructor due to our experience with Solidworks and increased workload at the end of the semester from other subjects. We've included an image of our Gantt chart in the figure [1.3](#) on page [5](#).

A detailed view of our timeline can be found at <https://github.com/vishakhkumar/ME1770>

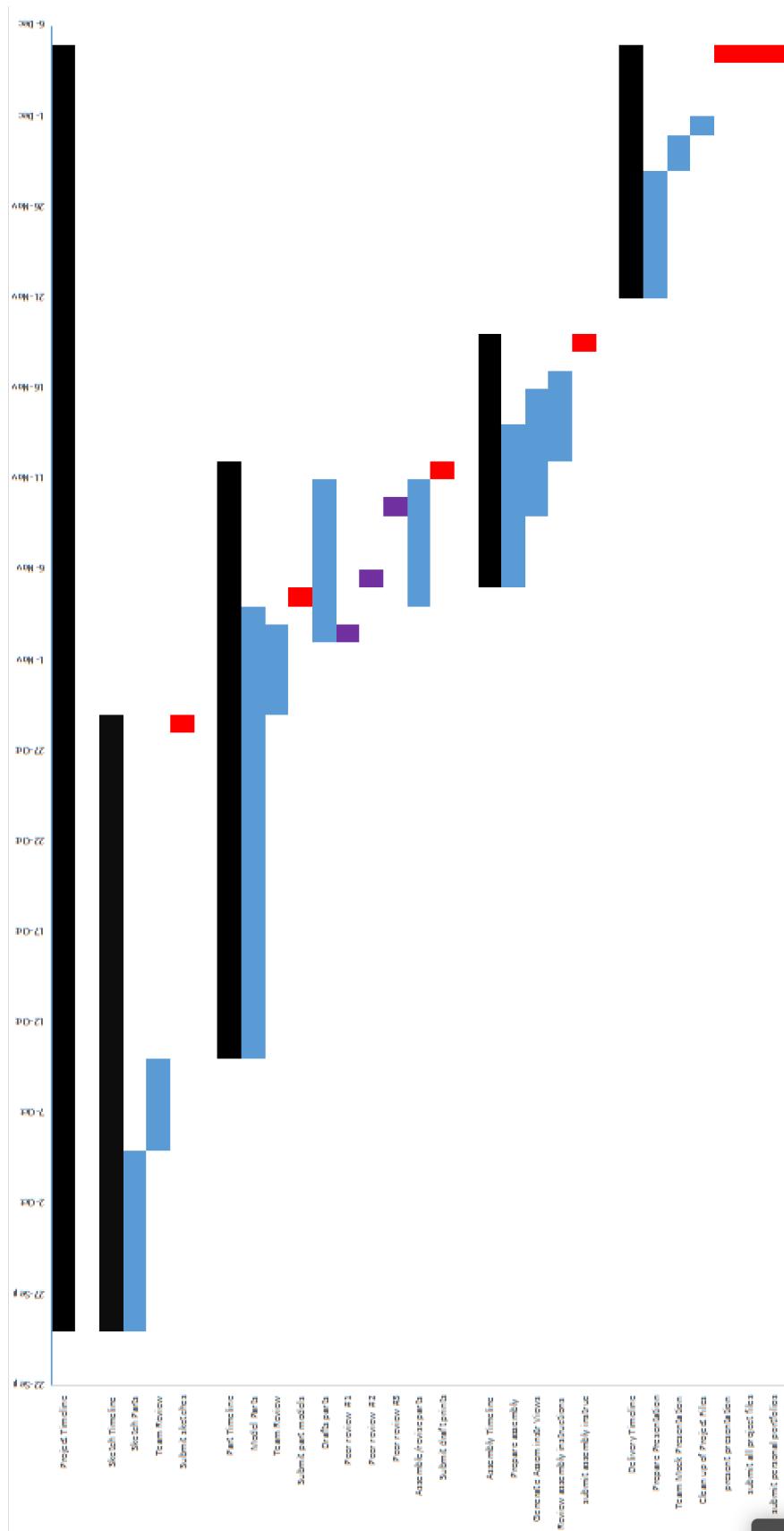


FIGURE 1.3: Gantt Chart



## Chapter 2

# Preliminary Design

Like any group of engineers, we used our intuition and napkin drawings to visualize our product before we proceeded to attempt to build a Mars rover. Preliminary designs also helped us build a context for our group to work on.

We organised our sketches into three categories.

- **2.1 Conceptual Sketches**

Our project was fairly ambitious in that we combined two very different worlds - the rough and tumble world of off-road vehicles and the pressurized environments of space vehicles. Conceptual drawings were invaluable in sketching out a basic idea of what this vehicle would look like.

- **2.2 Perspective Sketches**

After sketching out our conceptual drawings and allocating tasks between team members, we then proceeded to create isometric drawings of each assembly and the top level subassemblies. This helped us refine our ideas about what our parts would look like and how we could improve them. As our product was fairly complicated, we also had the benefit of improving our drawing skills - more than a few parts had interesting features that were a challenge to draw.

- **2.3 Multiview Sketches**

The final step of our preliminary design was to sketch multiviews of each part. This was to provide initial dimensions to each part and to improve our understanding of each part.

## 2.1 Conceptual Sketches

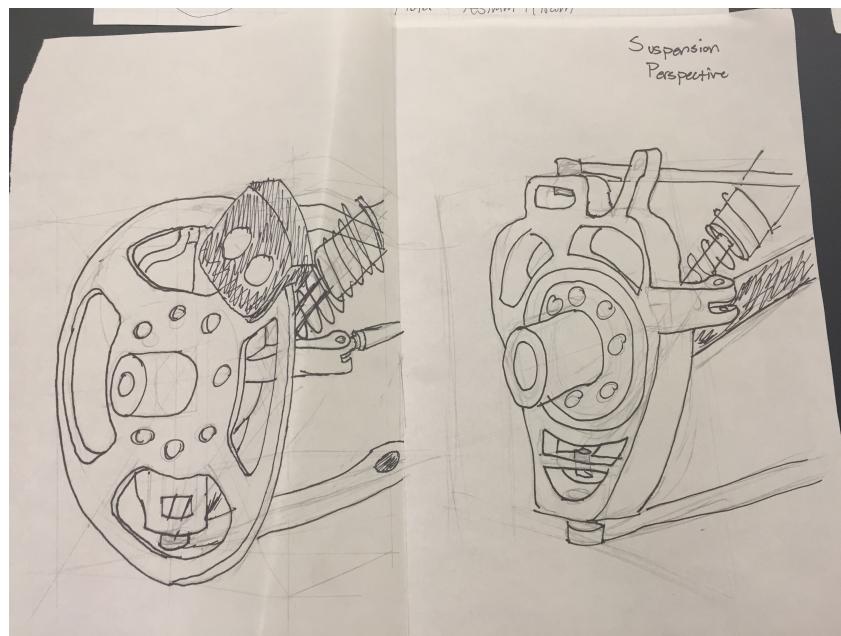


FIGURE 2.1: Hirani, Asimm: Suspension

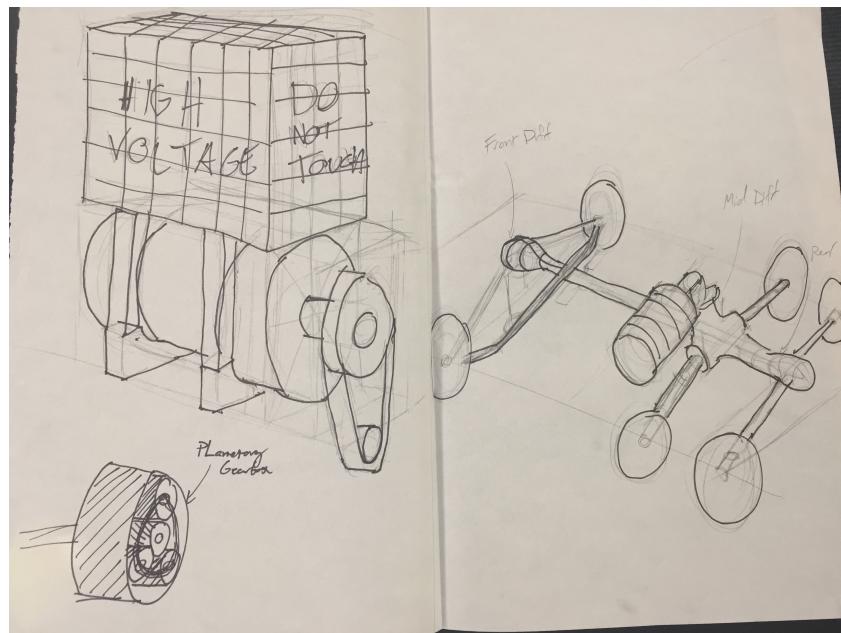


FIGURE 2.2: Hirani, Asimm: Powertrain

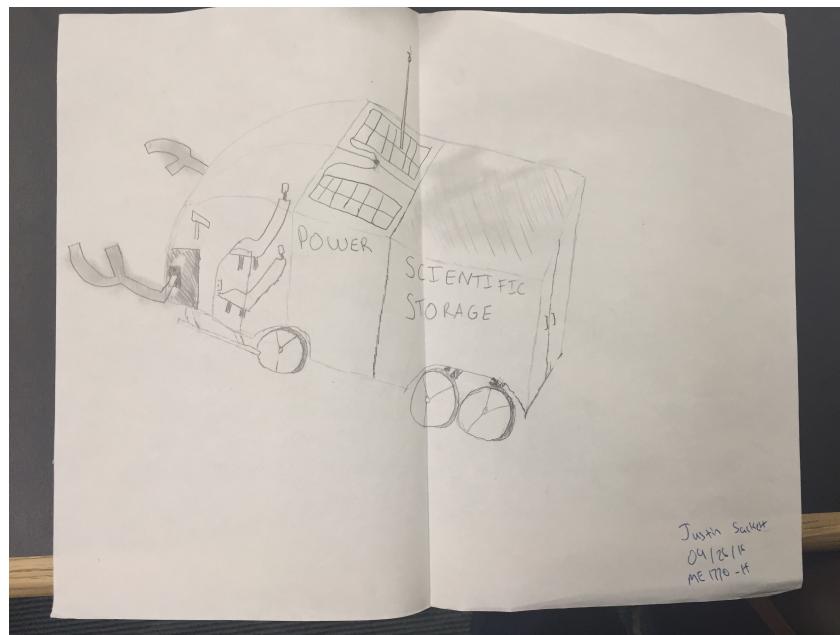


FIGURE 2.3: Hirani, Asimm: Scientiic Storage

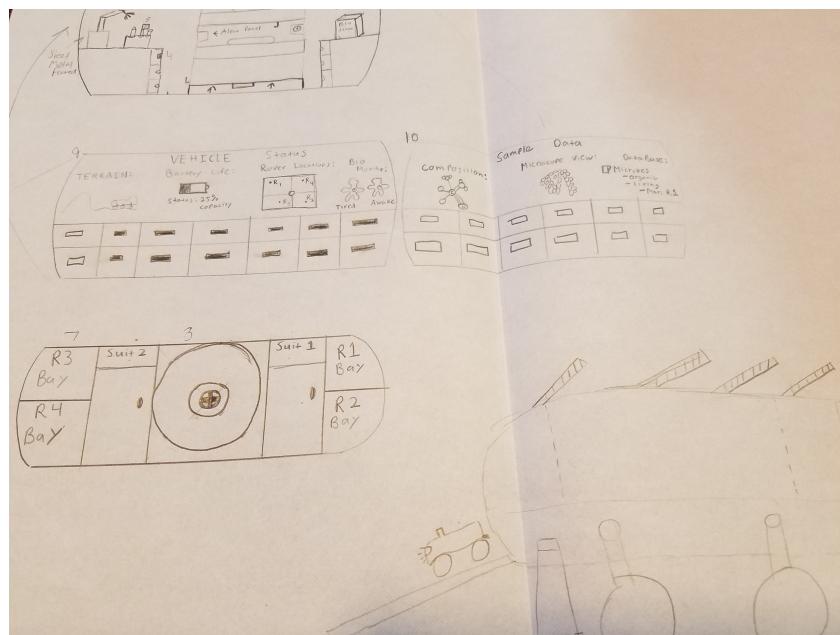


FIGURE 2.4: Kumar, Vishakh: Exterior

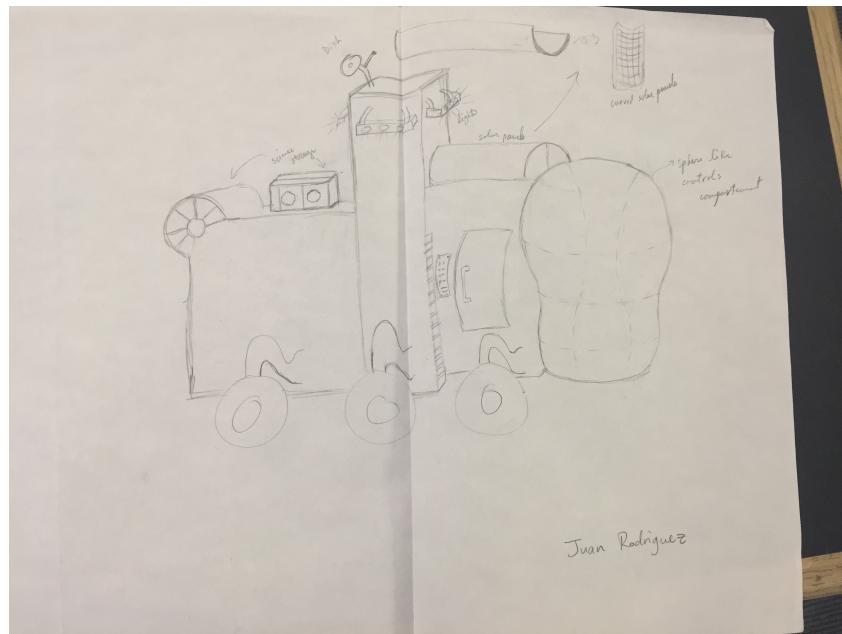


FIGURE 2.5: Rodriguez, Juan: Overview

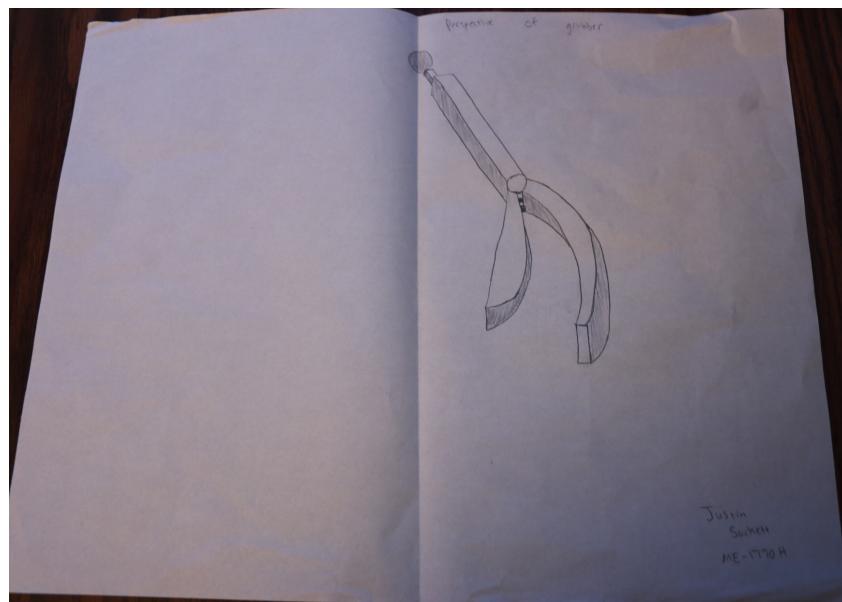


FIGURE 2.6: Sackett, Justin: Grabber

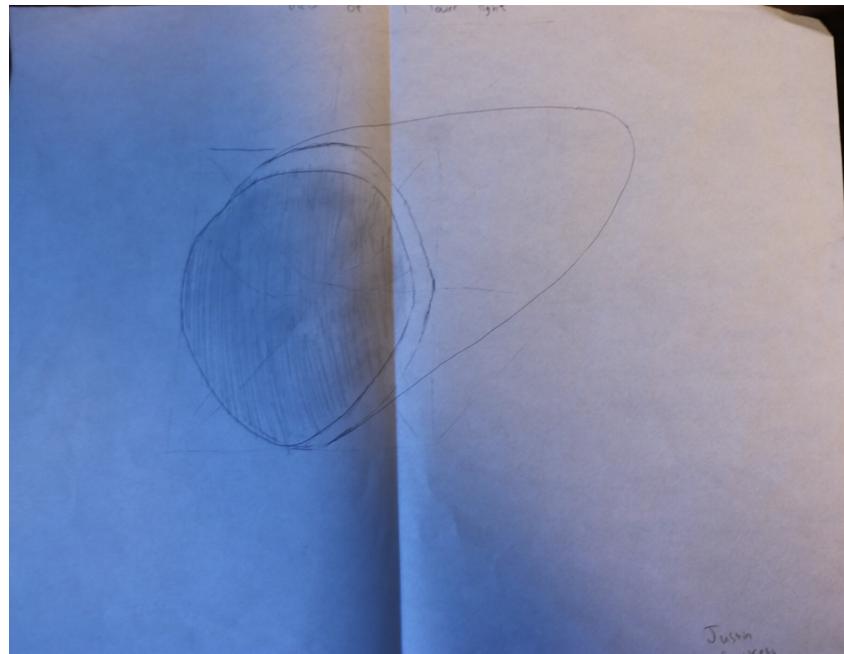


FIGURE 2.7: Sackett, Justin: Lights

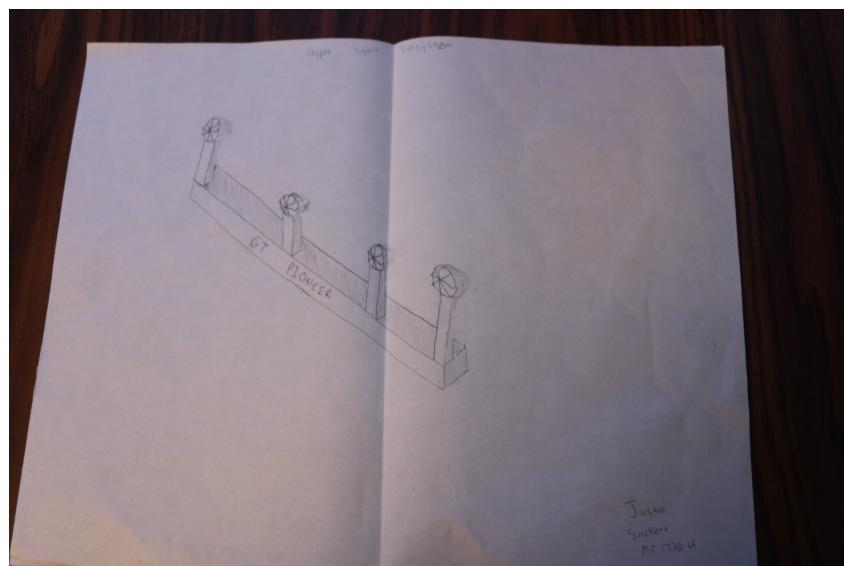


FIGURE 2.8: Sackett, Justin: Light Assembly

## 2.2 Perspective Sketches

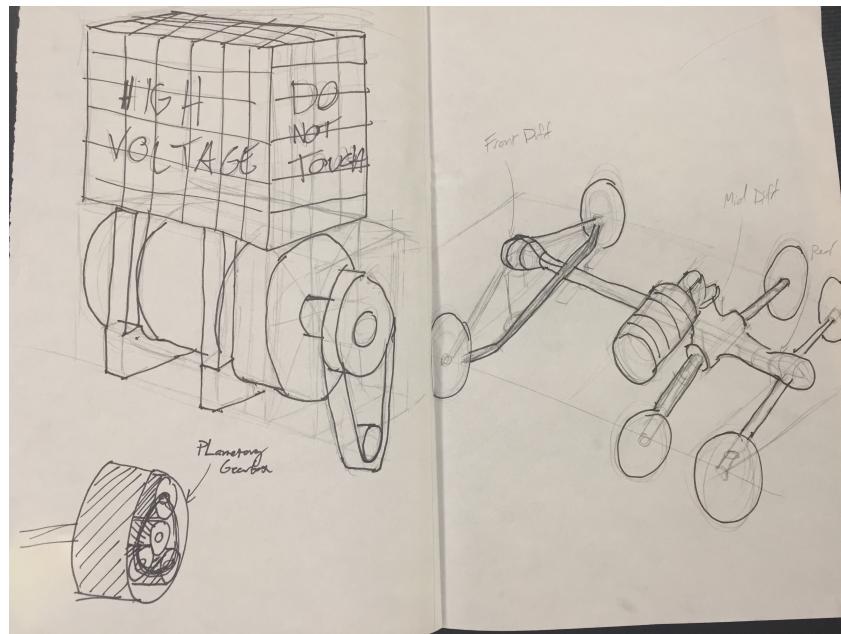


FIGURE 2.9: Hirani, Asimm: Suspension

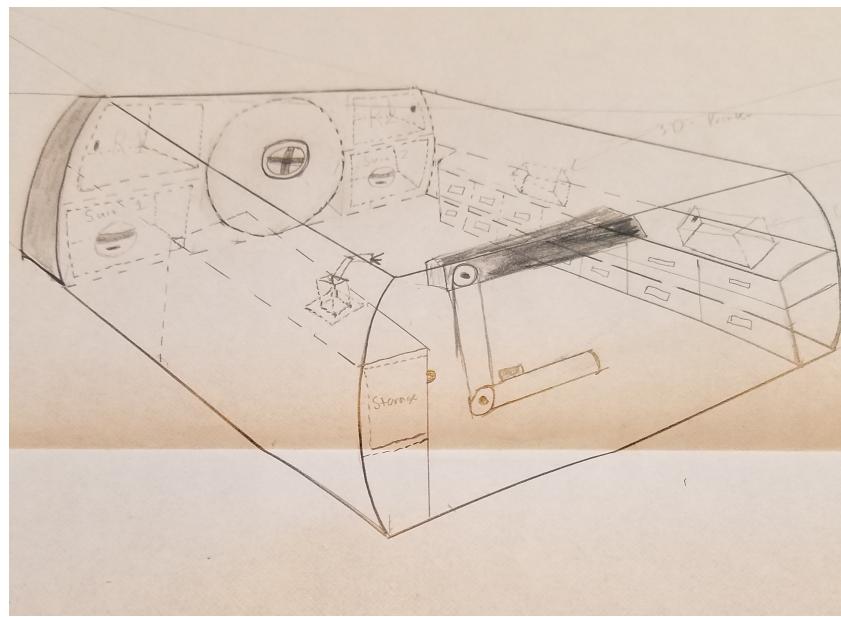


FIGURE 2.10: Ferrarer, Auston: Exterior

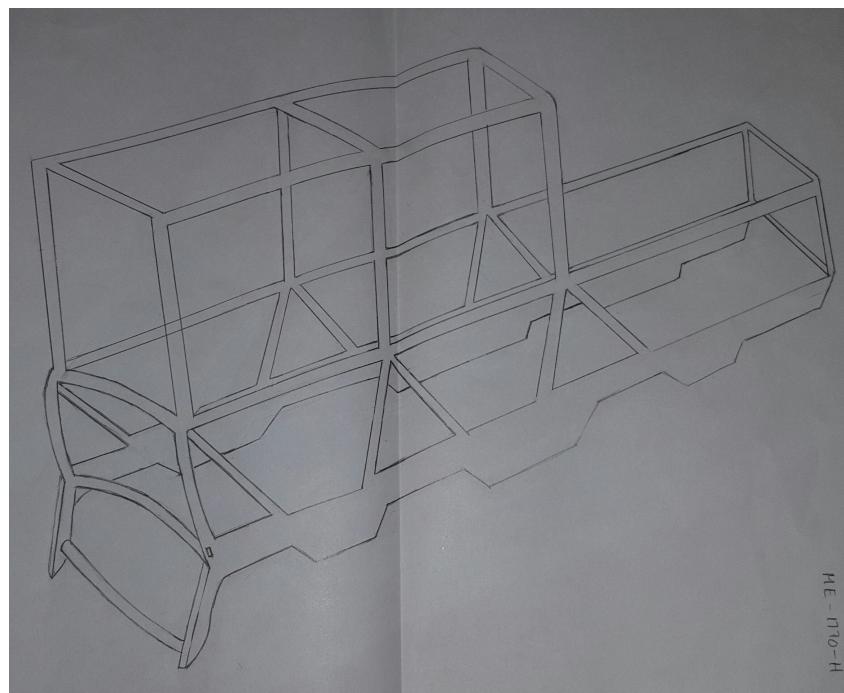


FIGURE 2.11: Rodriguez, Juan: Chassis

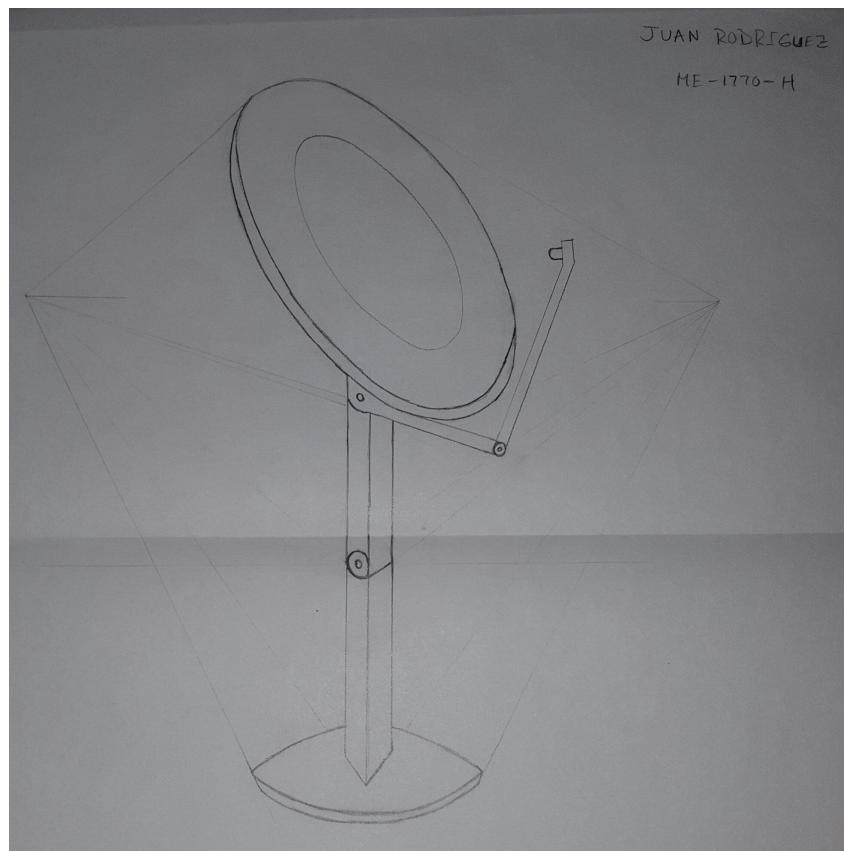


FIGURE 2.12: Rodriguez, Juan: Antenna

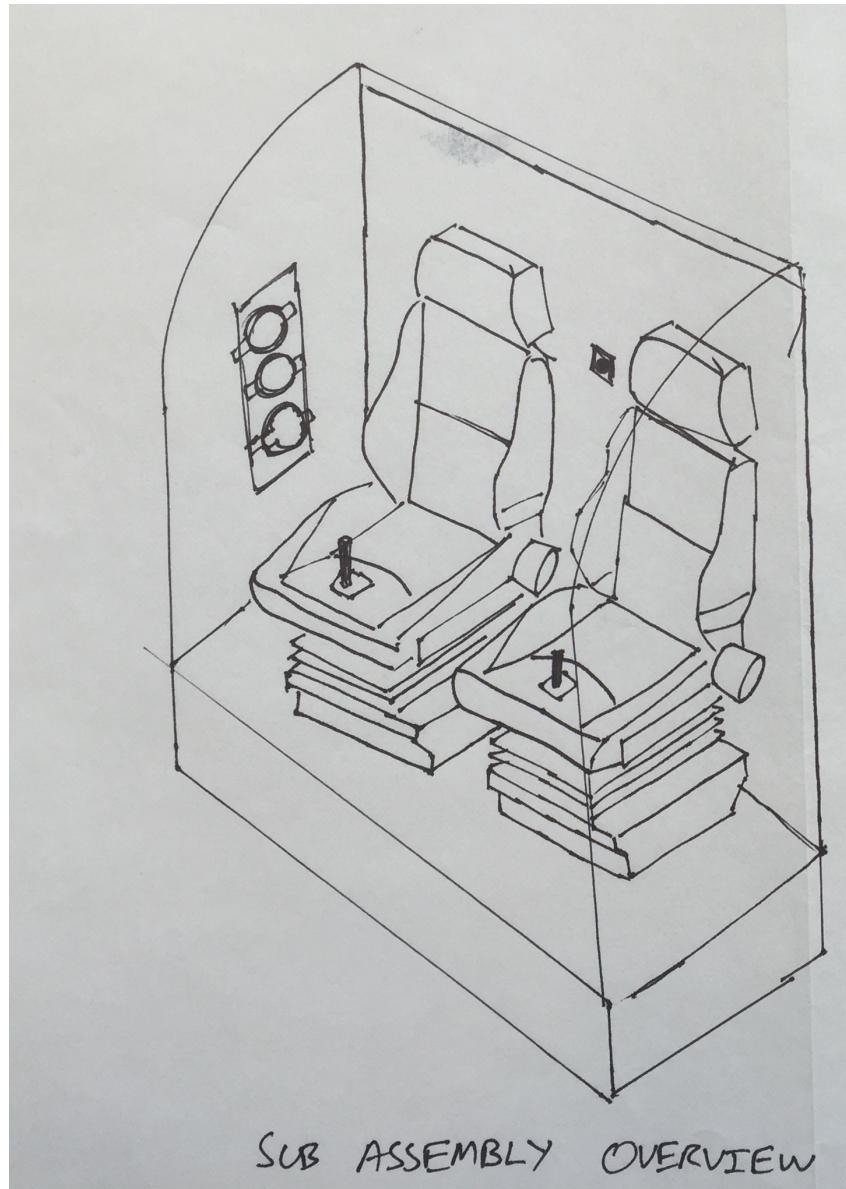


FIGURE 2.13: Kumar, Vishakh: Cockpit

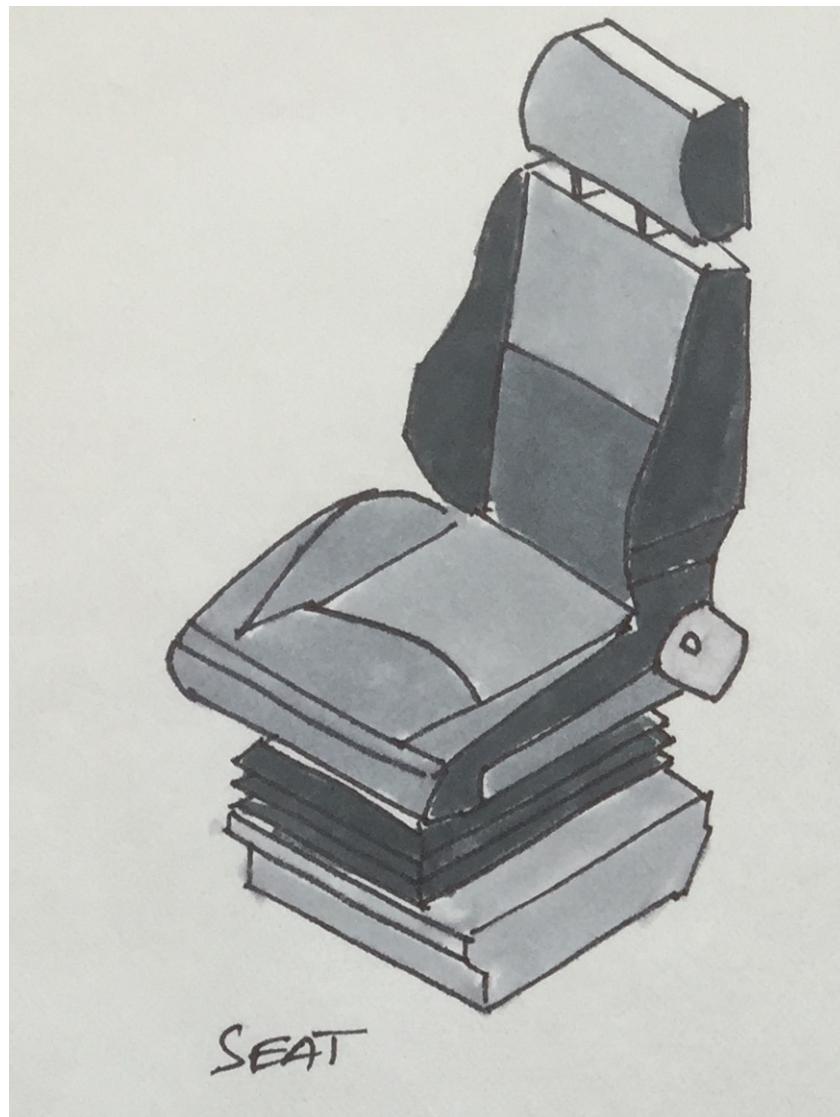
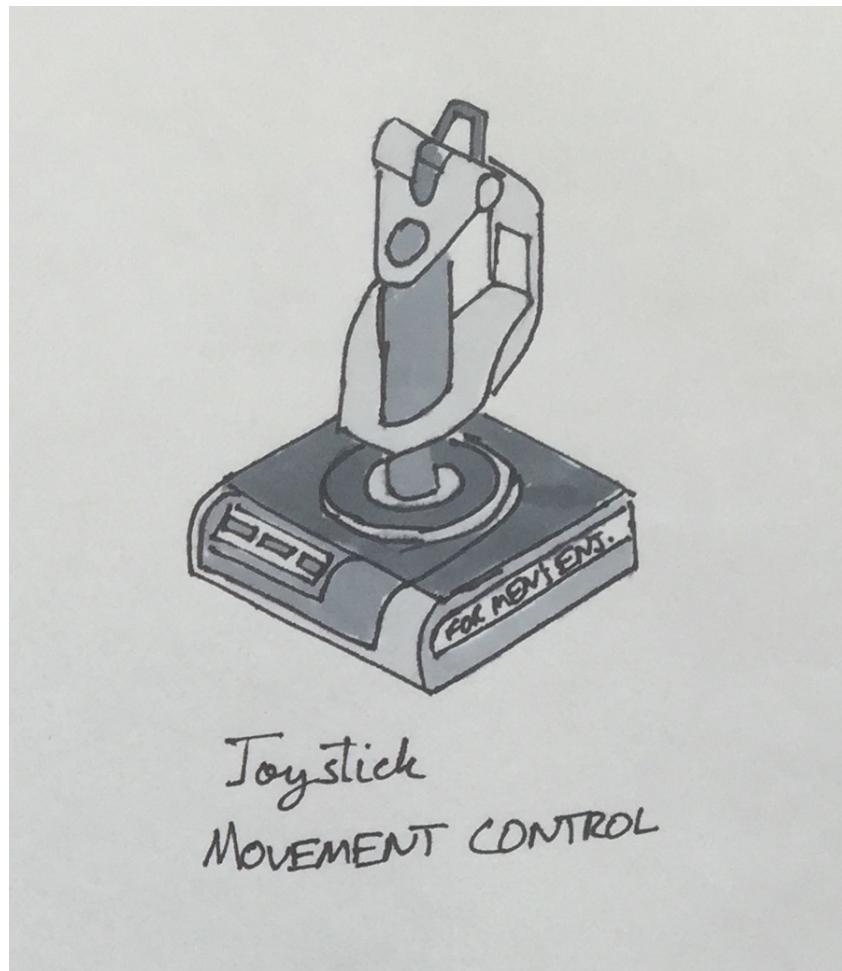


FIGURE 2.14: Kumar, Vishakh: Seat



Joystick  
MOVEMENT CONTROL

FIGURE 2.15: Kumar, Vishakh: Joystick

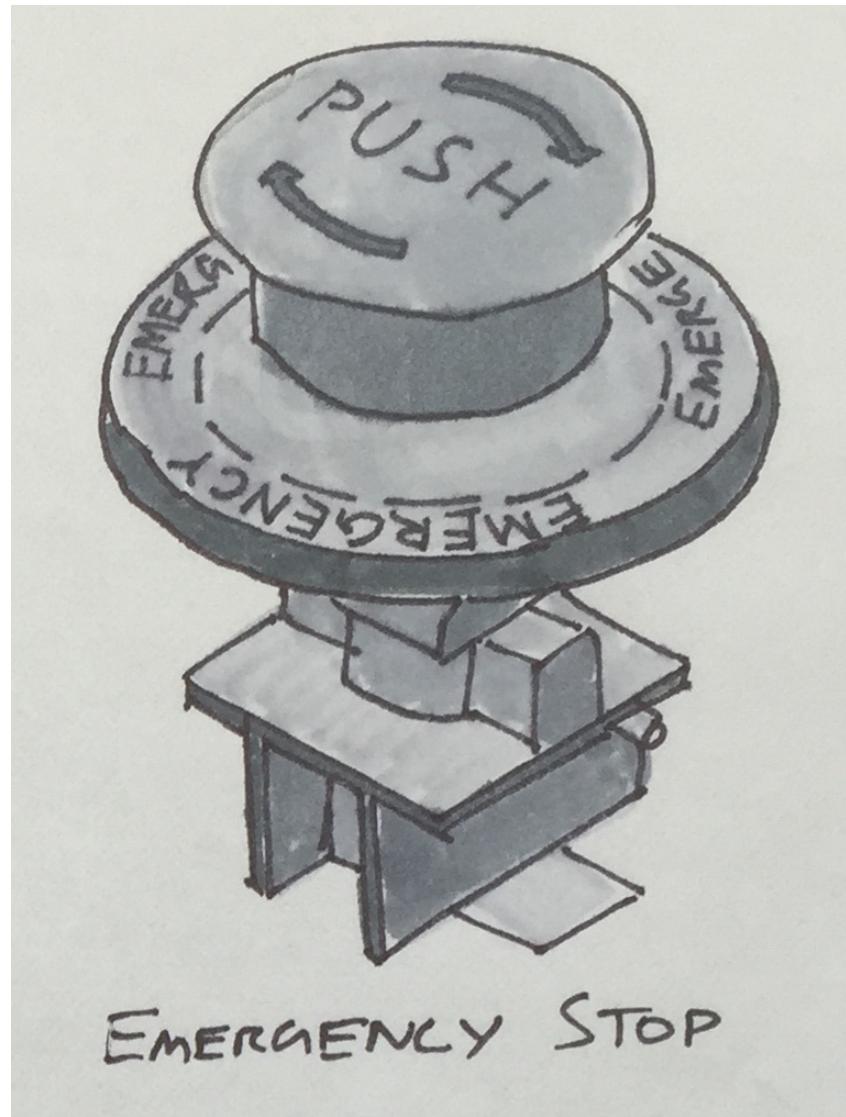
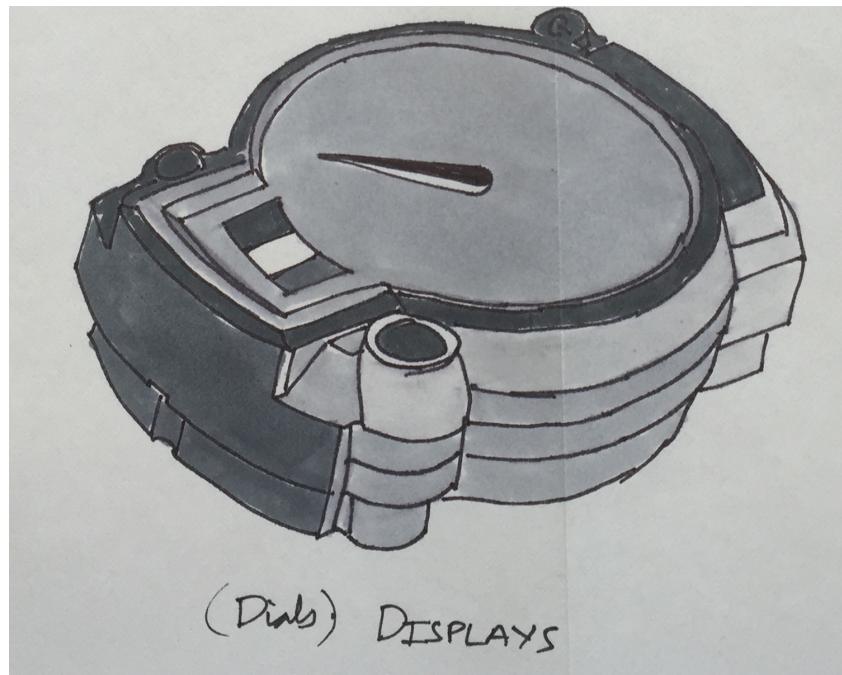


FIGURE 2.16: Kumar, Vishakh: Emergency



(Dials) DISPLAYS

FIGURE 2.17: Kumar, Vishakh: Mechanical Dials

## 2.3 Multiview Sketches

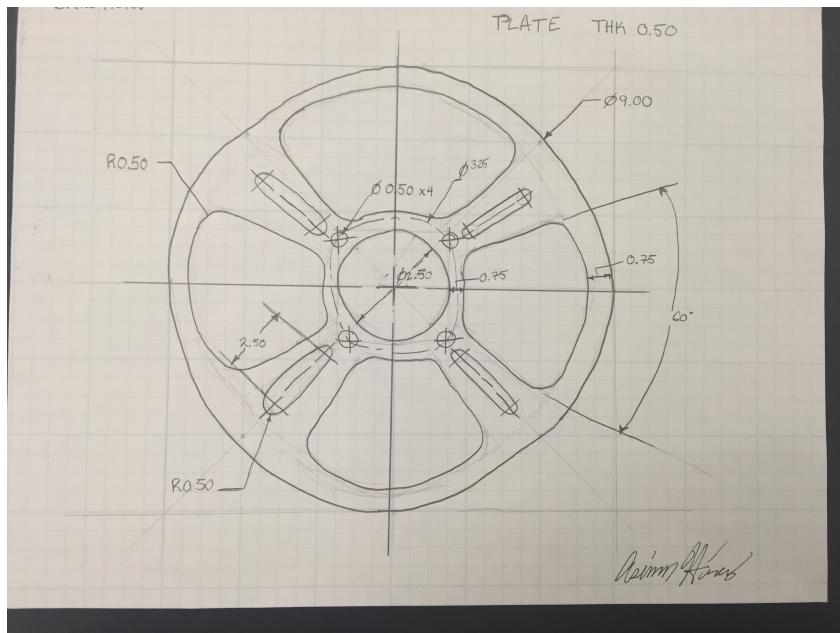


FIGURE 2.18: Hirani, Asimm: Gear One

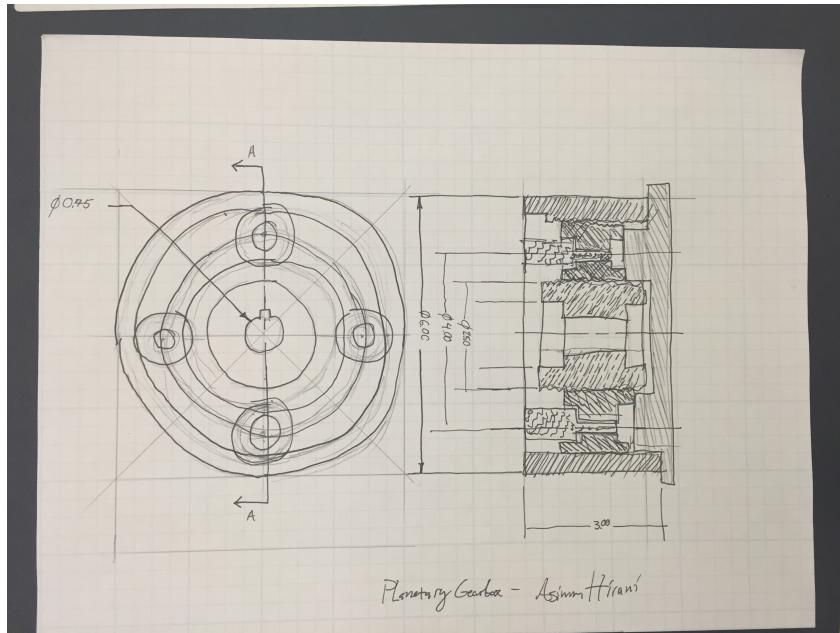


FIGURE 2.19: Hirani, Asimm: Disc Brake

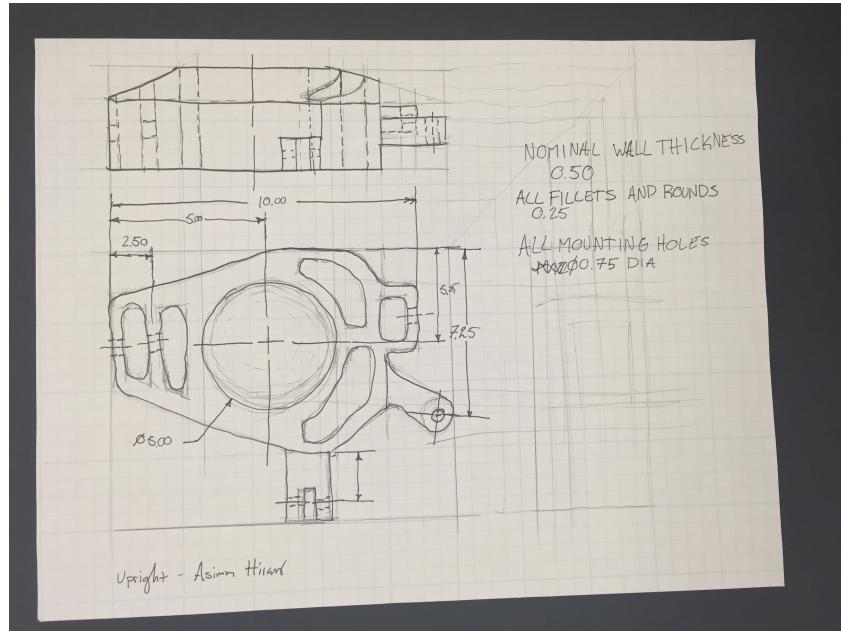


FIGURE 2.20: Hirani, Asimm: Upright

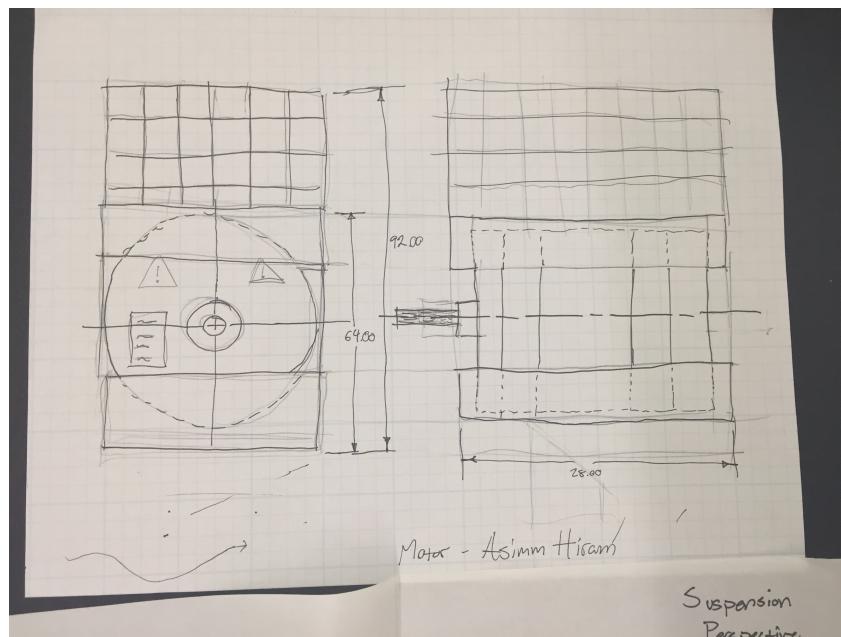


FIGURE 2.21: Hirani, Asimm: Motor

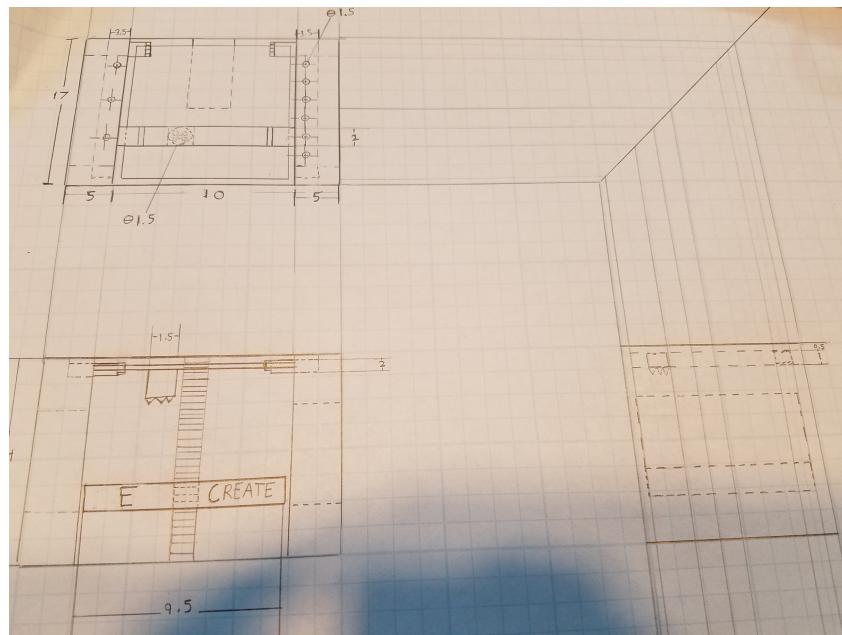


FIGURE 2.22: Ferrarer, Auston: 3D Printer

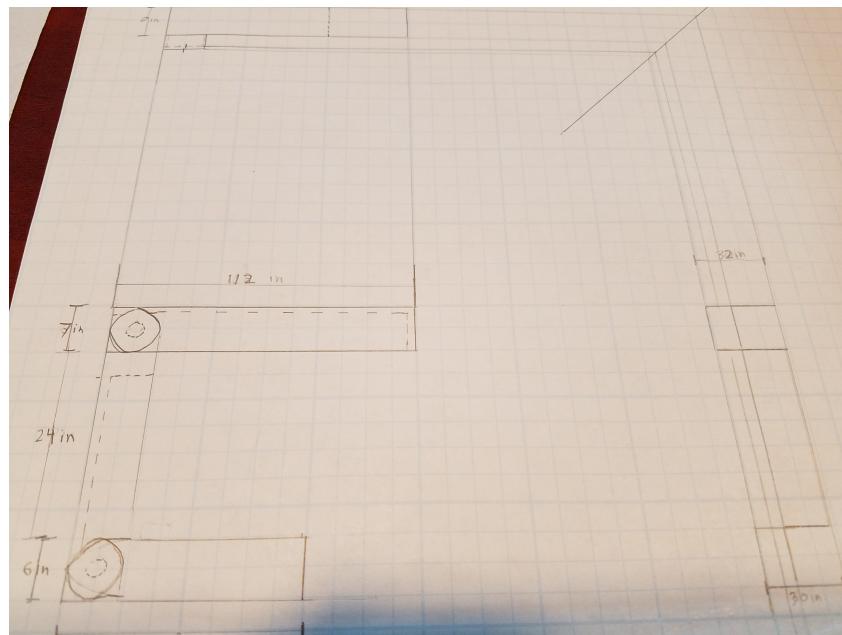


FIGURE 2.23: Ferrarer, Auston: Bed

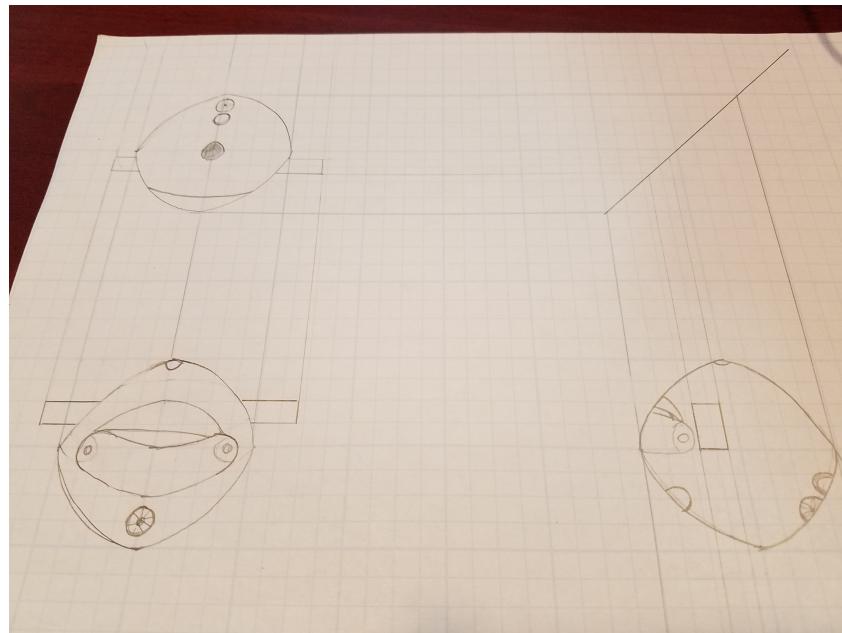


FIGURE 2.24: Ferrarer, Auston: Helmet

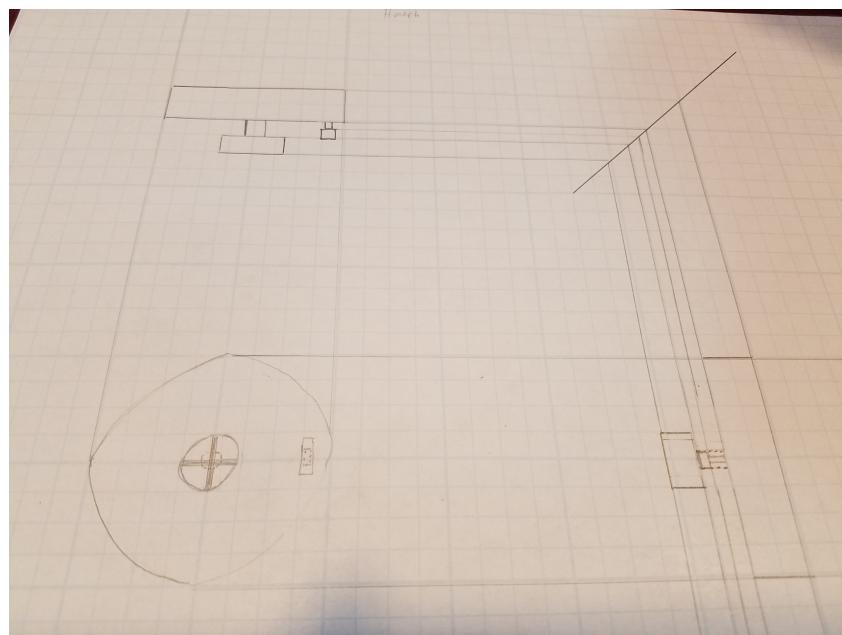


FIGURE 2.25: Ferrarer, Auston: Rear Hatch

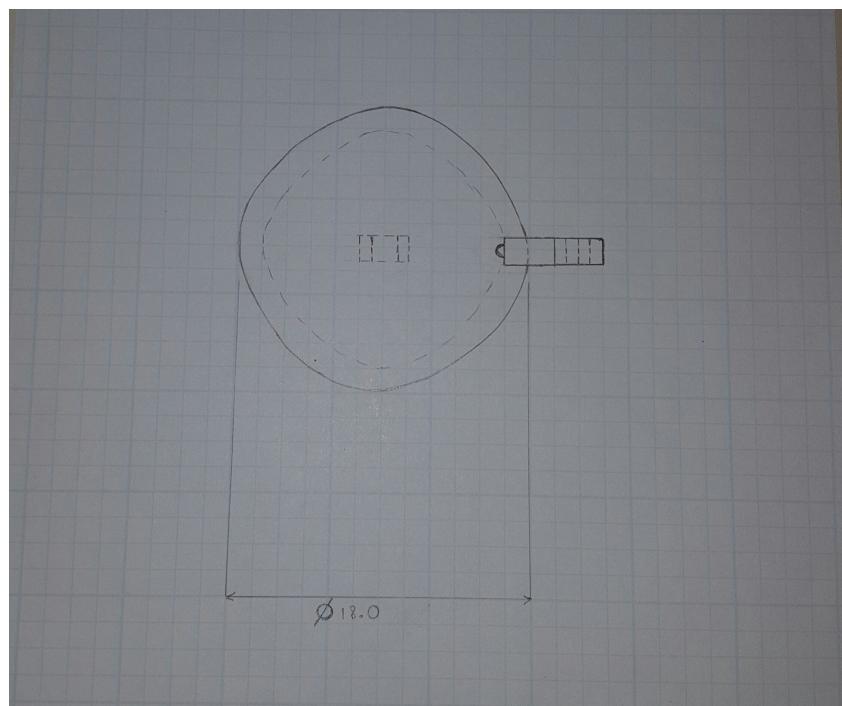


FIGURE 2.26: Rodriguez, Juan: Antenna

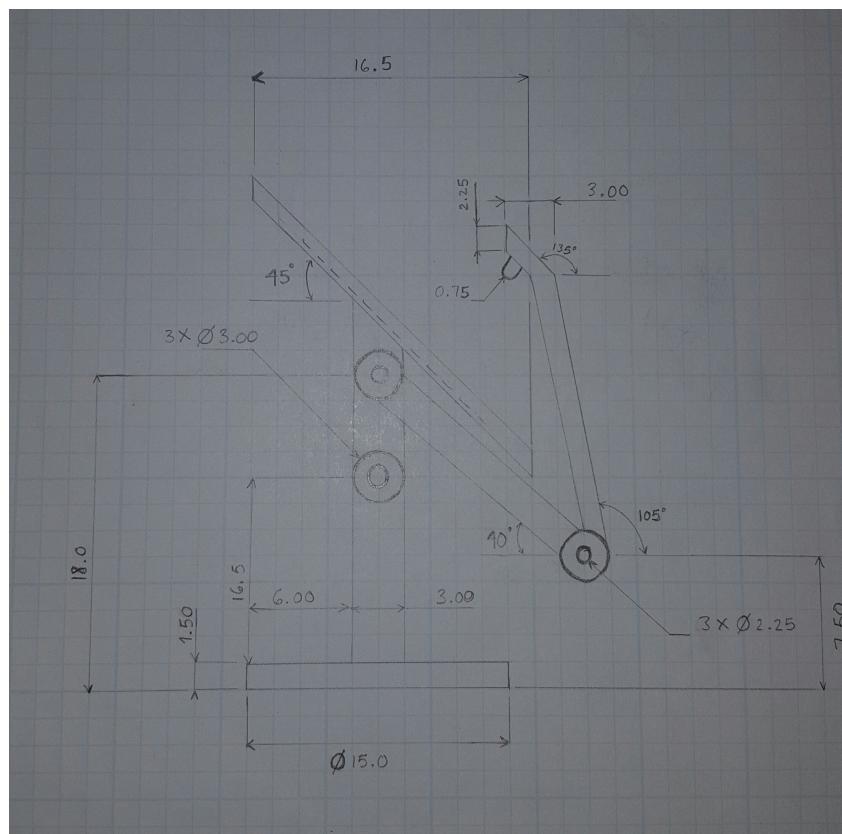


FIGURE 2.27: Rodriguez, Juan: Antenna

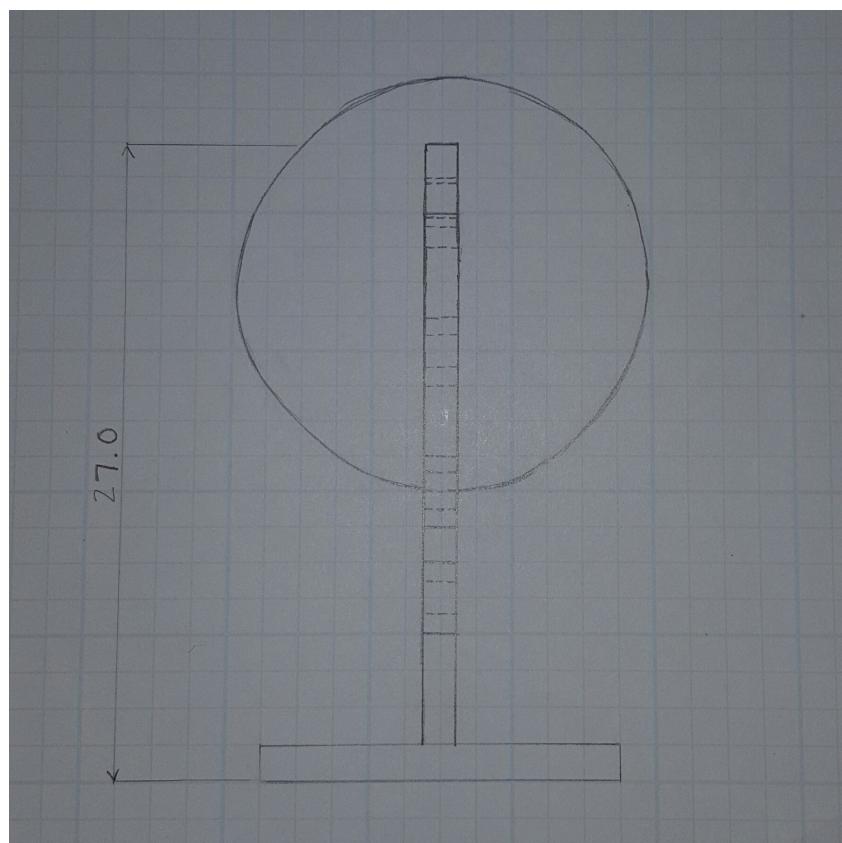


FIGURE 2.28: Rodriguez, Juan: Antenna

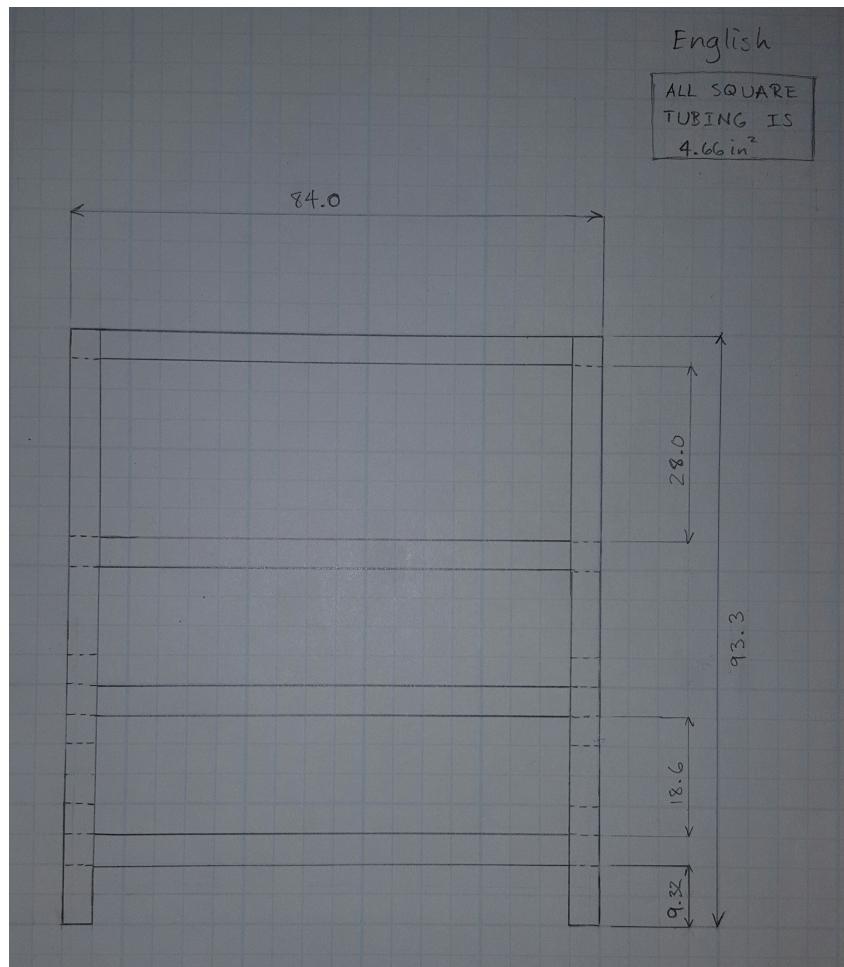


FIGURE 2.29: Rodriguez, Juan: Chassis

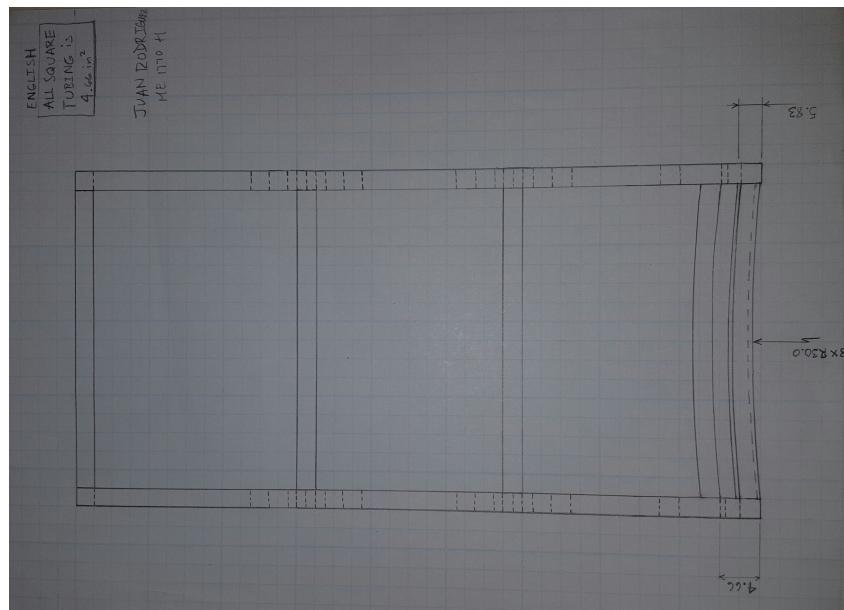


FIGURE 2.30: Rodriguez, Juan: Chassis

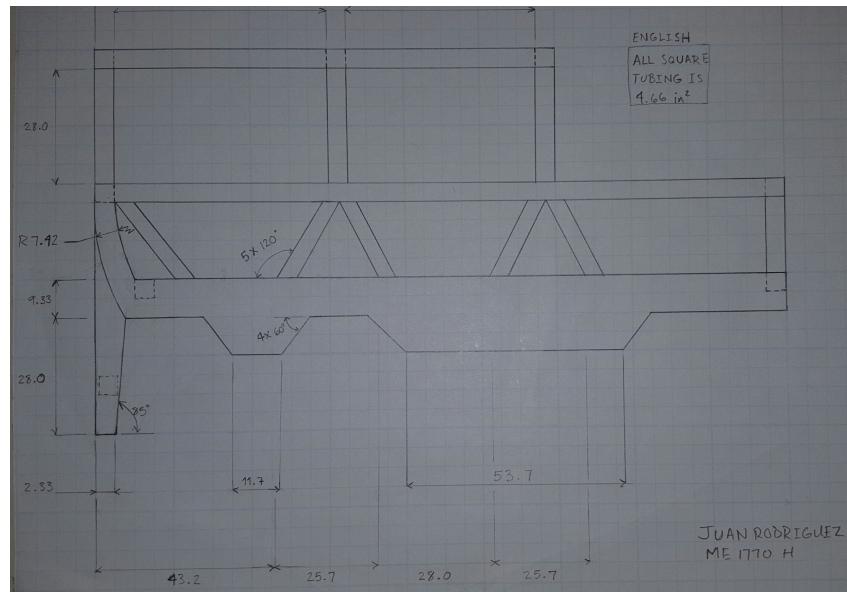


FIGURE 2.31: Rodriguez, Juan: Chassis

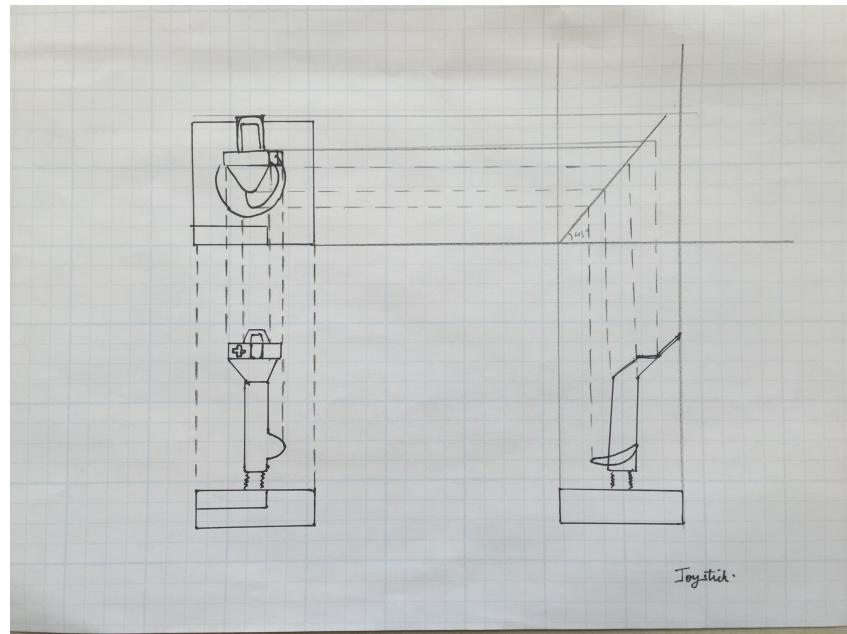


FIGURE 2.32: Kumar, Vishakh: Joystick

## Chapter 3

# Detail Design

### 3.1 Seat



FIGURE 3.1: Kumar, Vishakh: Seat View 1

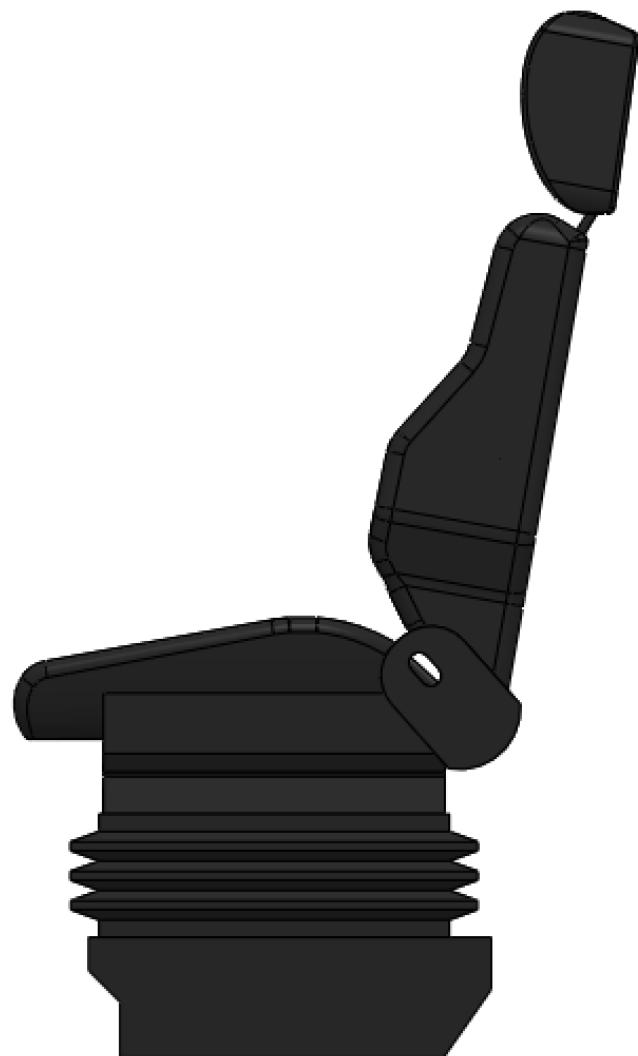


FIGURE 3.2: Kumar, Vishakh: Seat View 2

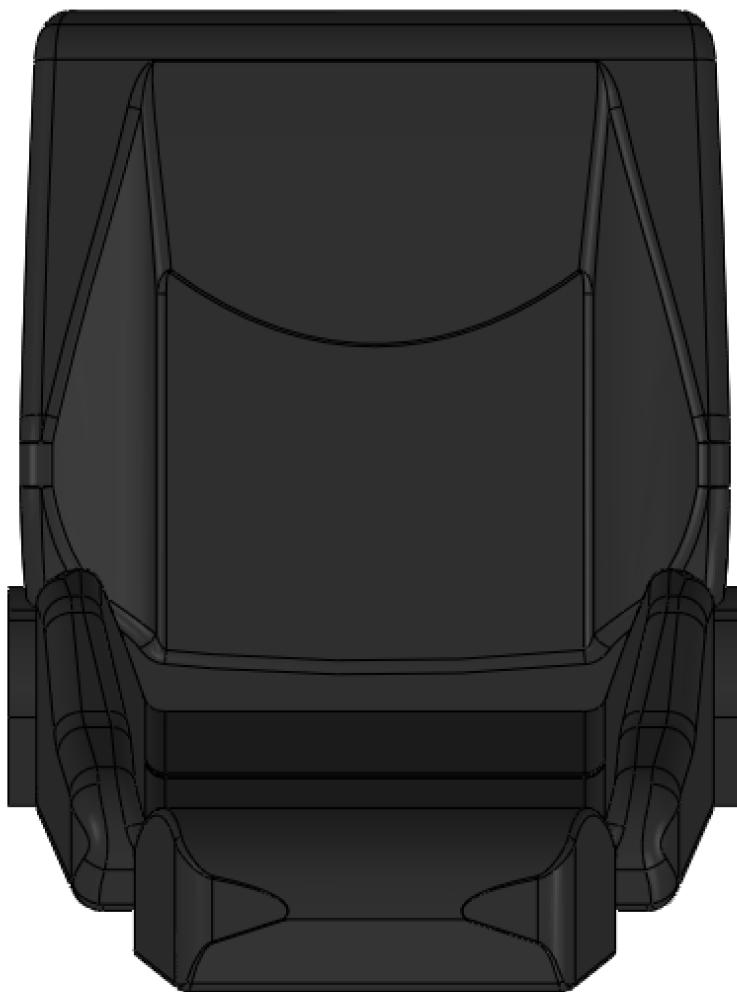


FIGURE 3.3: Kumar, Vishakh: Seat View 3

### 3.2 Bed

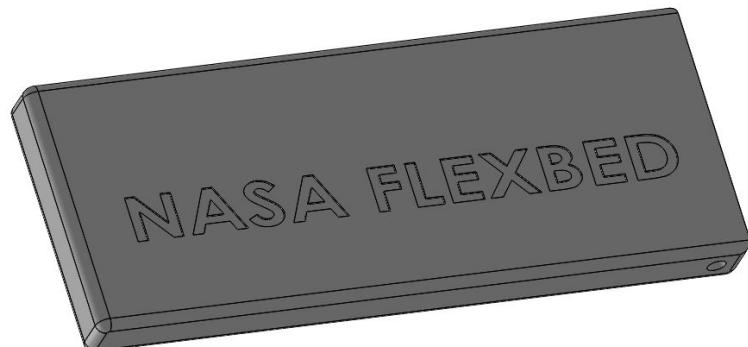


FIGURE 3.4: Ferrarer, Auston: Mattress

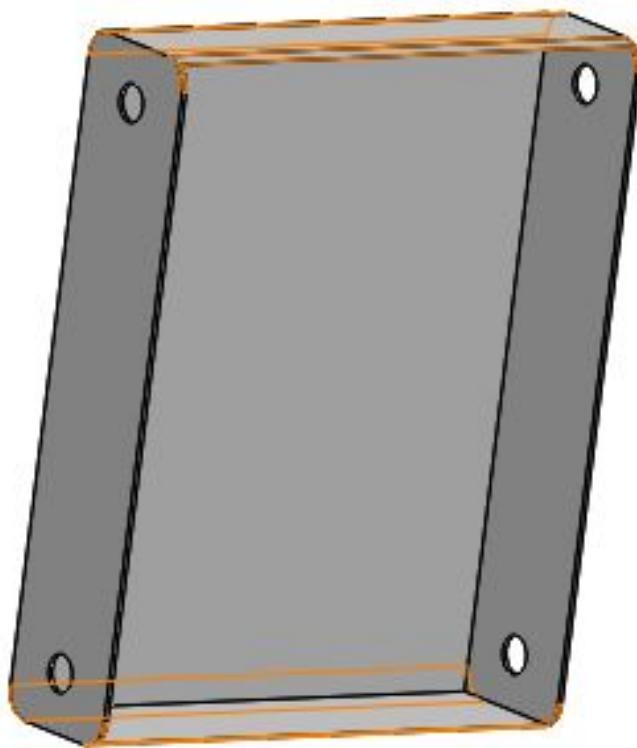


FIGURE 3.5: Ferrarer, Auston: Slide Bracket



FIGURE 3.6: Ferrarer, Auston: Sliding Bolt

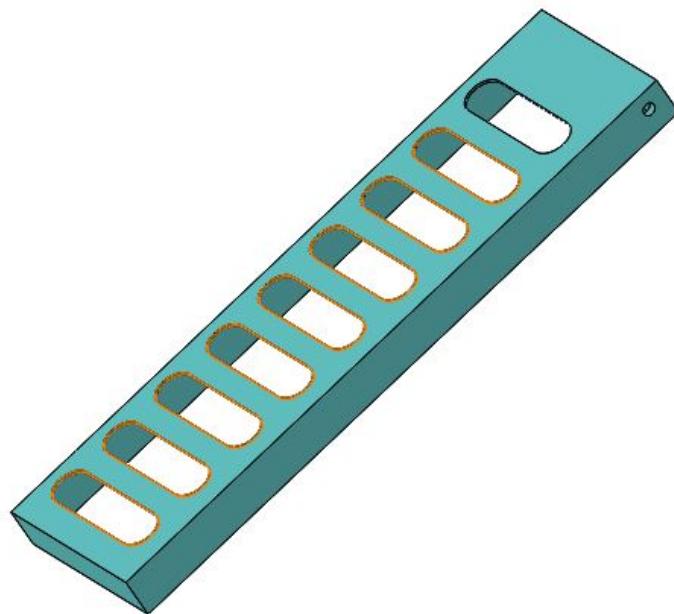


FIGURE 3.7: Ferrarer, Auston: Top Bed Bracket

### 3.3 Door and Exterior

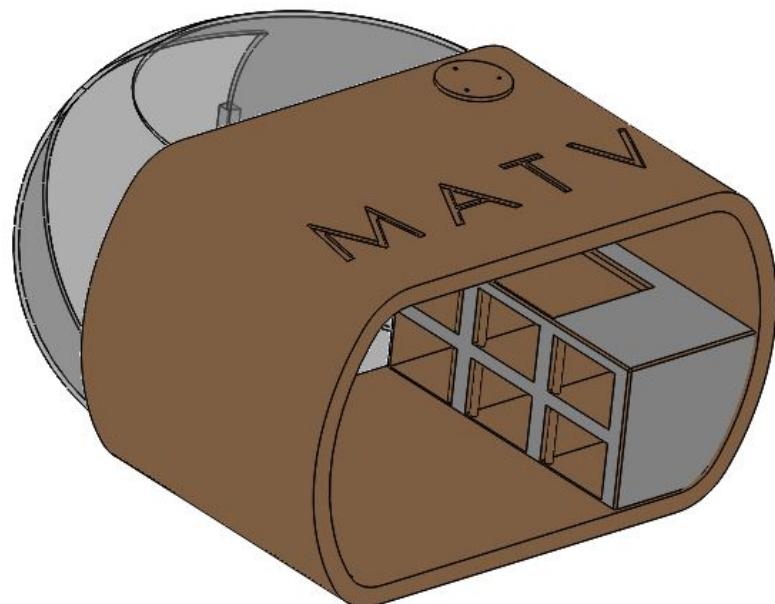


FIGURE 3.8: Ferrarer, Auston: Exterior Structure

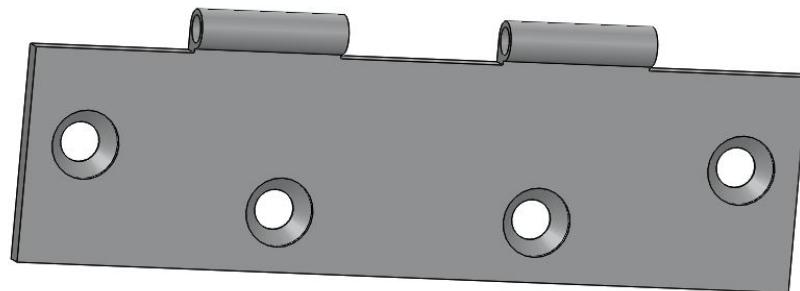


FIGURE 3.9: Ferrarer, Auston: Hinge Right Side

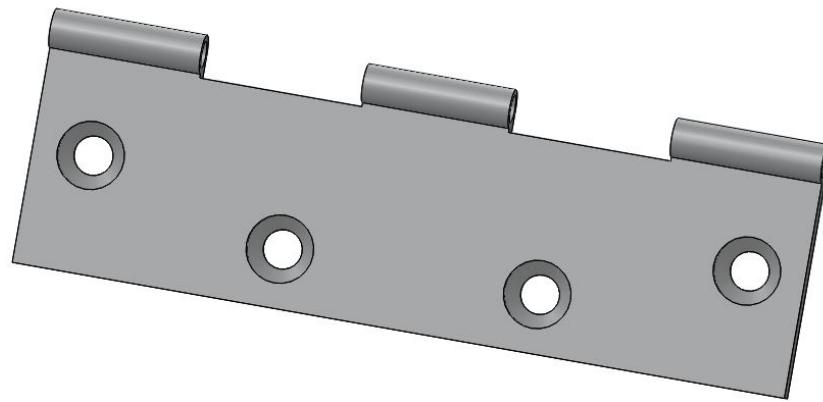


FIGURE 3.10: Ferrarer, Auston: Hinge Left Side



FIGURE 3.11: Ferrarer, Auston: Pin

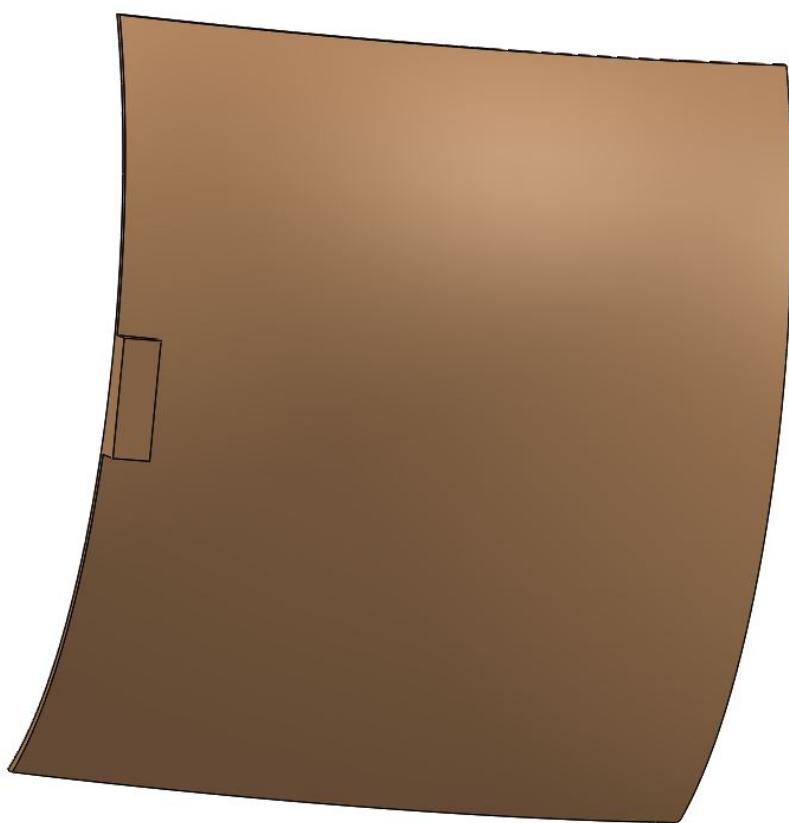


FIGURE 3.12: Ferrarer, Auston: Rear Door

### 3.4 Cockpit

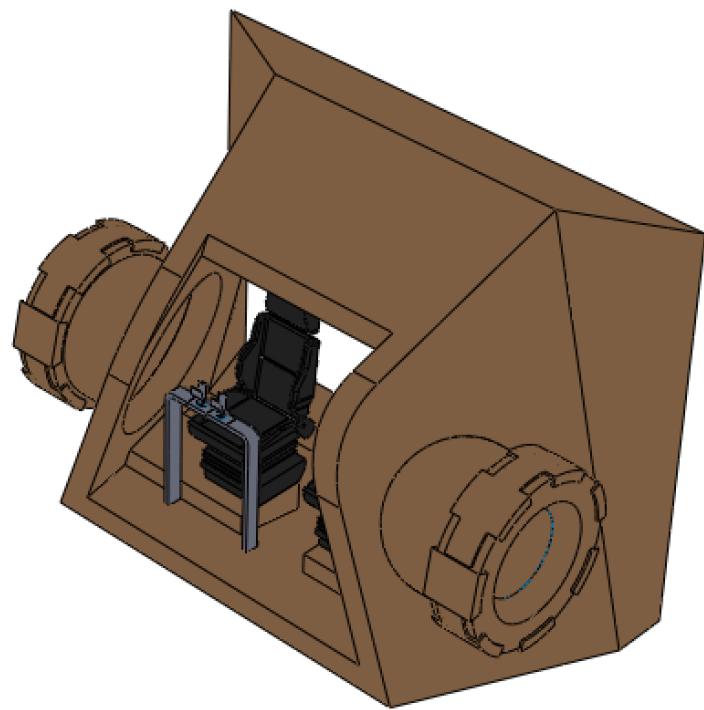


FIGURE 3.13: Kumar, Vishakh: Cockpit View 1

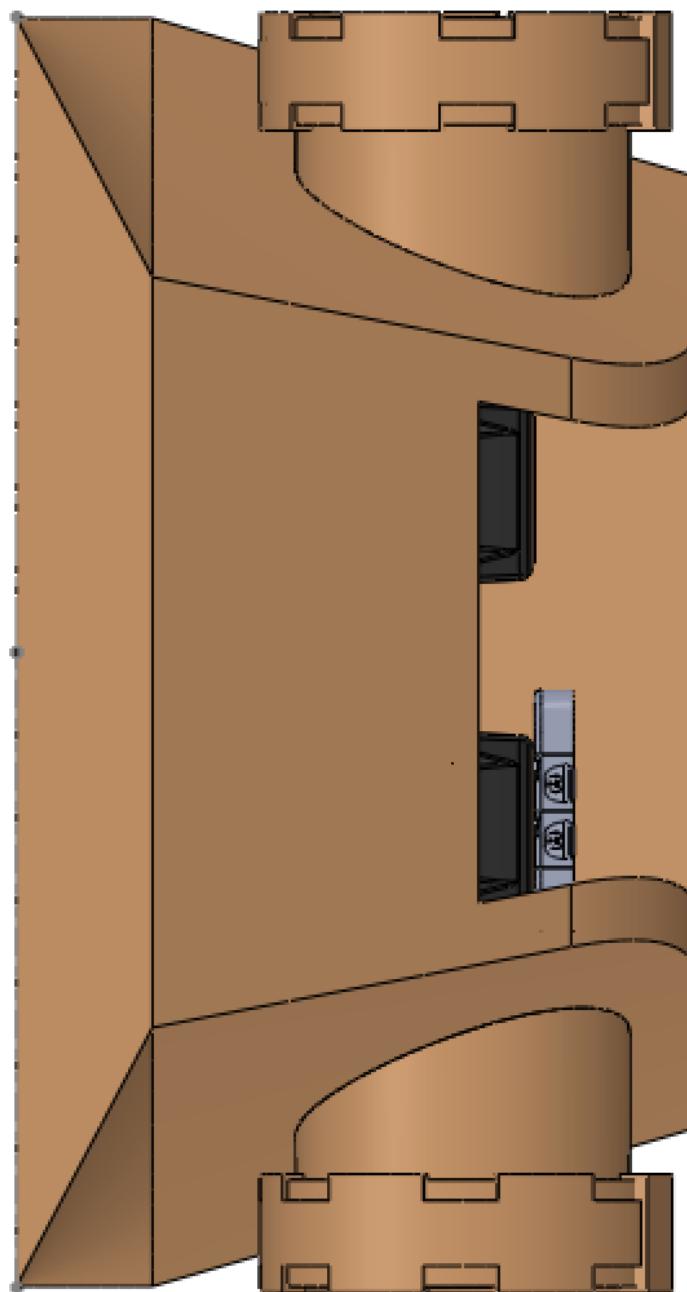


FIGURE 3.14: Kumar, Vishakh: Cockpit View 2

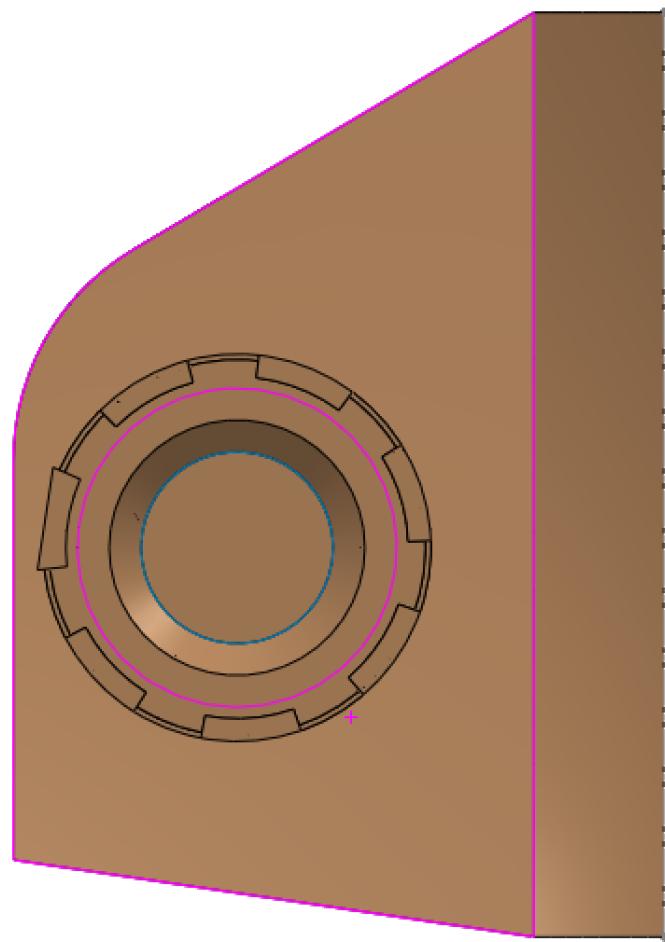


FIGURE 3.15: Kumar, Vishakh: Cockpit View 3



FIGURE 3.16: Kumar, Vishakh: Cockpit View 4

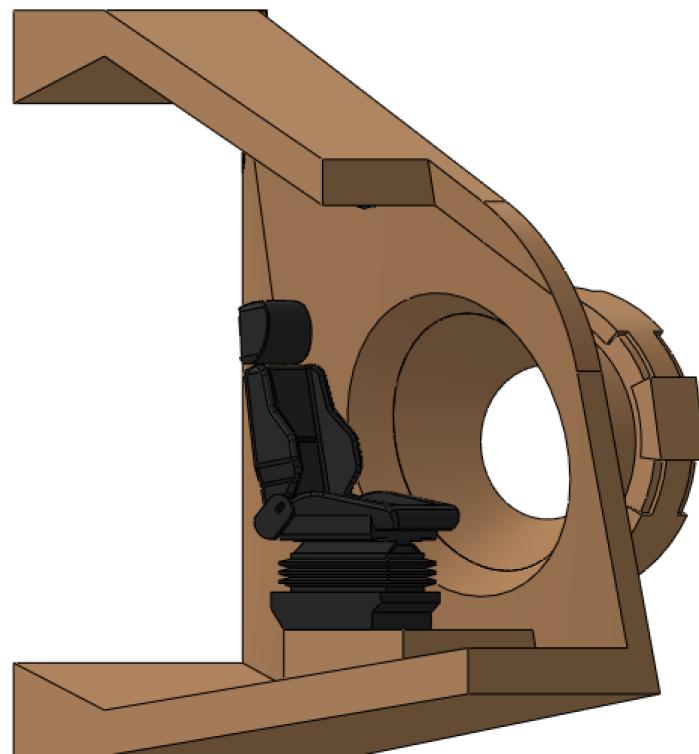


FIGURE 3.17: Kumar, Vishakh: Cockpit View 4

### 3.5 Joystick

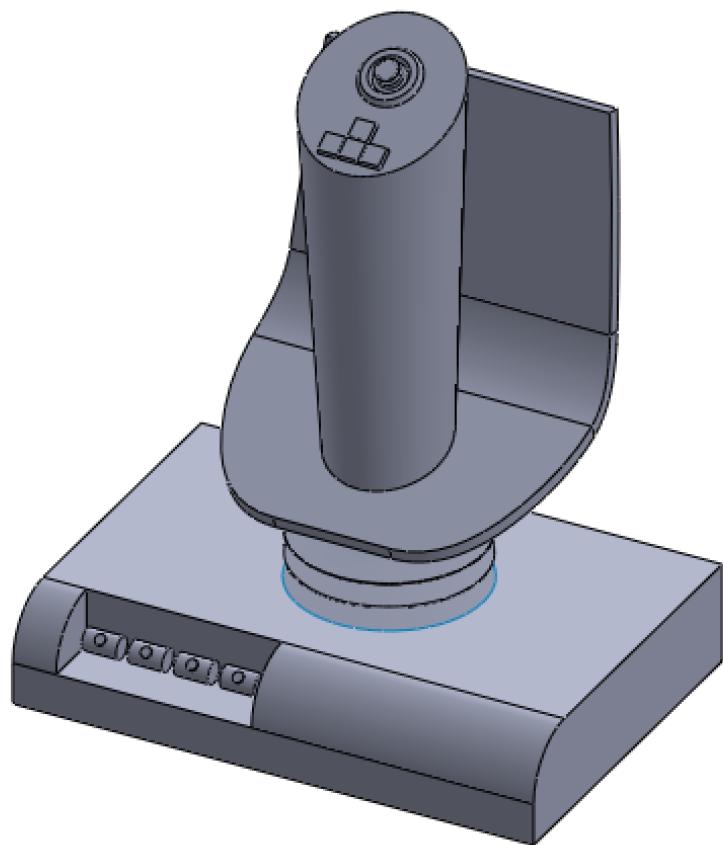


FIGURE 3.18: Kumar, Vishakh: Joystick View 1

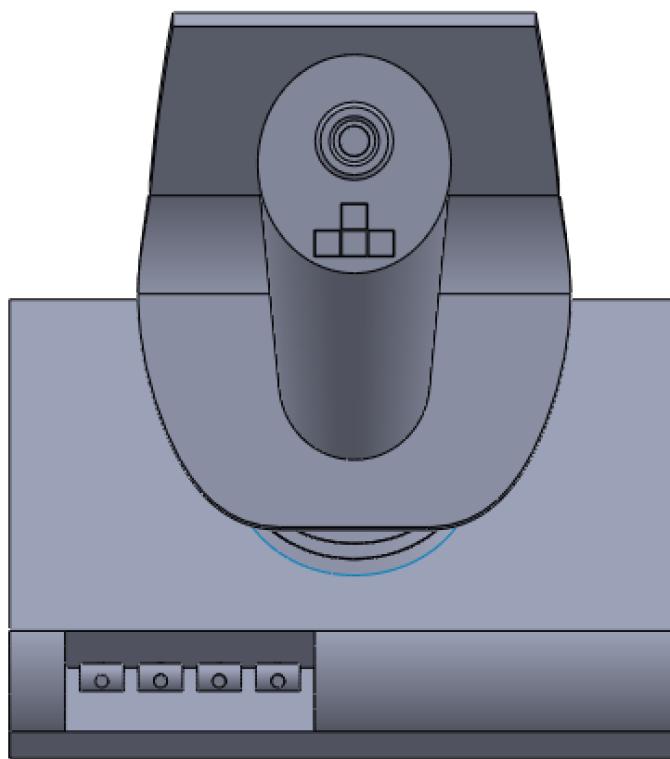


FIGURE 3.19: Kumar, Vishakh: Joystick View 2

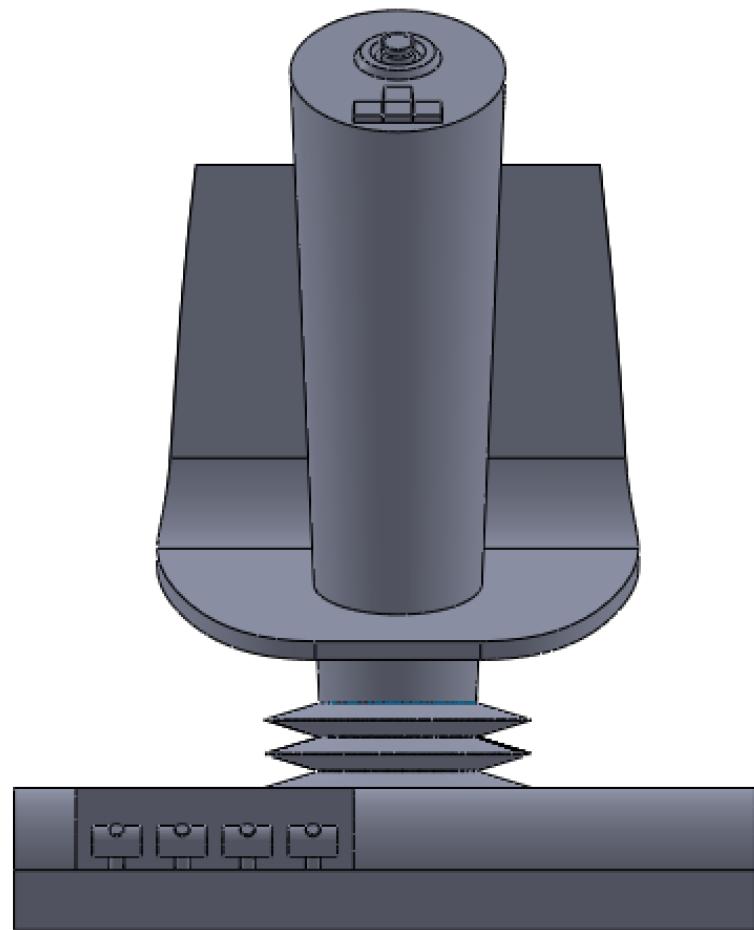


FIGURE 3.20: Kumar, Vishakh: Joystick View 3

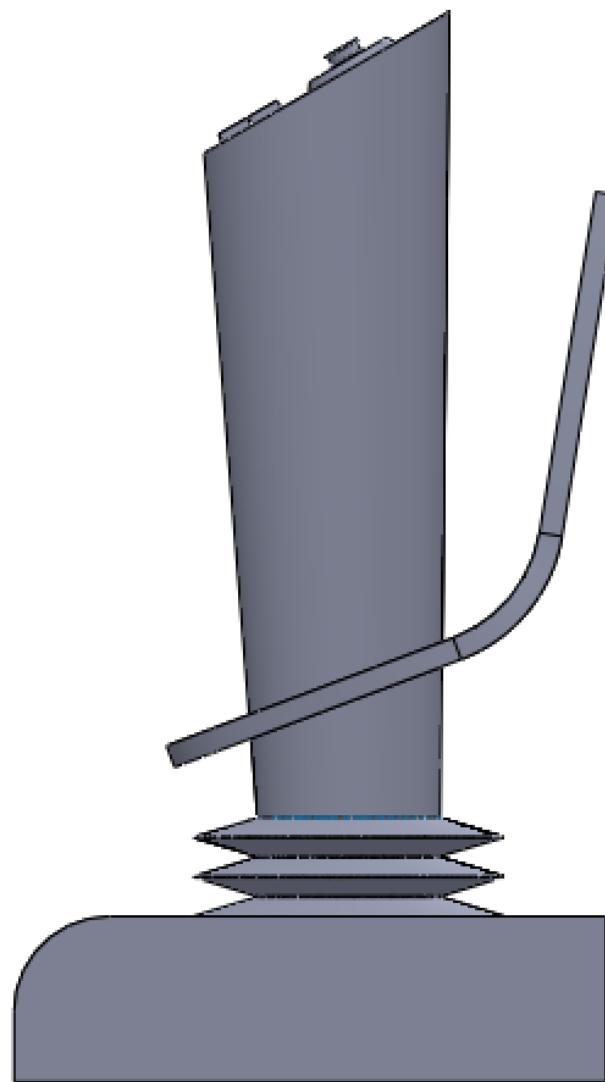


FIGURE 3.21: Kumar, Vishakh: Joystick View 4

### 3.6 Dial

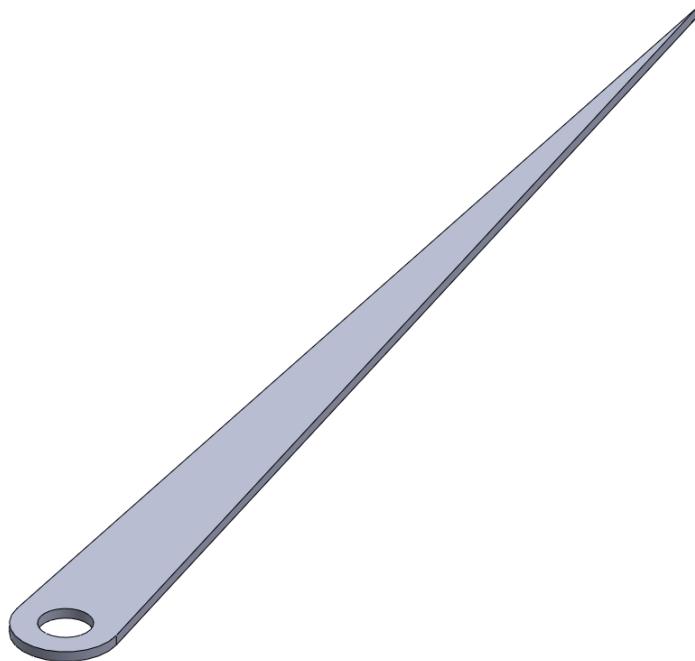


FIGURE 3.22: Kumar, Vishakh: Dial

### 3.7 CabinetDoor



FIGURE 3.23: Ferrarer, Auston: Cabinet Door

### 3.8 EmergencySwitch

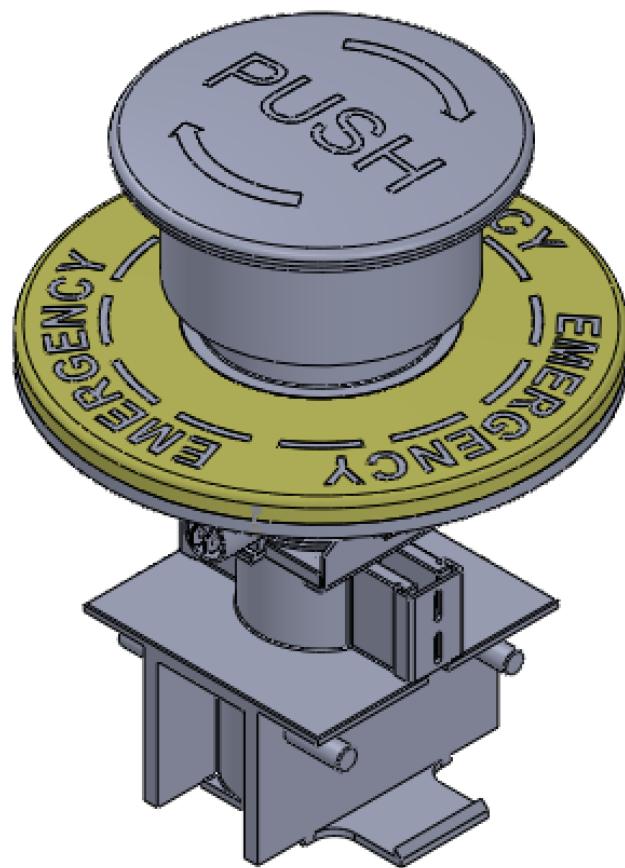


FIGURE 3.24: Kumar, Vishakh: Emergency Switch View 1



FIGURE 3.25: Kumar, Vishakh: Emergency Switch View 2



FIGURE 3.26: Kumar, Vishakh: Emergency Button Top

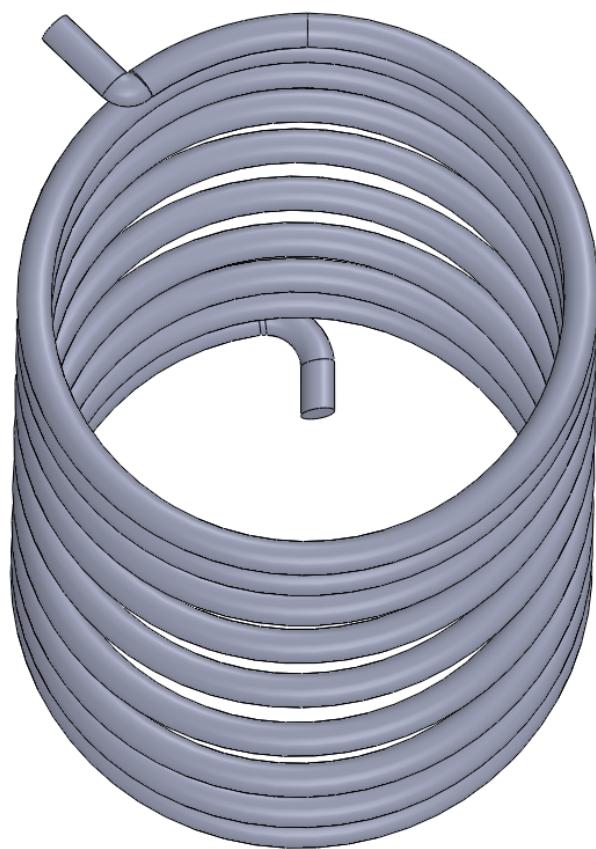


FIGURE 3.27: Kumar, Vishakh: Emergency Switch Spring

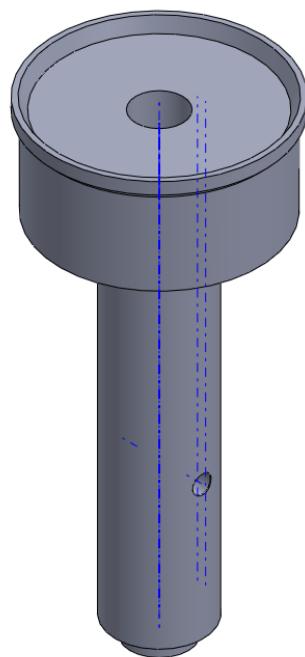


FIGURE 3.28: Kumar, Vishakh: Emergency Switch Main Casing

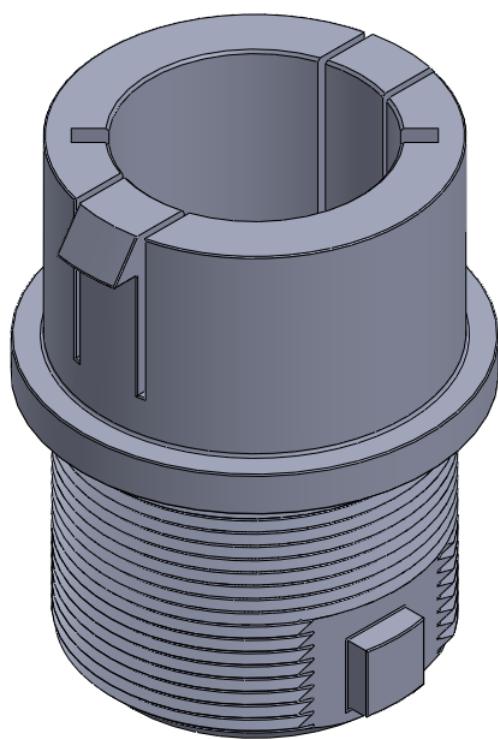


FIGURE 3.29: Kumar, Vishakh: Emergency Switch Pod Casing

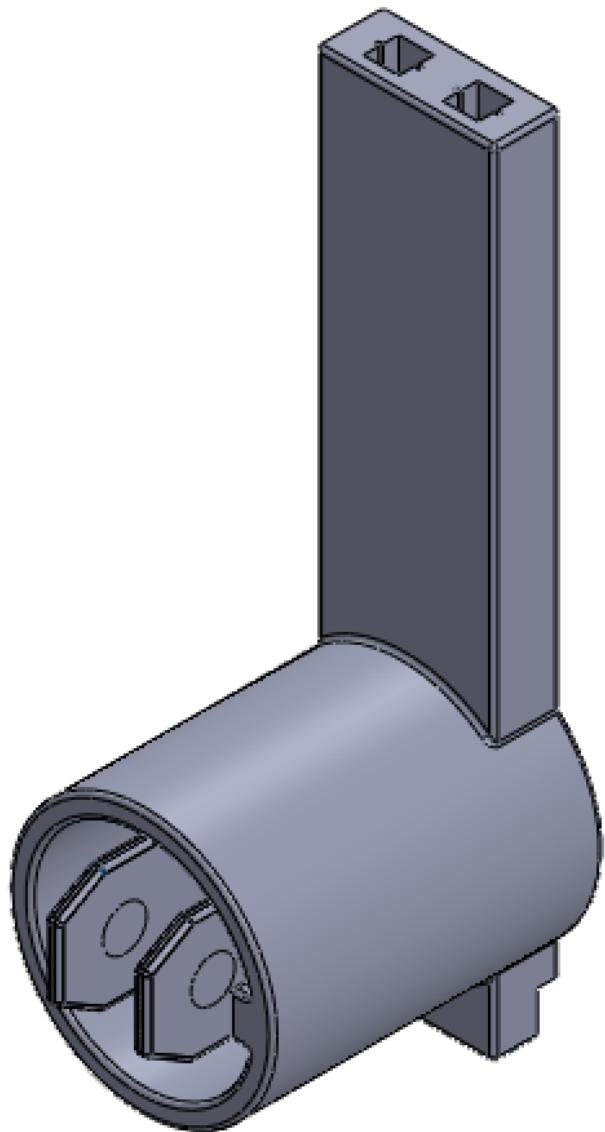


FIGURE 3.30: Kumar, Vishakh: Stecker

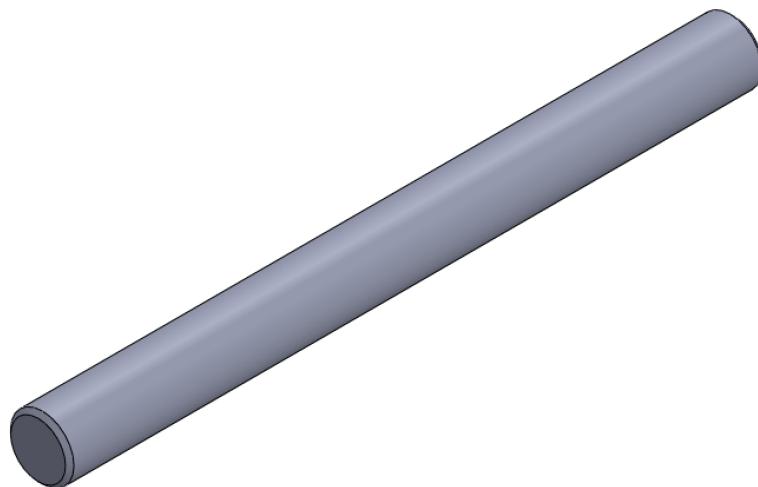


FIGURE 3.31: Kumar, Vishakh: Buckle Axis

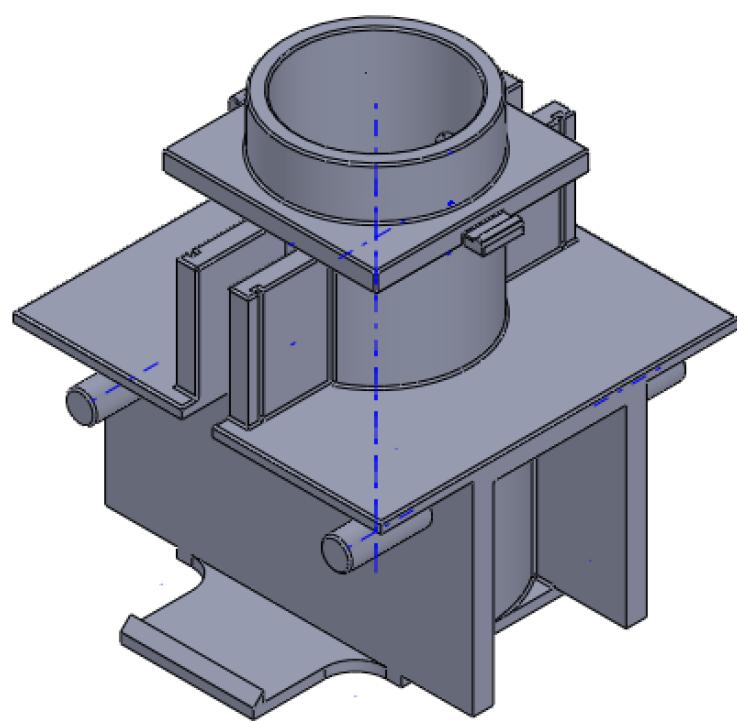


FIGURE 3.32: Kumar, Vishakh: Switch Base

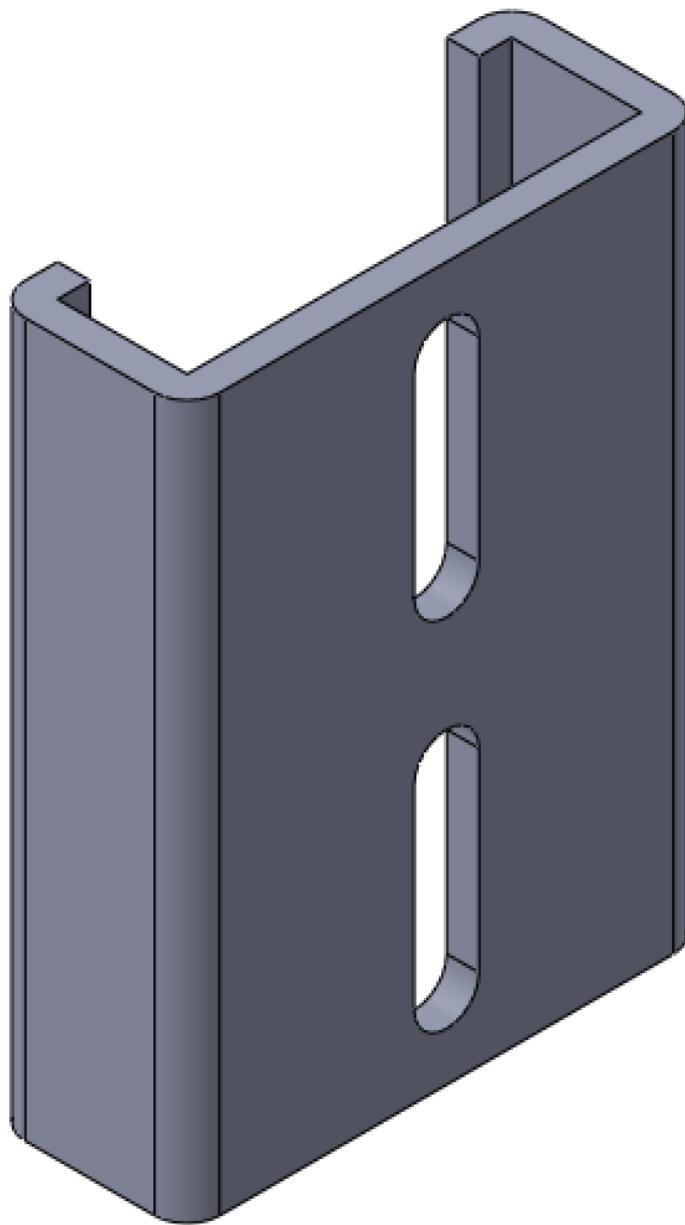


FIGURE 3.33: Kumar, Vishakh: Buckle

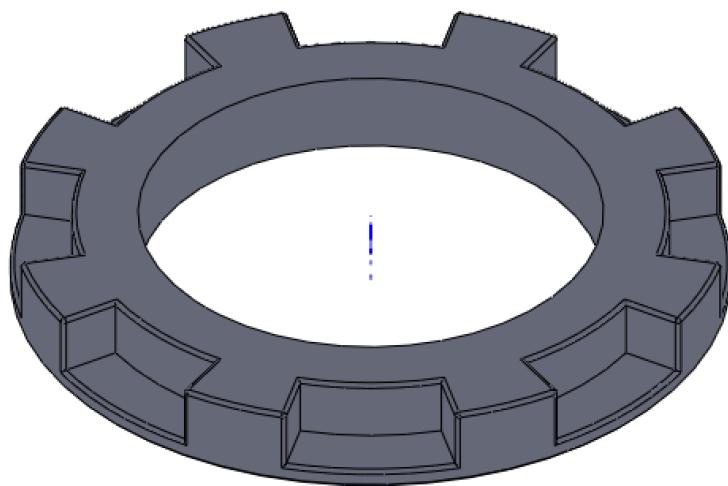


FIGURE 3.34: Kumar, Vishakh: Nut

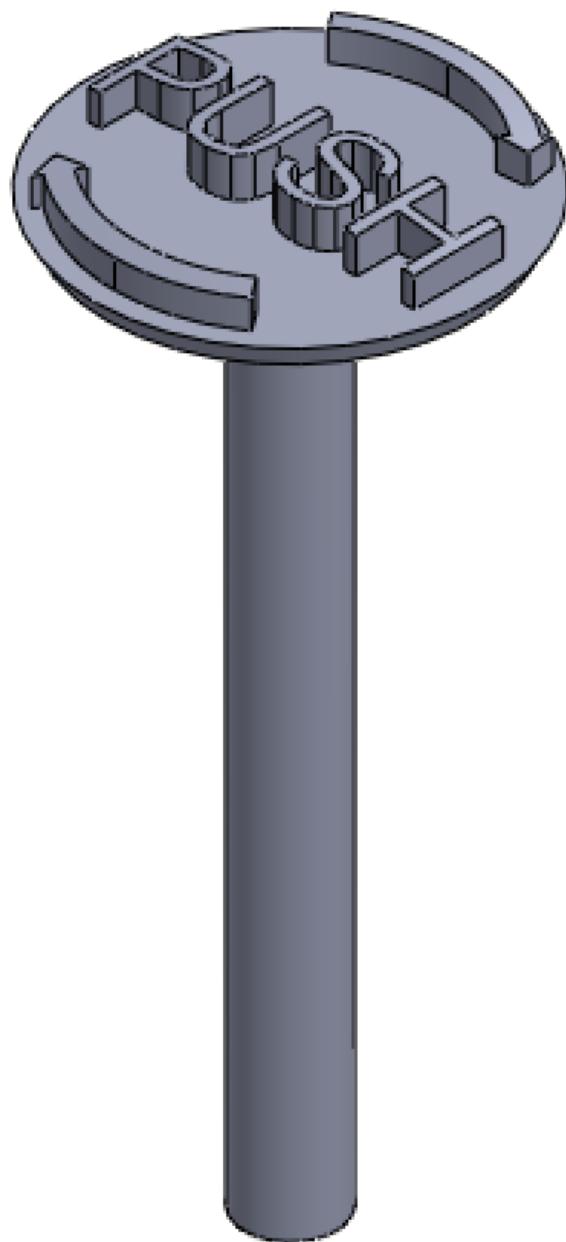


FIGURE 3.35: Kumar, Vishakh: Plastic Axis

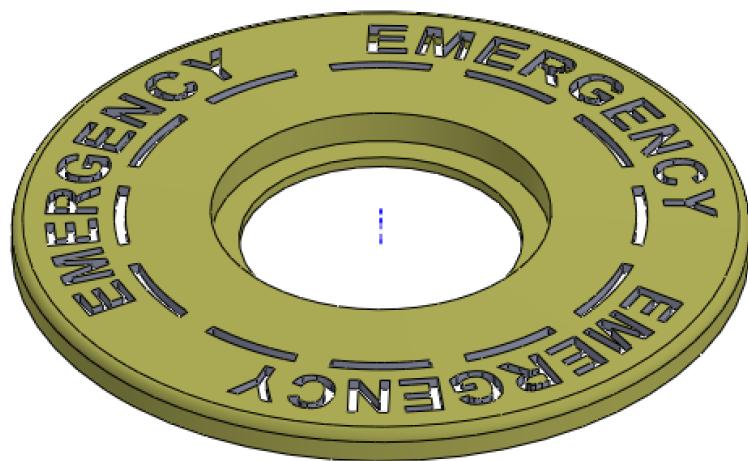


FIGURE 3.36: Kumar, Vishakh: Emergency Dial Top

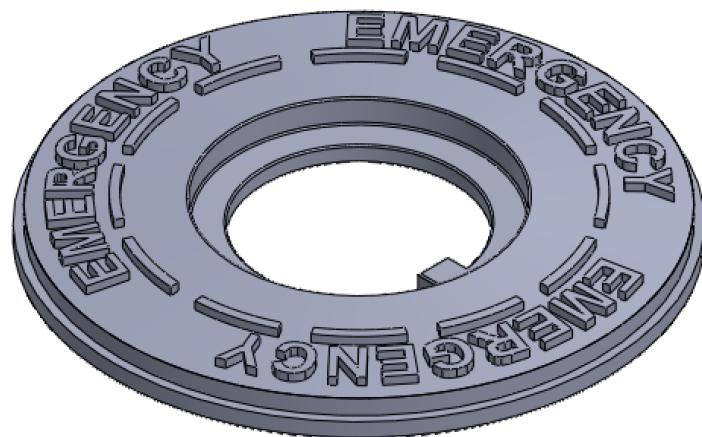


FIGURE 3.37: Kumar, Vishakh: Emergency Dial Bottom

### 3.9 MechanicalDisplay

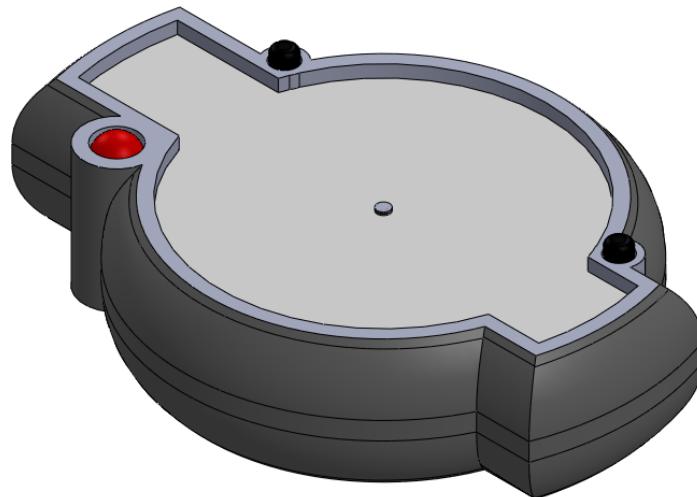


FIGURE 3.38: Kumar, Vishakh: Mechanical Display View 1

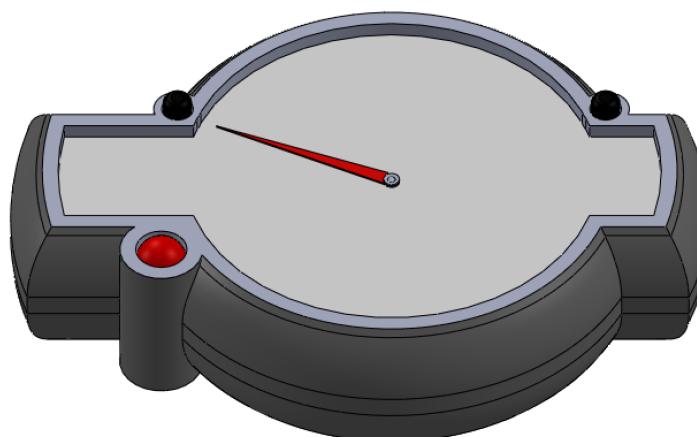


FIGURE 3.39: Kumar, Vishakh: Mechanical DisplayView 2

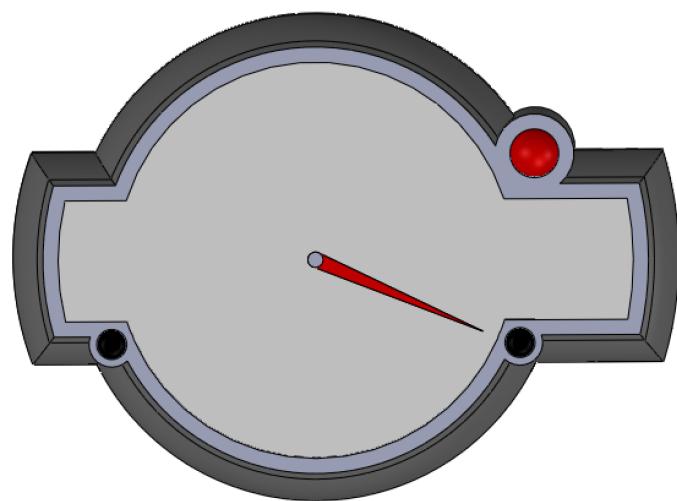


FIGURE 3.40: Kumar, Vishakh: Mechanical Display View 3

### 3.10 3DPrinter

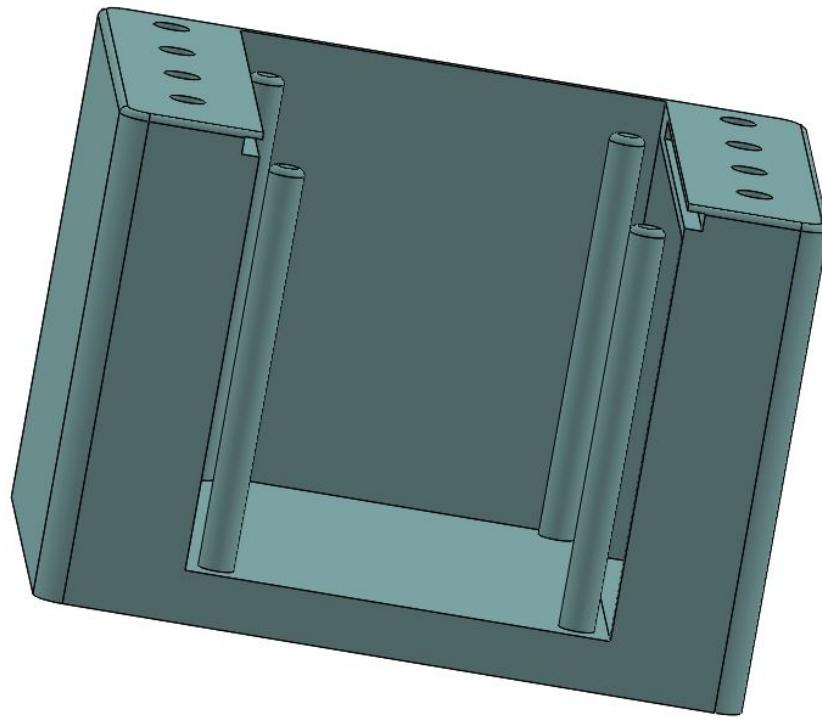


FIGURE 3.41: Ferrarer, Auston: Basic Cut Extrude

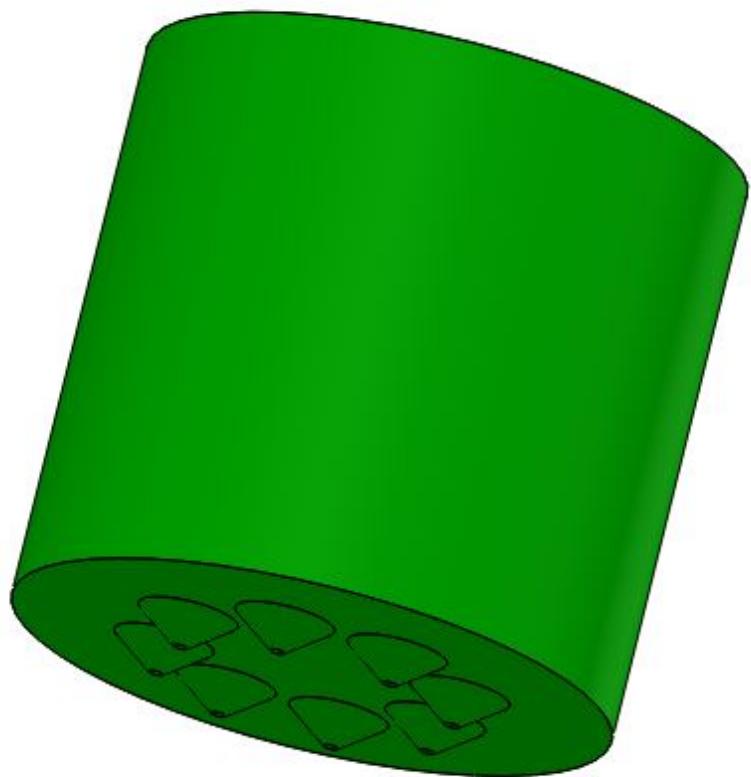


FIGURE 3.42: Ferrarer, Auston: Extruder

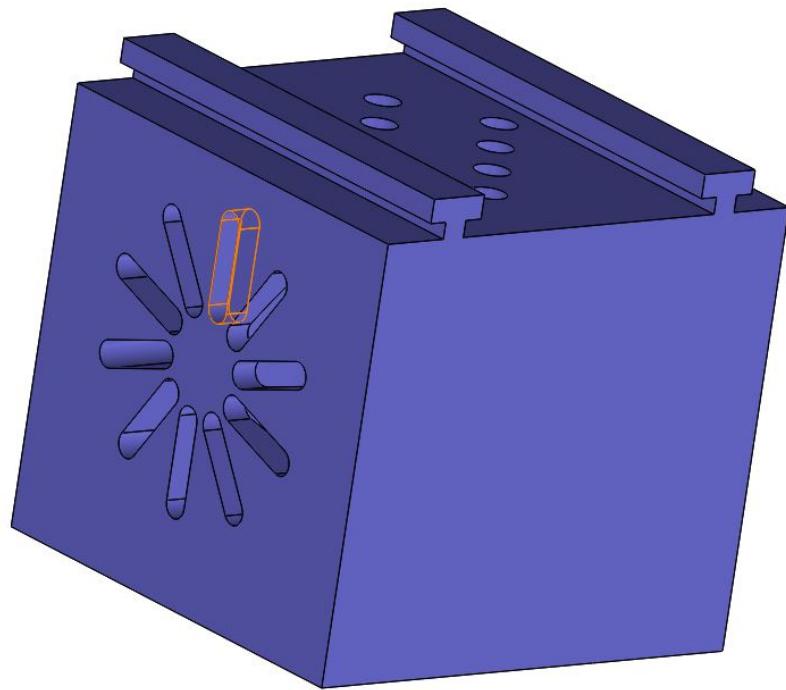


FIGURE 3.43: Ferrarer, Auston: Extruder Housing

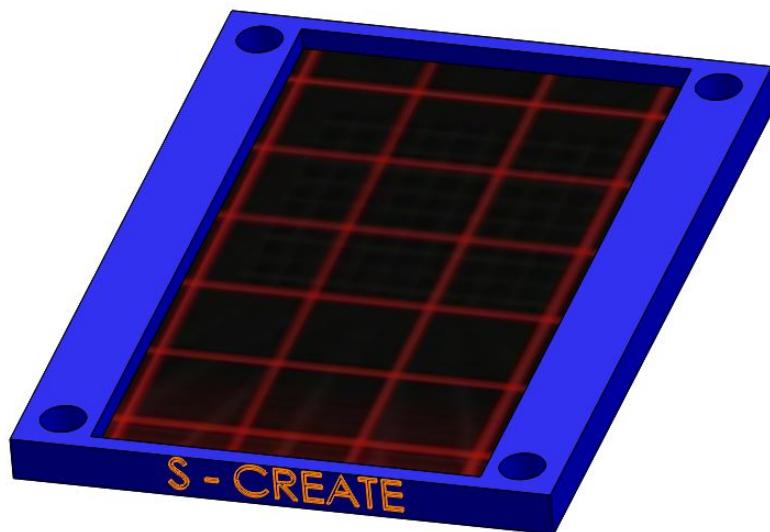


FIGURE 3.44: Ferrarer, Auston: Printing Plate

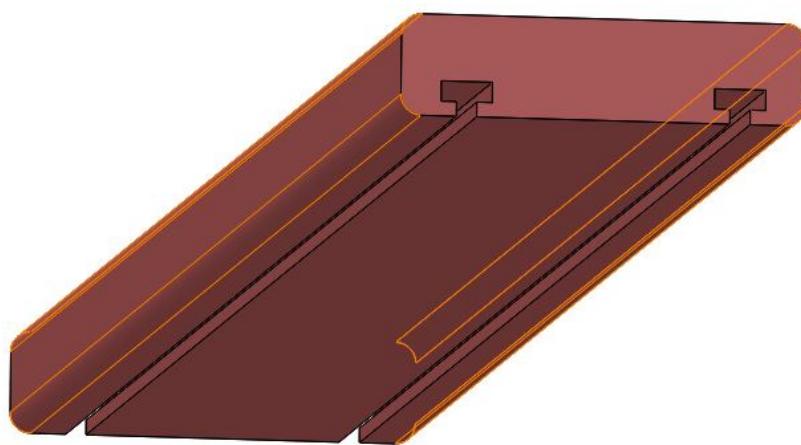


FIGURE 3.45: Ferrarer, Auston: Slide Bar

### 3.11 Chassis

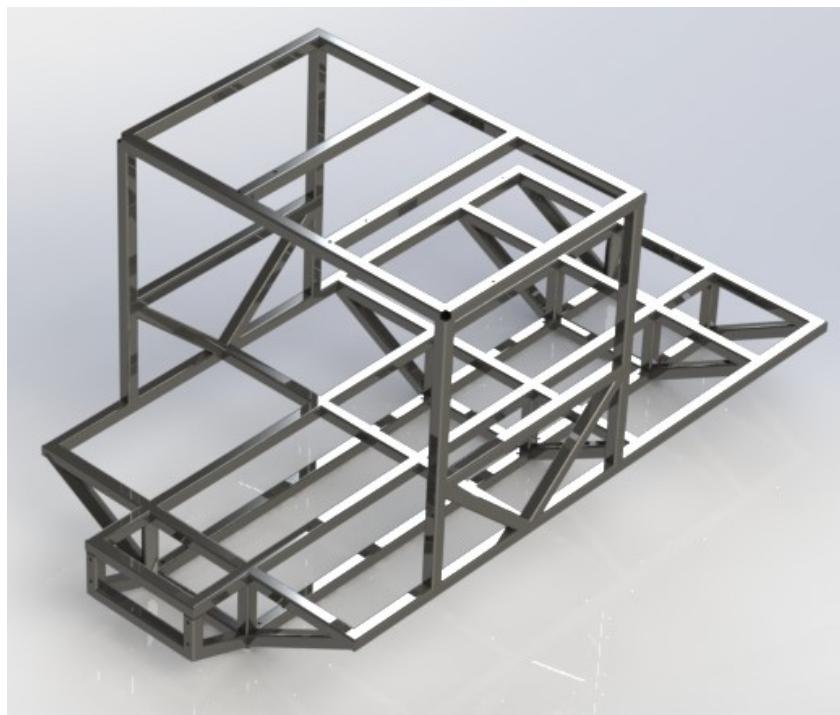


FIGURE 3.46: Rodriguez, Juan: Chasis Render

### 3.12 Helmet

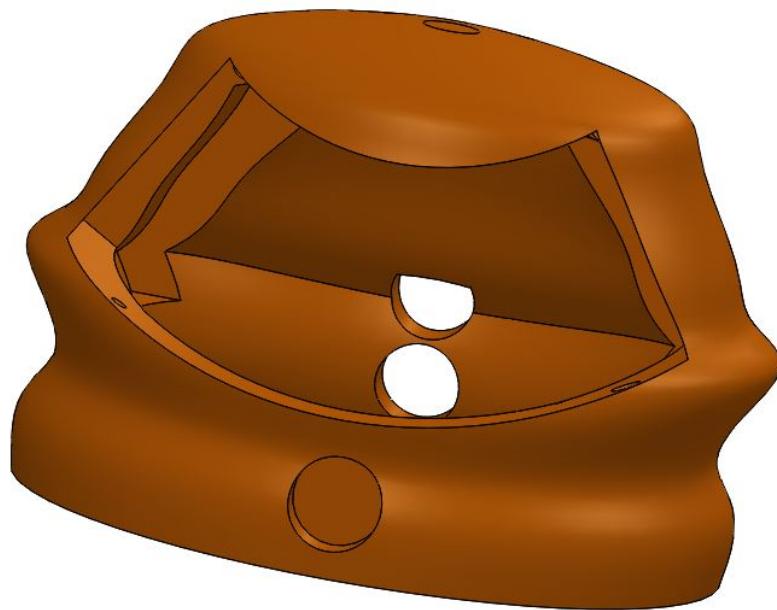


FIGURE 3.47: Ferrarer, Auston: Helmet Shell

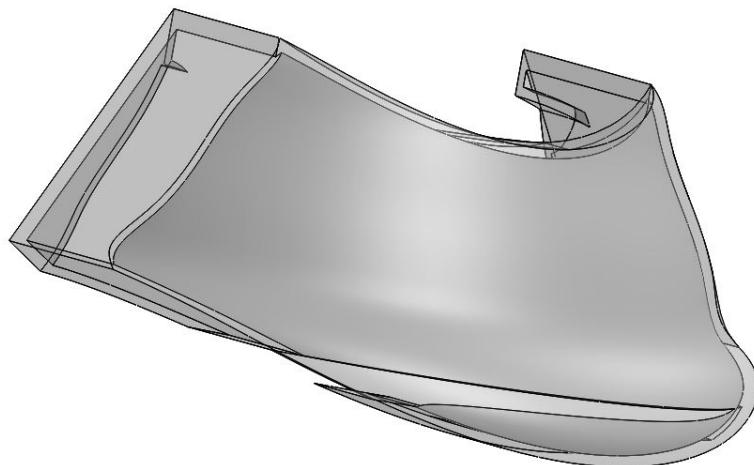


FIGURE 3.48: Ferrarer, Auston: Helmet Visor

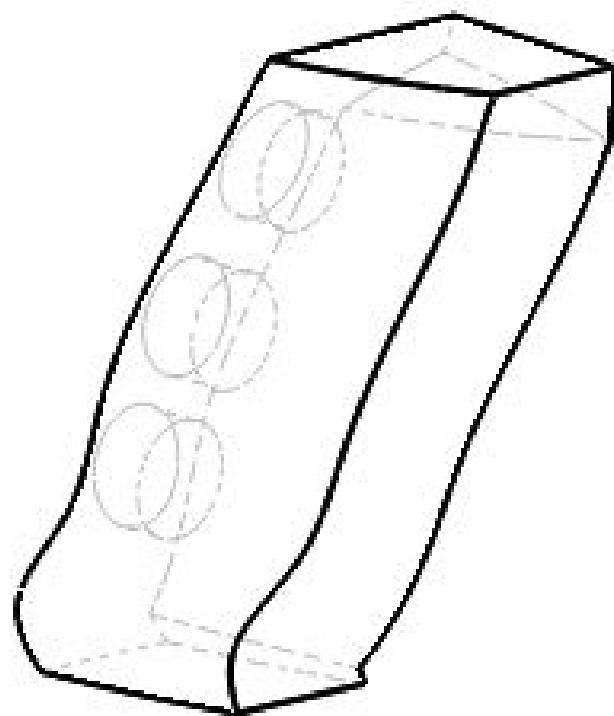


FIGURE 3.49: Ferrarer, Auston: Left light



FIGURE 3.50: Ferrarer, Auston: Right light

### 3.13 Suspension



FIGURE 3.51: Hirani, Asimm: 25 Tooth Gear

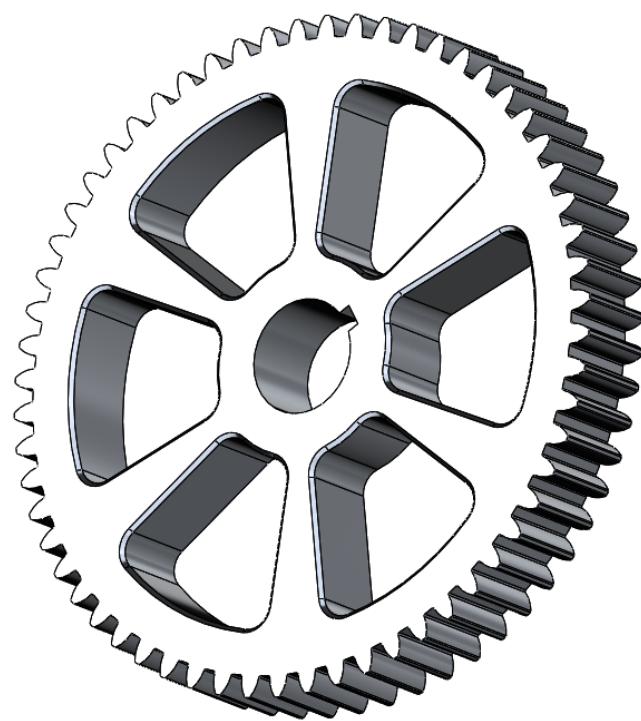


FIGURE 3.52: Hirani, Asimm: 60 Tooth Gear



FIGURE 3.53: Hirani, Asimm: Brake Caliper

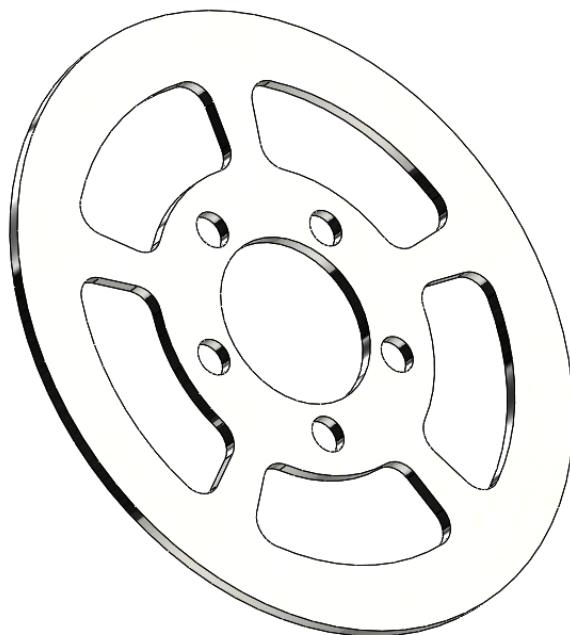


FIGURE 3.54: Hirani, Asimm:Brake Disk

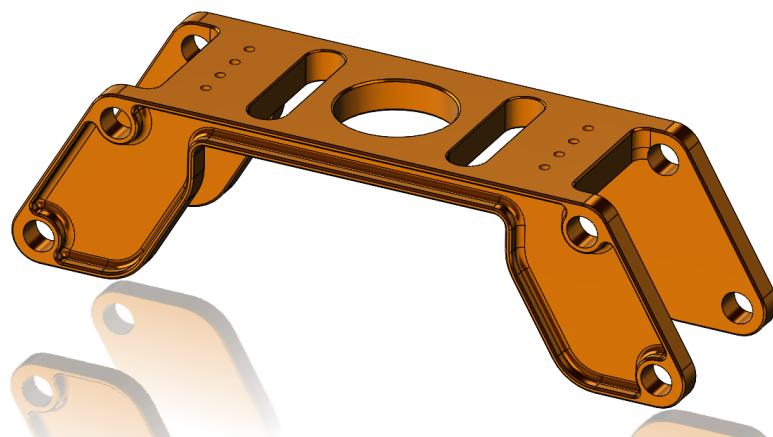


FIGURE 3.55: Hirani, Asimm: Center Frame

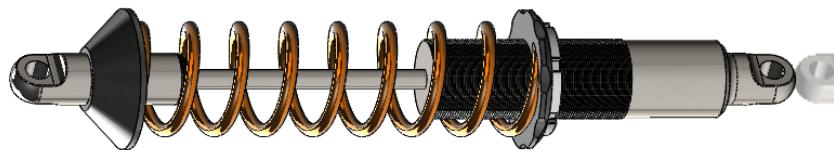


FIGURE 3.56: Hirani, Asimm: Coilover

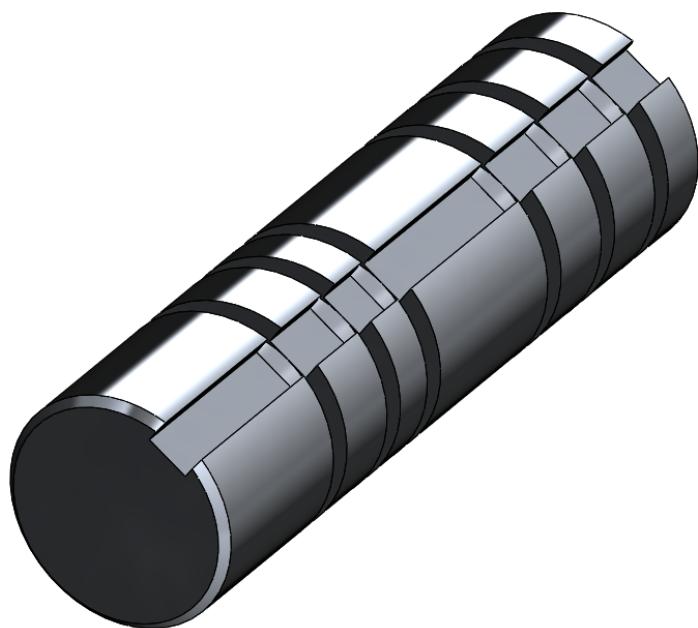


FIGURE 3.57: Hirani, Asimm: Gearbox Drive Shaft



FIGURE 3.58: Hirani, Asimm: Gearbox Idler Shaft



FIGURE 3.59: Hirani, Asimm: Gearbox Output Shaft

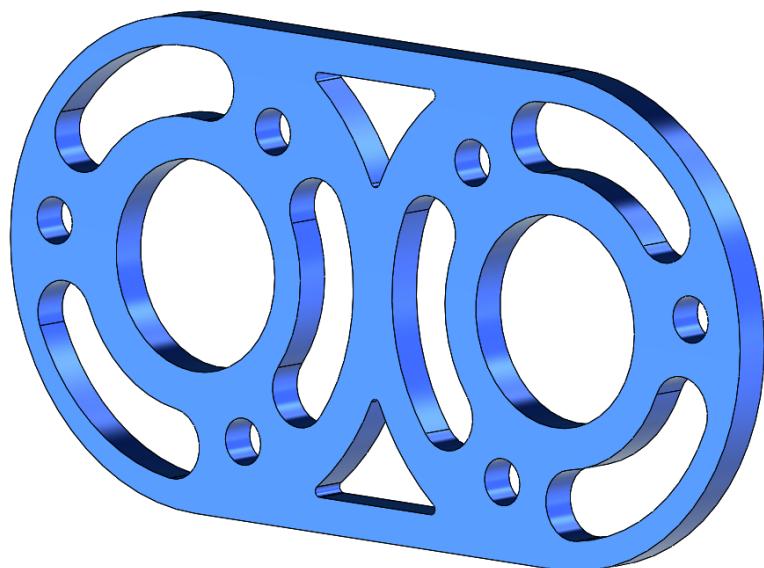


FIGURE 3.60: Hirani, Asimm: Gearbox Steel Plate

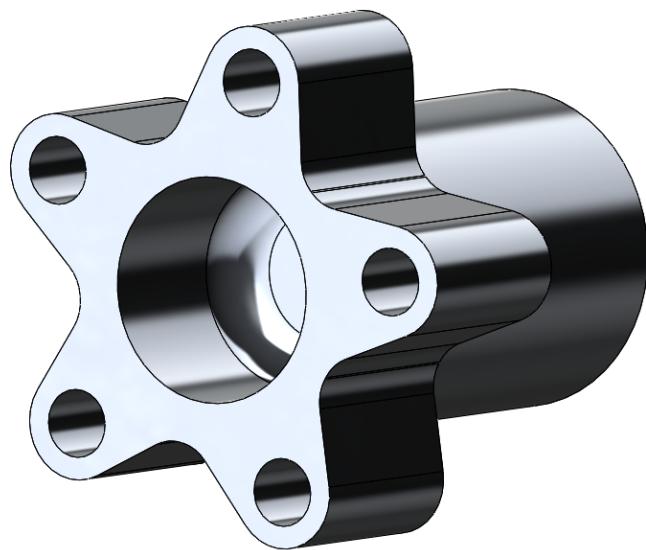


FIGURE 3.61: Hirani, Asimm: Hub

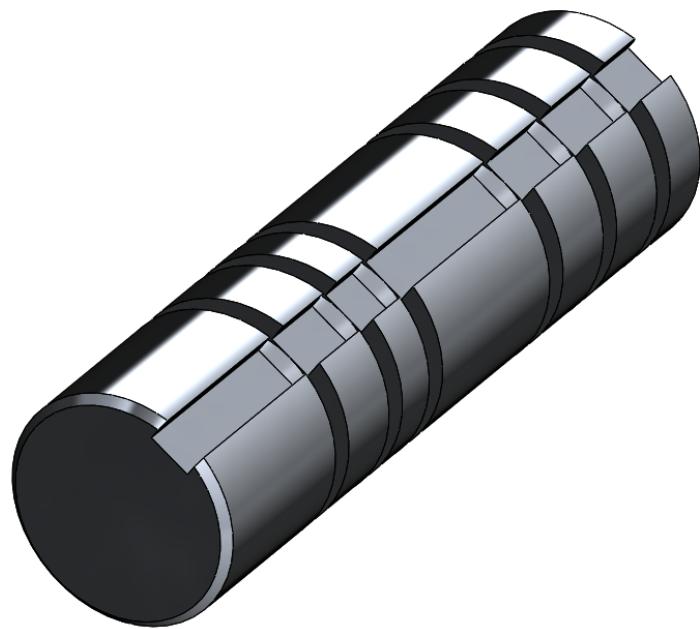


FIGURE 3.62: Hirani, Asimm: Gearbox Drive Shaft

### 3.14 Antenna



FIGURE 3.63: Rodriguez, Juan: Antenna Rendering

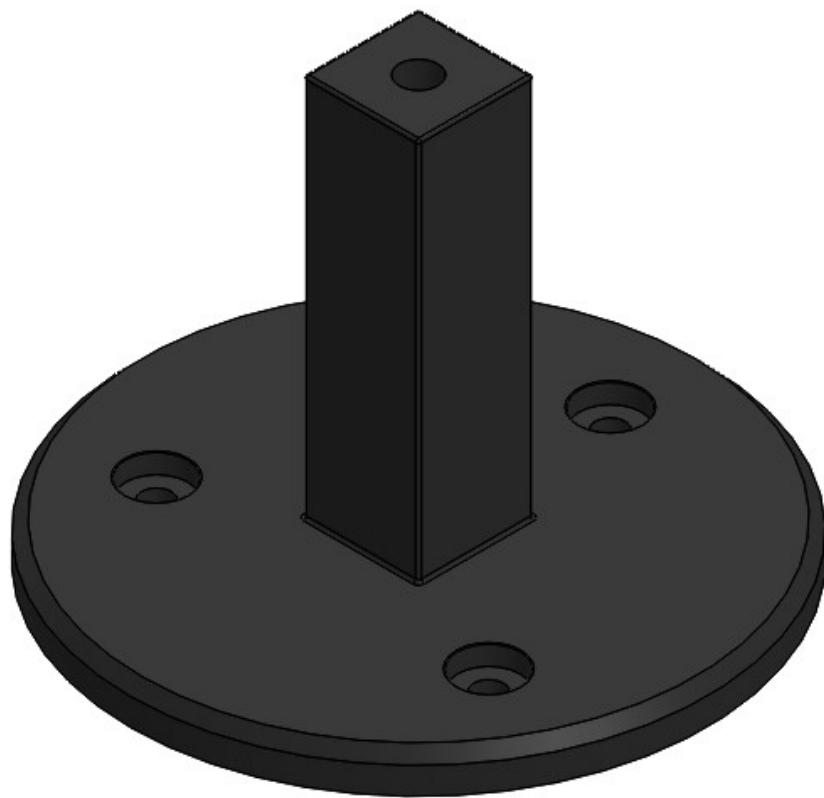


FIGURE 3.64: Rodriguez, Juan: Antenna Base

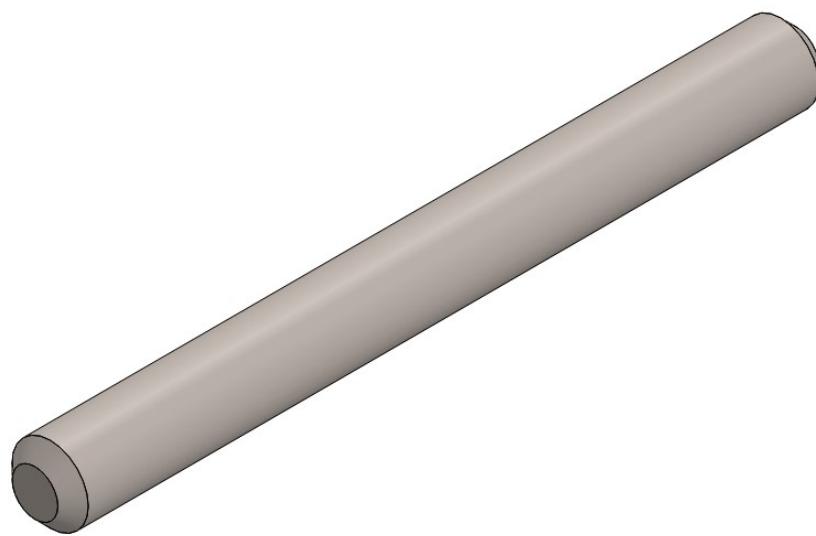


FIGURE 3.65: Rodriguez, Juan: pin A



FIGURE 3.66: Rodriguez, Juan: pin B

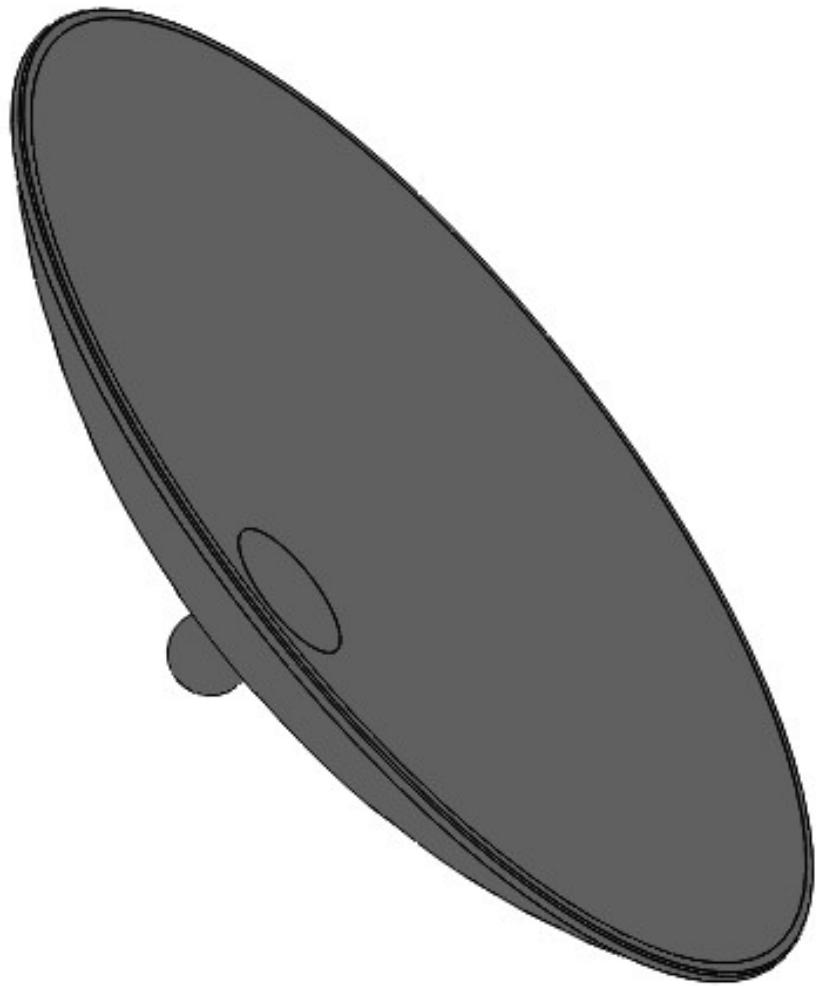


FIGURE 3.67: Rodriguez, Juan: Antenna

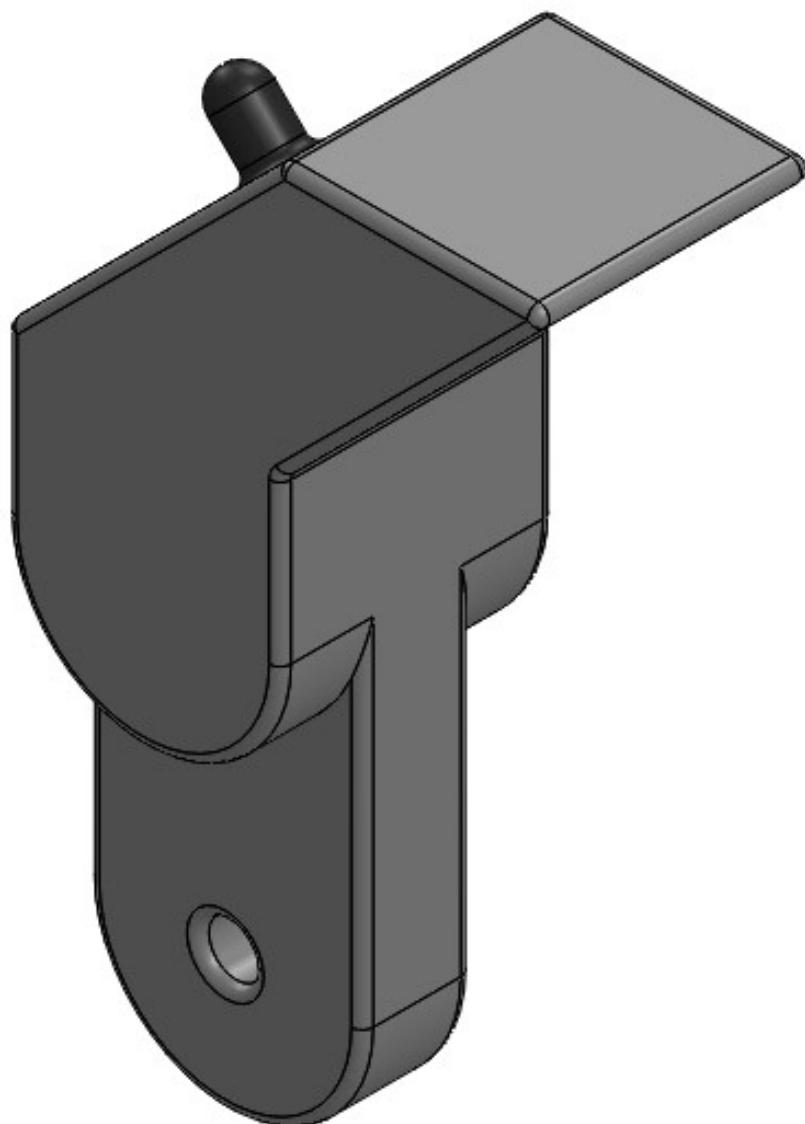


FIGURE 3.68: Rodriguez, Juan: Receiver

## Chapter 4

# Manufacturing Working Drawing

- **4.1 Working Drawings**

A product cannot be counted as finished unless there are plans to manufacture that product. While the plans for our product is definitely beyond the ability of a student run organization (or small countries), we've added working drawings to highlight important features and dimensions of our work.

- **4.2 Assembly Instruction Manual**

While our product is unlikely to ever reach the manufacturing line, it's prudent to think about how products are manufactured and assembled in order to create functional products. In that spirit, we've created assembly instructions for an intrepid student to follow should s/he ever attempt building a Mars Rover.

- **4.3 Exploded View**

We've created renders of exploded views of our subassemblies. This helped us understand how our team member's parts fit together in our project.

- **4.4 Part List**

We've added a bill of materials for relevant subassemblies.

## 4.1 Working Drawings

### 4.1.1 Joystick

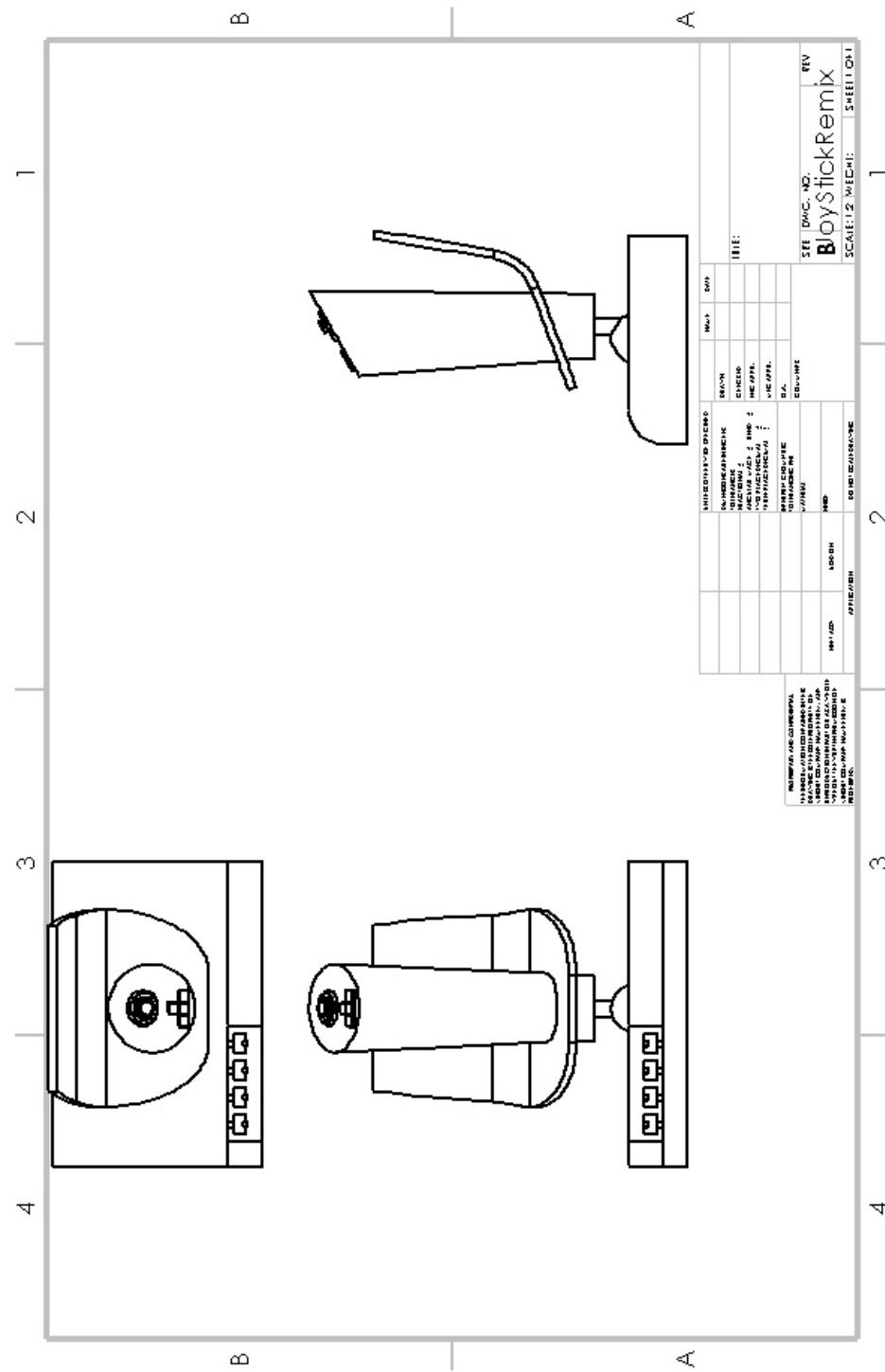


FIGURE 4.1: Kumar, Vishakh: JoyStick Full Assembly

### 4.1.2 Emergency Switch

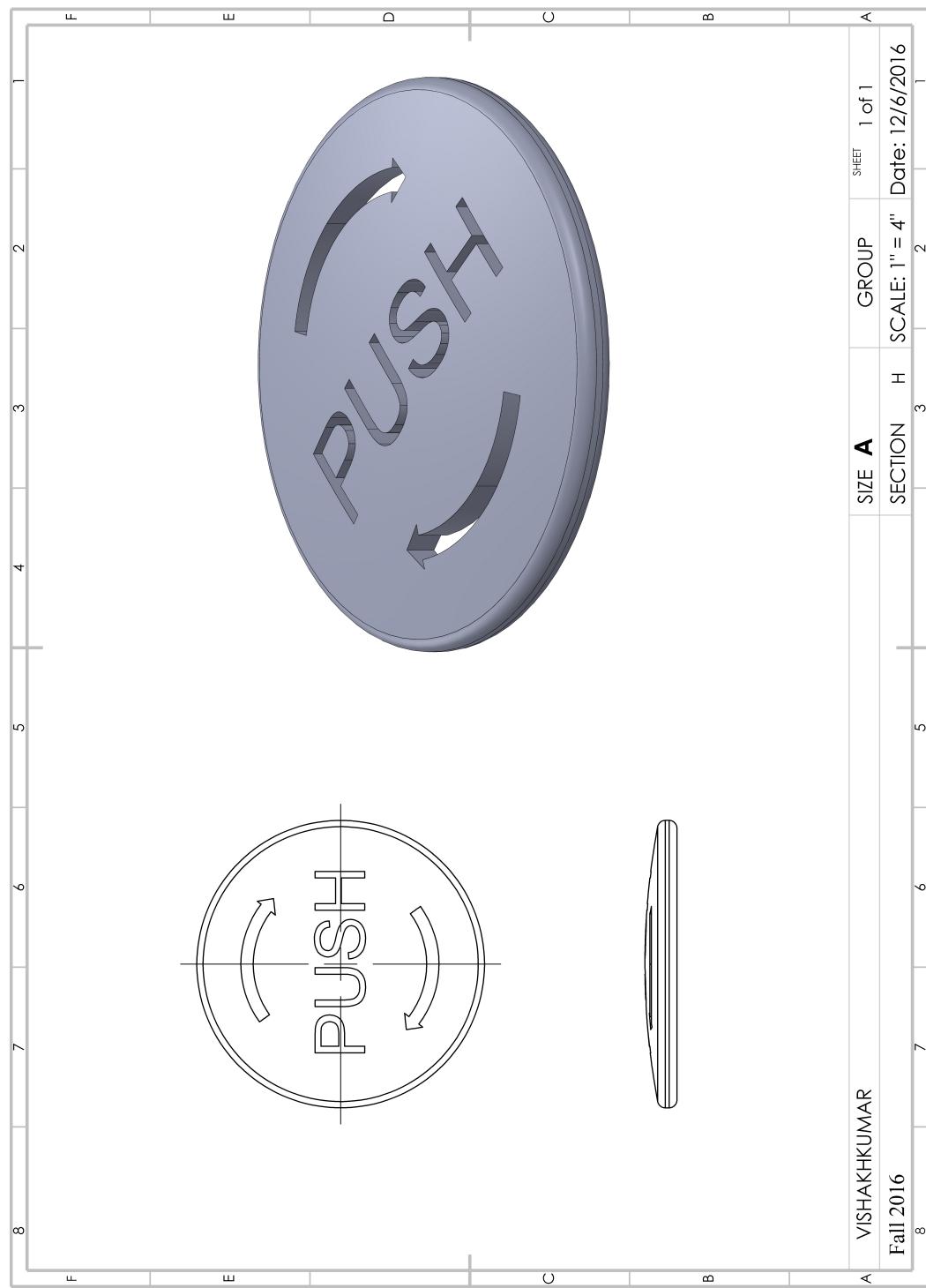


FIGURE 4.2: Kumar, Vishakh: Top

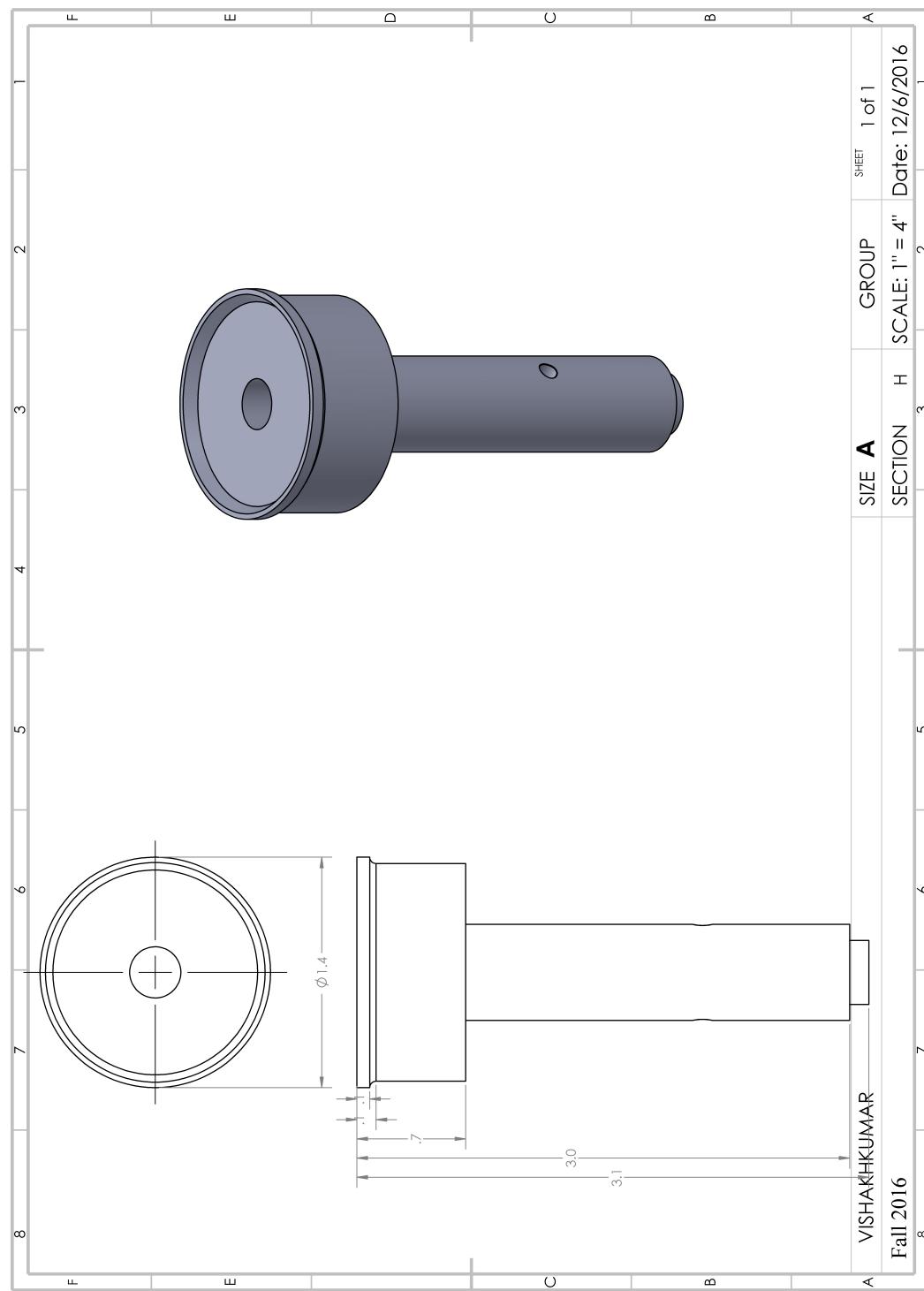


FIGURE 4.3: Kumar, Vishakh: Main Casing

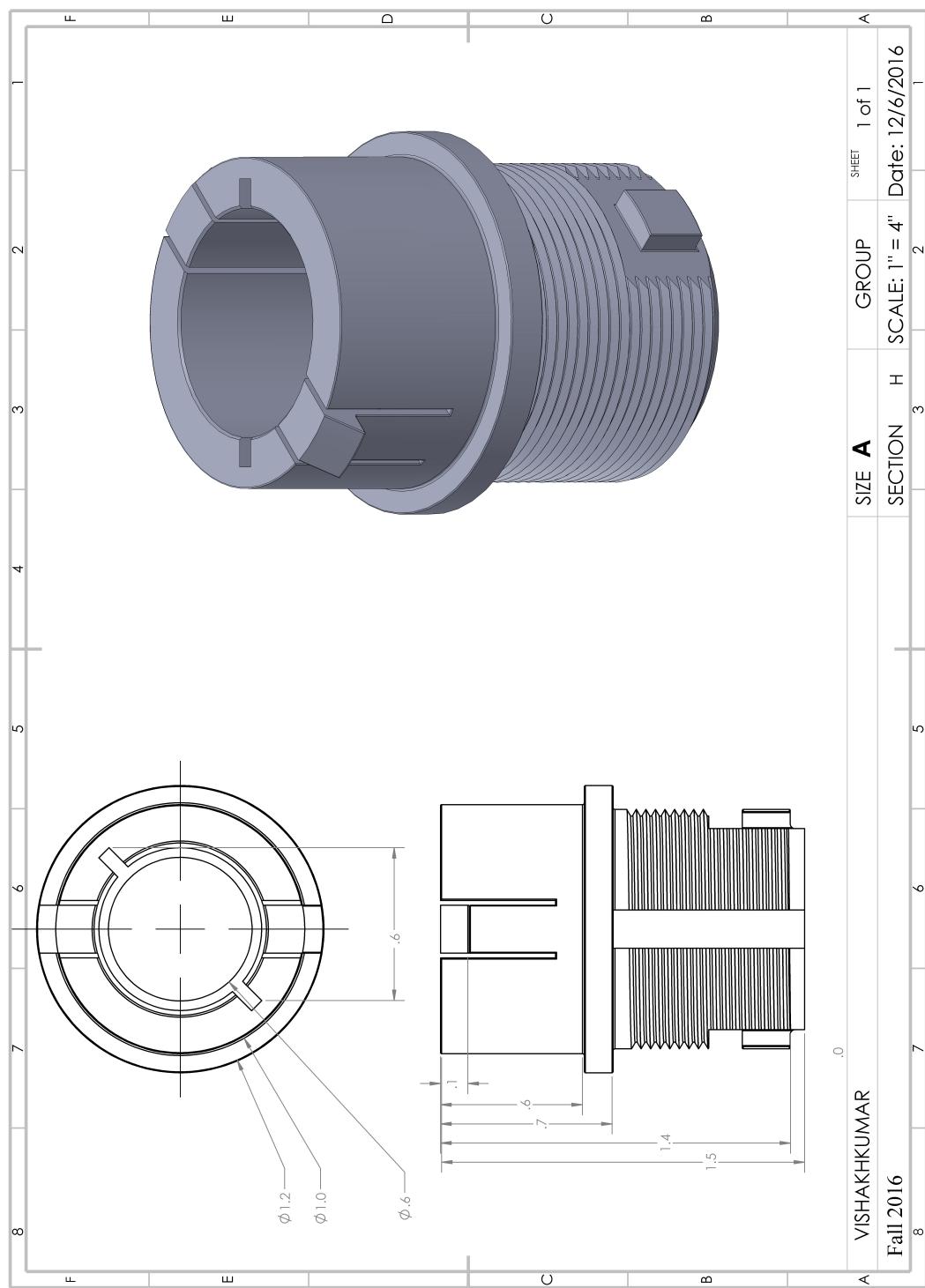


FIGURE 4.4: Kumar, Vishakh: Pod Casing

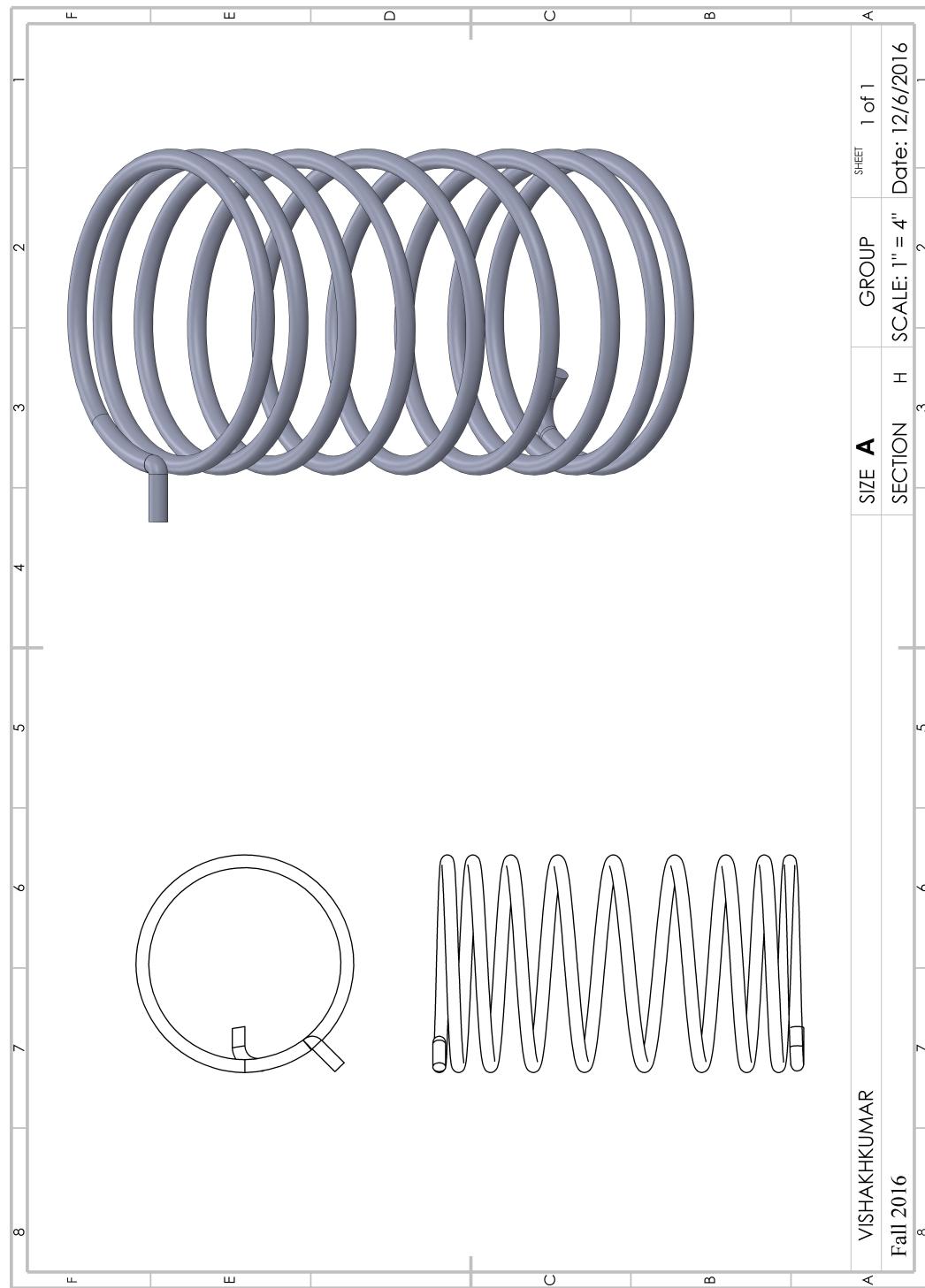


FIGURE 4.5: Kumar, Vishakh: Spring

### 4.1.3 Seat

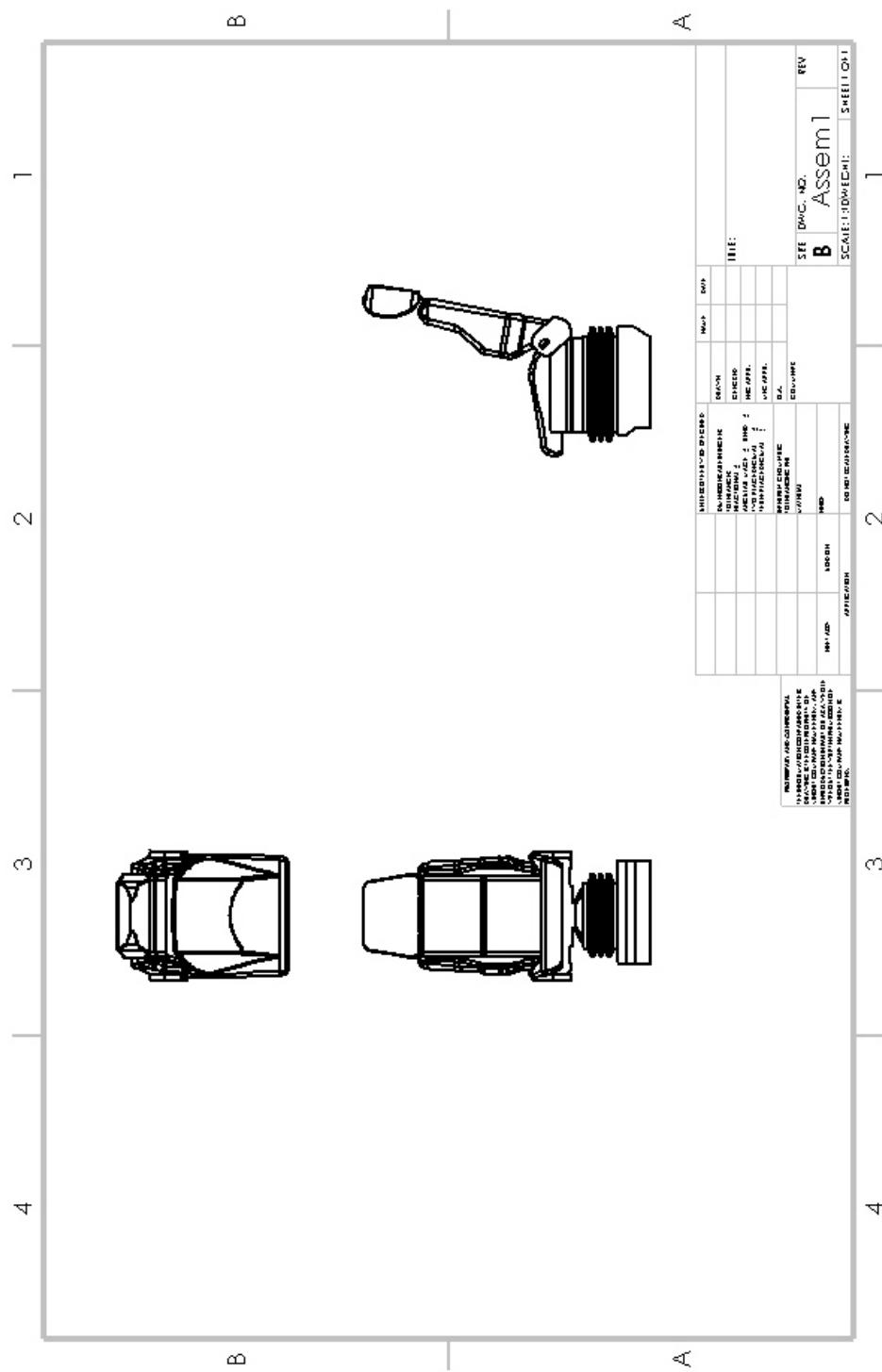


FIGURE 4.6: Kumar, Vishakh: Seat Full Assembly

#### 4.1.4 Mechanical Display

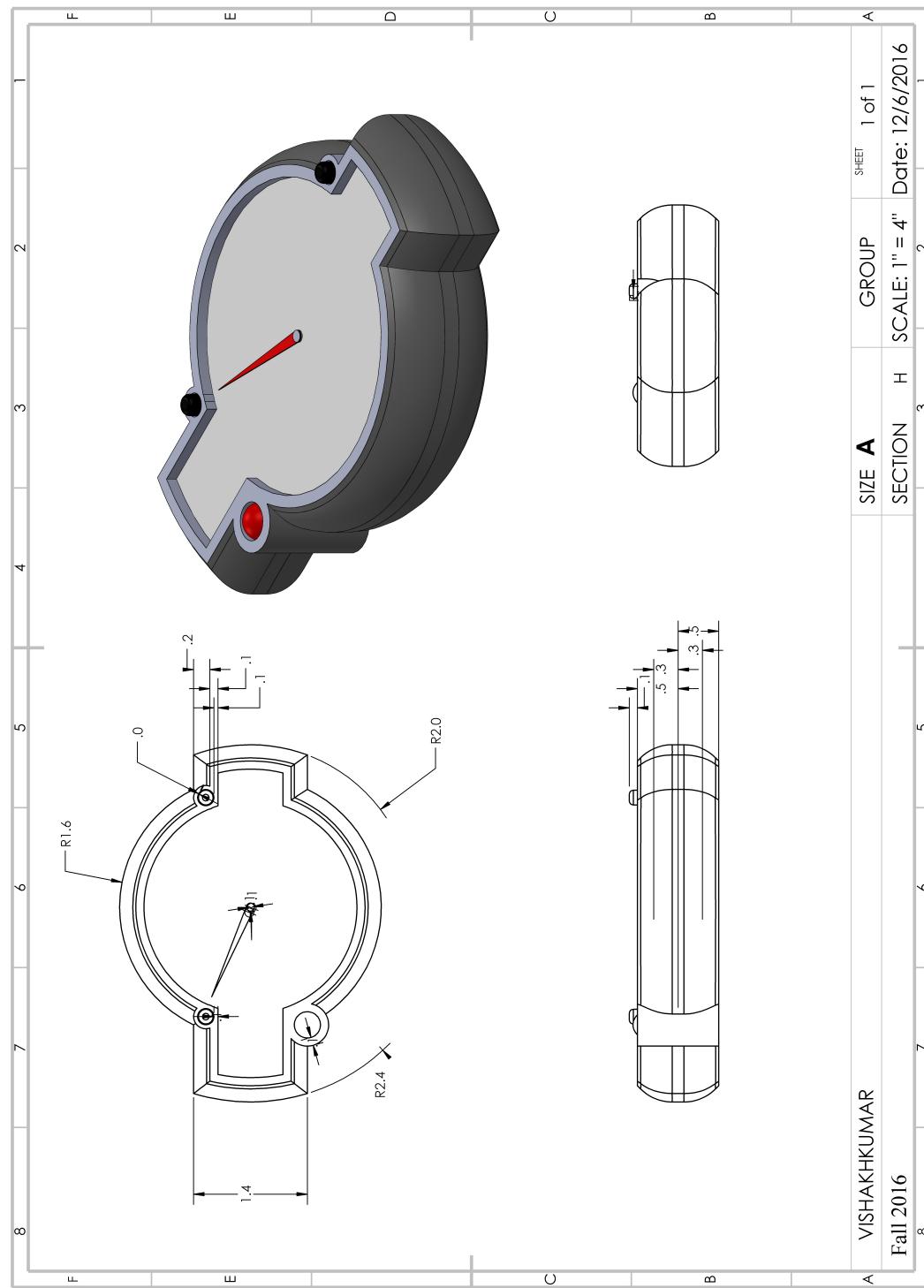


FIGURE 4.7: Kumar, Vishakh: Mechanical Display

#### 4.1.5 Antenna

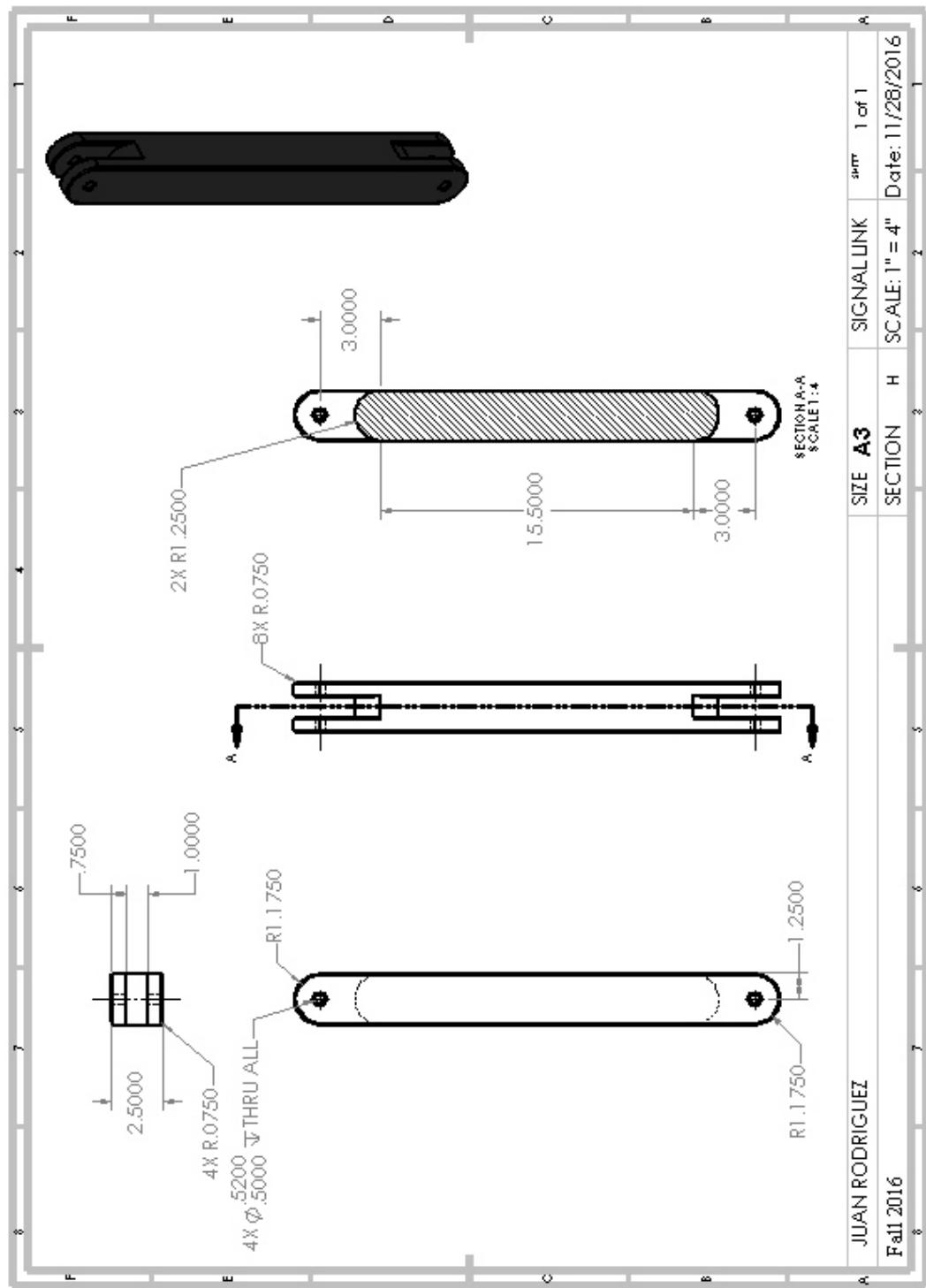


FIGURE 4.8: Signal Bar

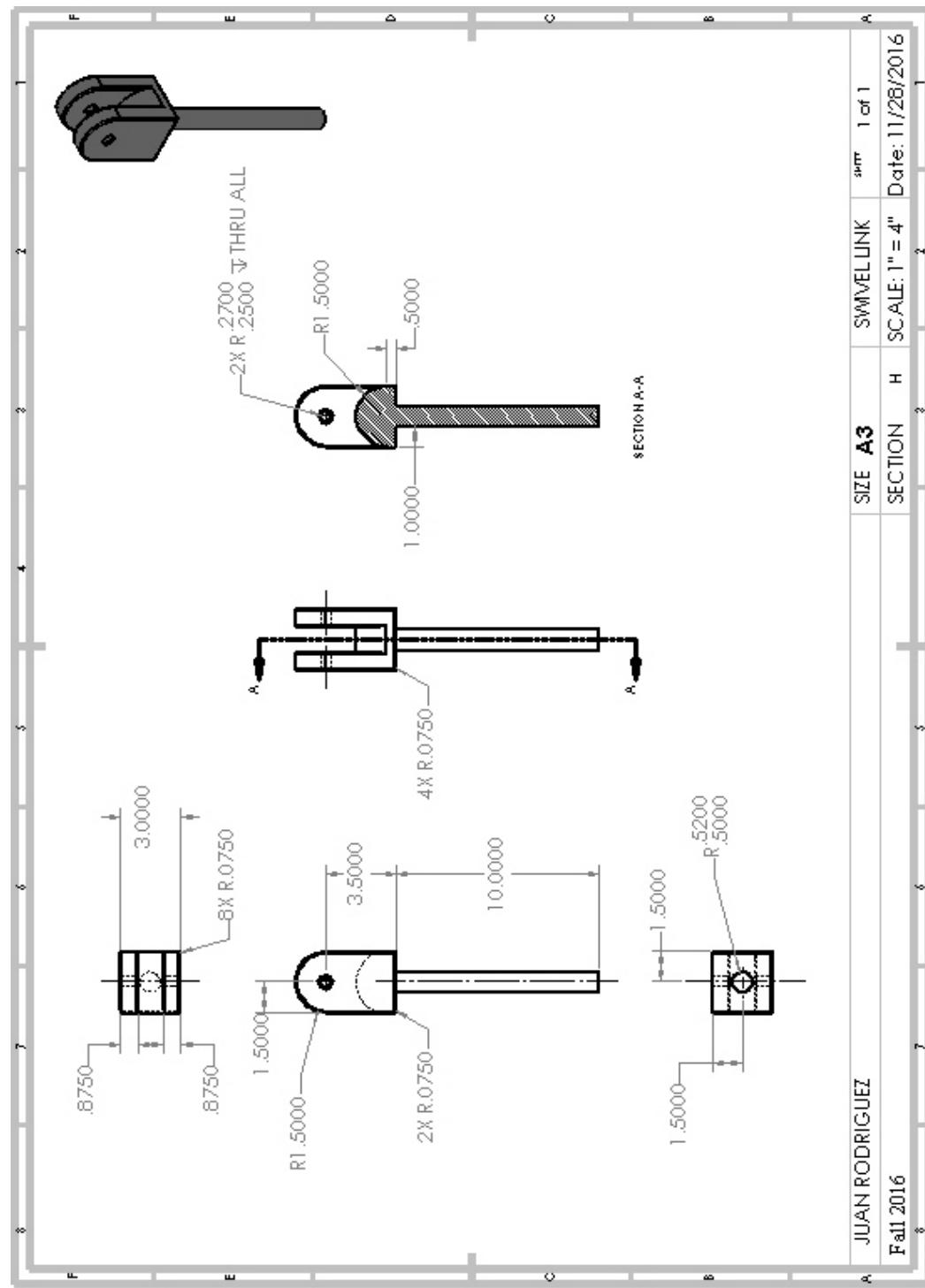


FIGURE 4.9: Swivel Link

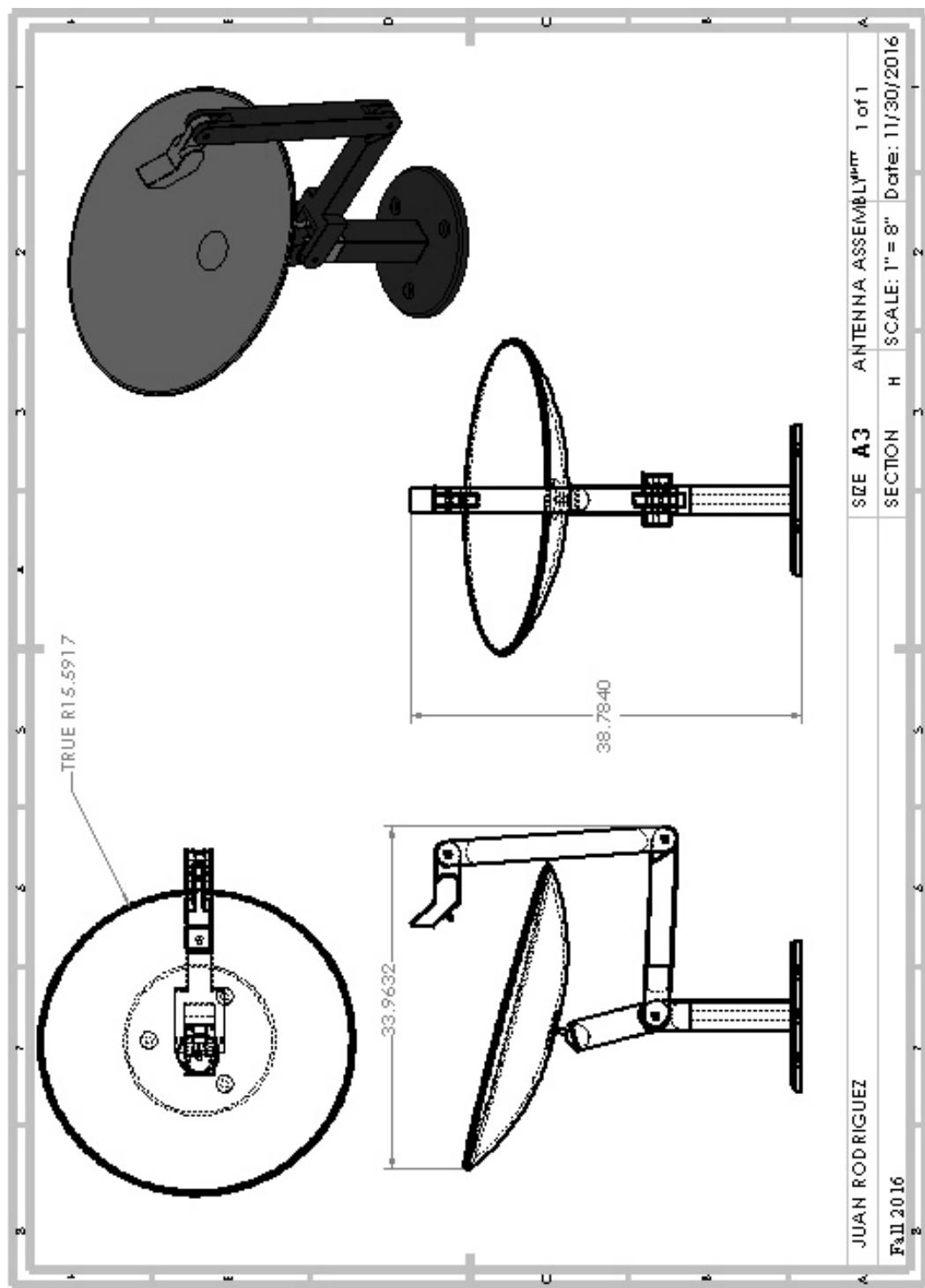


FIGURE 4.10: Antenna Assembly

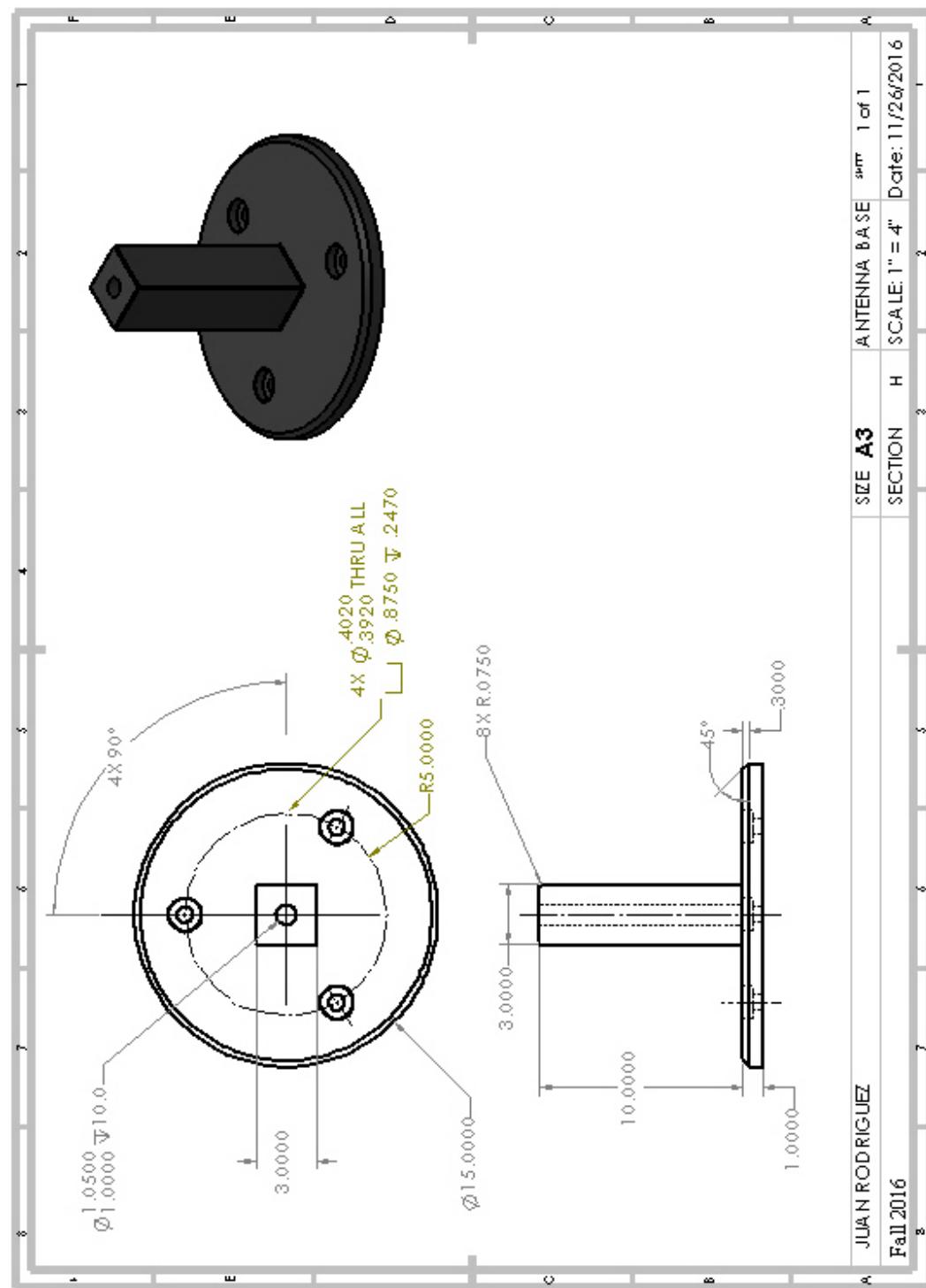


FIGURE 4.11: Antenna Base

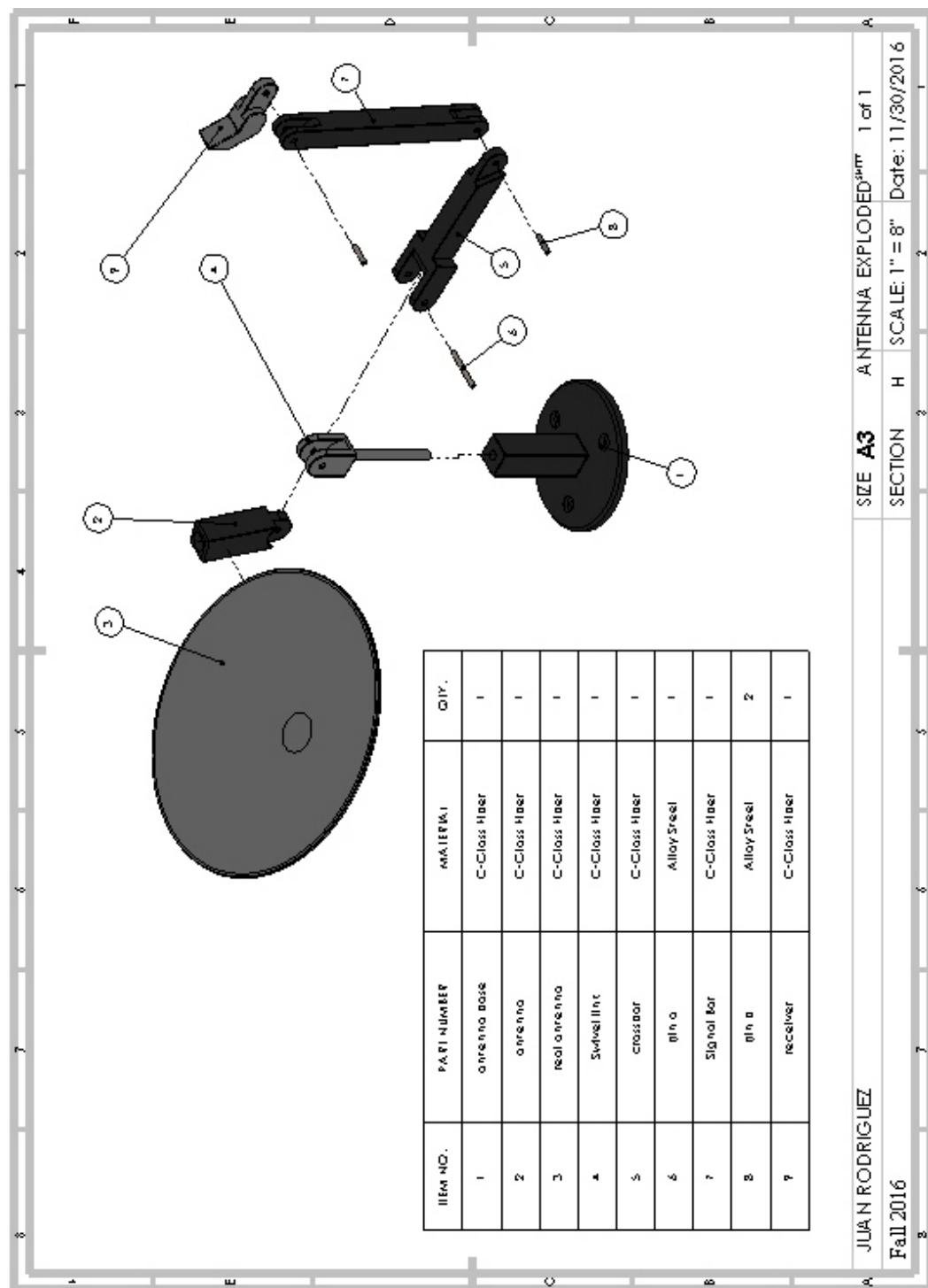


FIGURE 4.12: Antenna Exploded

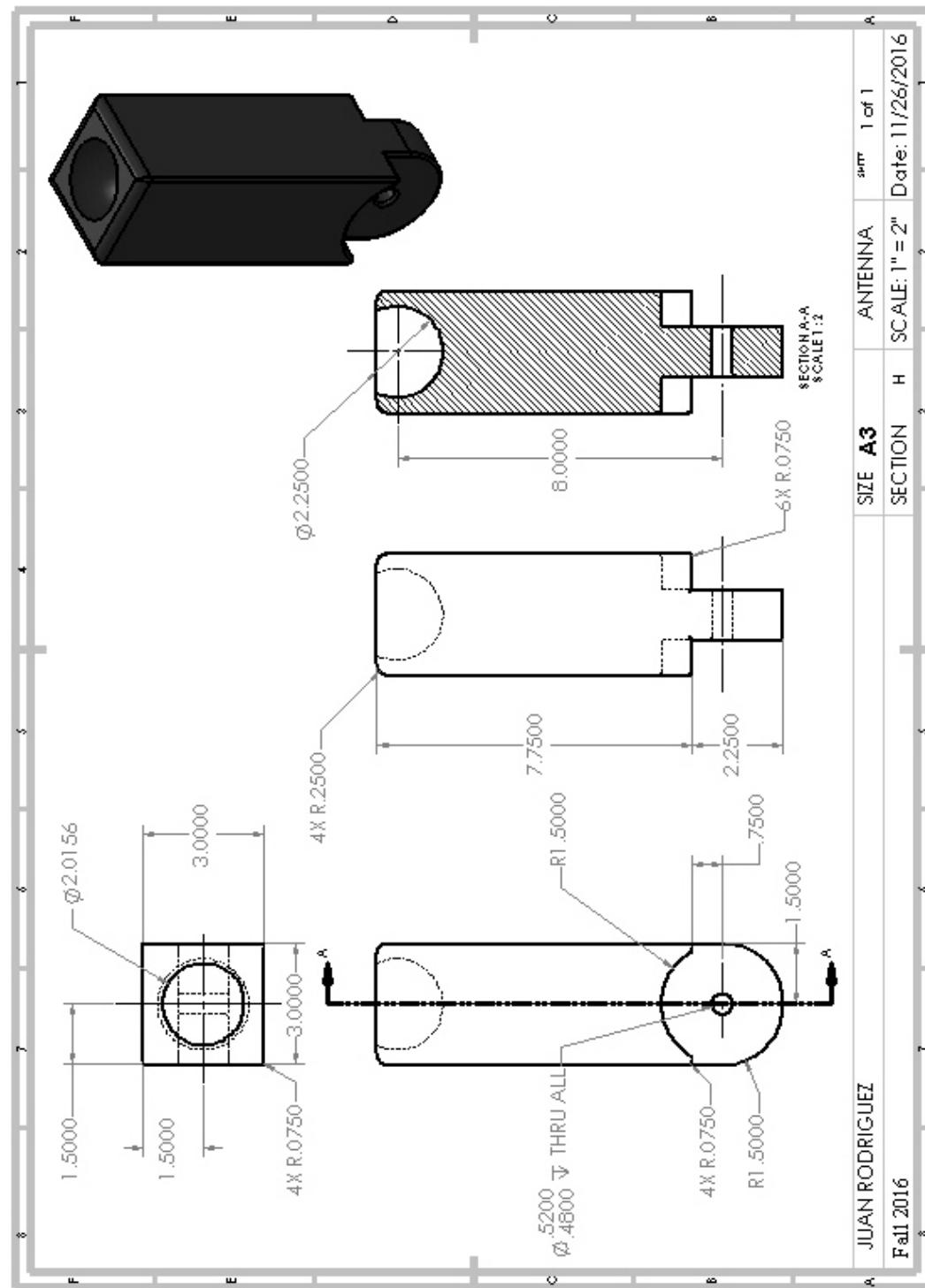


FIGURE 4.13: Antenna Support

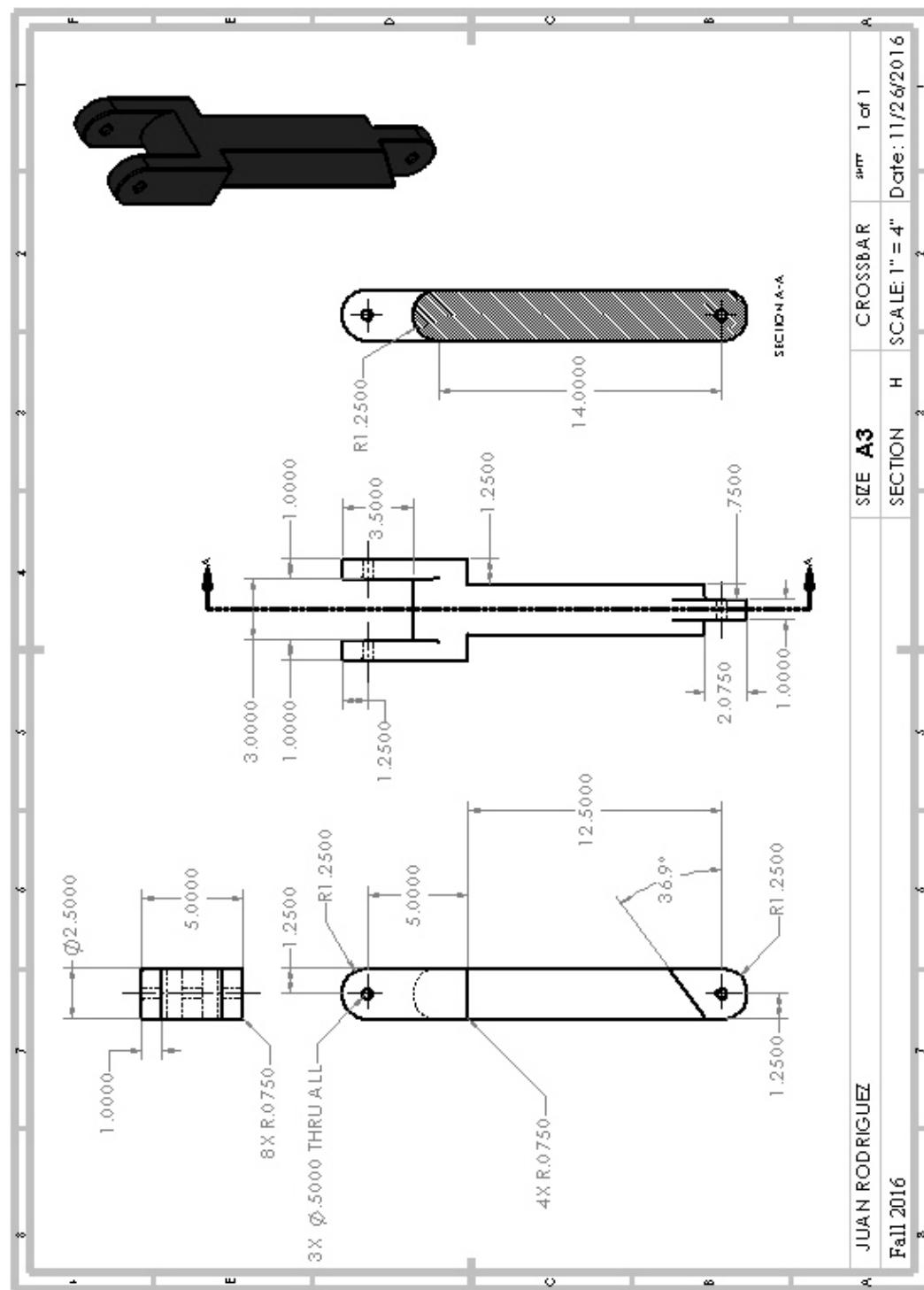


FIGURE 4.14: Crossbar

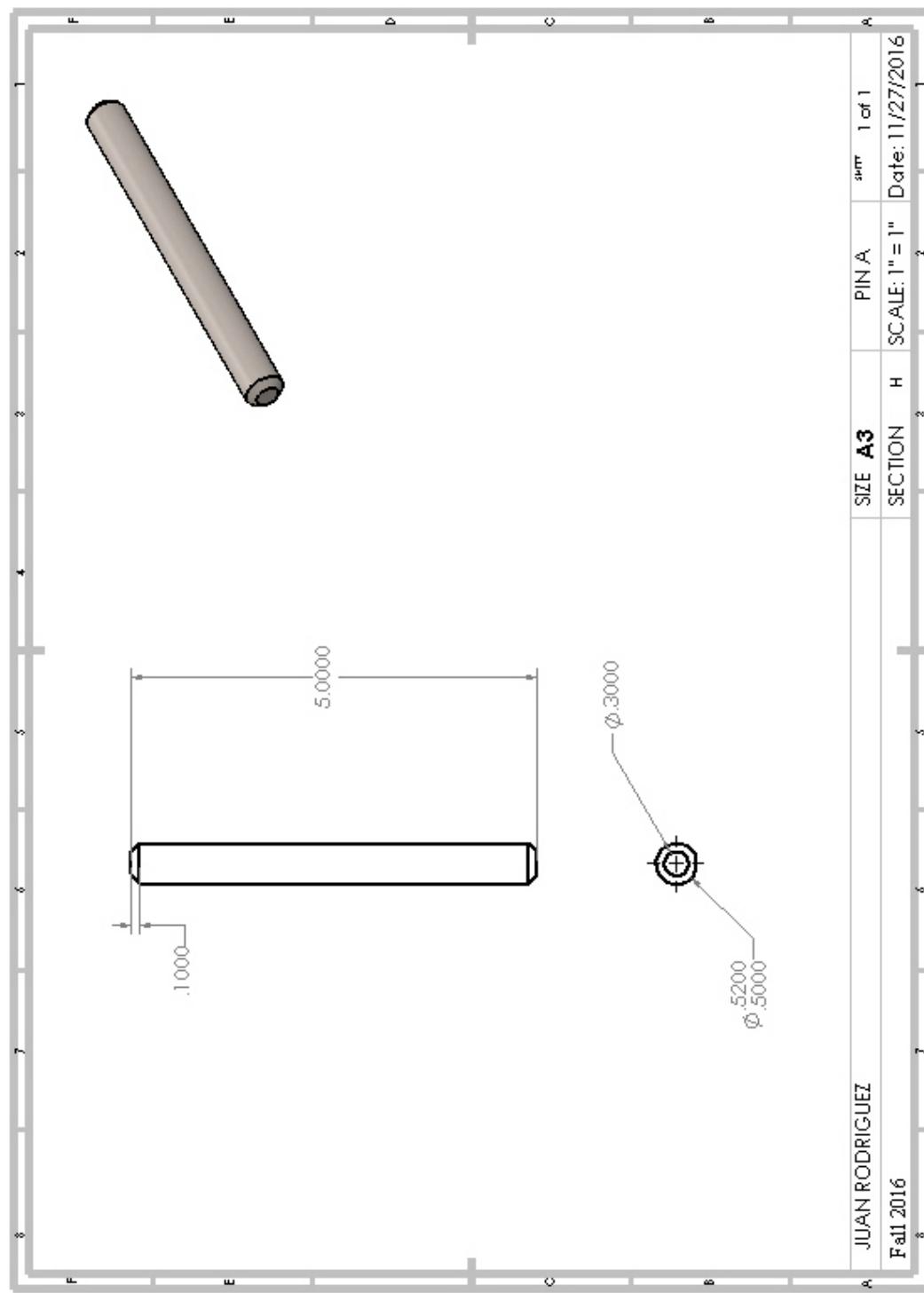


FIGURE 4.15: Pin A

### 4.1.6 Chassis

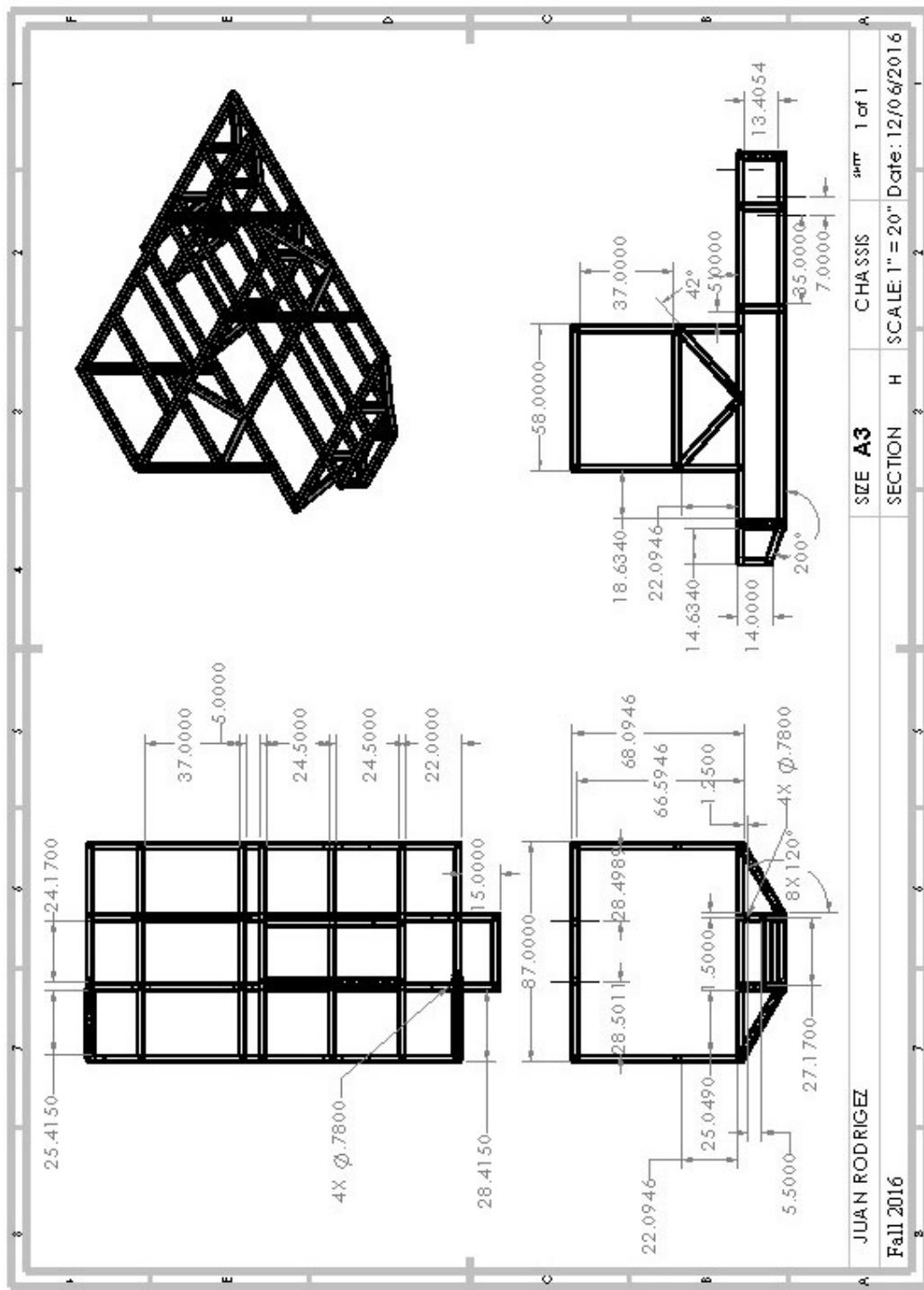


FIGURE 4.16: Rodriguez, Juan: Chassis

#### 4.1.7 Cabinet Drawer

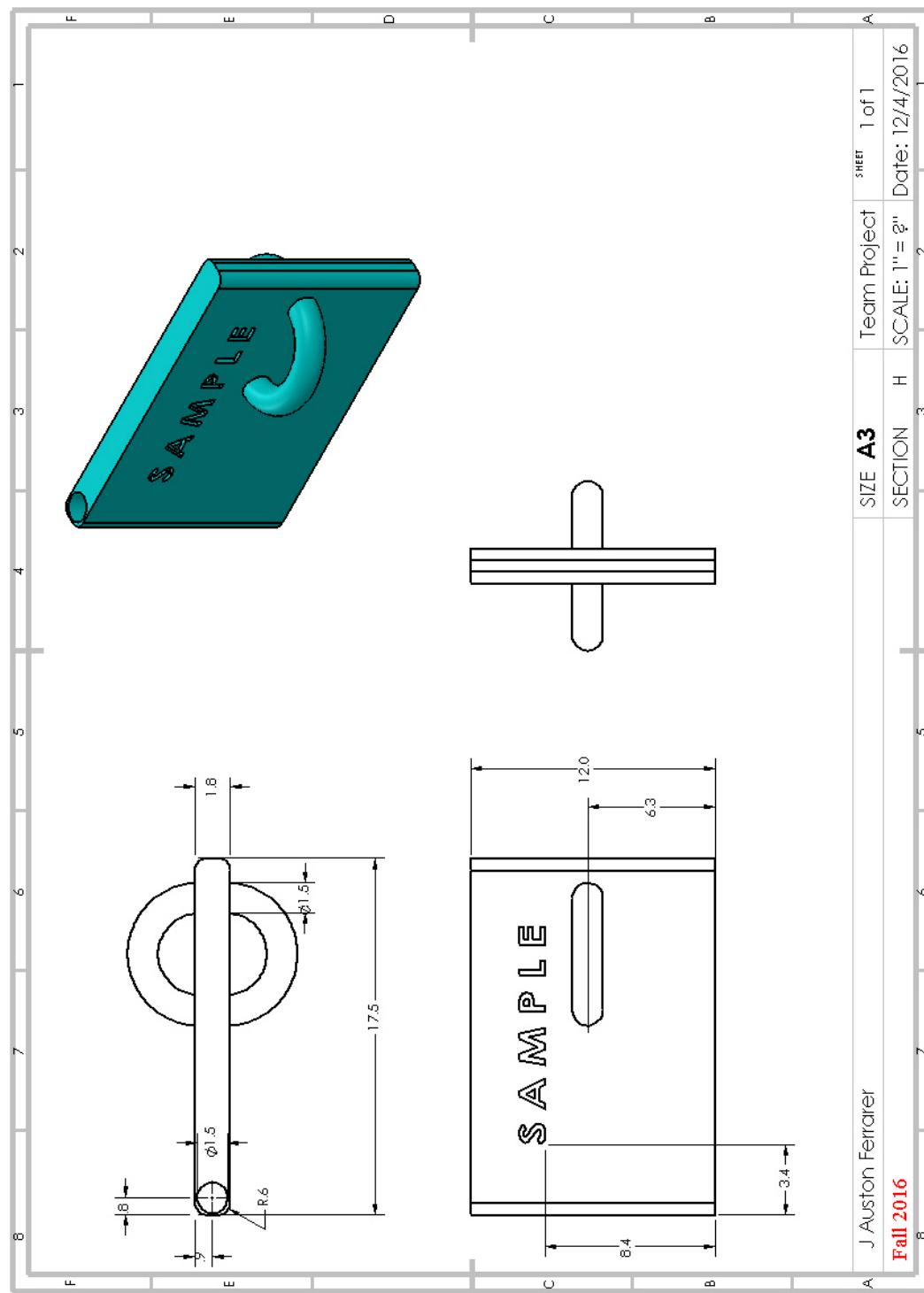


FIGURE 4.17: Rodriguez, Juan: Cabinet Drawer

#### 4.1.8 Door and Hinge

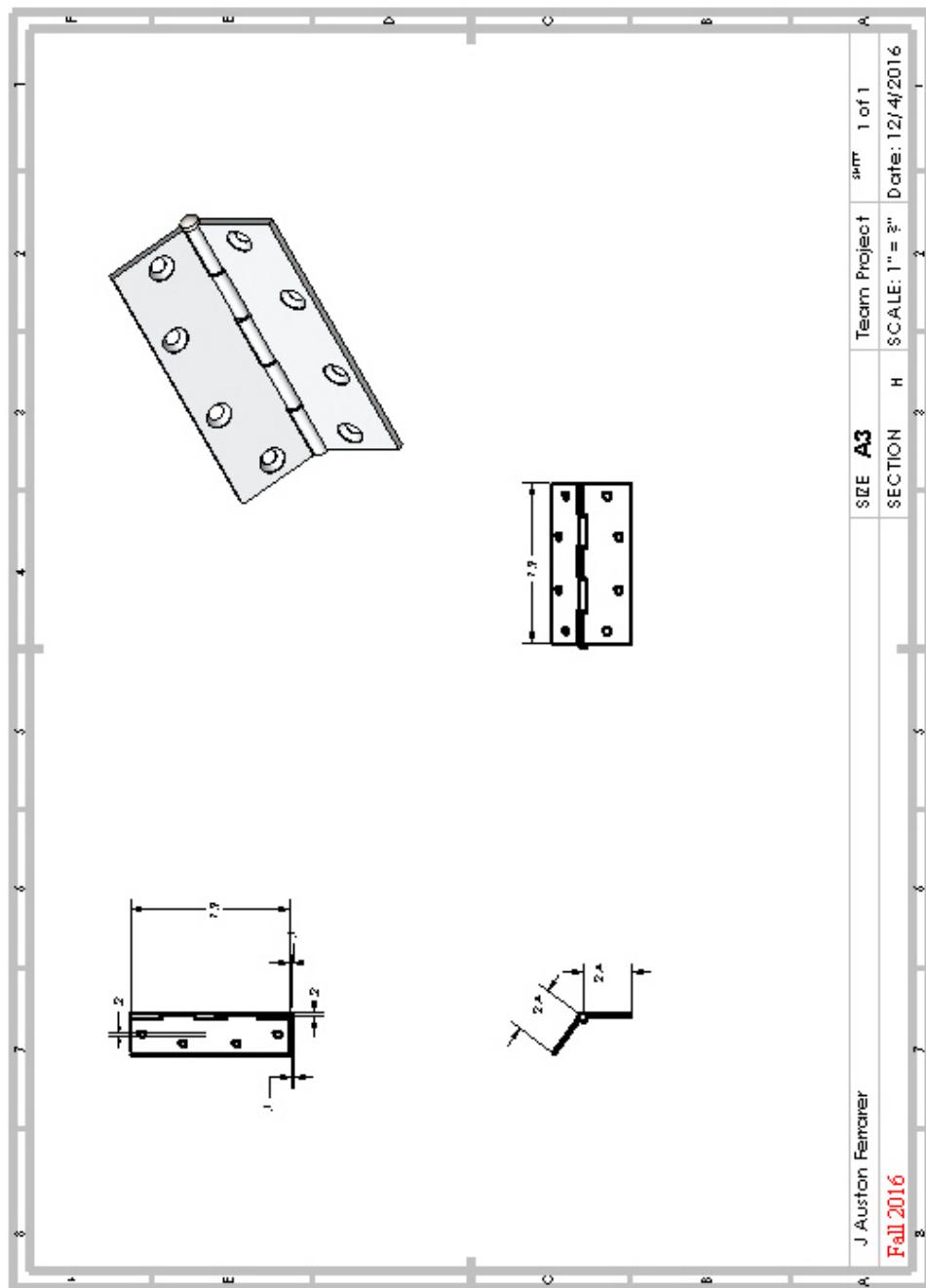


FIGURE 4.18: Ferrarer, Auston: Complete Hinge

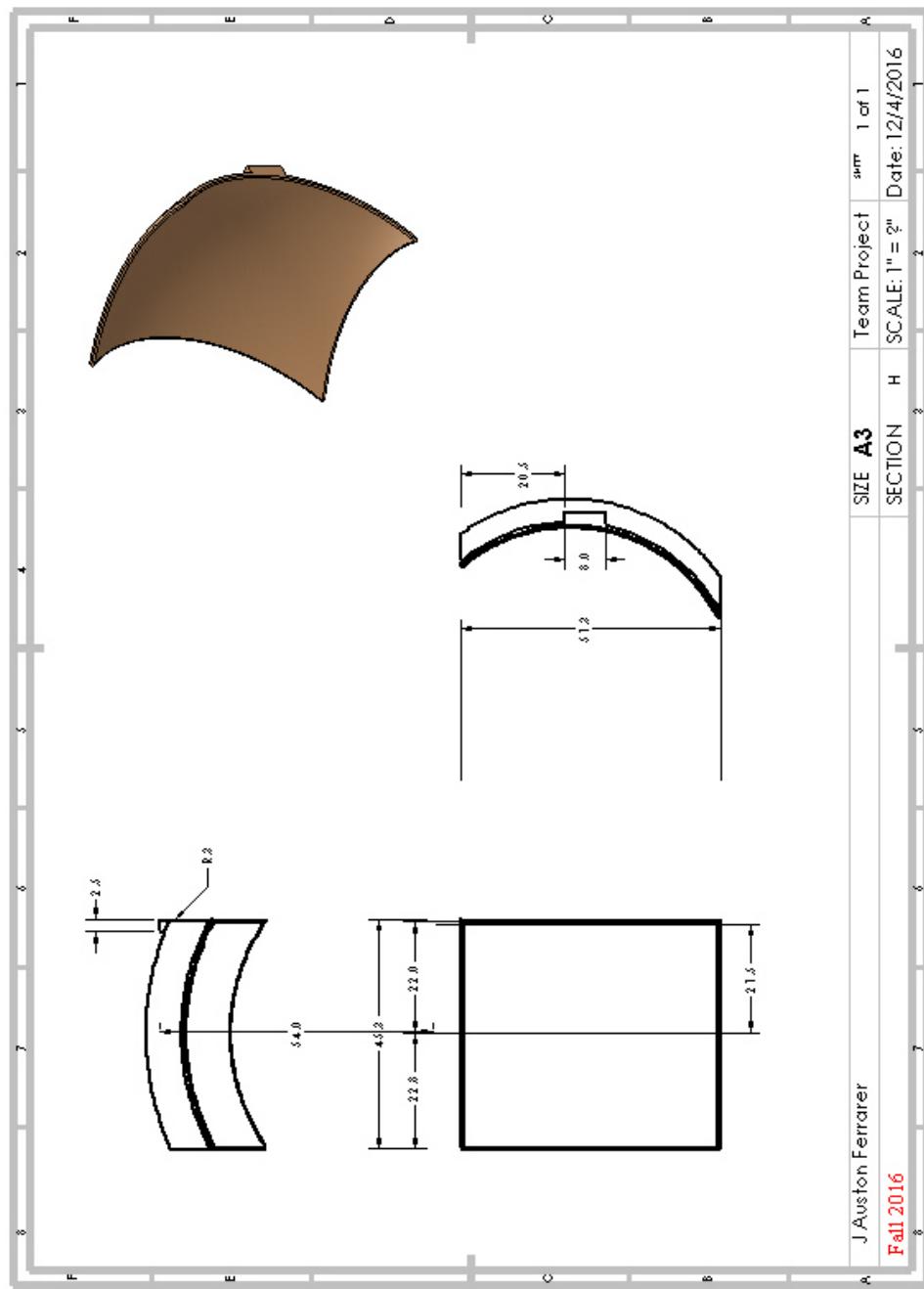


FIGURE 4.19: Ferrarer, Auston: Exterior Door

## 4.1.9 Exterior Shell

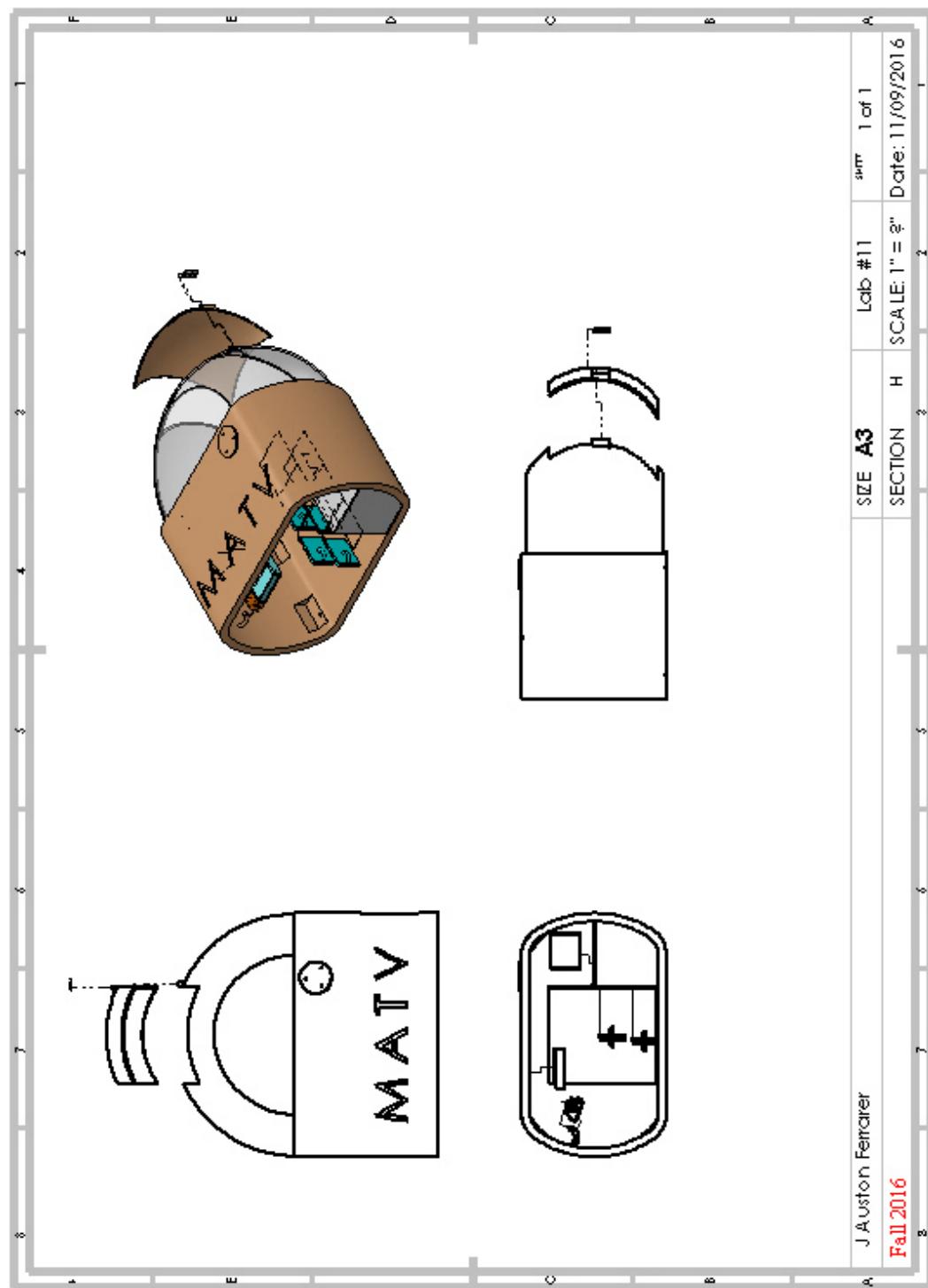


FIGURE 4.20: Ferrarer, Auston: Assembly

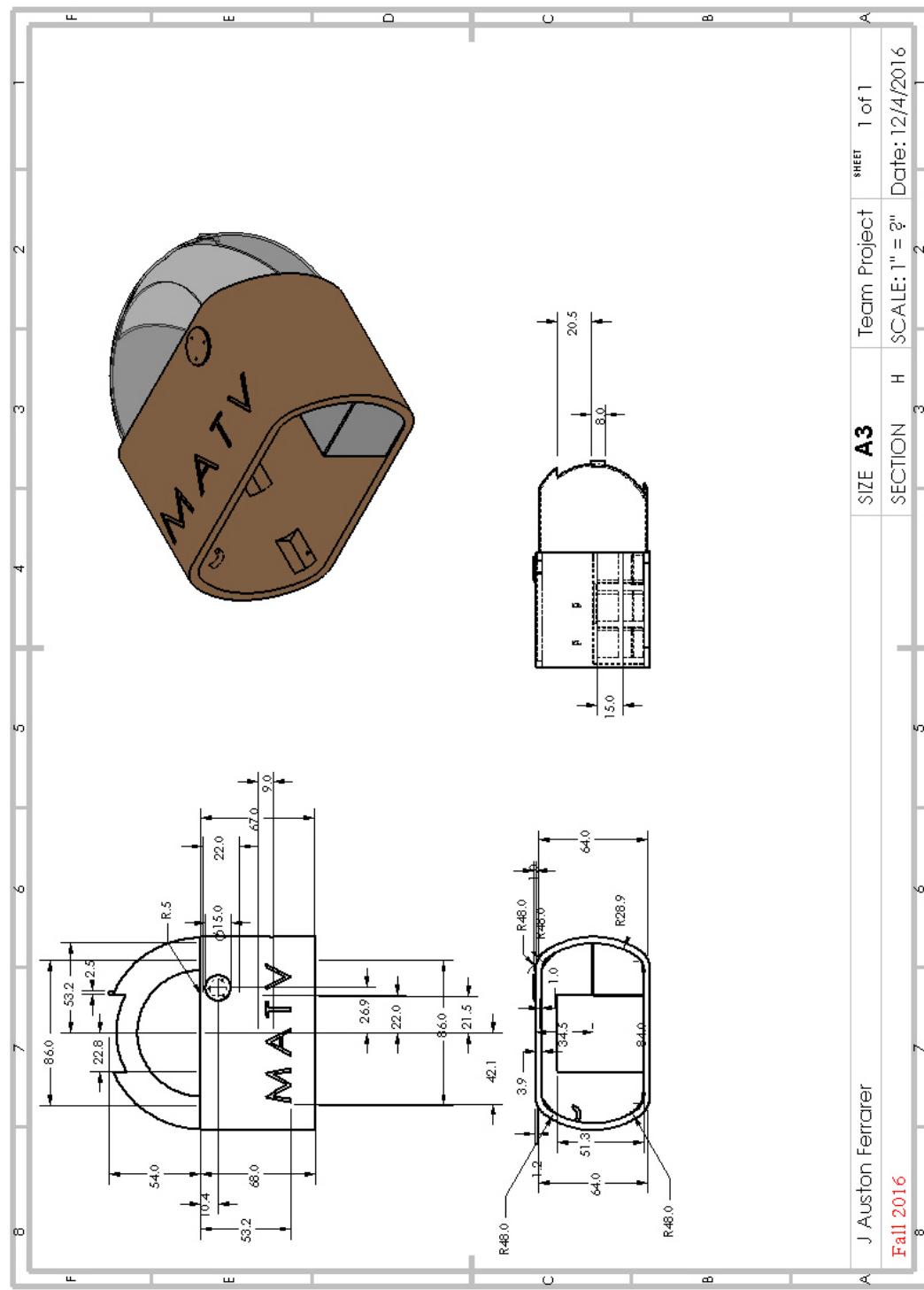


FIGURE 4.21: Ferrarer, Auston: Full Shell

#### 4.1.10 Helmet

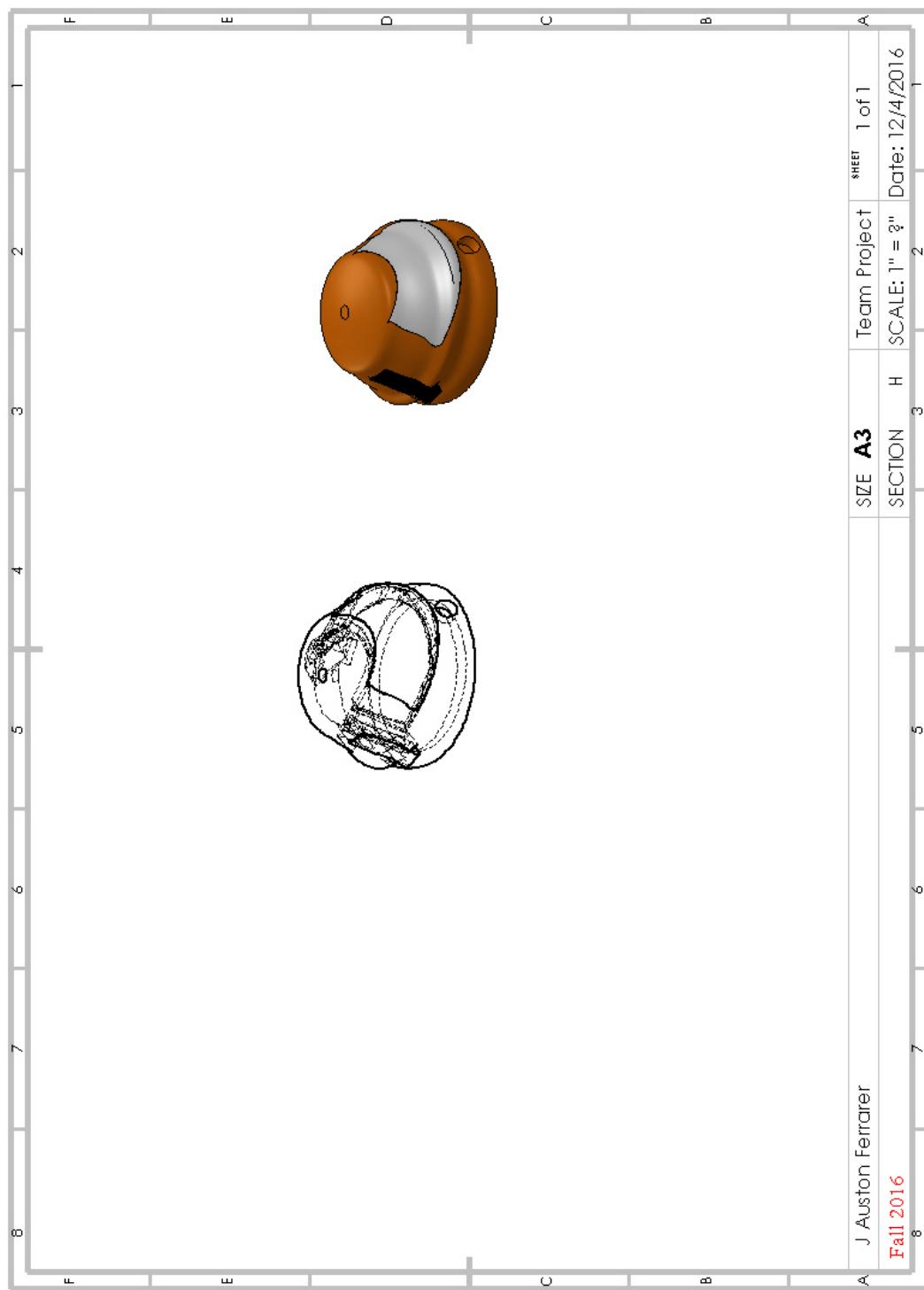


FIGURE 4.22: Ferrarer, Auston: Helmet Full Assembly

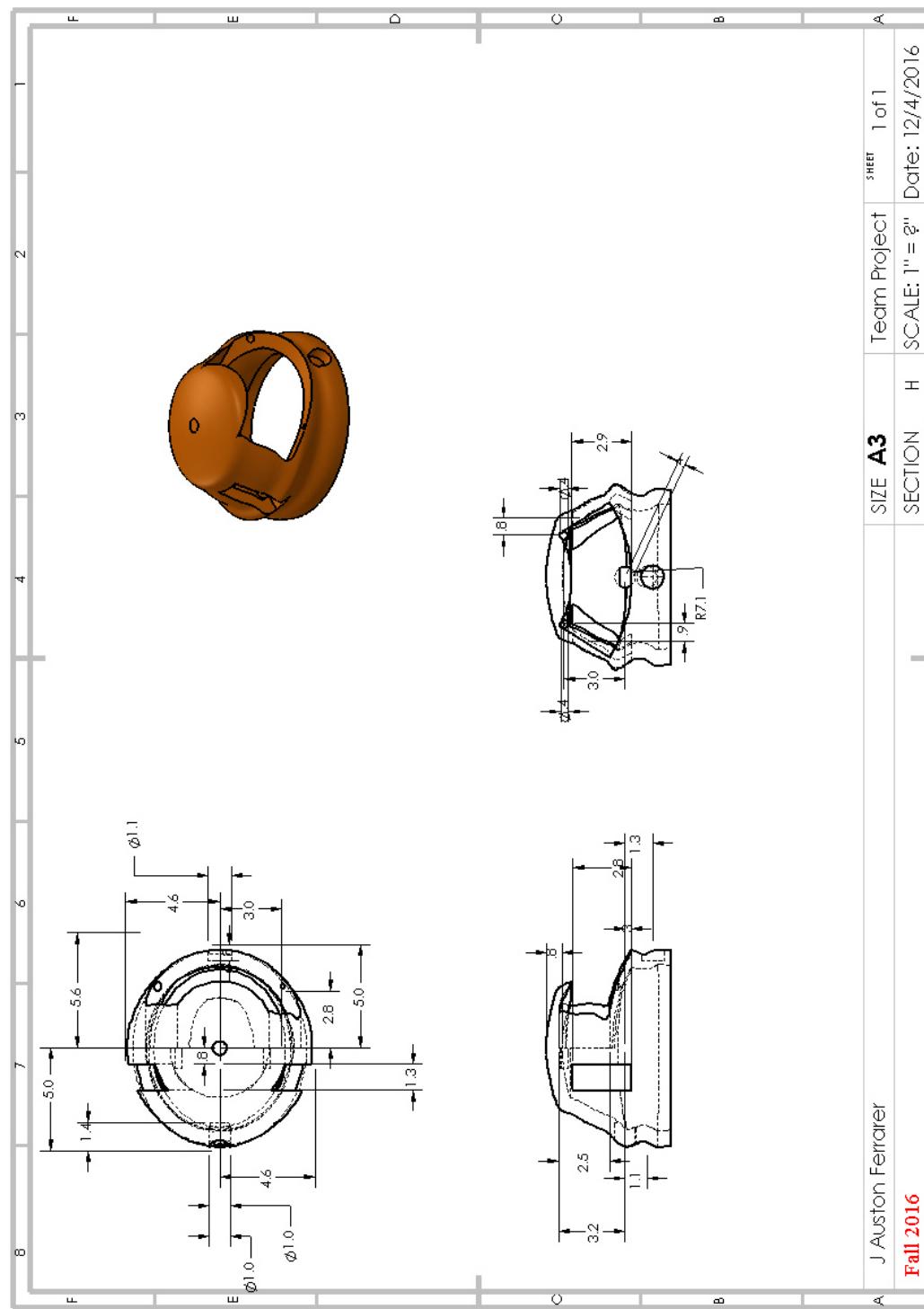


FIGURE 4.23: Ferrarer, Auston: Helmet Shell

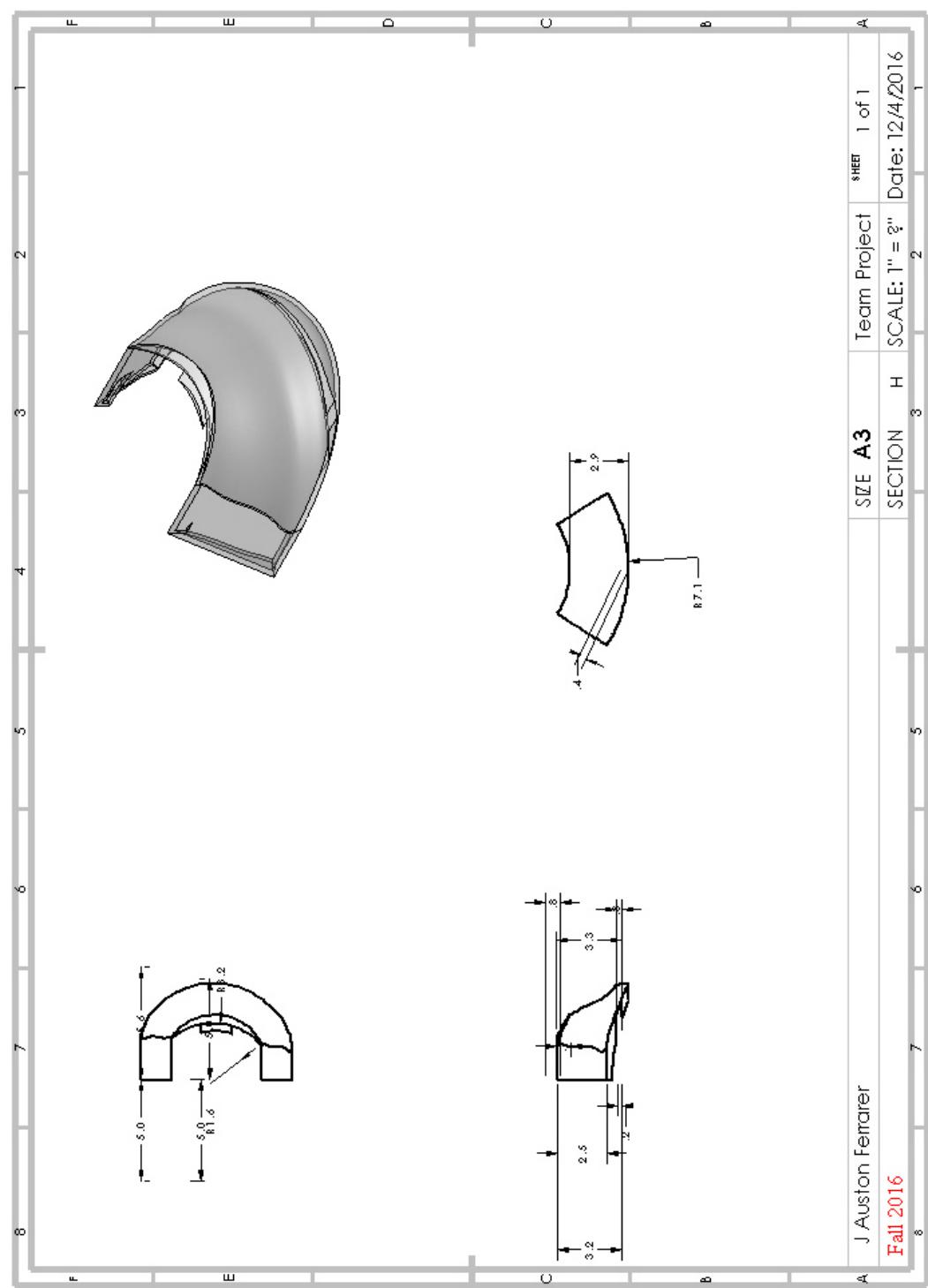


FIGURE 4.24: Ferrarer, Auston: Helmet Visor

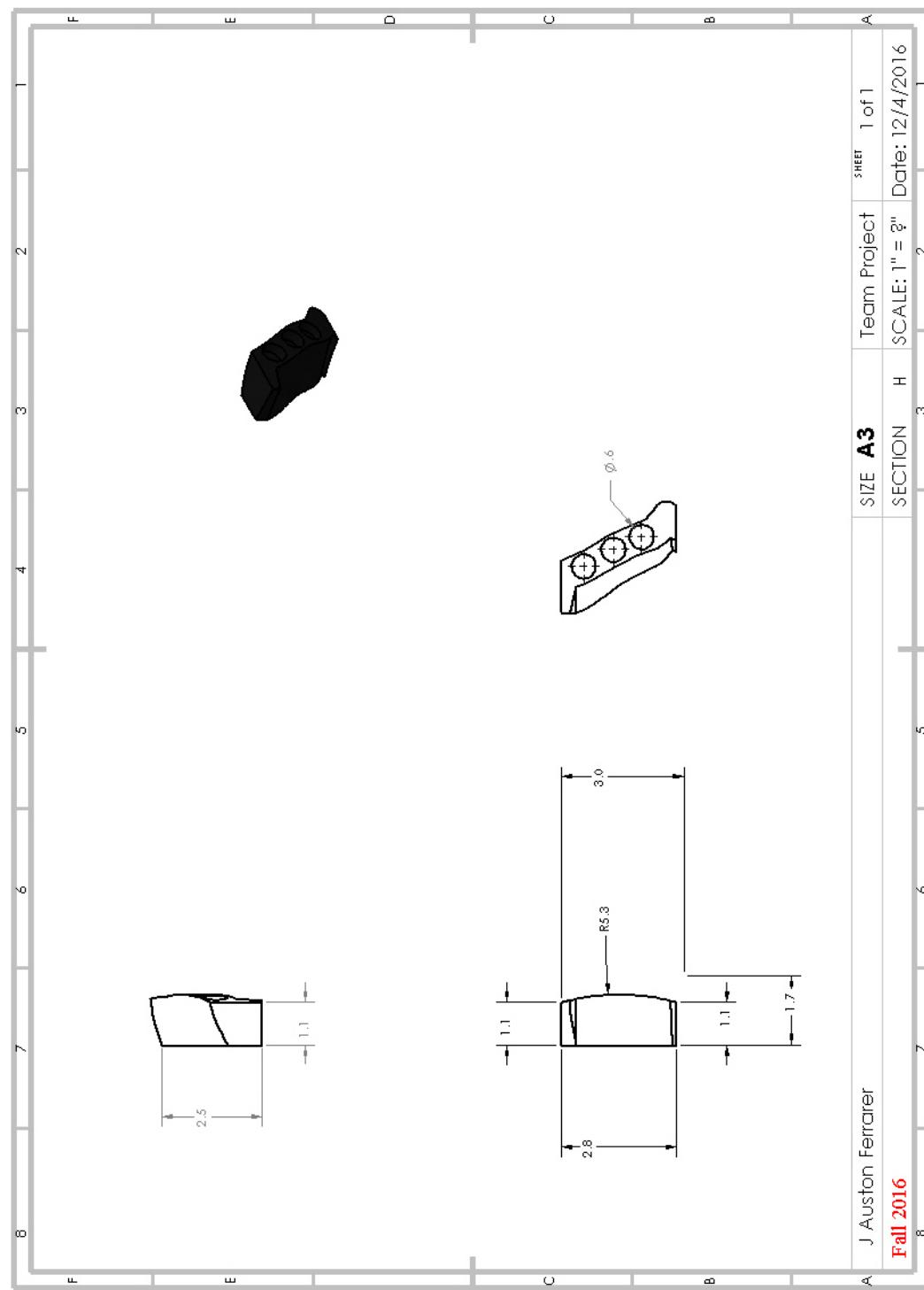


FIGURE 4.25: Ferrarer, Auston: Side Lights

### 4.1.11 Grabber

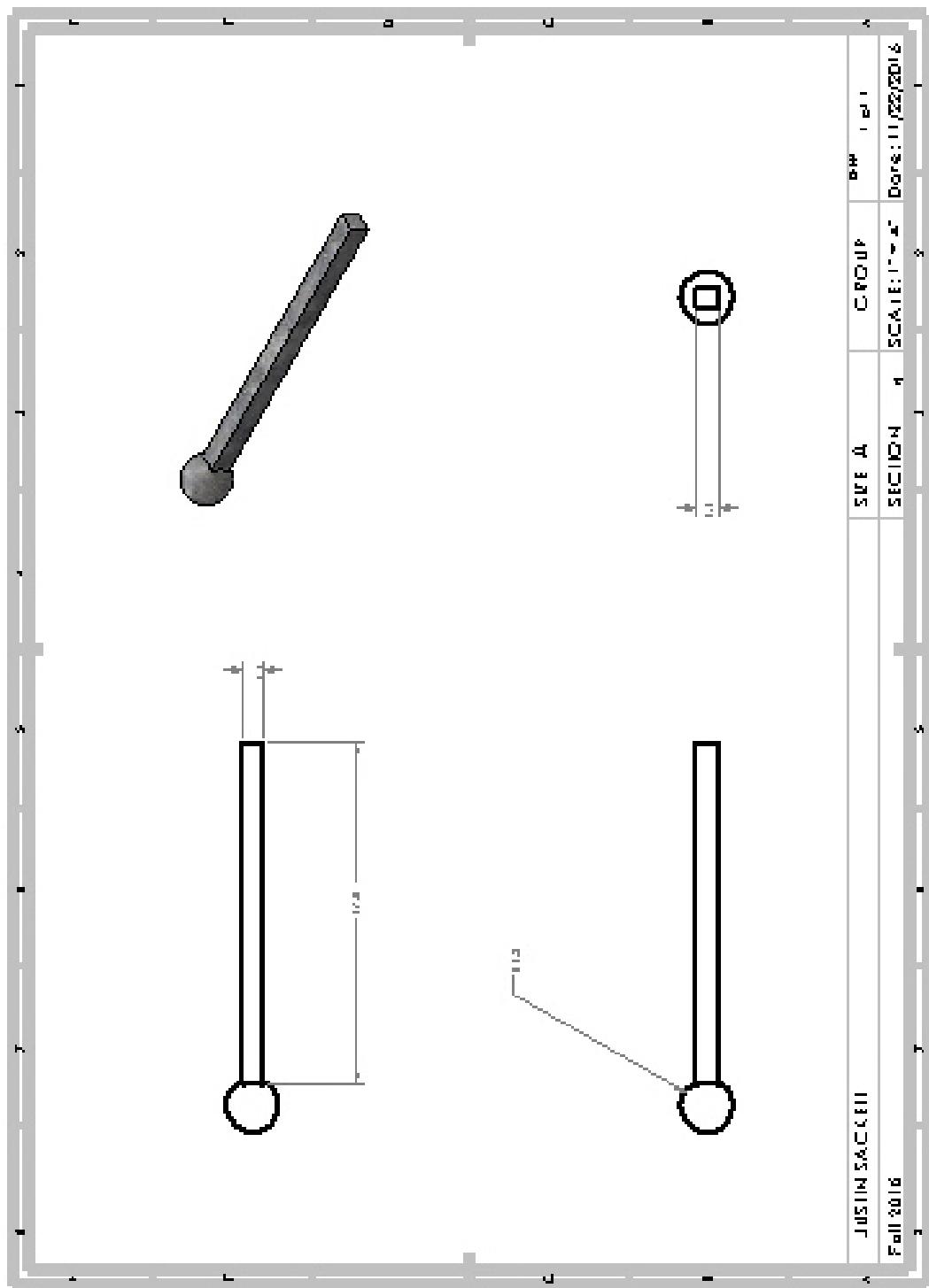


FIGURE 4.26: Sackett, Justin: Ball Rod

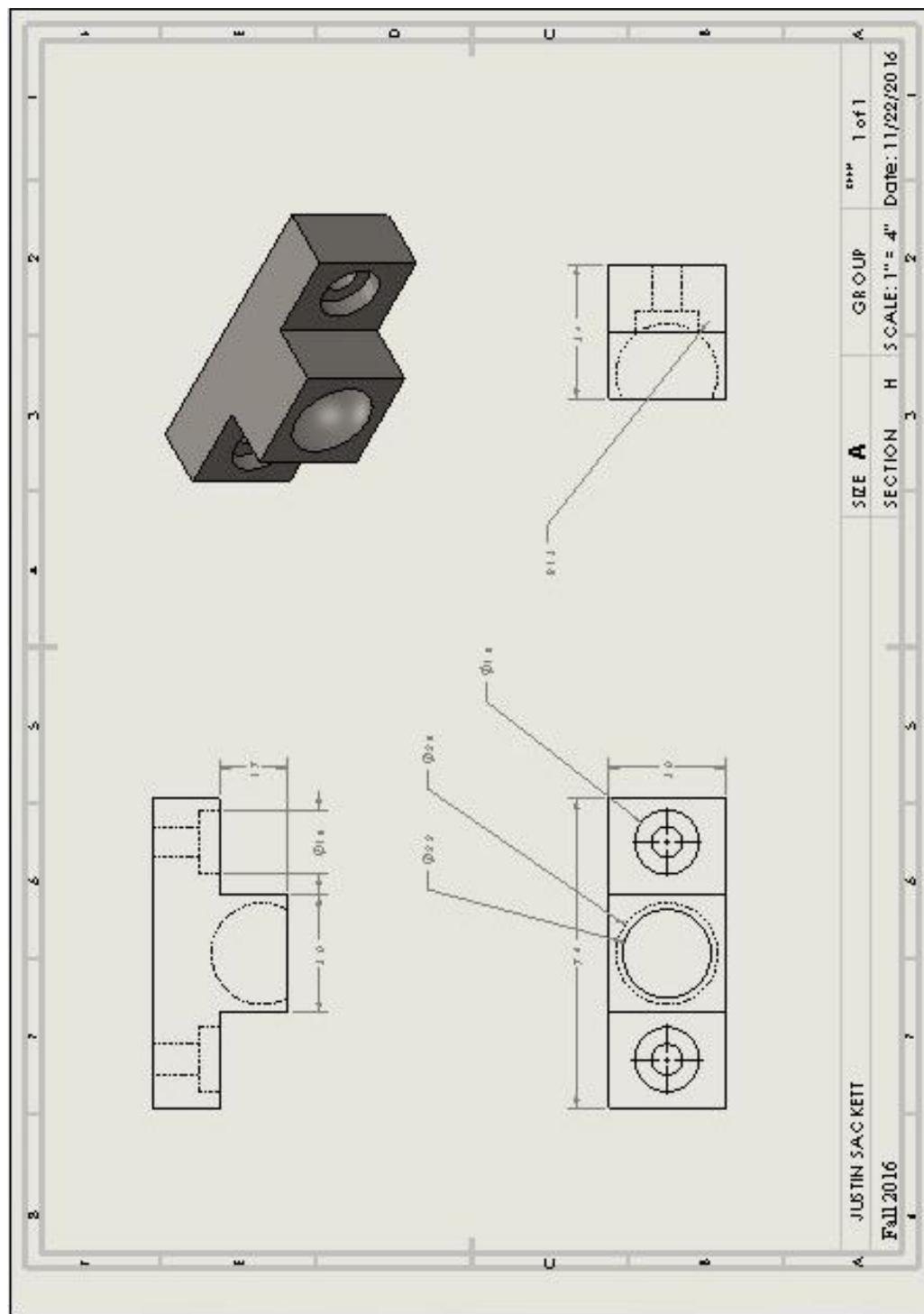


FIGURE 4.27: Sackett, Justin: Ball Socket

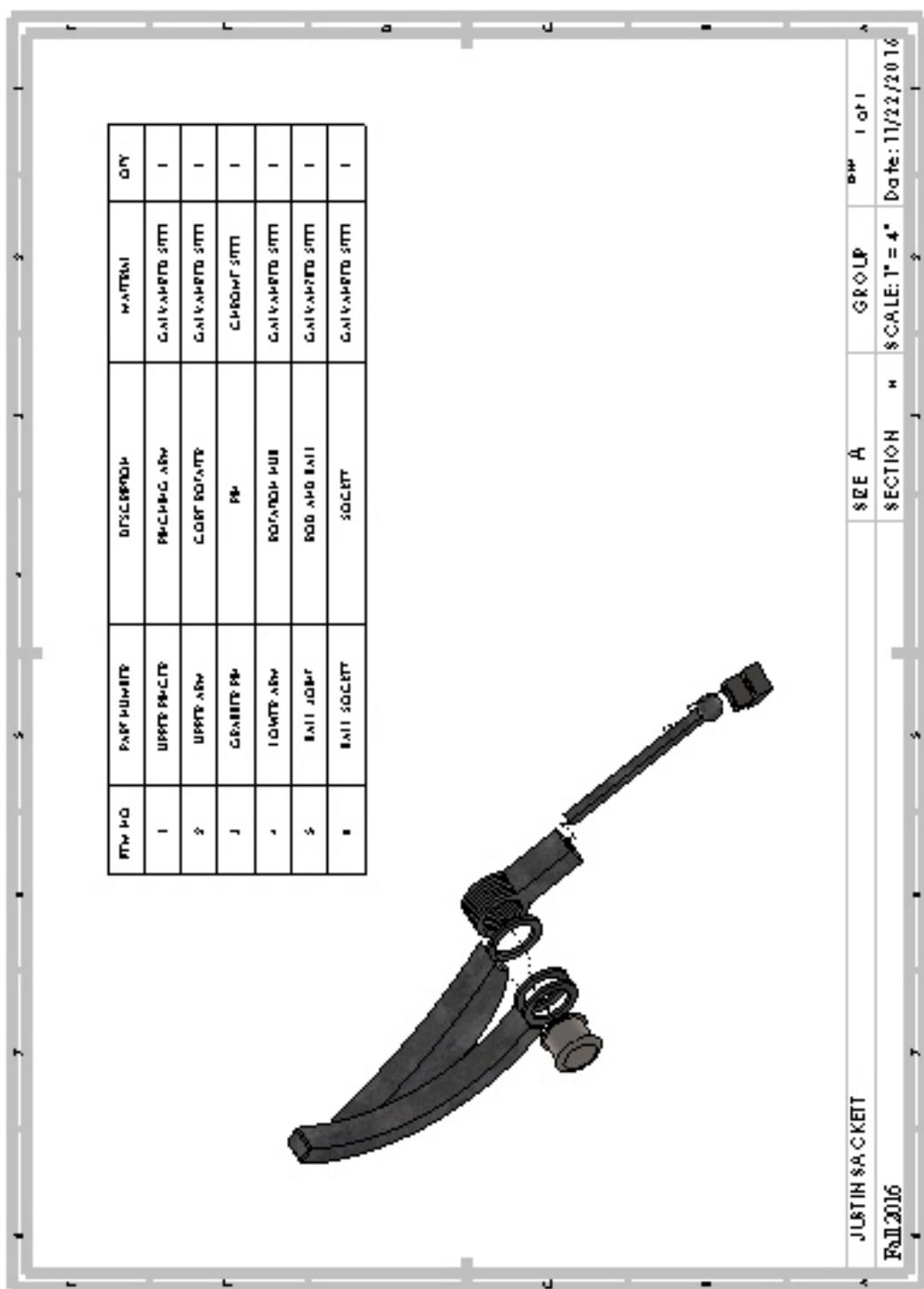


FIGURE 4.28: Sackett, Justin: Grabber Exploded

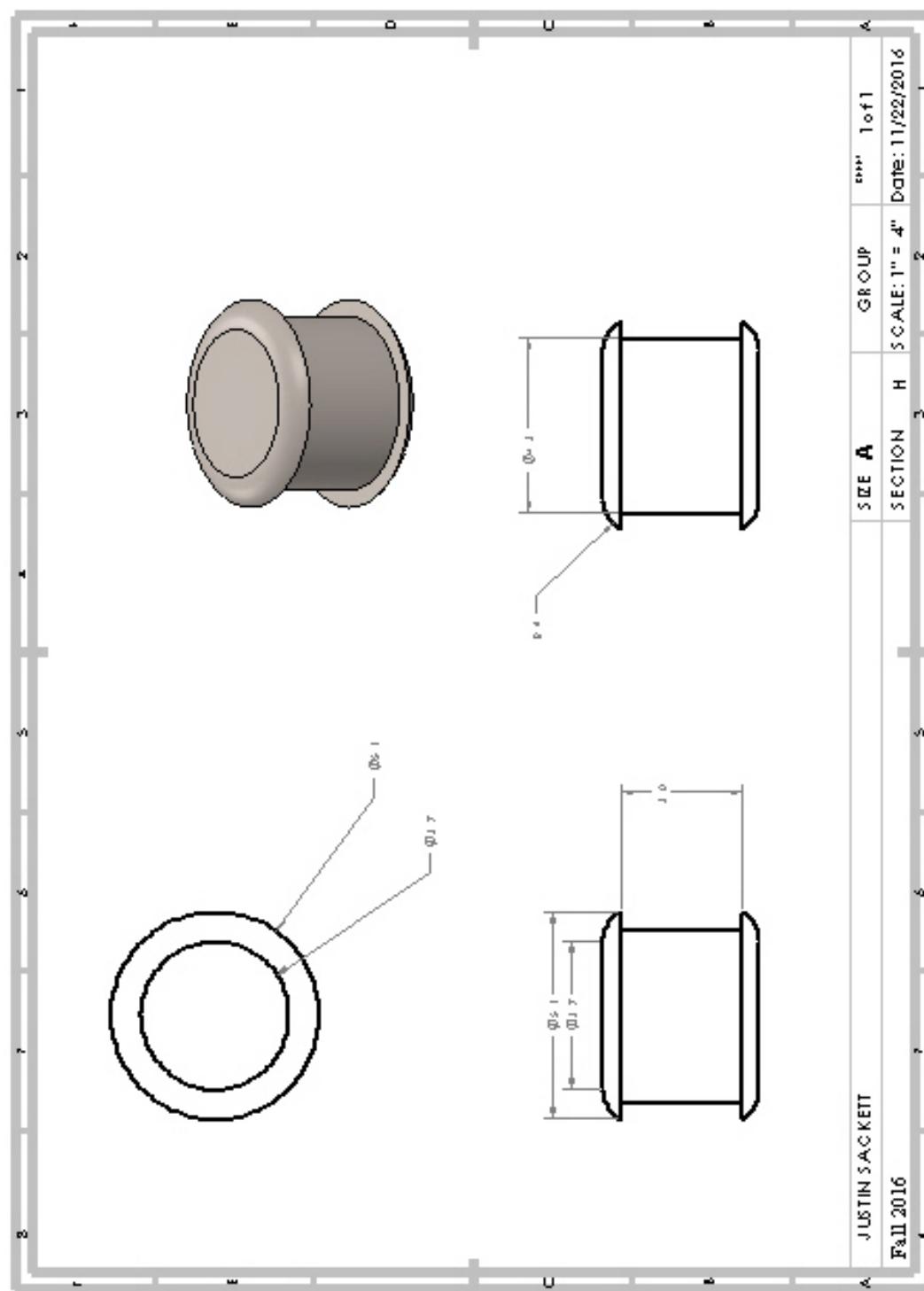
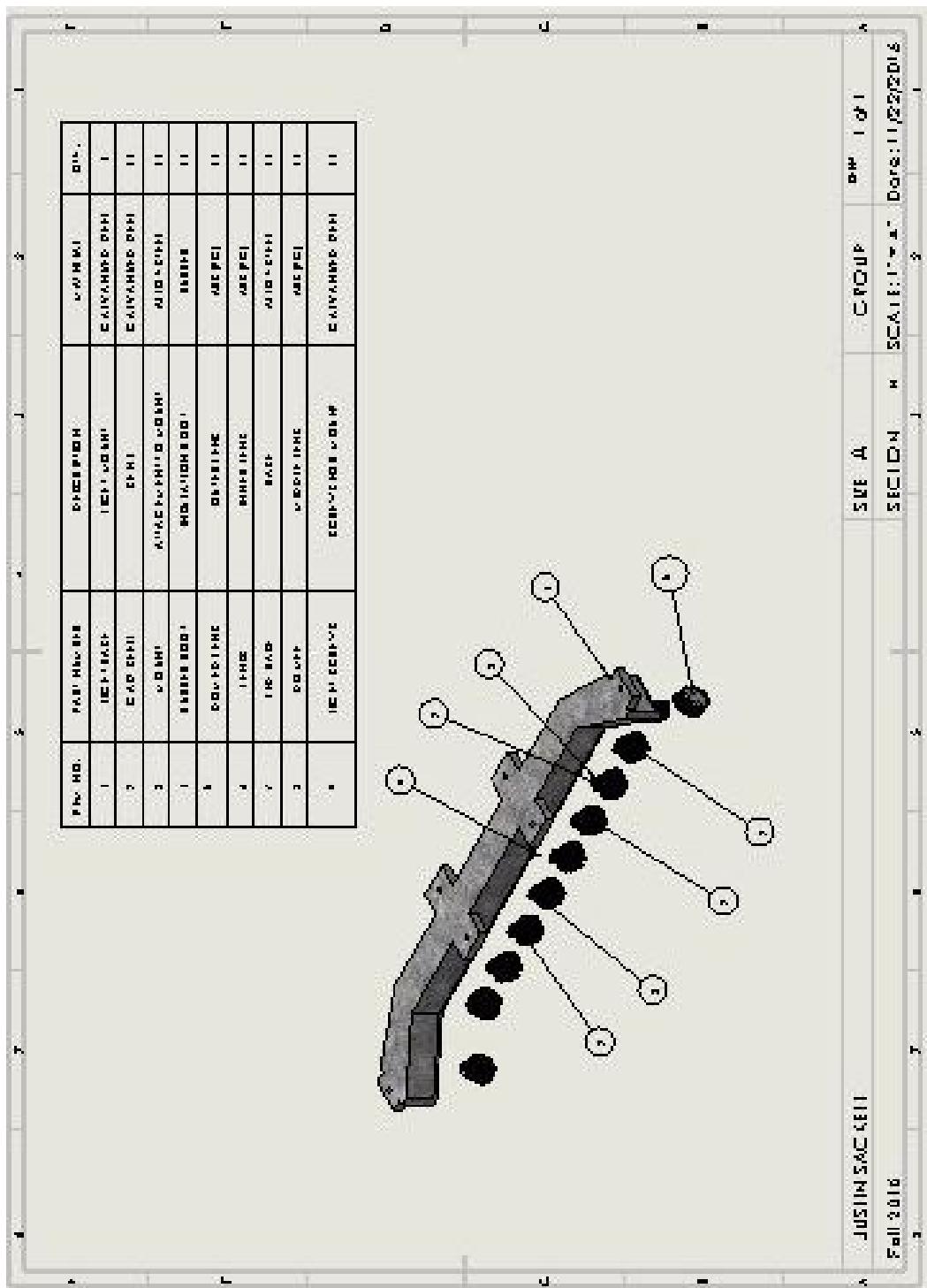


FIGURE 4.29: Sackett, Justin: Grabber Pin



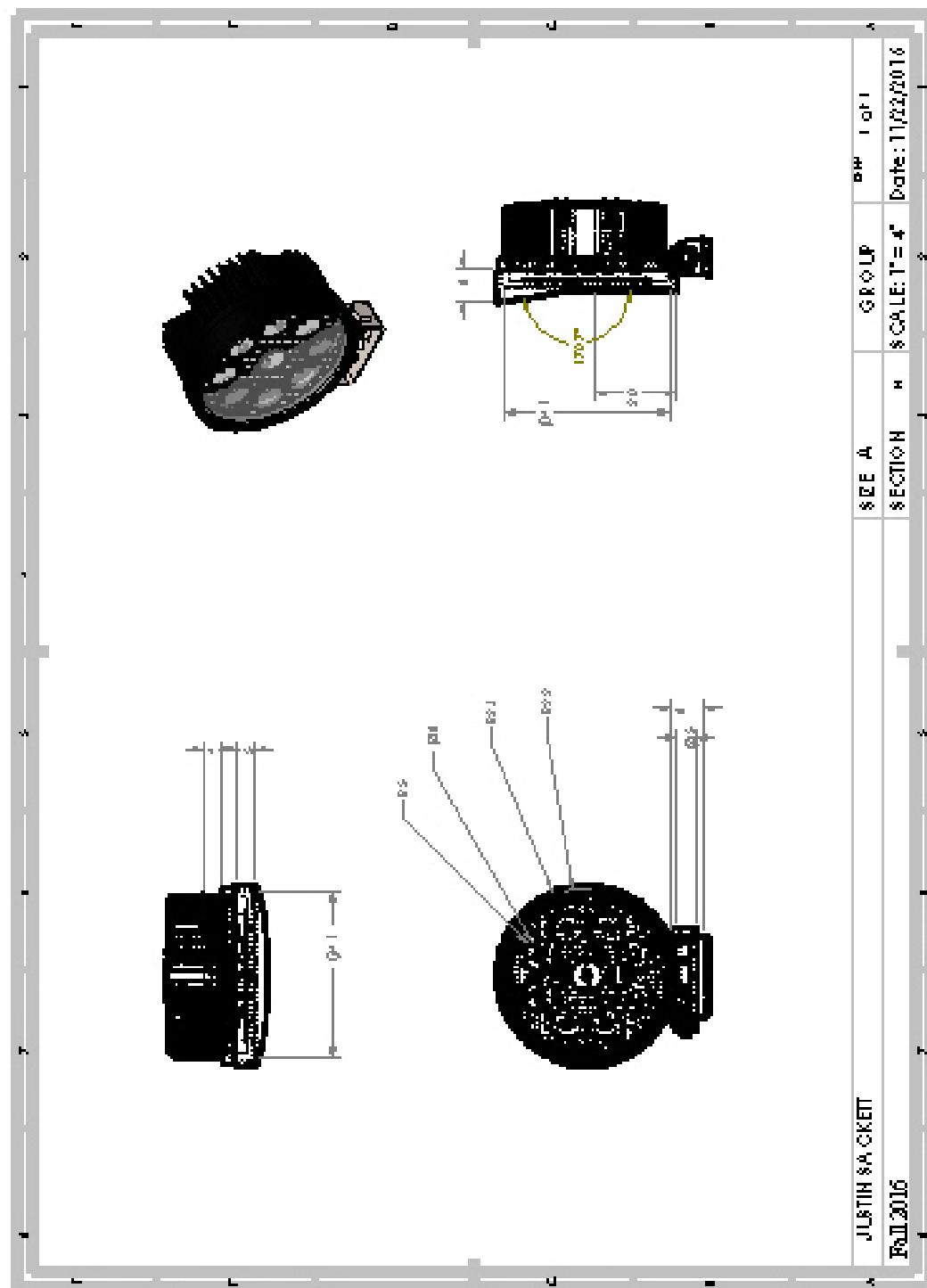


FIGURE 4.31: Sackett, Justin: Light

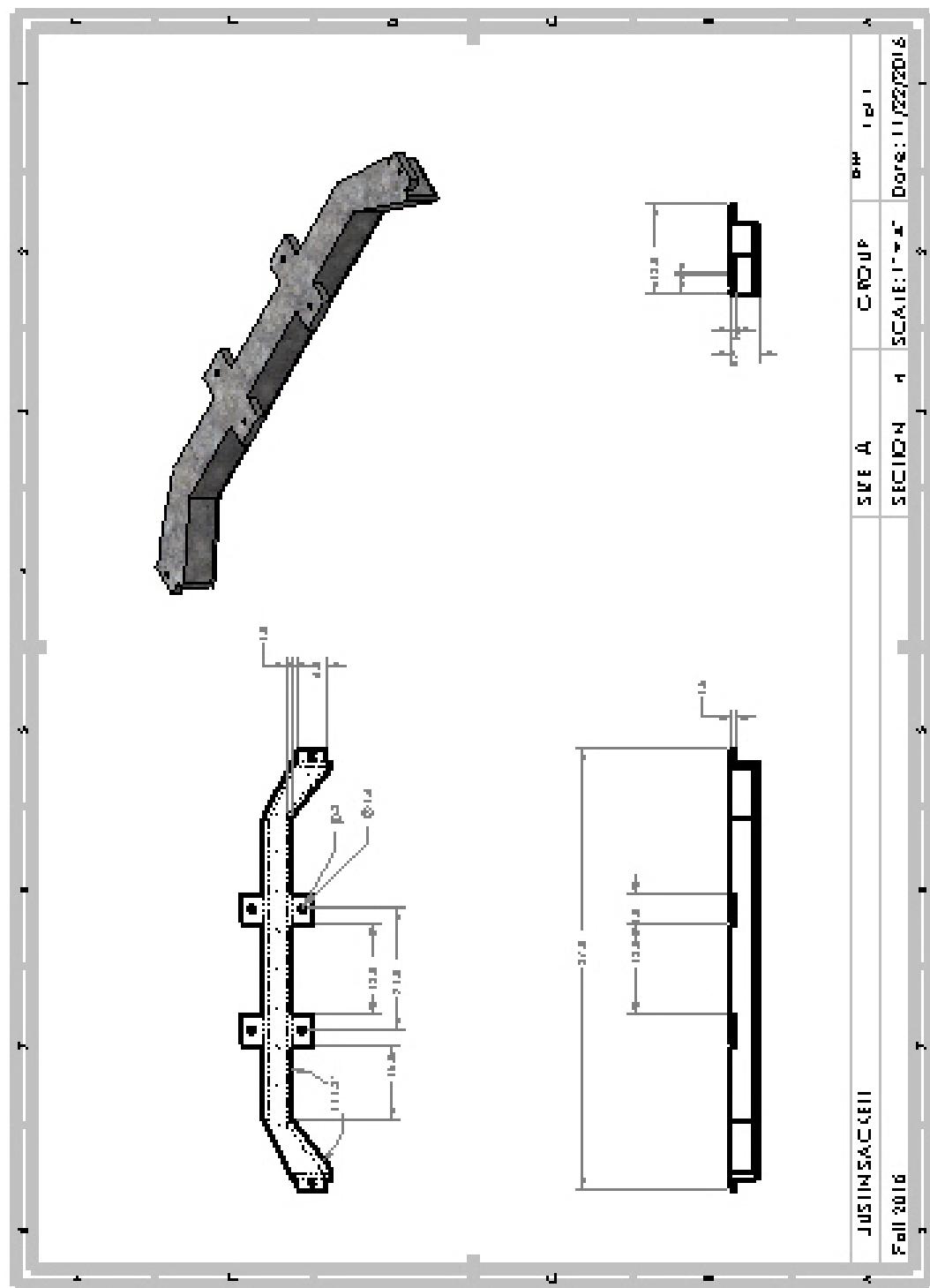


FIGURE 4.32: Sackett, Justin: Light Base

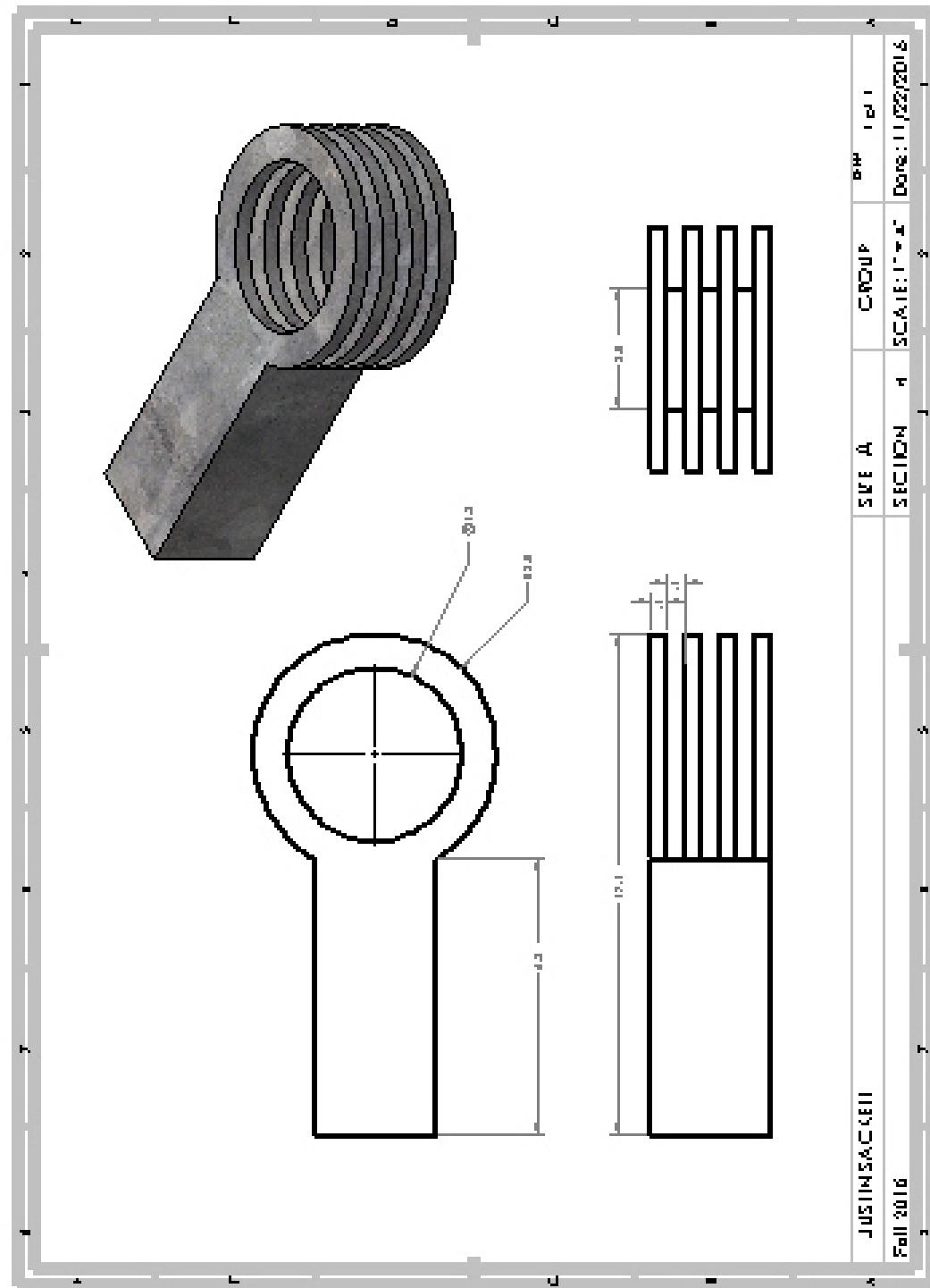


FIGURE 4.33: Sackett, Justin: Lower Arm

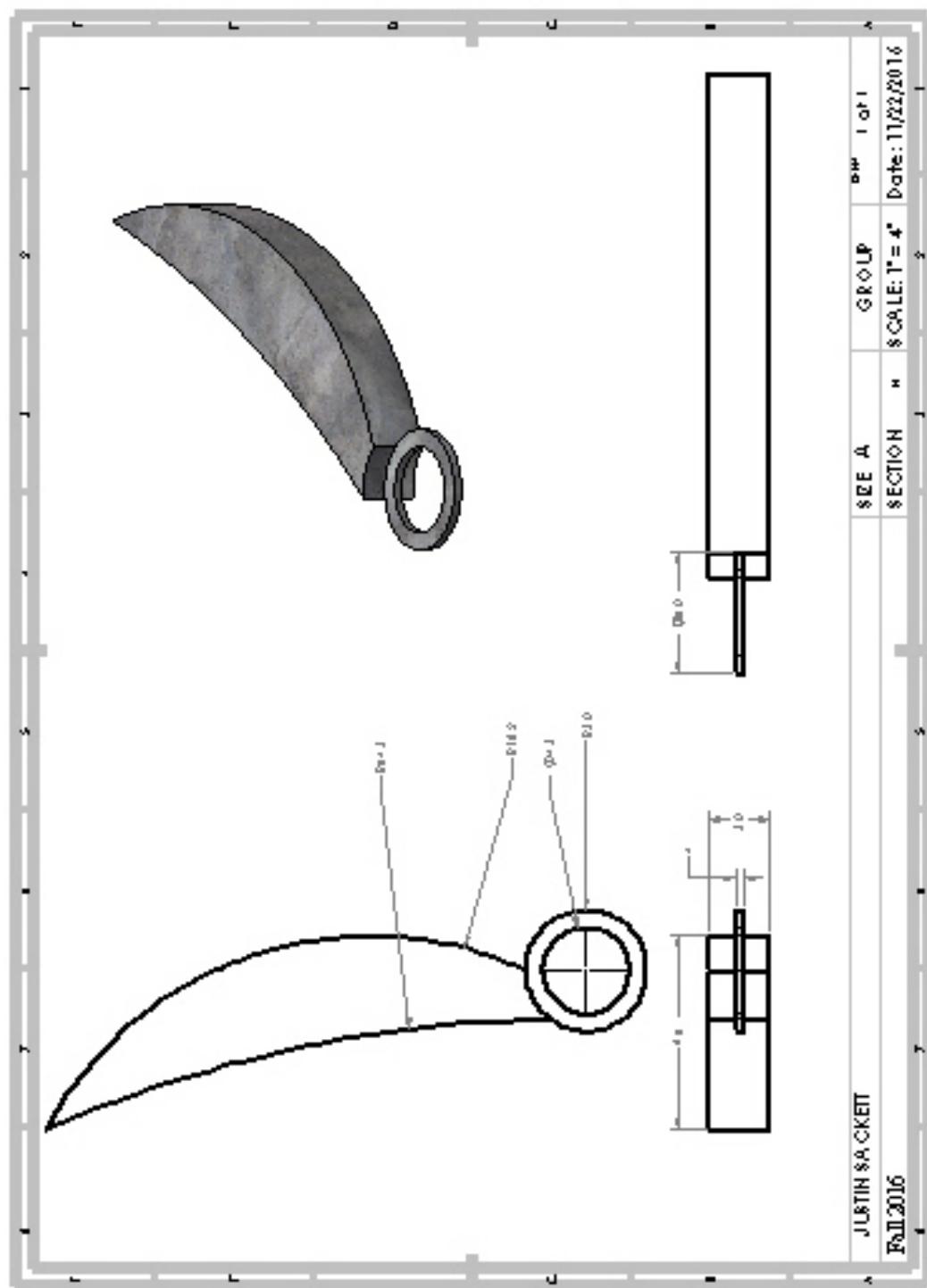


FIGURE 4.34: Sackett, Justin: Upper Pincer

#### 4.1.12 Suspension

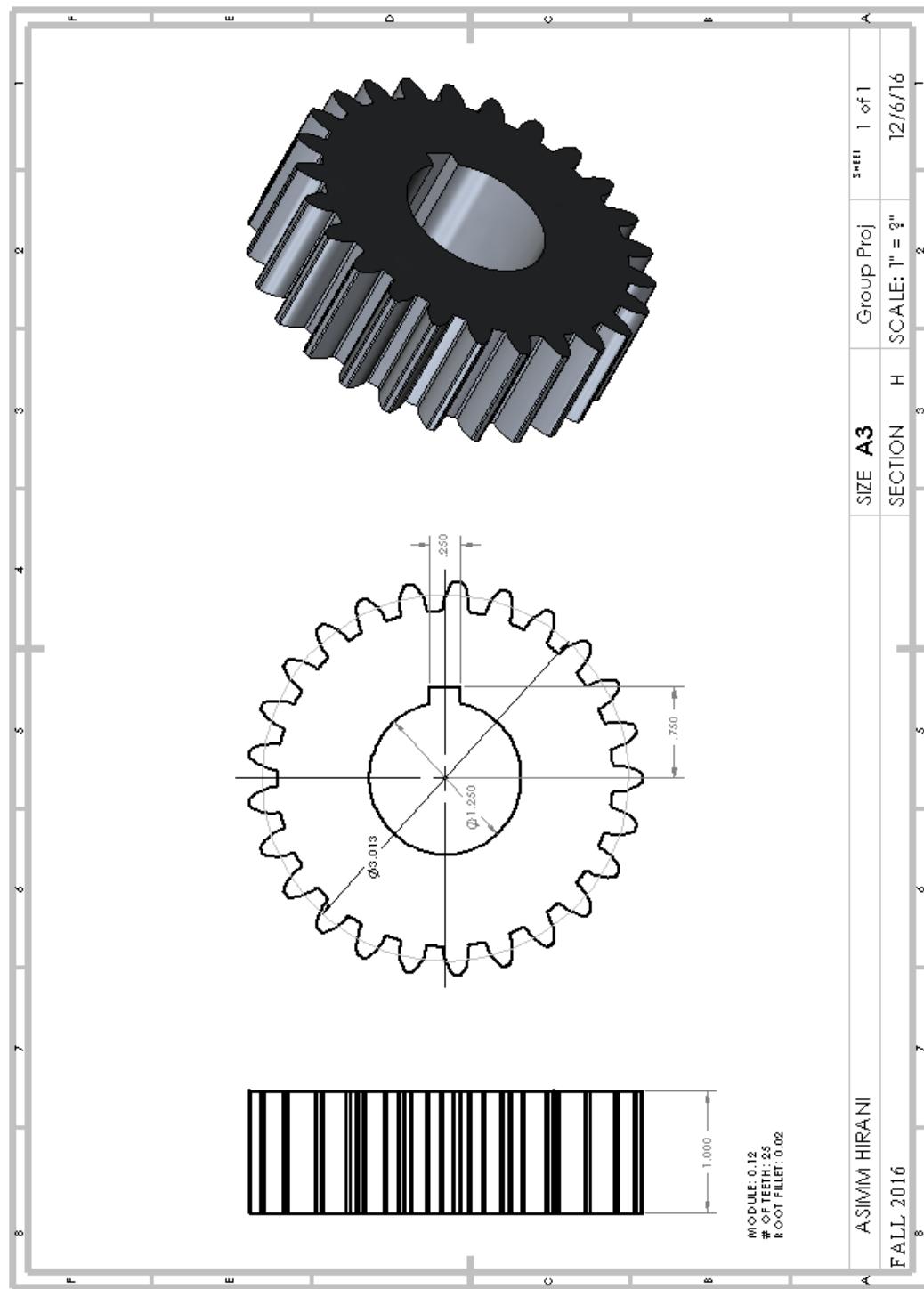


FIGURE 4.35: Hirani, Asimm: 25 Tooth Gear

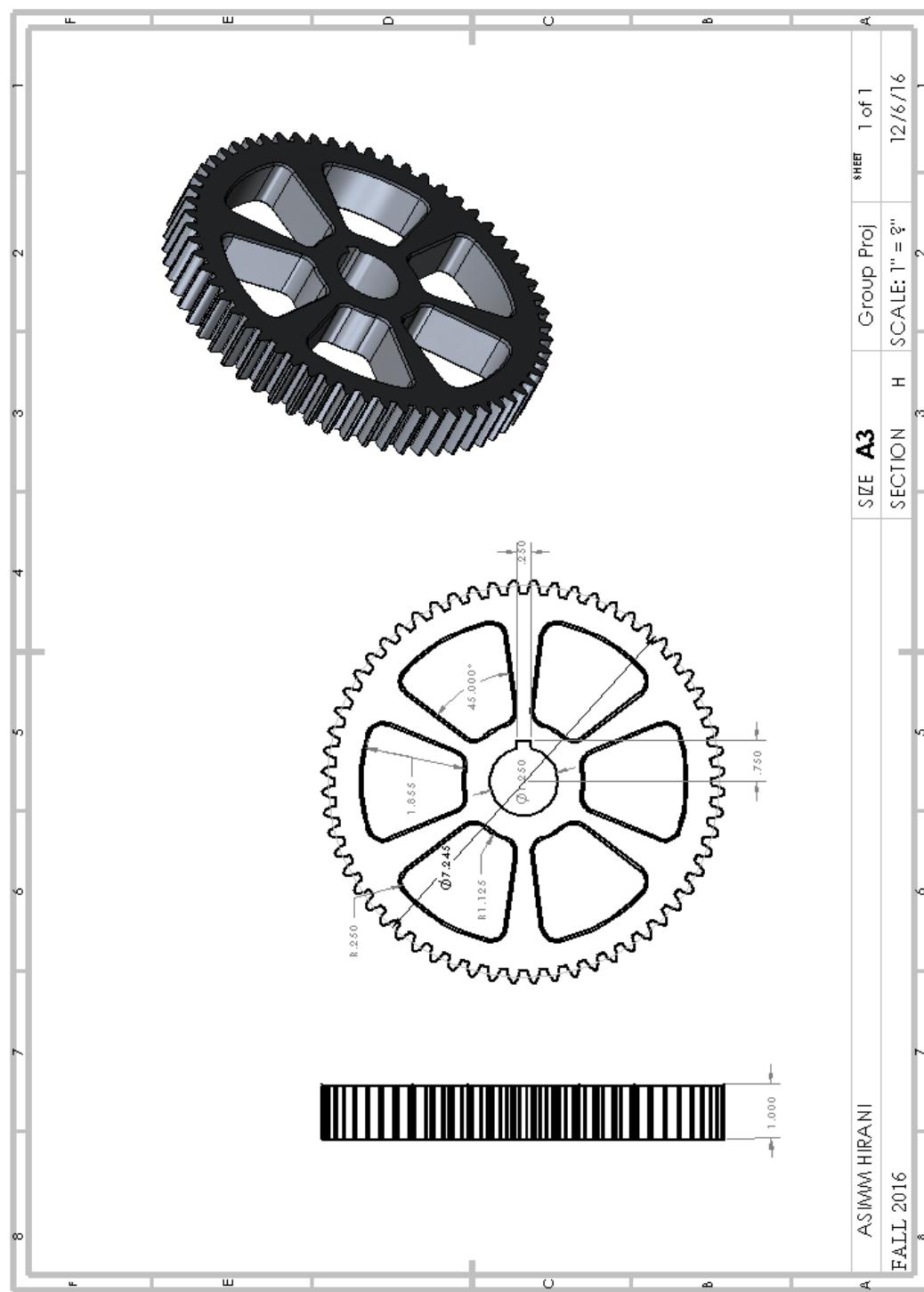


FIGURE 4.36: Hirani, Asimm: 60 Tooth Gear

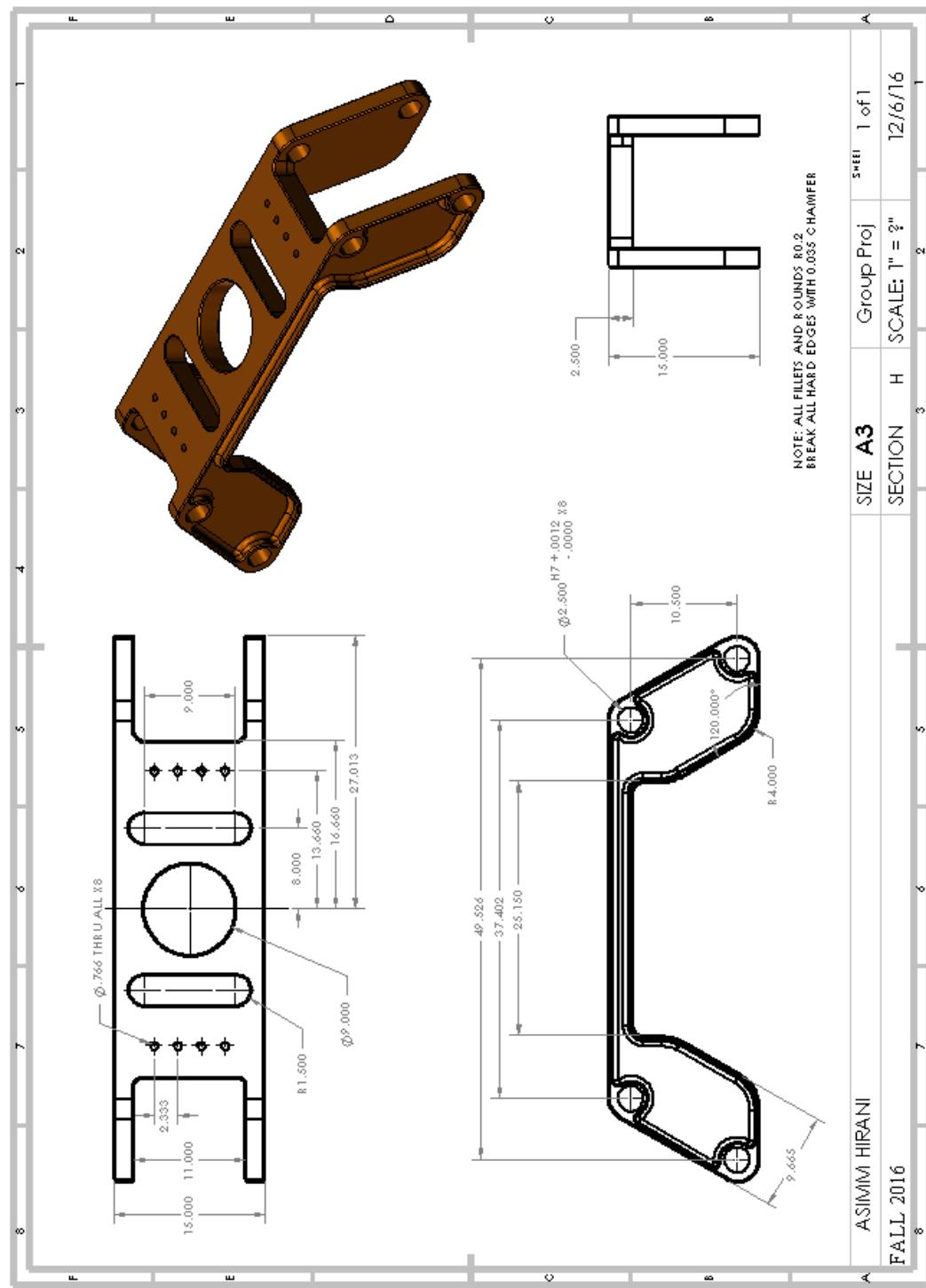


FIGURE 4.37: Hirani, Asimm: Center Frame

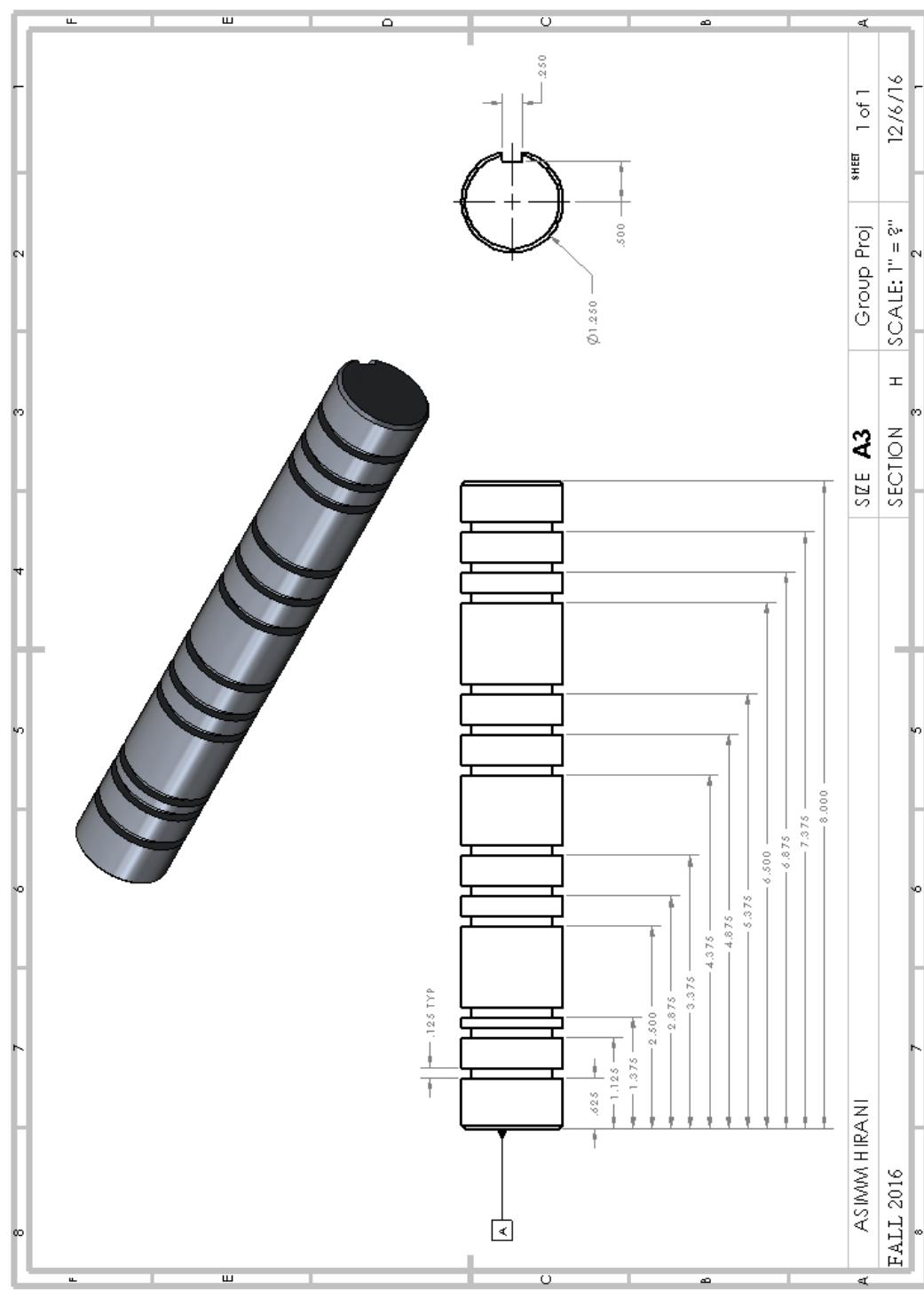


FIGURE 4.38: Hirani, Asimm: Gearbox Idler Shaft

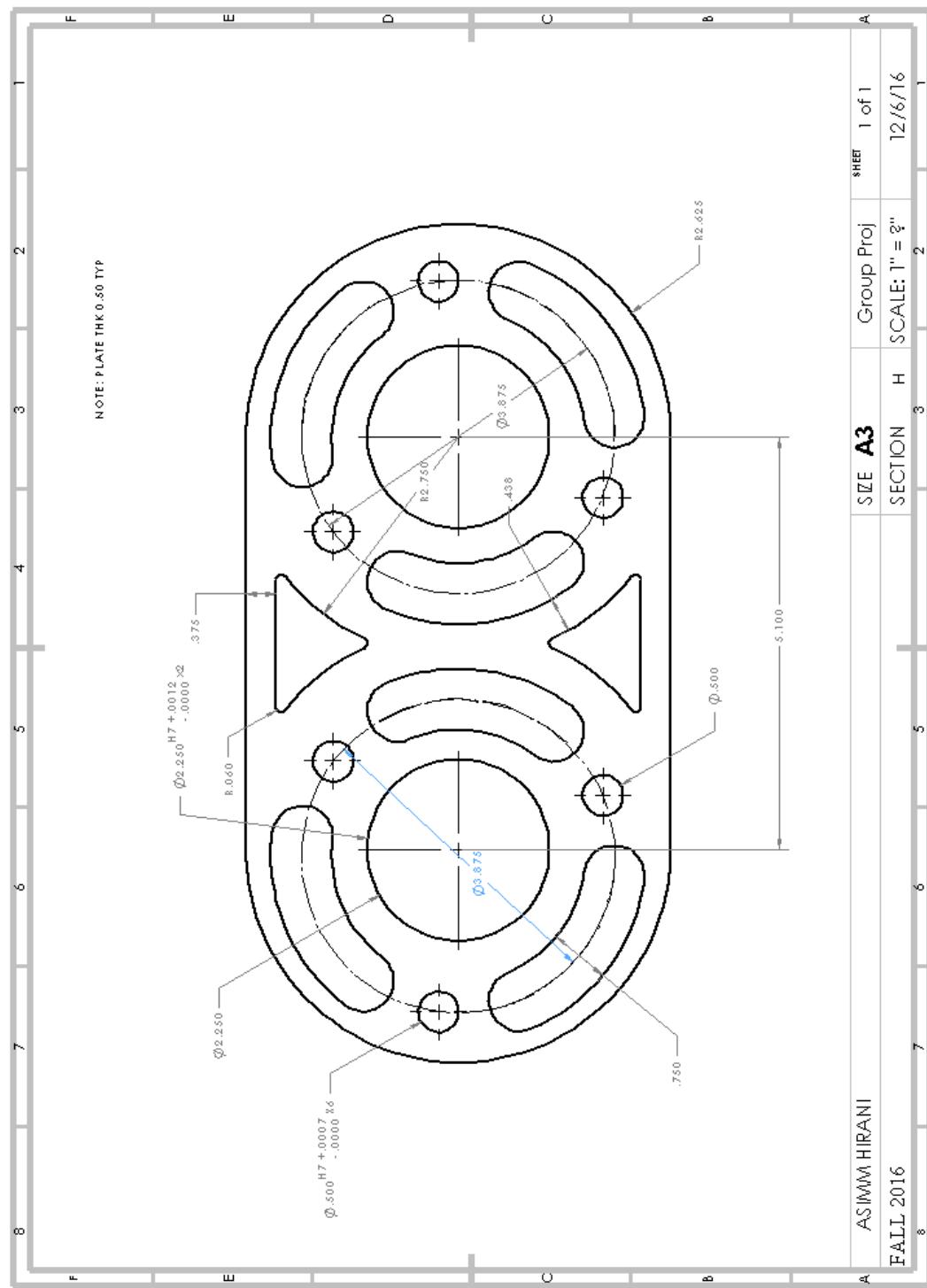


FIGURE 4.39: Hirani, Asimm: Gearbox Plate

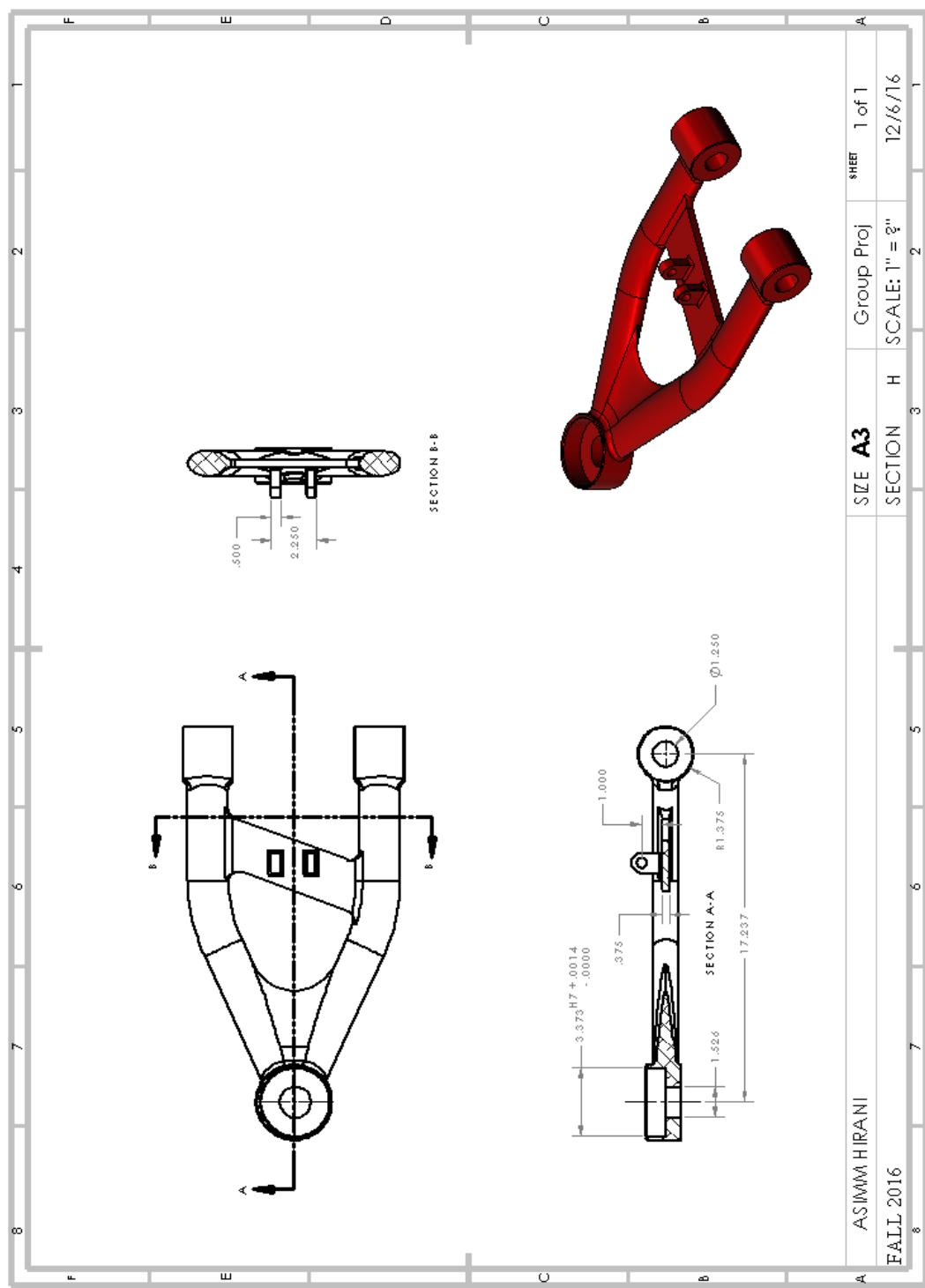


FIGURE 4.40: Hirani, Asimm: LCA

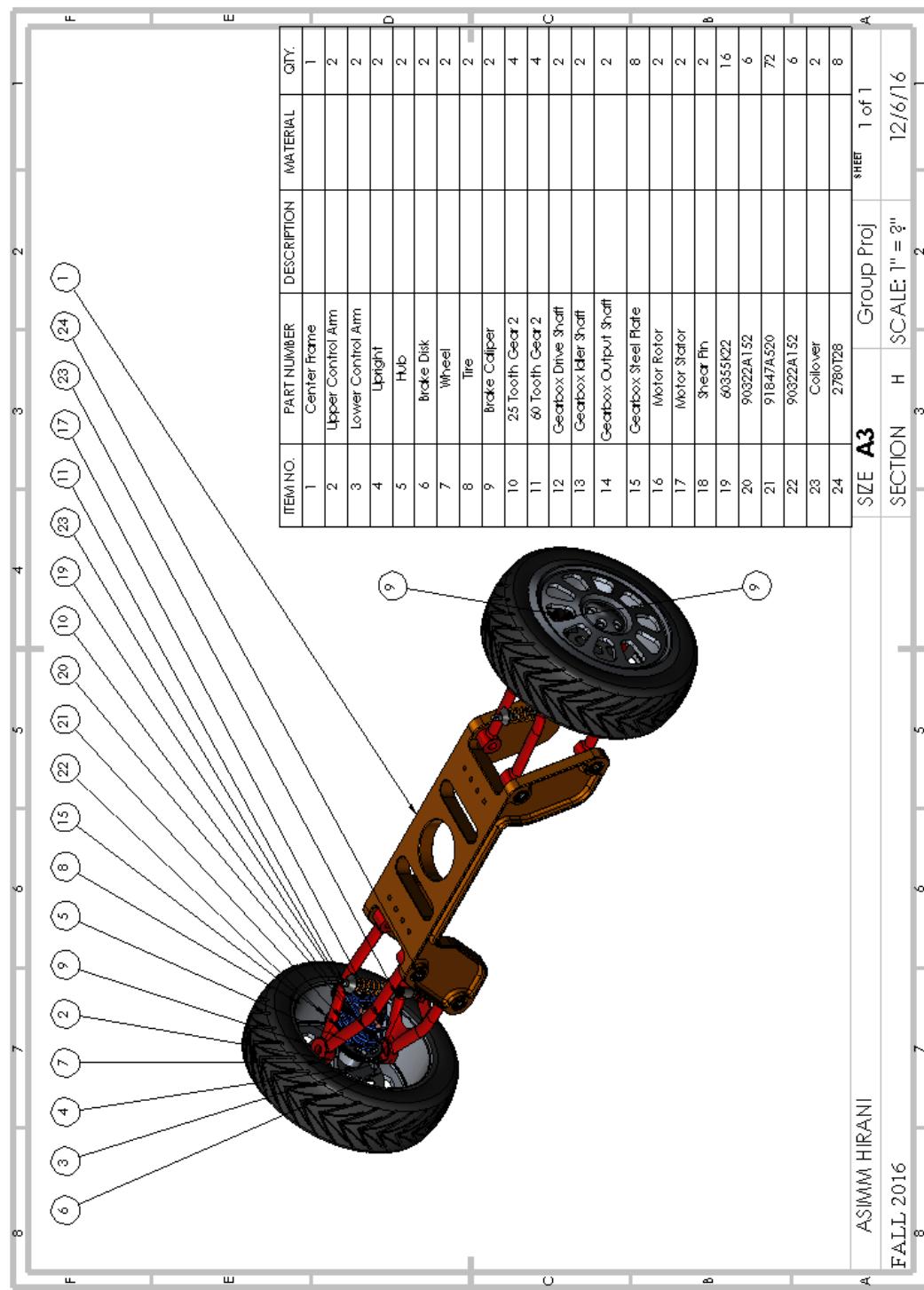


FIGURE 4.41: Hirani, Asimm: Suspension Assembly

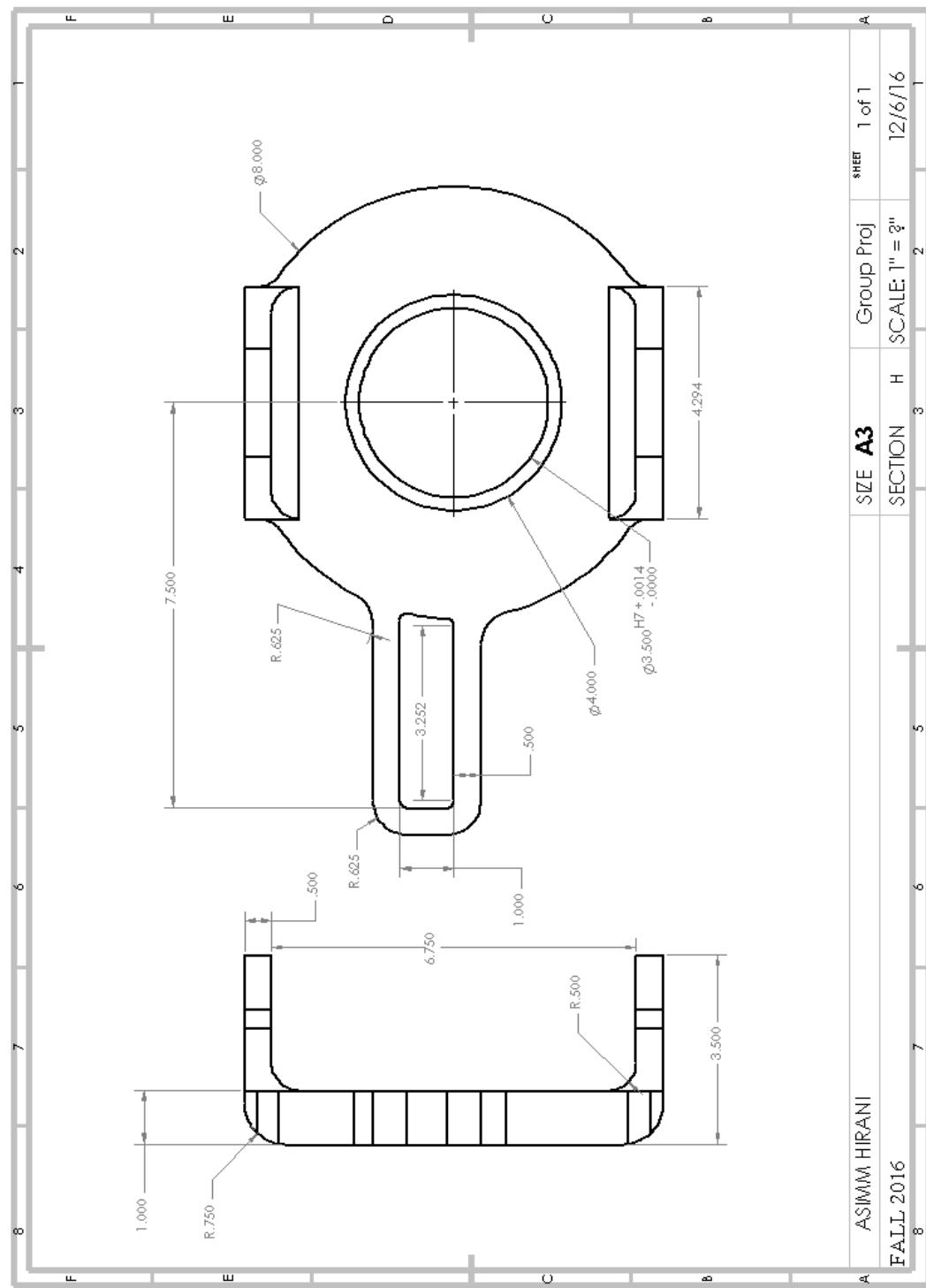


FIGURE 4.42: Hirani, Asimm: Upright

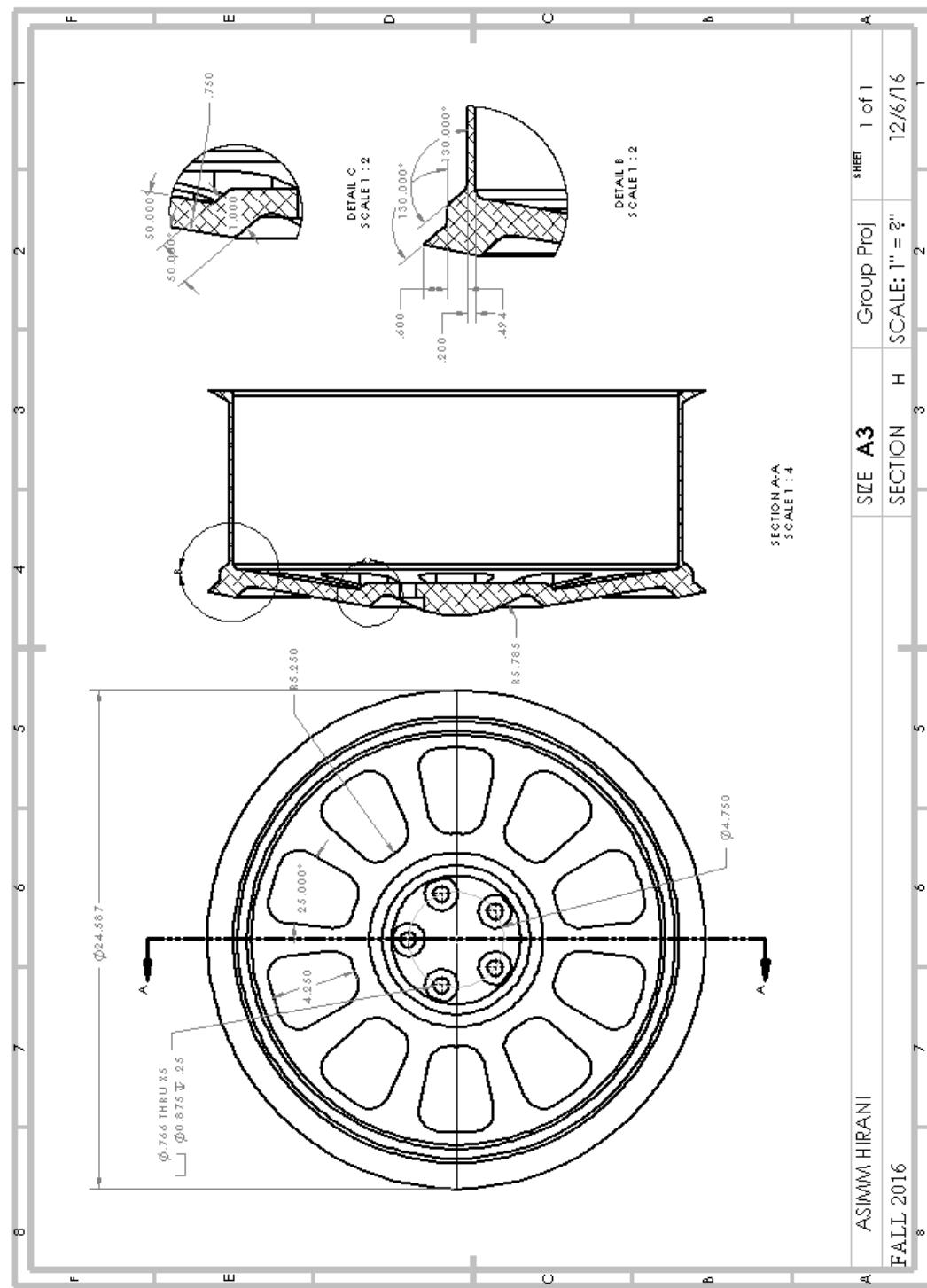


FIGURE 4.43: Hirani, Asimm: Wheel

## 4.1.13 3D Printer

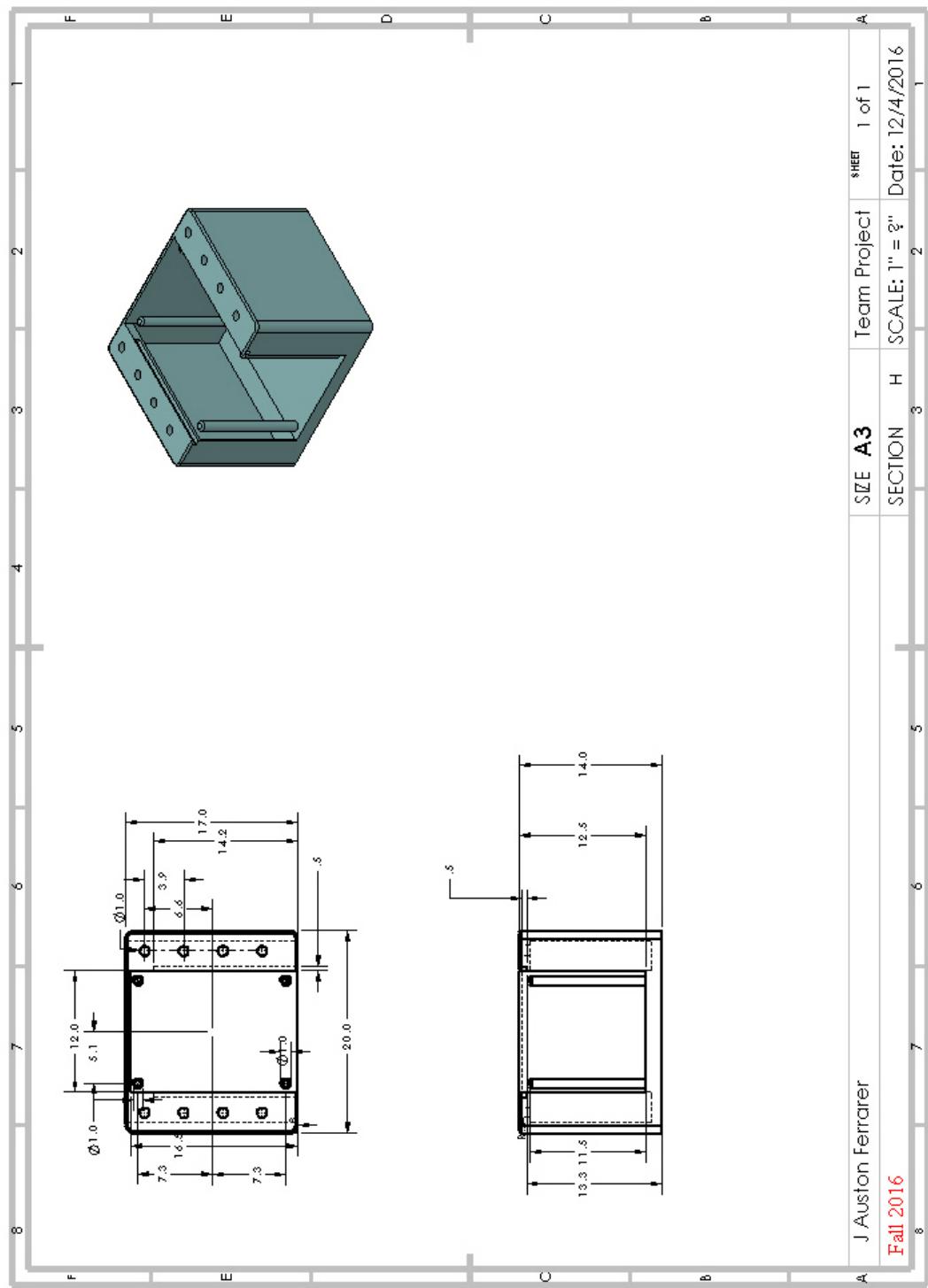


FIGURE 4.44: Ferrarer, Auston: Base Extrusion

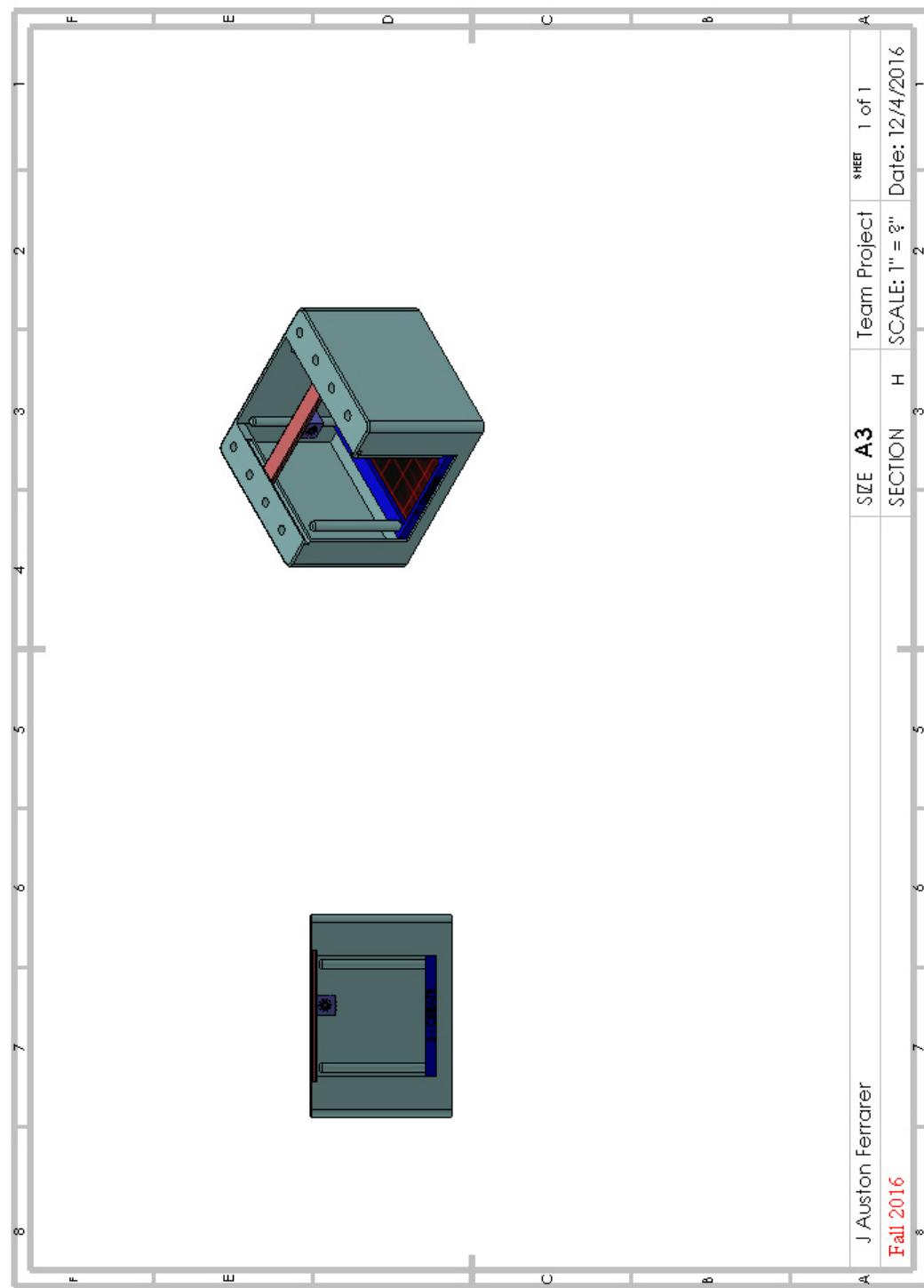


FIGURE 4.45: Ferrarer, Auston: Full 3D Printer

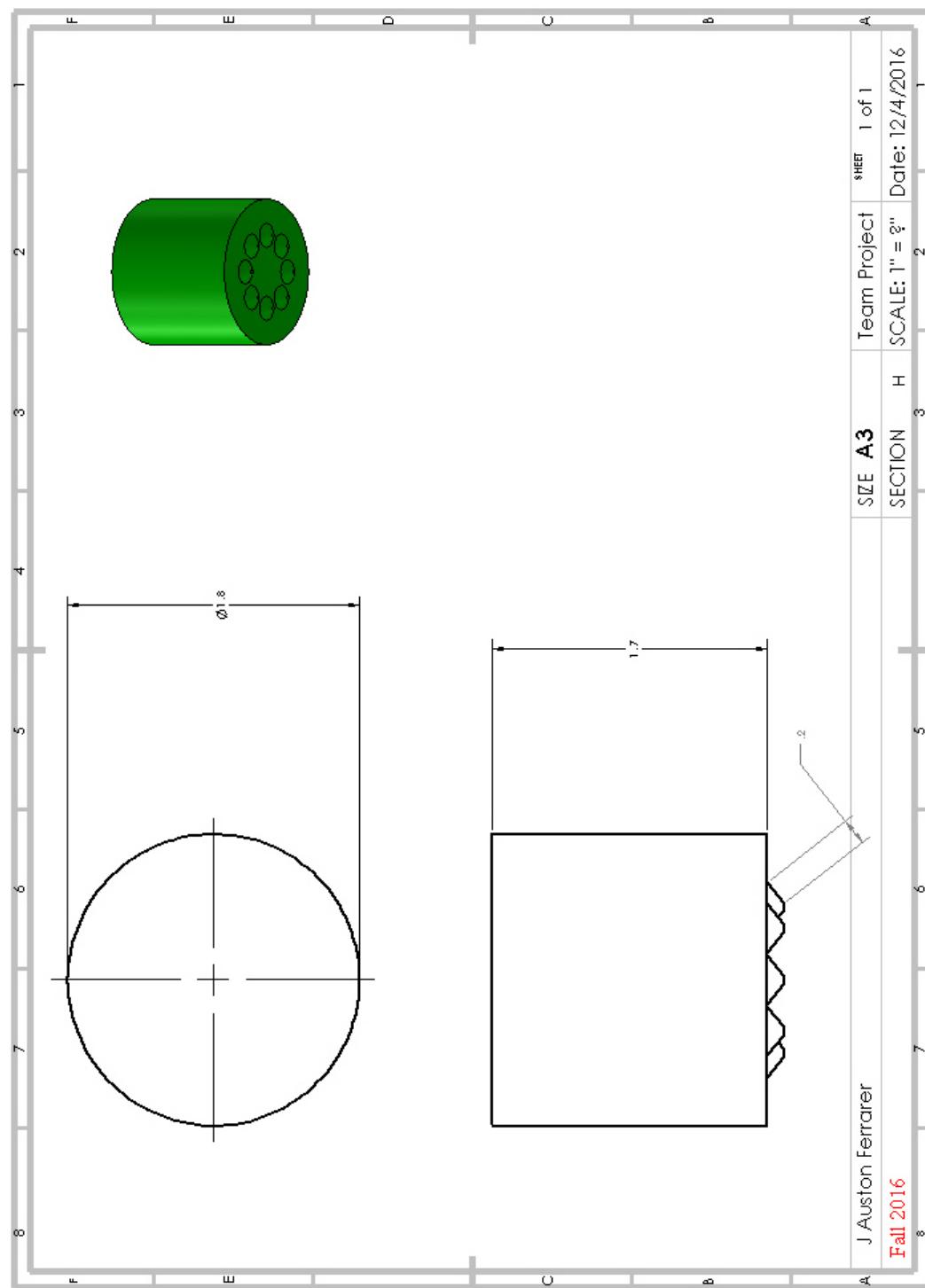


FIGURE 4.46: Ferrarer, Auston: Printing Nozel

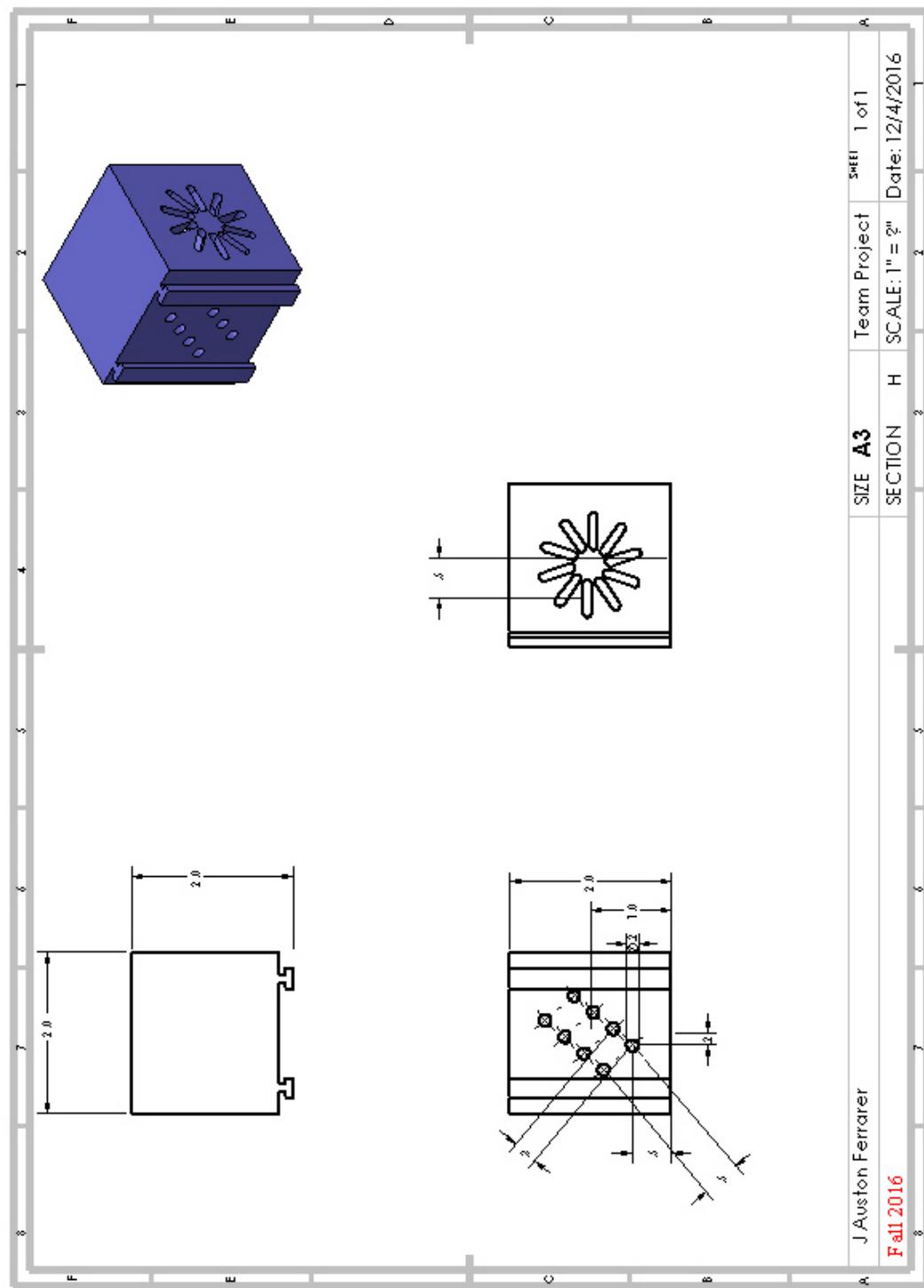


FIGURE 4.47: Ferrarer, Auston: Printing Nozel Casing

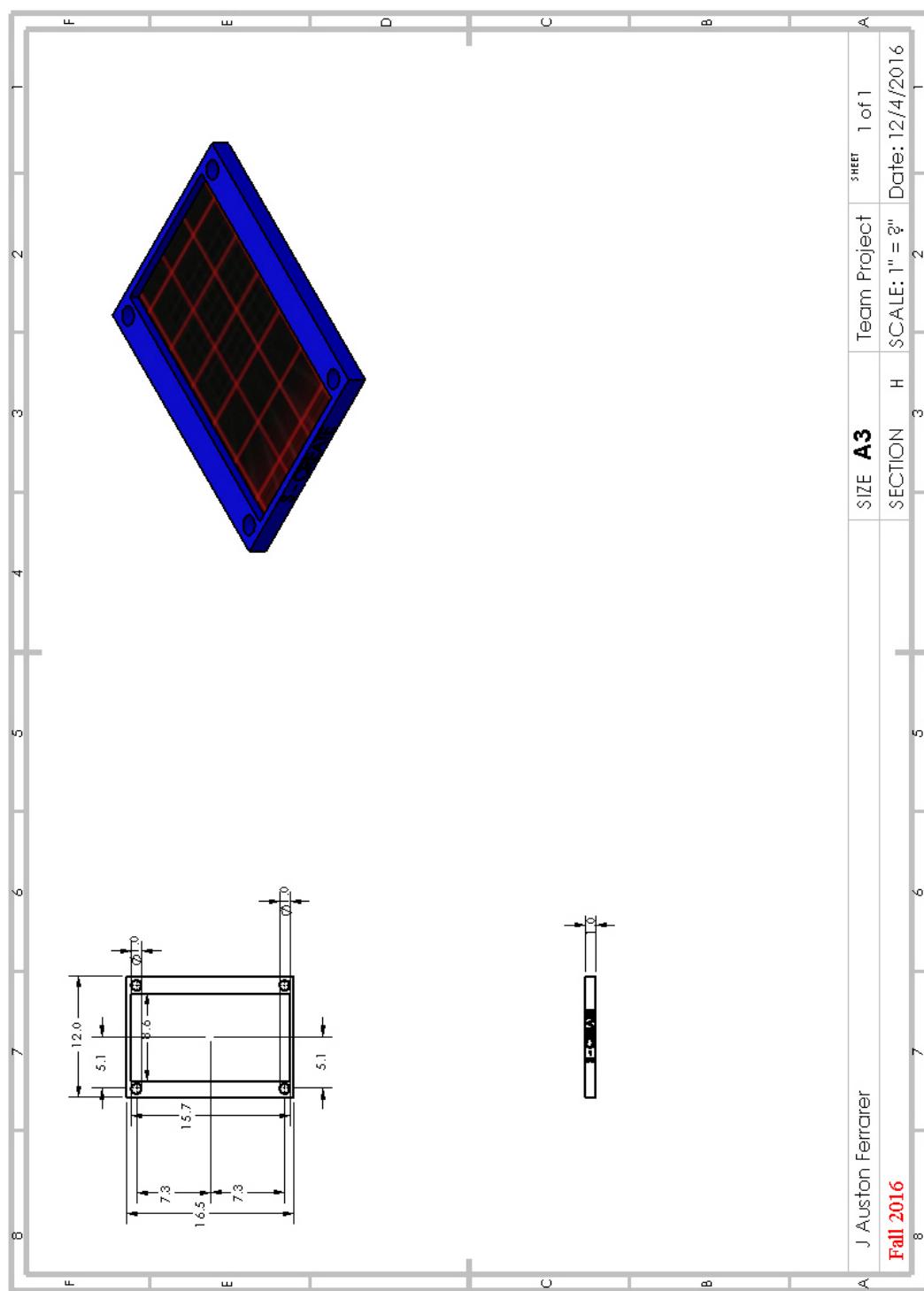


FIGURE 4.48: Ferrarer, Auston: Printing Pad

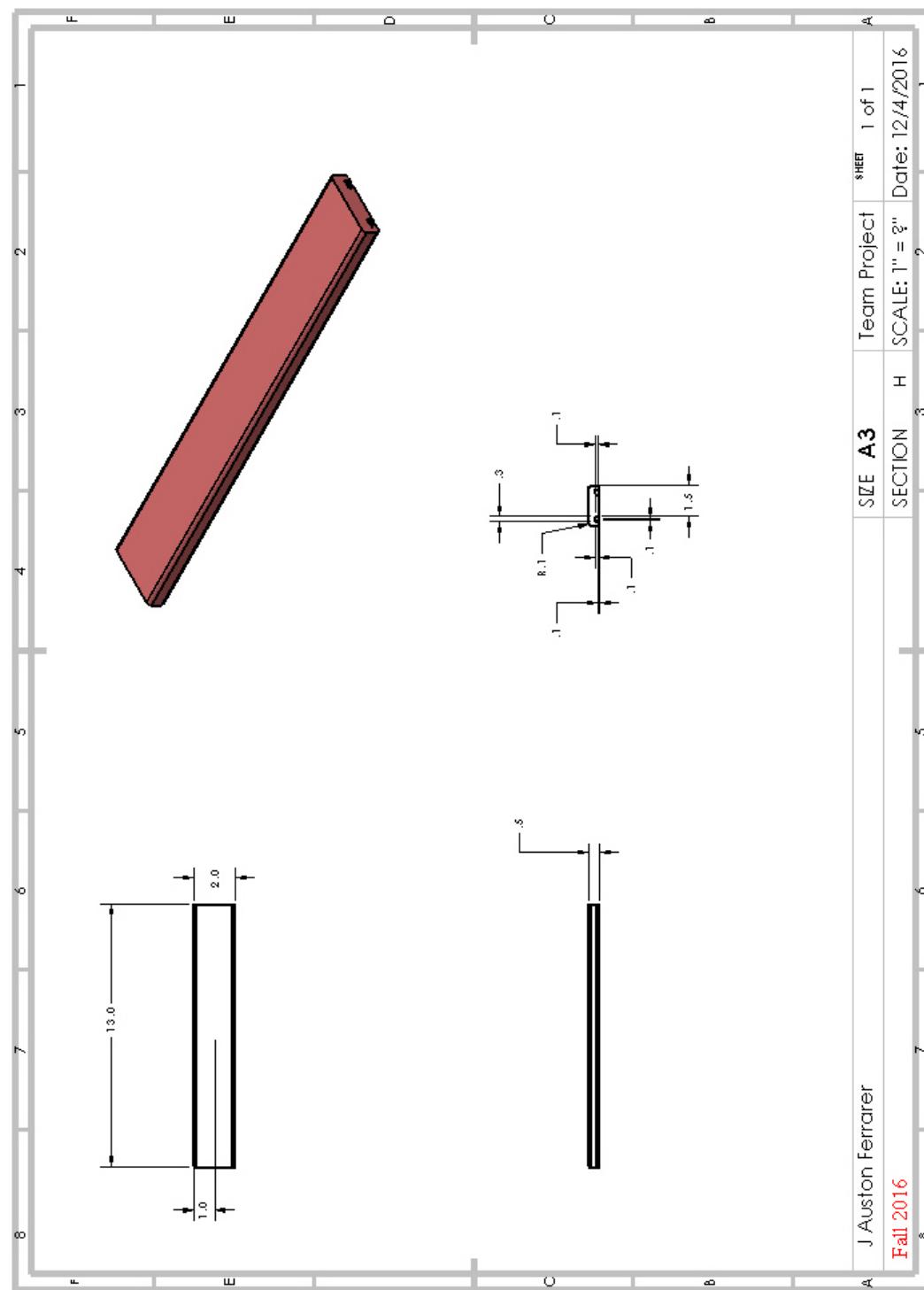


FIGURE 4.49: Ferrarer, Auston: Sidebar for Nozel

## 4.1.14 Bed

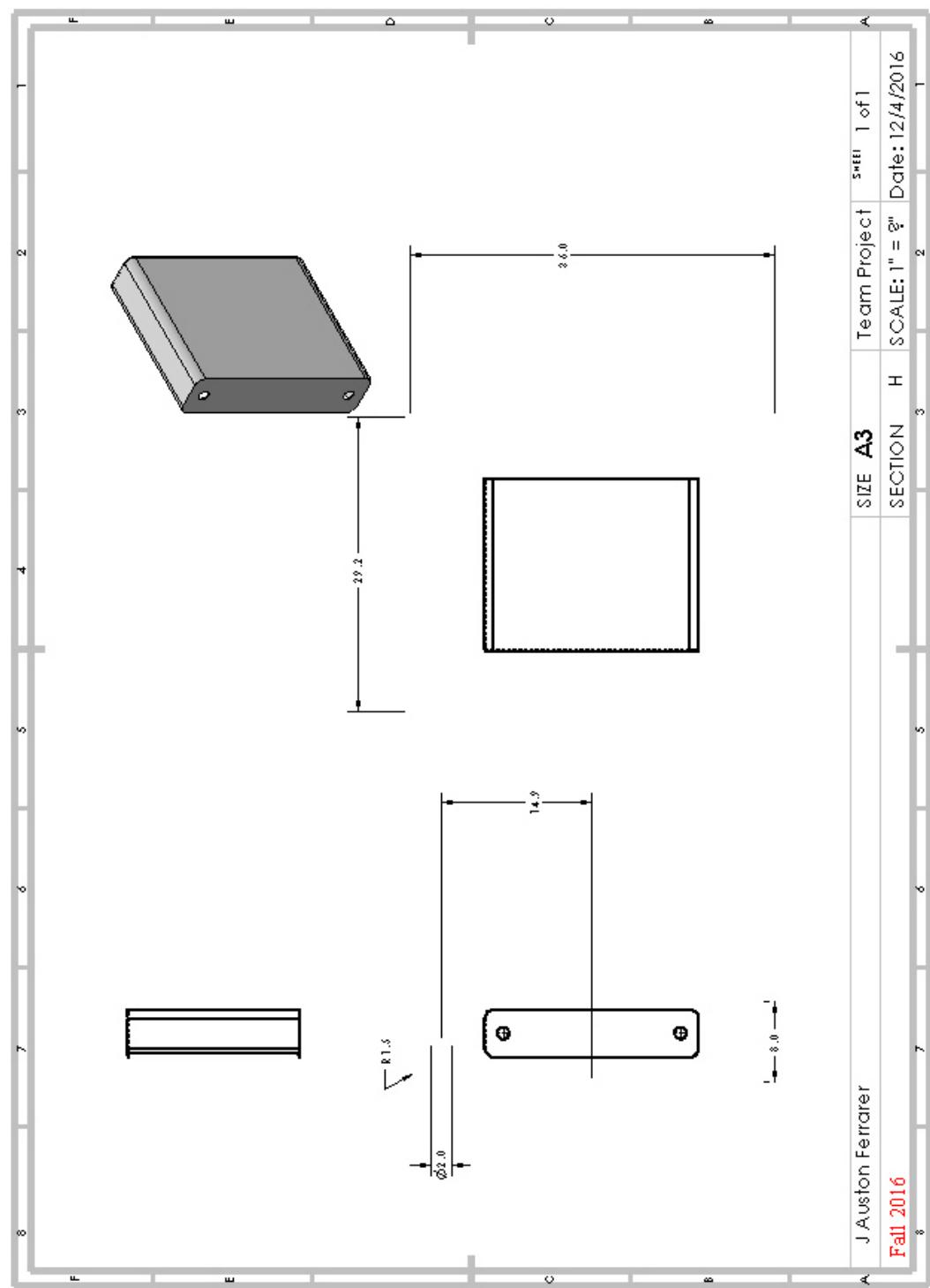


FIGURE 4.50: Ferrarer, Auston: Connecting Side Bracket

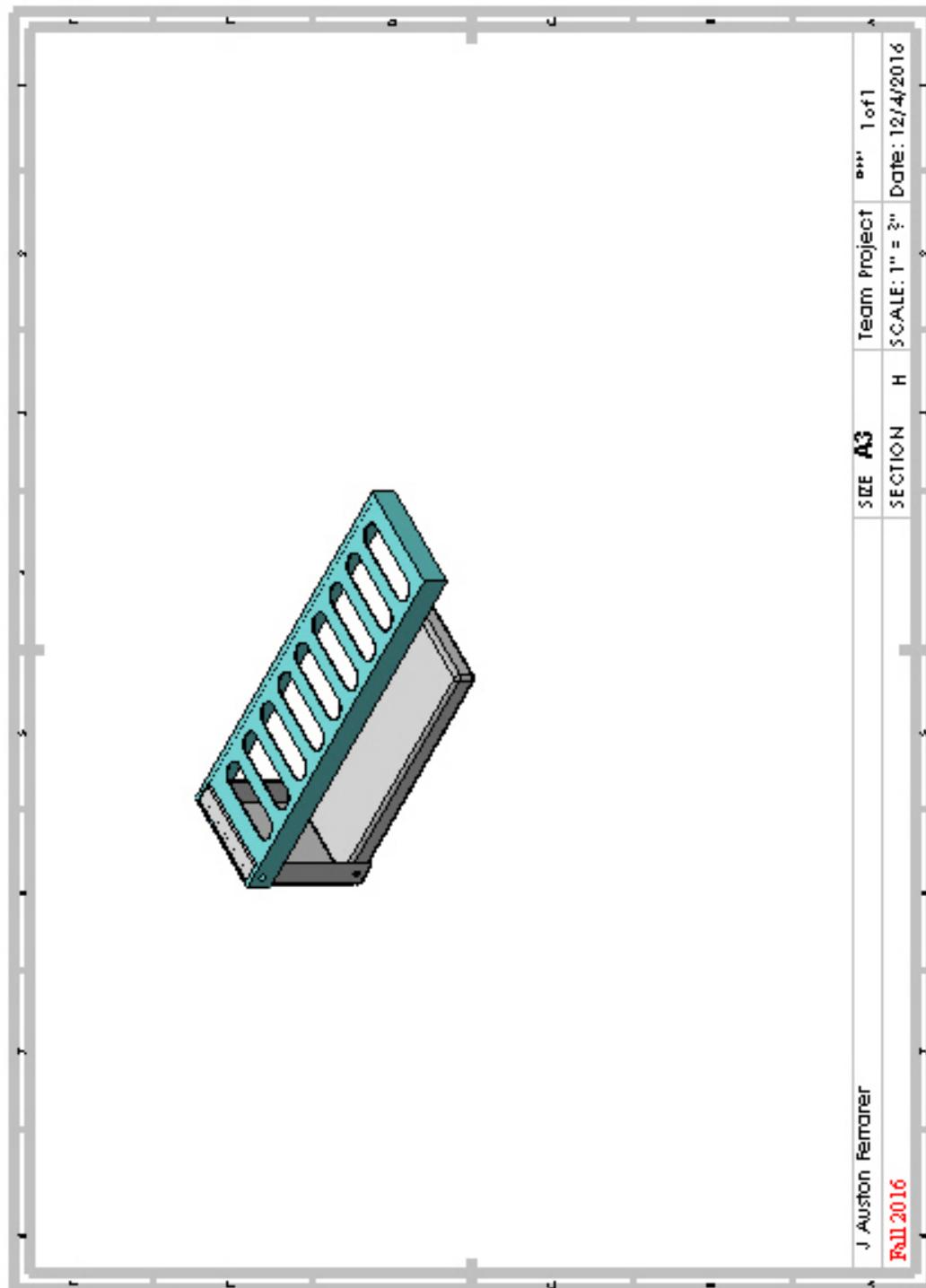


FIGURE 4.51: Ferrarer, Auston: Full Bed

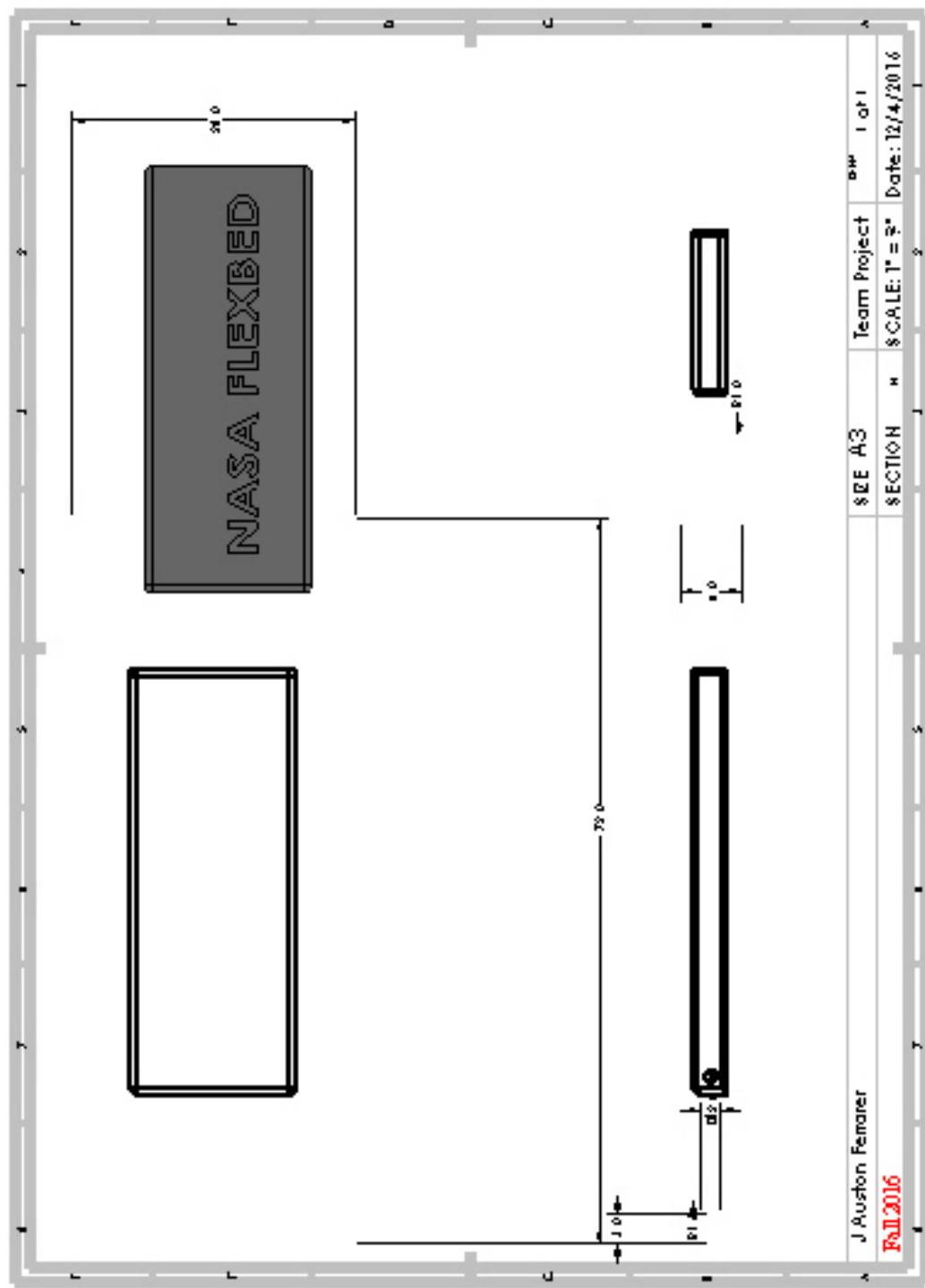


FIGURE 4.52: Ferrarer, Auston: Mattress

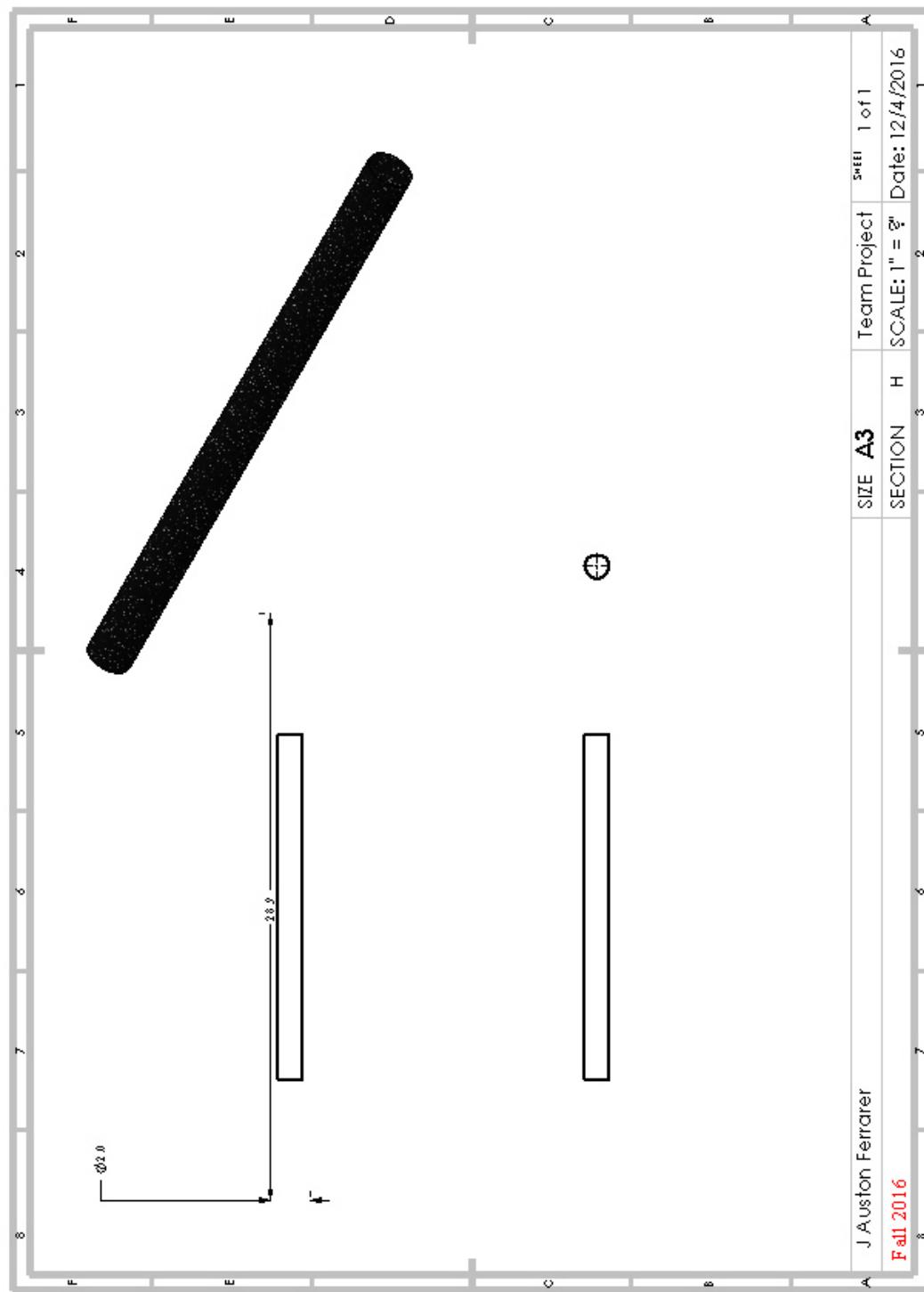


FIGURE 4.53: Ferrarer, Auston: Slide Bolt For Brackets

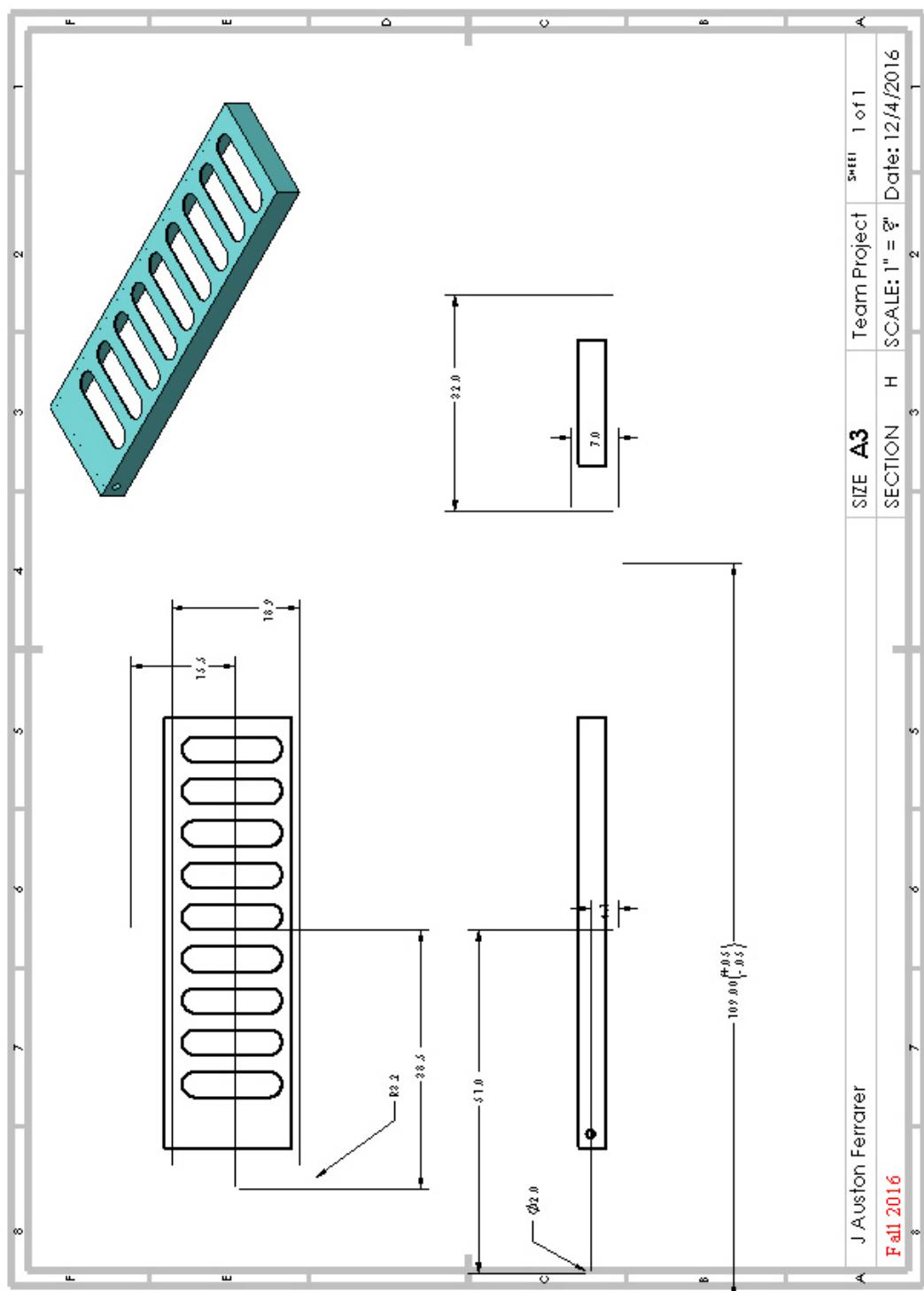


FIGURE 4.54: Ferrarer, Auston: Top Brackets

## 4.2 Assembly Instruction Manual

### 4.2.1 Antenna

#### Step 1

Insert the Swivel Link into the antenna base and check for tight fit.



FIGURE 4.55: Rodriguez, Juan: Assembly Step 1

**Step 2**

Align the holes of the antenna support, the crossbar and then swivel link. Insert pin a.

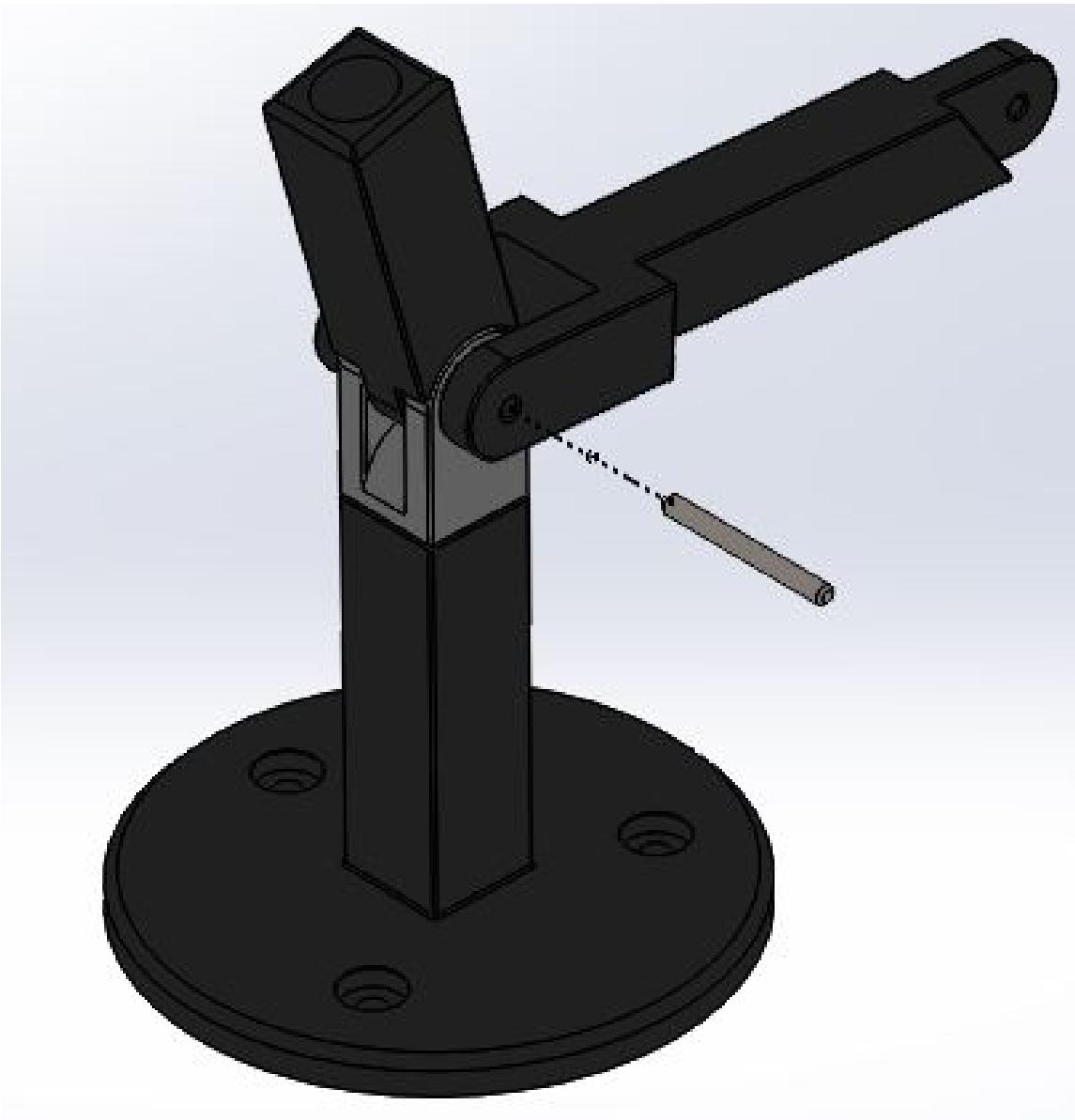


FIGURE 4.56: Rodriguez, Juan: Assembly Step 2

**Step 3**

Align the holes of the signal bar and the retriever. Insert the second pin b.

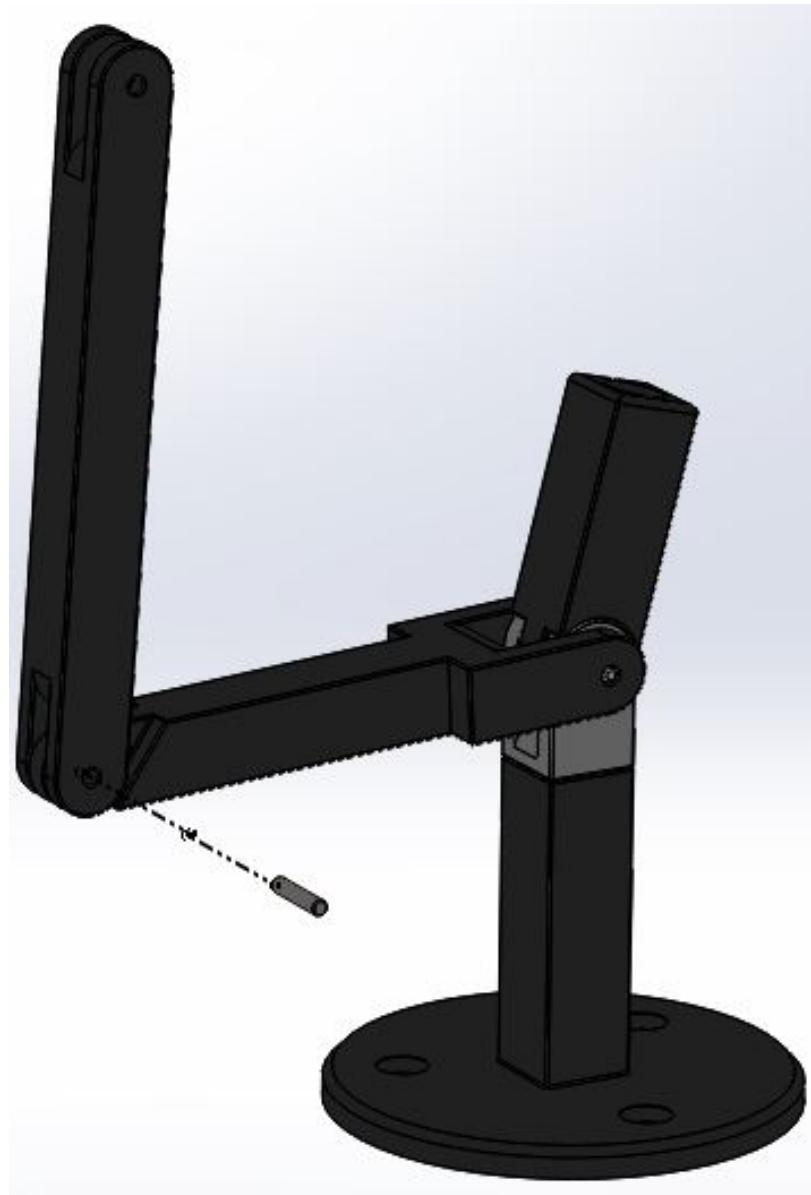


FIGURE 4.57: Rodriguez, Juan: Assembly Step 3

**Step 4**

Align the holes of the signal bar and the retriever. Insert the second pin b.



FIGURE 4.58: Rodriguez, Juan: Assembly Step 4

**Step 5**

Attach the ball and socket joint to existing assembly.

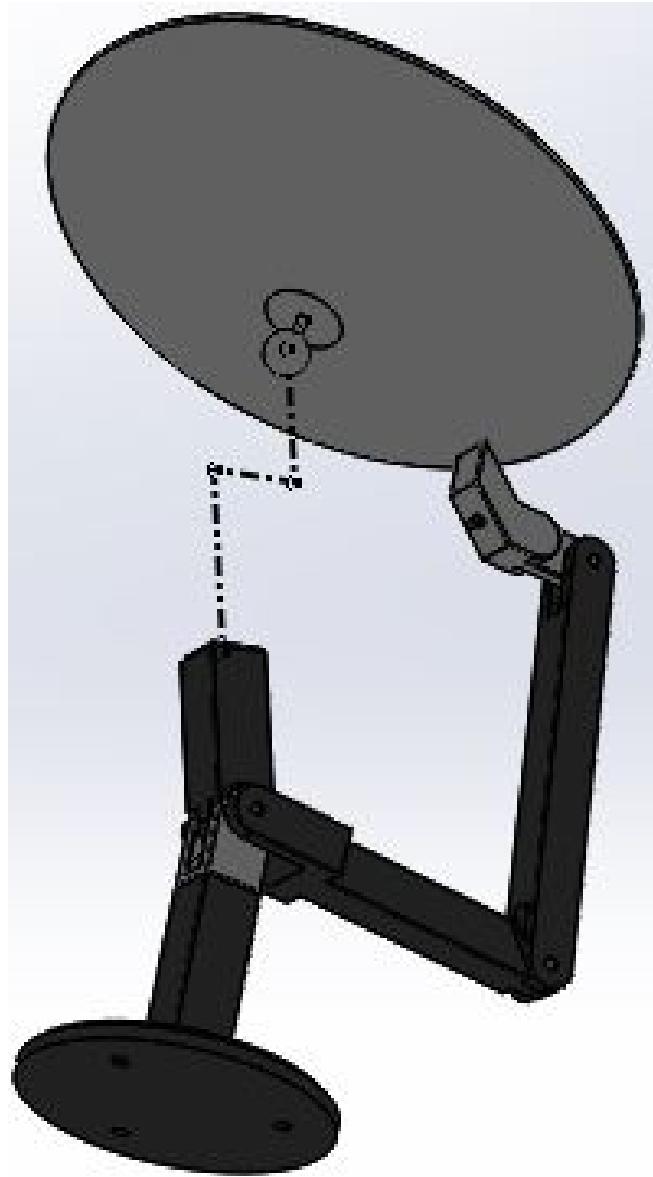


FIGURE 4.59: Rodriguez, Juan: Assembly Step 5

### 4.2.2 Grabber

#### Step 1

Ball and socket will be premanufactured using a cast.

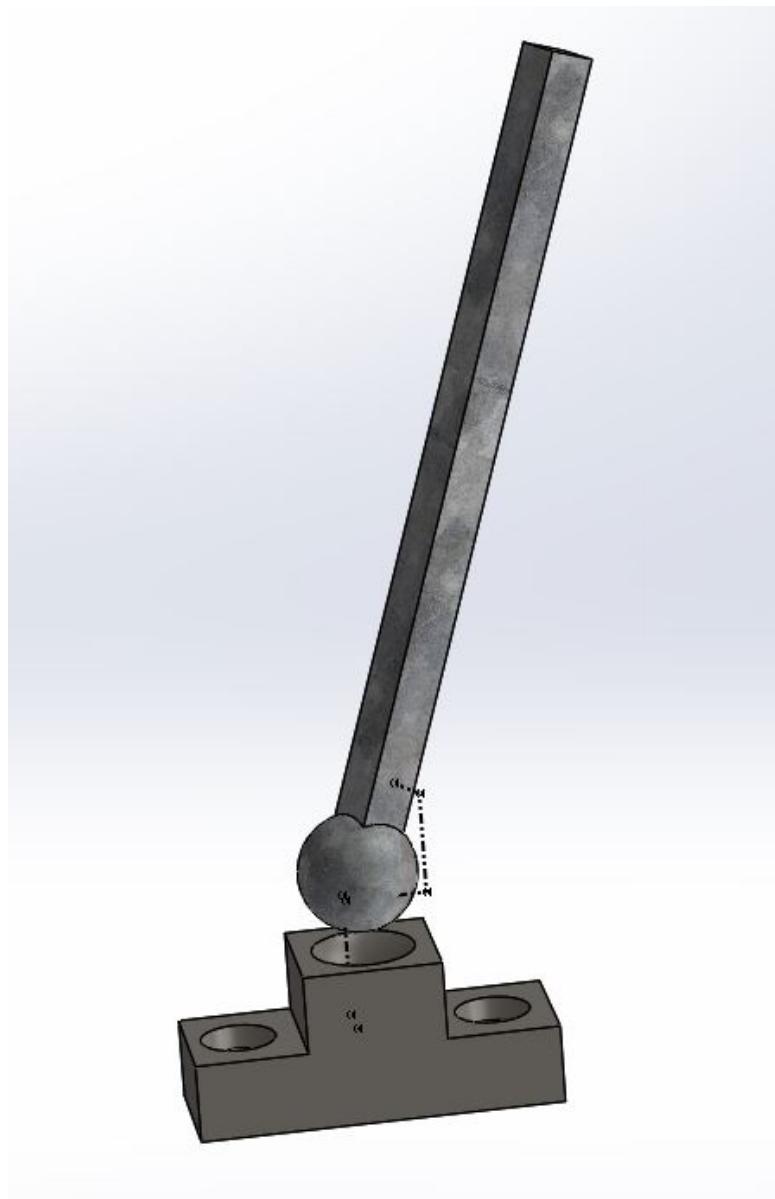


FIGURE 4.60: Sackett, Justin: Assembly Step 1

**Step 2**

Slide the Upper arm joint onto the hydraulic arm of the ball joint



FIGURE 4.61: Sackett, Justin: Assembly Step 2

**Step 3**

Slide the Upper arm and Upper pincer into the slots of the upper arm joint. The pincer should slide into the central slot. The upper arm should slide into the two slots on either side of the center.

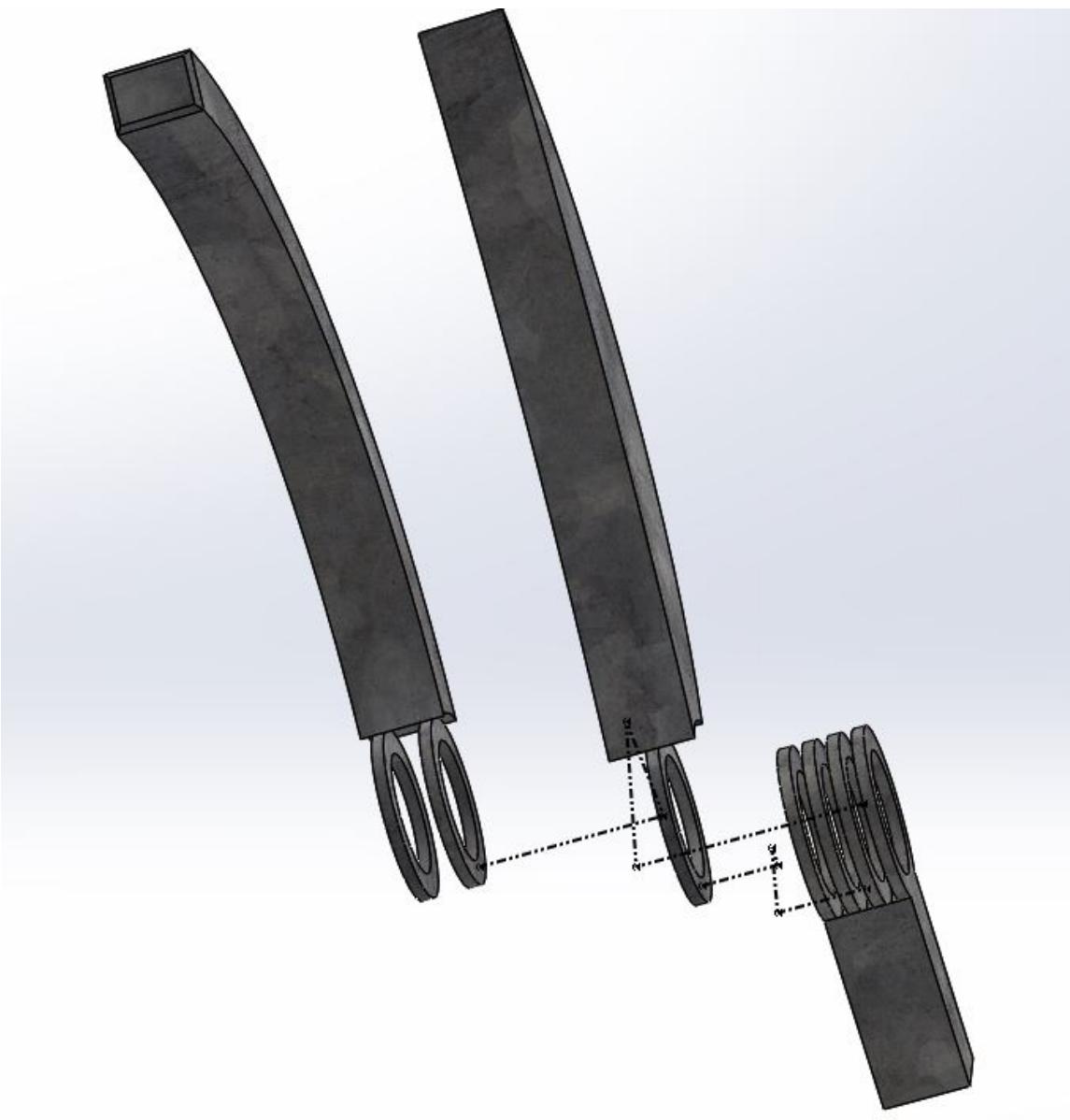


FIGURE 4.62: Sackett, Justin: Assembly Step 3

**Step 4**

Insert the Hinge pin into the central hole of the Upper arm, Upper pincer, and upper arm joint.

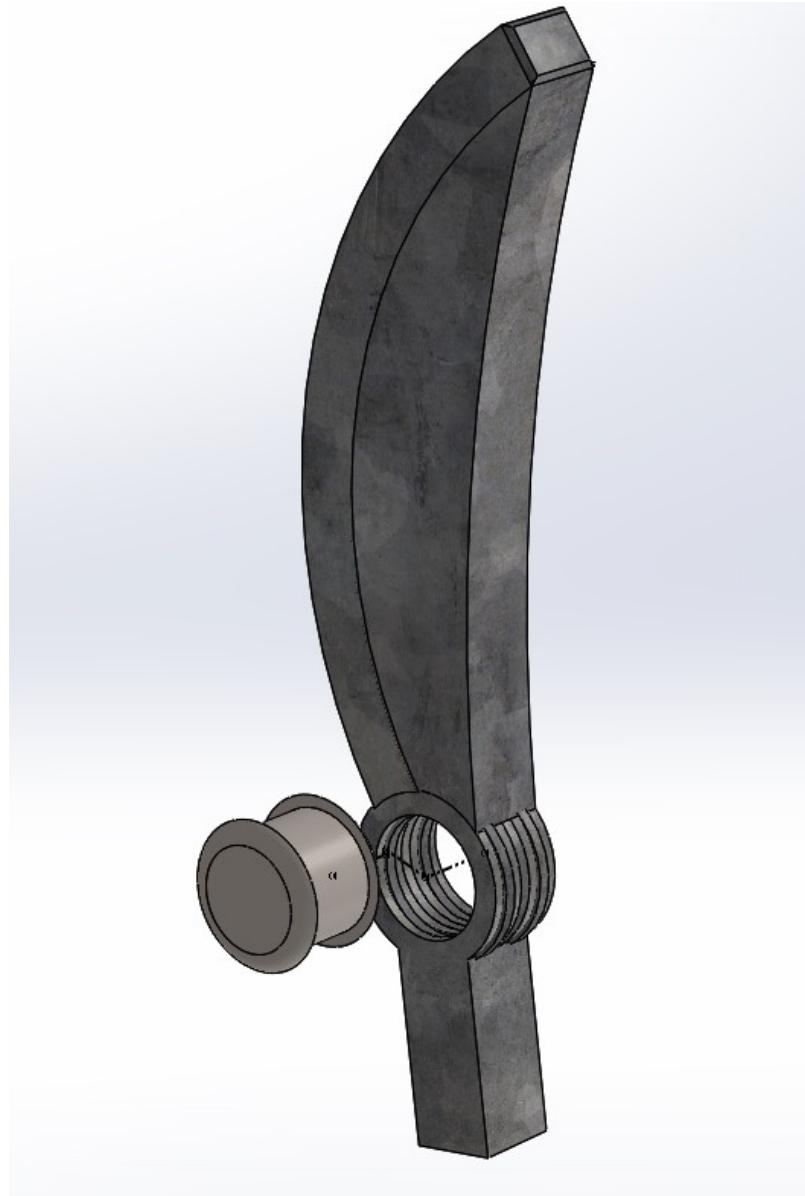


FIGURE 4.63: Sackett, Justin: Assembly Step 4

**Step 5**

Complete the assembly by sliding the upper joint assembly onto the ball joint arm.



FIGURE 4.64: Sackett, Justin: Assembly Step 5

### 4.2.3 Lights

#### Step 1

Place all 11 light subassemblies on top of the 11 pre manufactured holes in the light base.

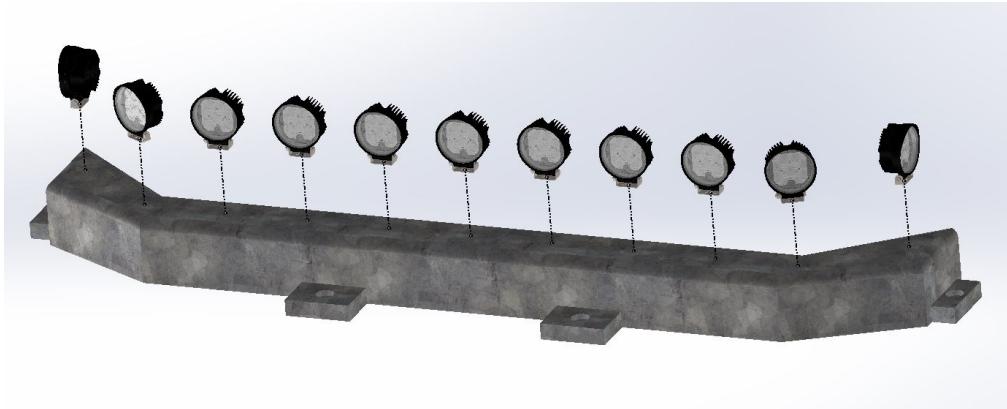


FIGURE 4.65: Sackett, Justin: Assembly Step 1

#### Step 2

Screw each of the 11 light screws into each of the 11 holes in order to secure the lights into the light base.



FIGURE 4.66: Sackett, Justin: Assembly Step 2

**Step 3**

Complete the assembly by securely fastening each screw.



FIGURE 4.67: Sackett, Justin: Assembly Step 3

#### 4.2.4 Suspension

##### Step 1

Assemble Full Wheel by taking wheel and putting into Tire.



FIGURE 4.68: Hirani, Asimm: Assembly Step 1

**Step 2**

Insert Hub into Wheel



FIGURE 4.69: Hirani, Asimm: Assembly Step 2

**Step 3**

Mount Brake Disk and Brake Caliper onto Hub

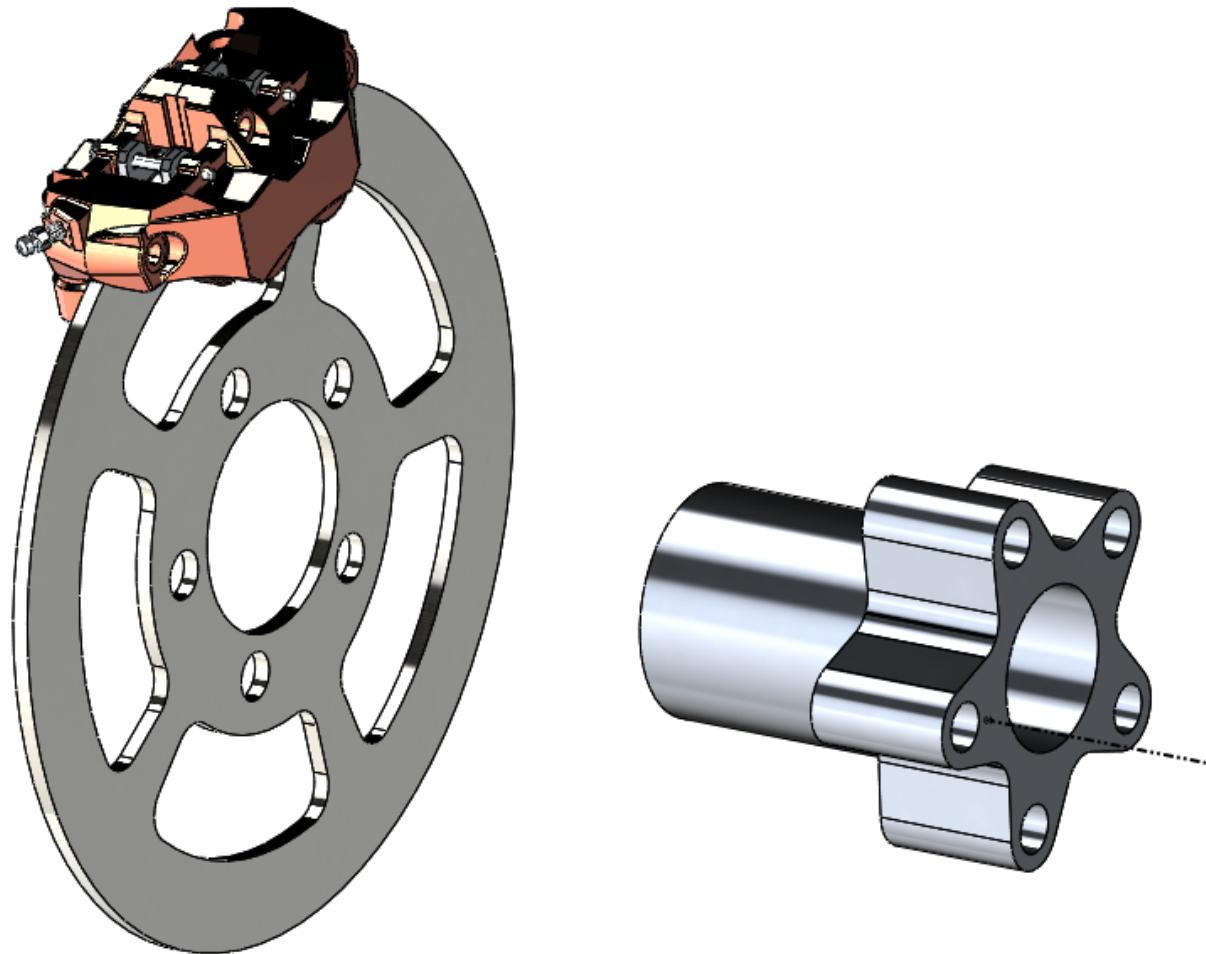


FIGURE 4.70: Hirani, Asimm: Assembly Step 3

**Step 4**

Mount hub and wheel assembly onto upright



FIGURE 4.71: Hirani, Asimm: Assembly Step 4

**Step 5**

Mount lower control arms and upper controls arms onto frame. Mount coilover onto LCA. Mount upright between control arms. Mirror assembly accross the frame.

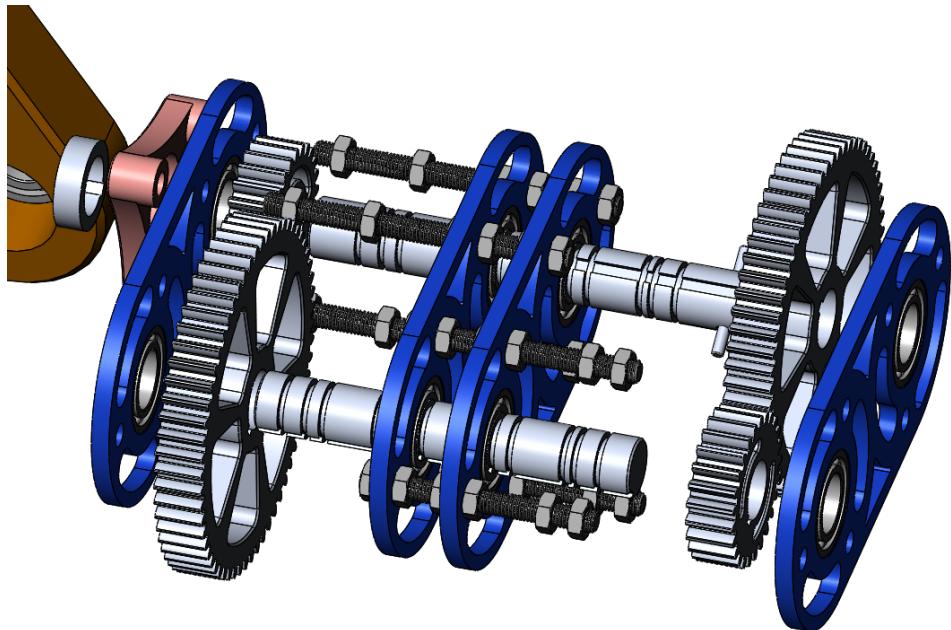


FIGURE 4.72: Hirani, Asimm: Assembly Step 5

#### 4.2.5 3DPrinter

##### Step 1

Place titanium extrusion cylinder inside of blue vented housing.

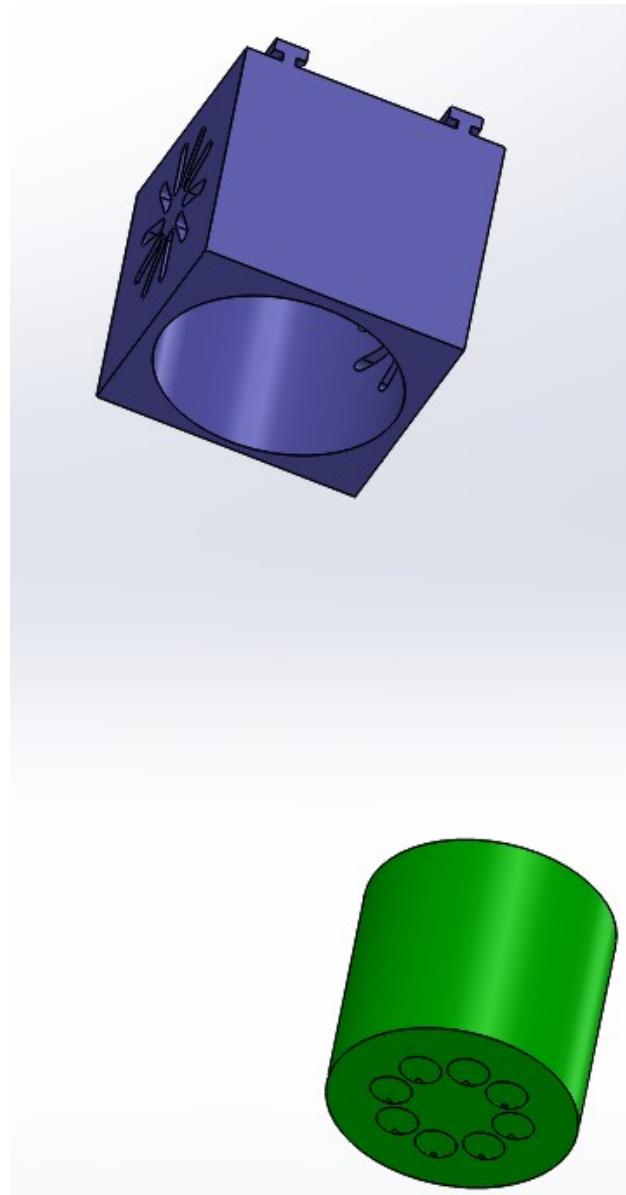


FIGURE 4.73: Ferrarer, Auston: Assembly Step 1

**Step 2**

Slide extrude cut ridges into red slide-bar. They should be allowed to move freely.

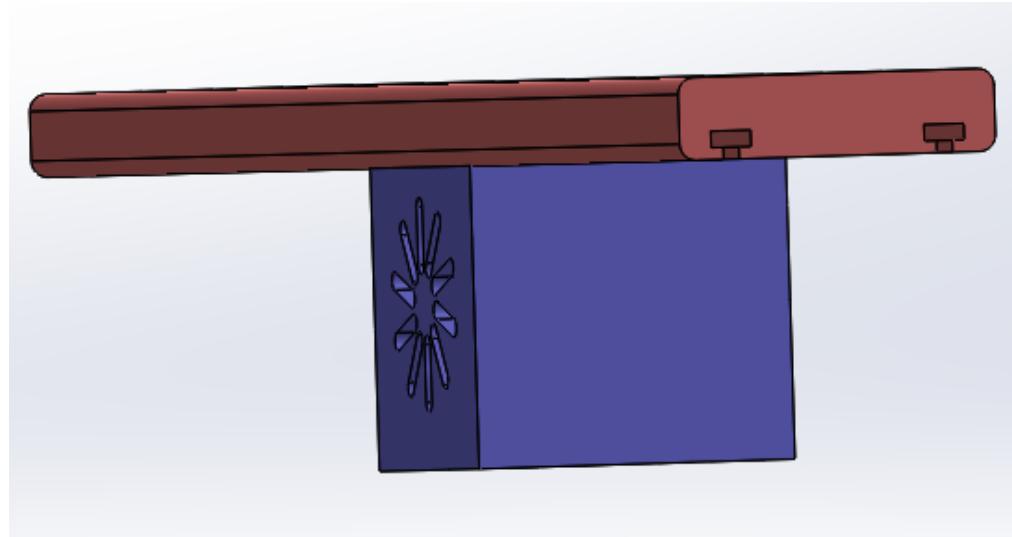


FIGURE 4.74: Ferrarer, Auston: Assembly Step 2

**Step 3**

Place royal blue 3D printing board into 3D printed shell by placing the four extrude cut holes on the plate into the four corresponding posts. Then slide the sidebar into the 3D printed shell.

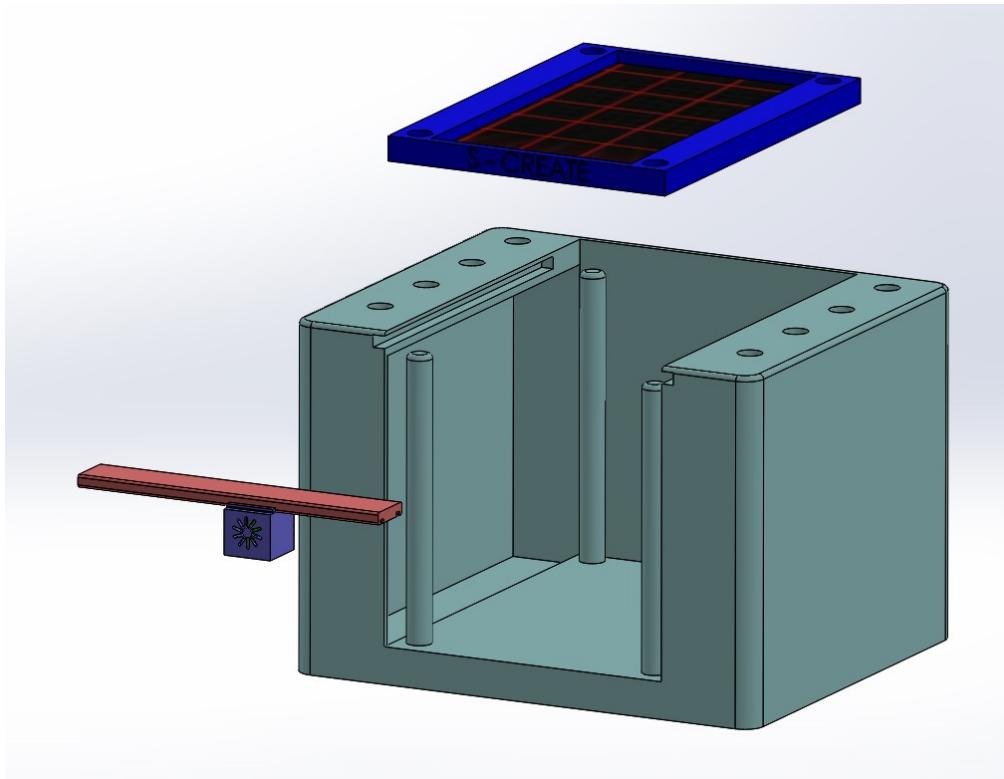


FIGURE 4.75: Ferrarer, Auston: Assembly Step 3

#### 4.2.6 FlexBed

##### Step 1

Place the bottom mattress and top bracket into the side bracket of the assembly.

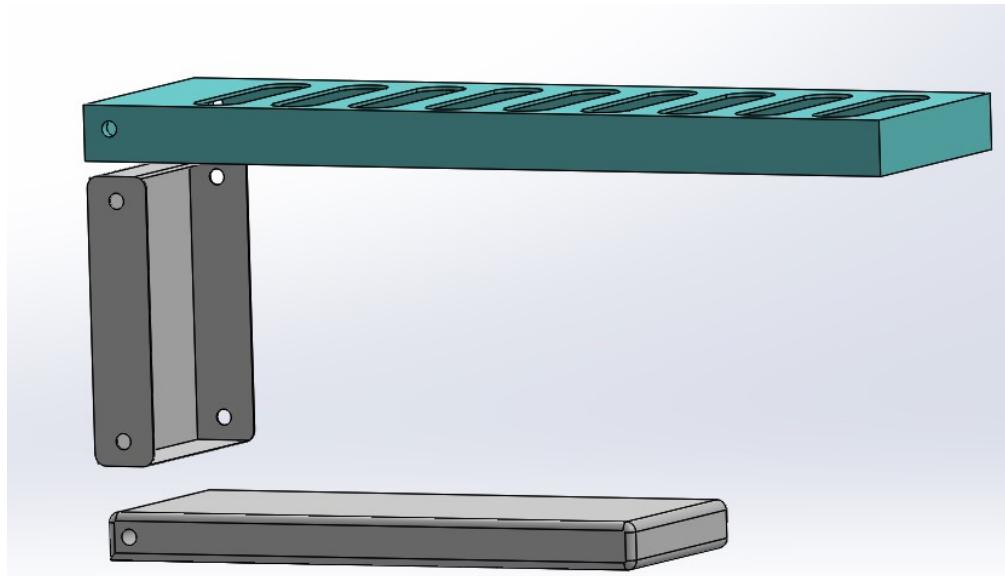


FIGURE 4.76: Ferrarer, Auston: Assembly Step 1

##### Step 2

Place two carbon fiber rotating rods into the holes shown to finish assembling the foldable flex bed.

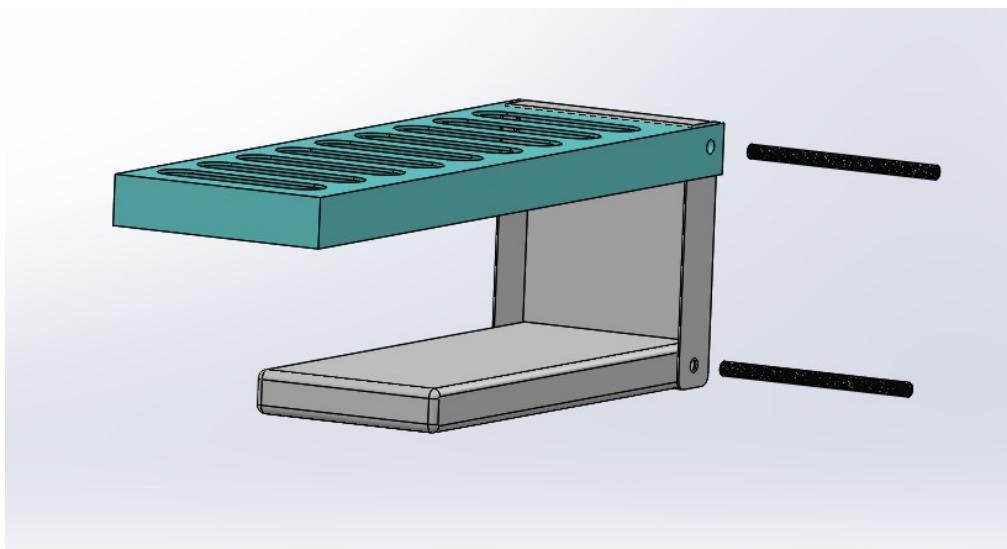


FIGURE 4.77: Ferrarer, Auston: Assembly Step 2

#### 4.2.7 Helmet

##### Step 1

Press fit the acrylic visor into the shell of the Mars helmet.

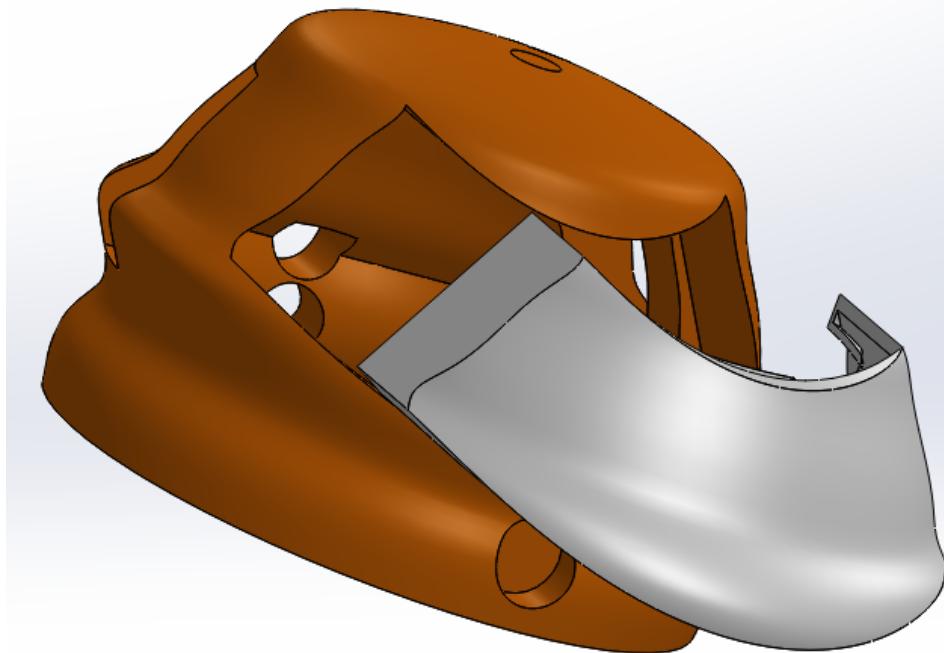


FIGURE 4.78: Ferrarer, Auston: Assembly Step 1

**Step 2**

Insert the black side lights into the press-fit whole in the side of the helmet.

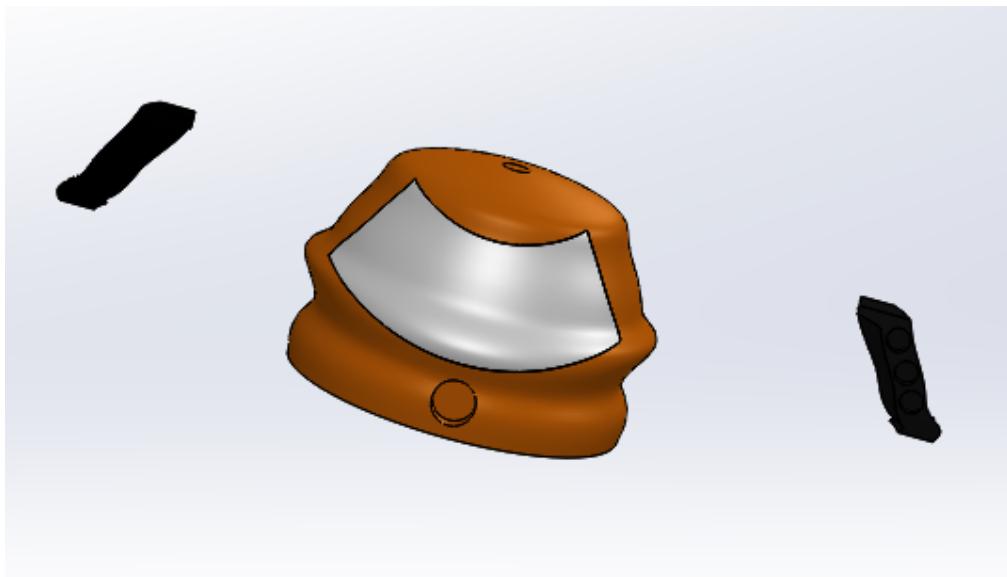


FIGURE 4.79: Ferrarer, Auston: Assembly Step 2

#### 4.2.8 Hinge

##### Step 1

Insert the Swivel Link into the antenna base and check for tight fit.

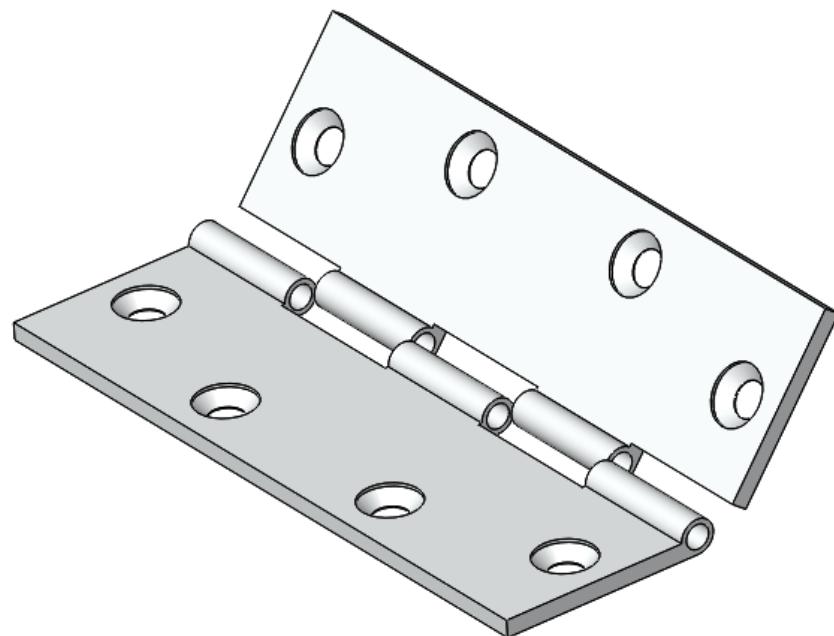


FIGURE 4.80: Ferrarer, Auston: Assembly Step 1

**Step 2**

Align the holes of the antenna support, the crossbar and then swivel link. Insert pin a.

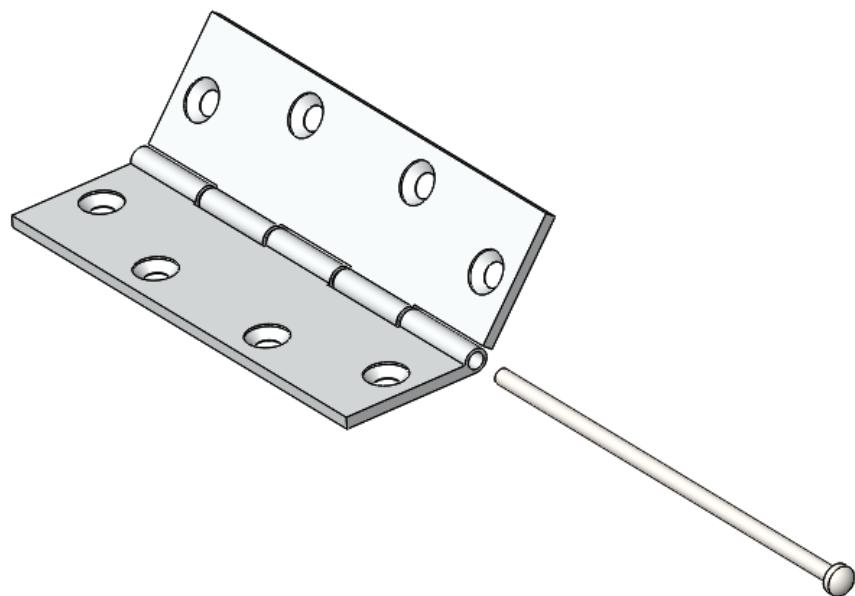


FIGURE 4.81: Ferrarer, Auston: Assembly Step 2

## 4.3 Exploded View

### 4.3.1 Antenna

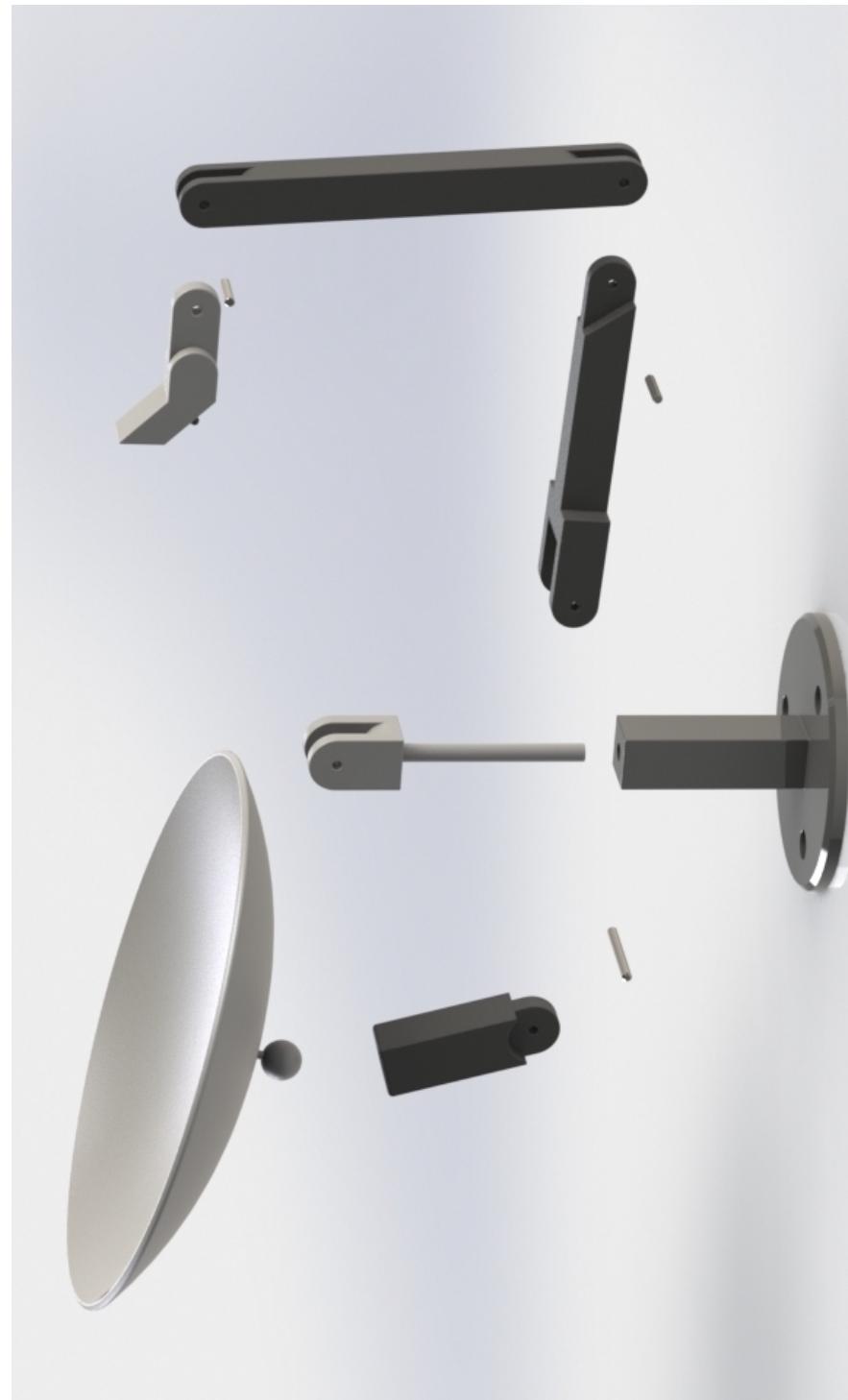


FIGURE 4.82: Rodriguez, Juan: Exploded View of Antenna Assembly

#### 4.3.2 Grabber



FIGURE 4.83: Sackett, Justin: Exploded View of Grabber Assembly

#### 4.3.3 Light

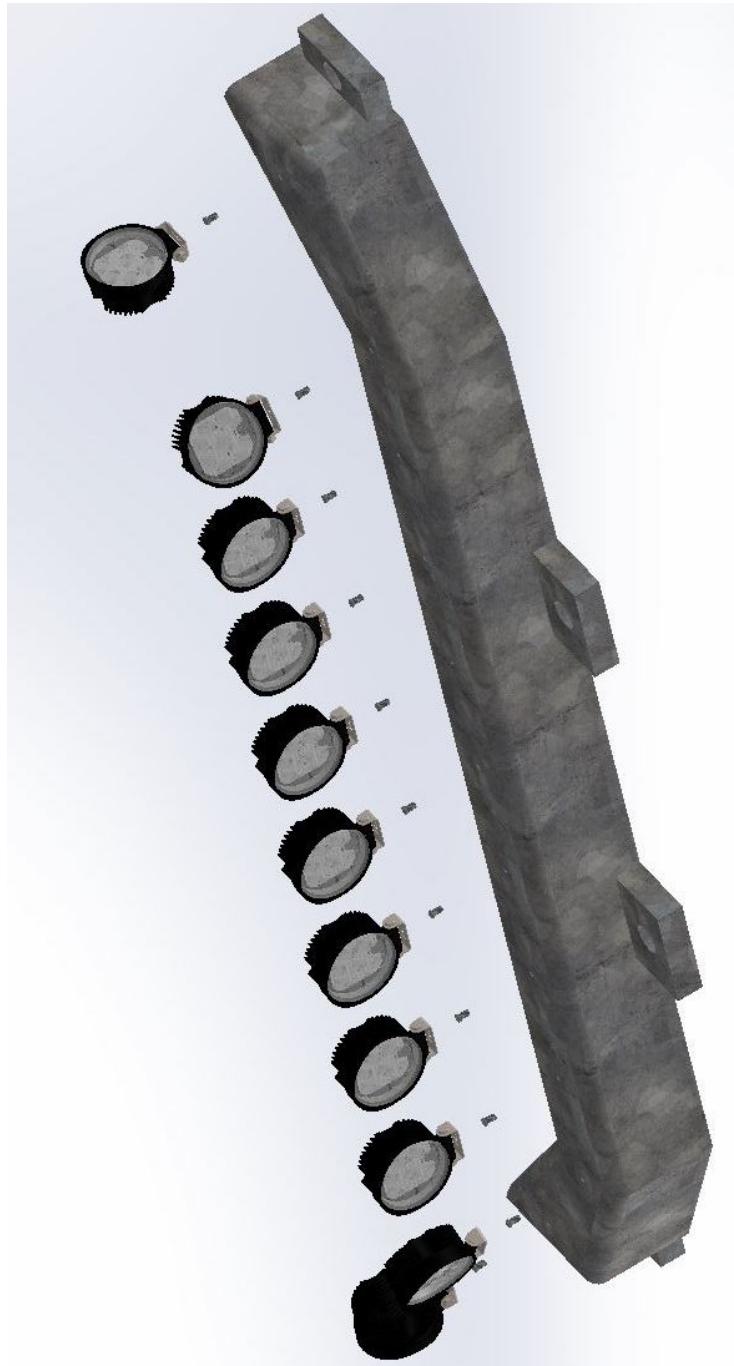


FIGURE 4.84: Sackett, Justin: Exploded View of Light Assembly

#### 4.3.4 Suspension



FIGURE 4.85: Hirani, Asimm: Exploded View of Suspension Assembly

#### 4.3.5 MechanicalDisplay



FIGURE 4.86: Kumar, Vishakh: Exploded View of Mechanical Display

#### 4.3.6 EmergencyButton

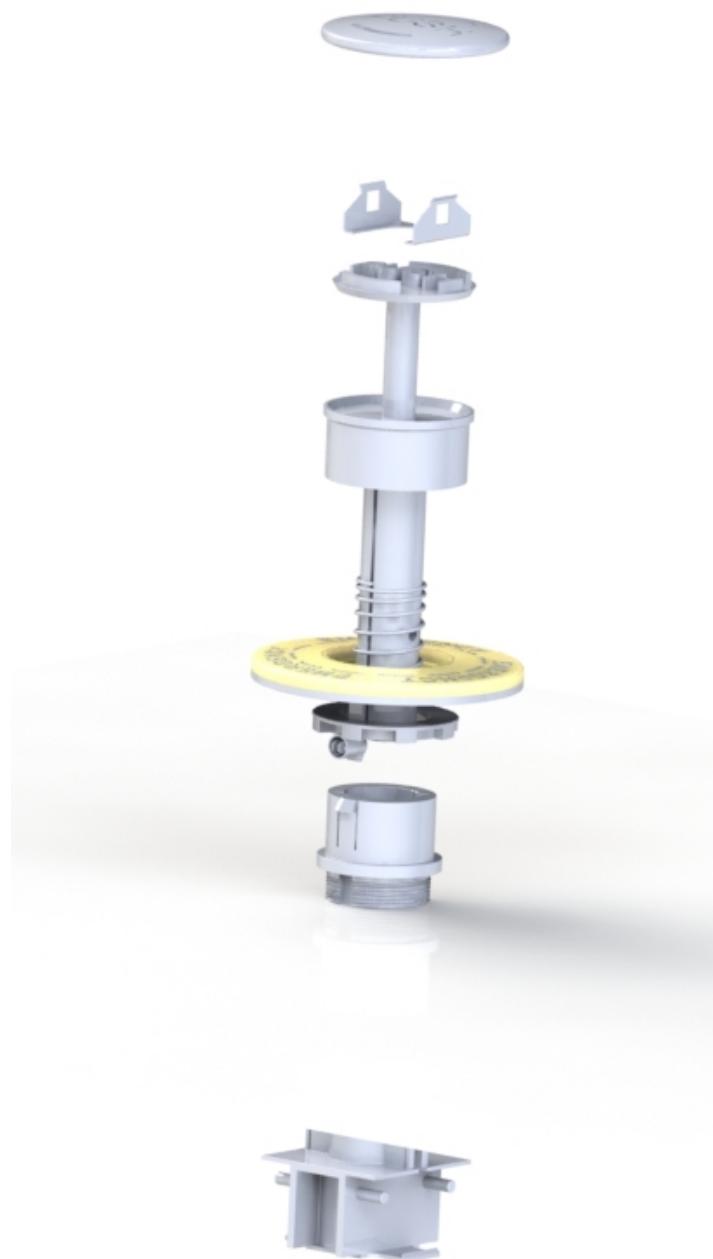


FIGURE 4.87: Kumar, Vishakh: Exploded View of Emergency Button

## 4.4 Part List

### 4.4.1 Antenna

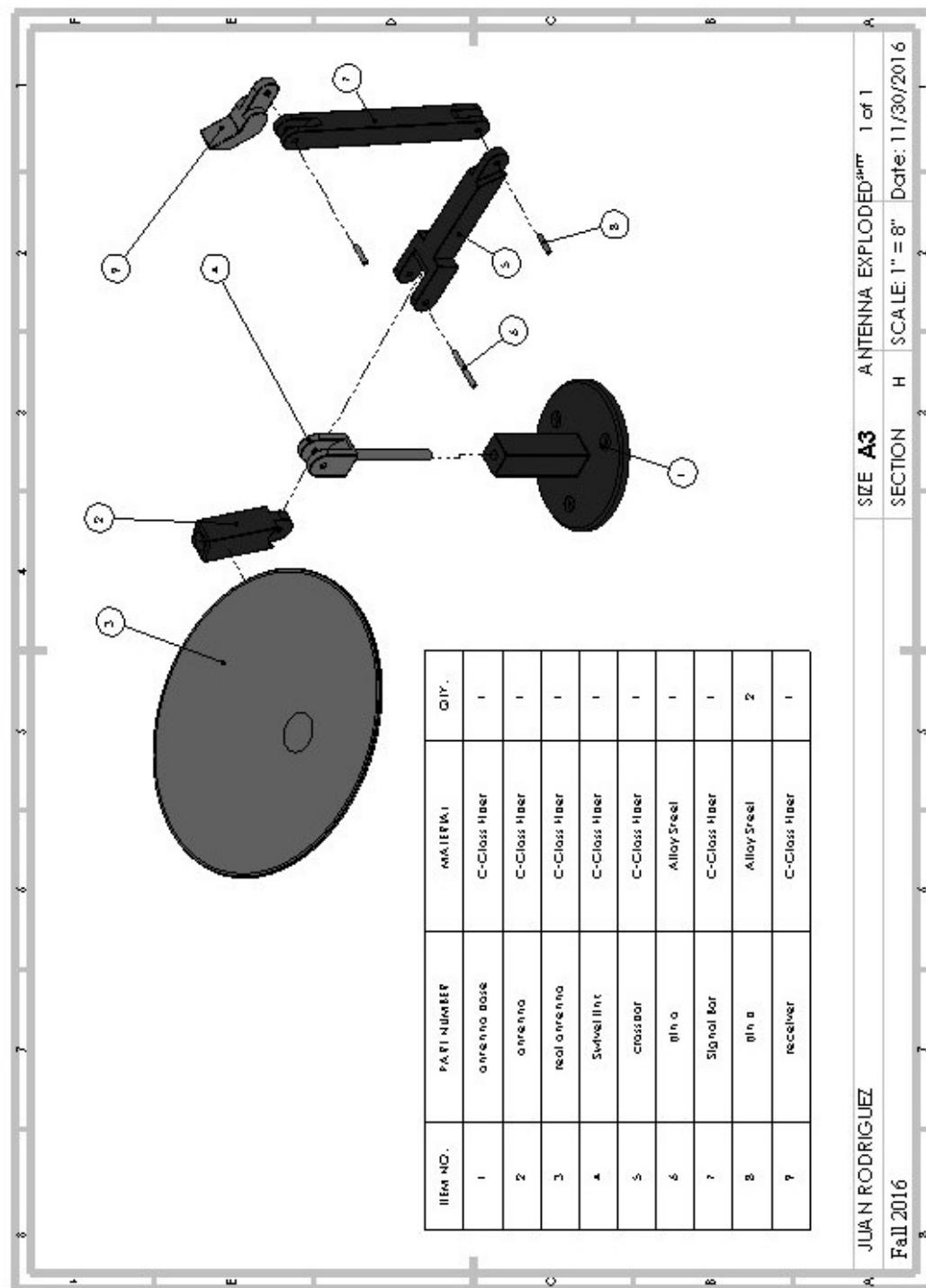


FIGURE 4.88: Rodriguez, Juan: Antenna

#### 4.4.2 Lights

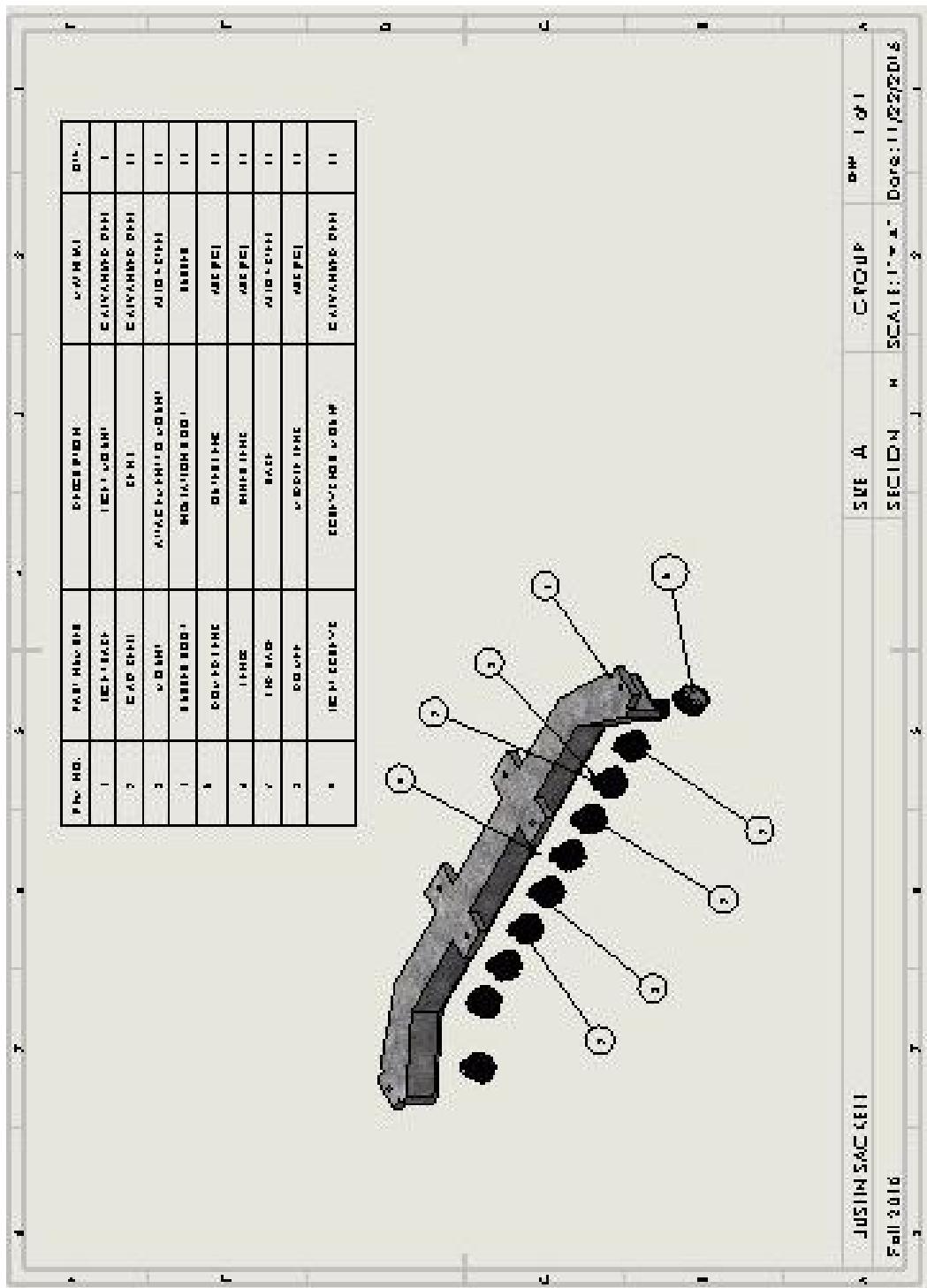


FIGURE 4.89: Sackett, Justin: Lights

#### 4.4.3 Suspension

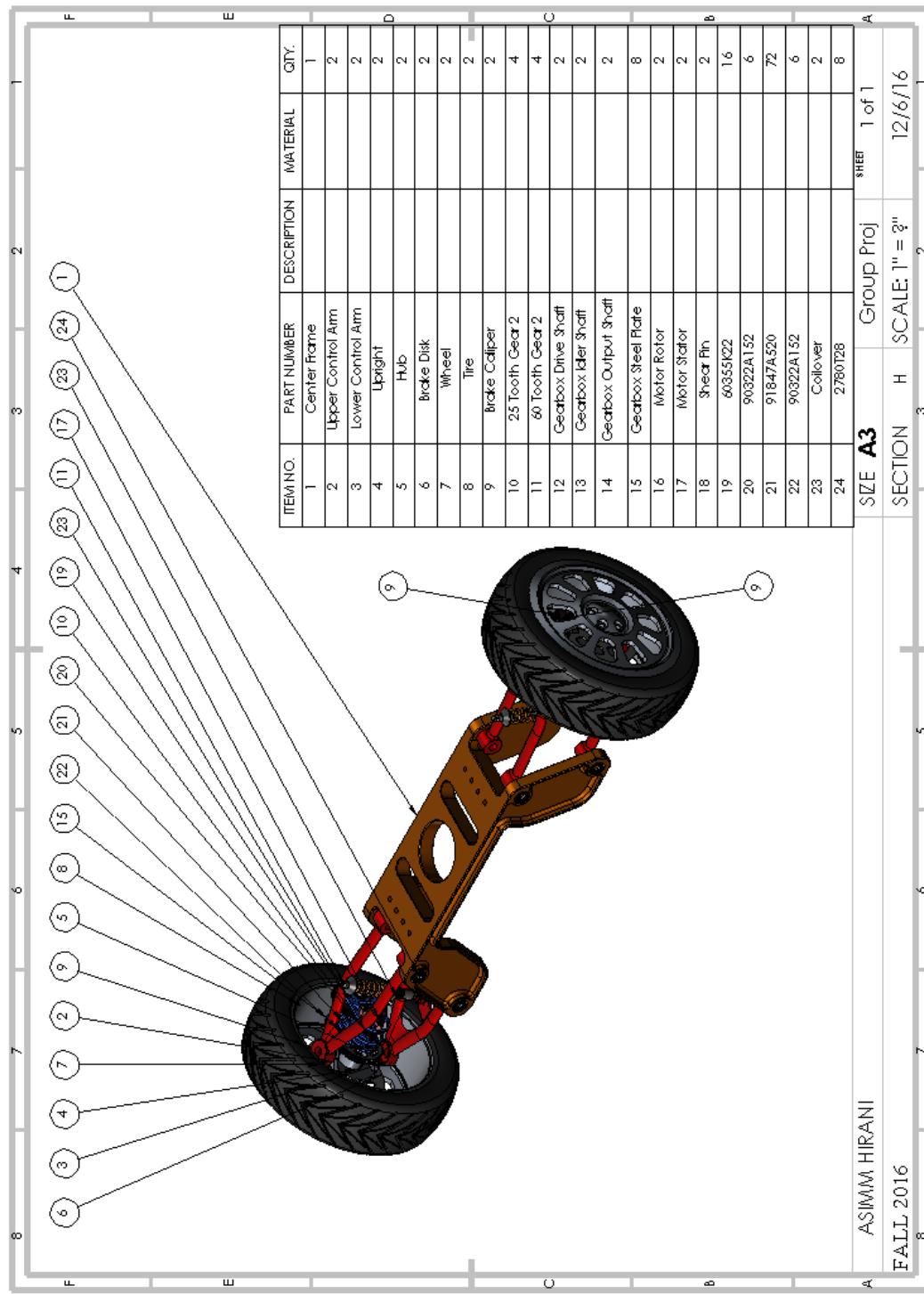


FIGURE 4.90: Hirani, Asimm: Suspension

#### 4.4.4 Grabbers

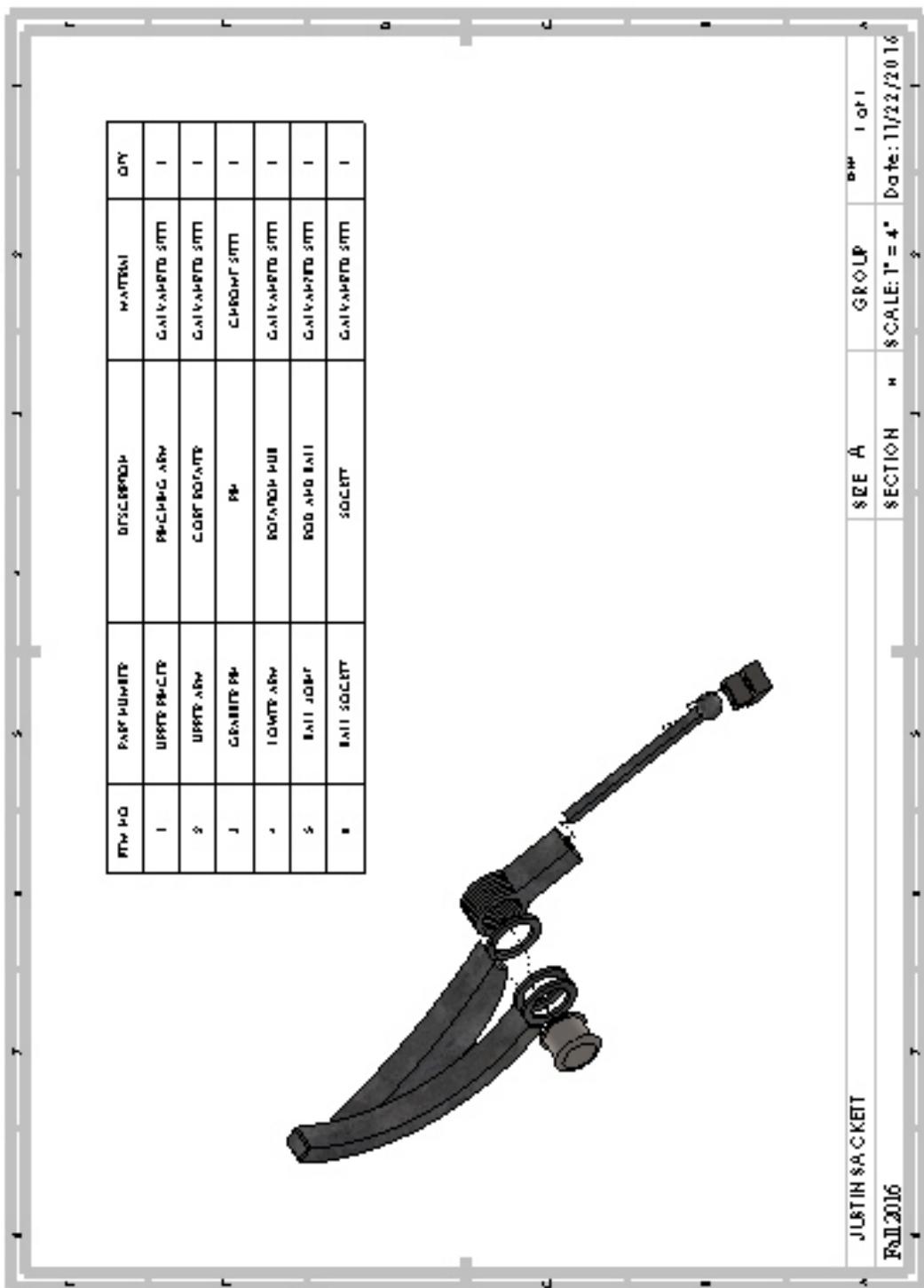


FIGURE 4.91: Sackett, Justin: Grabbers

#### 4.4.5 Emergency Button

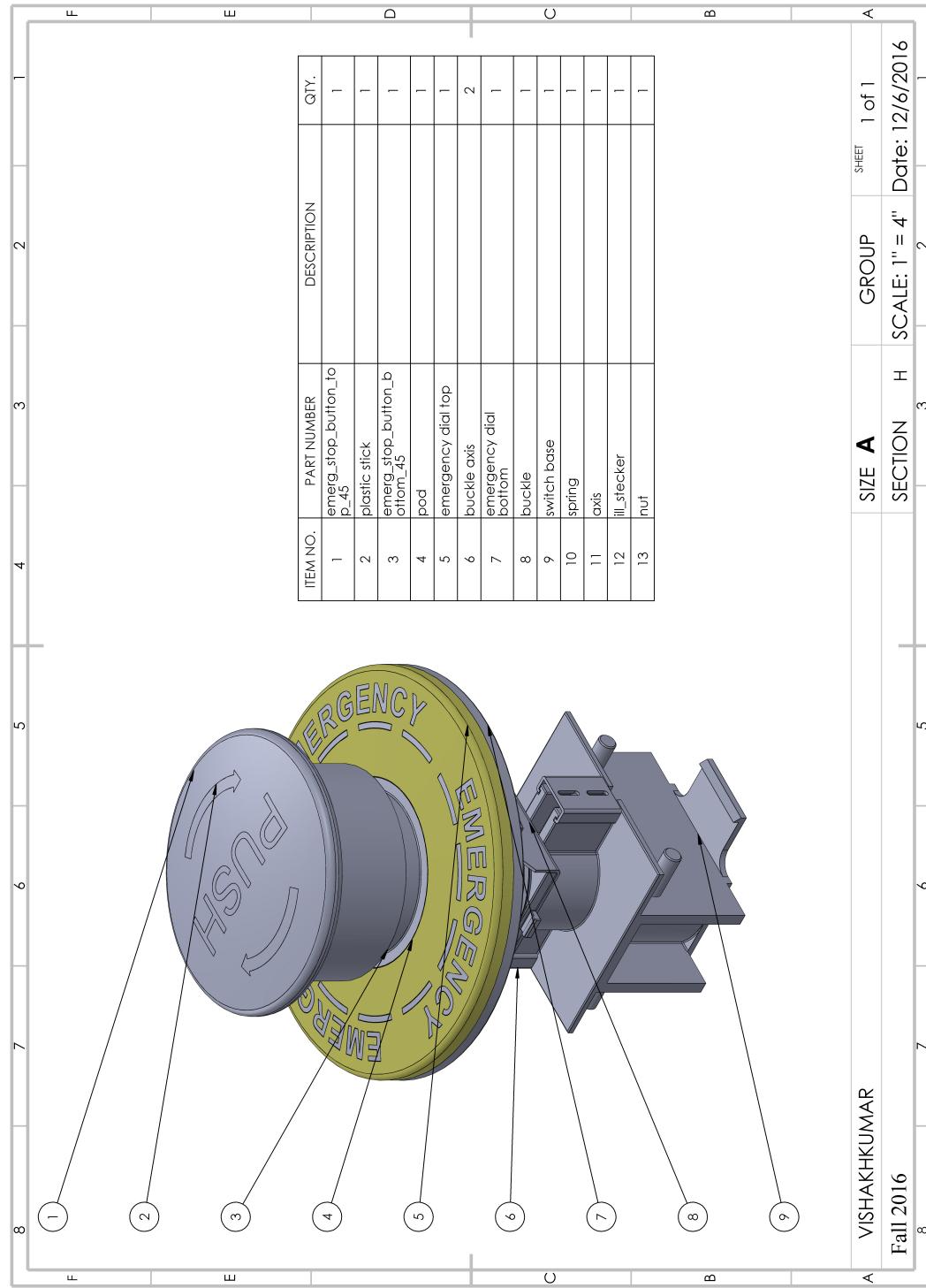


FIGURE 4.92: Kumar, Vishakh: Emergency Button

#### 4.4.6 Mechanical Display

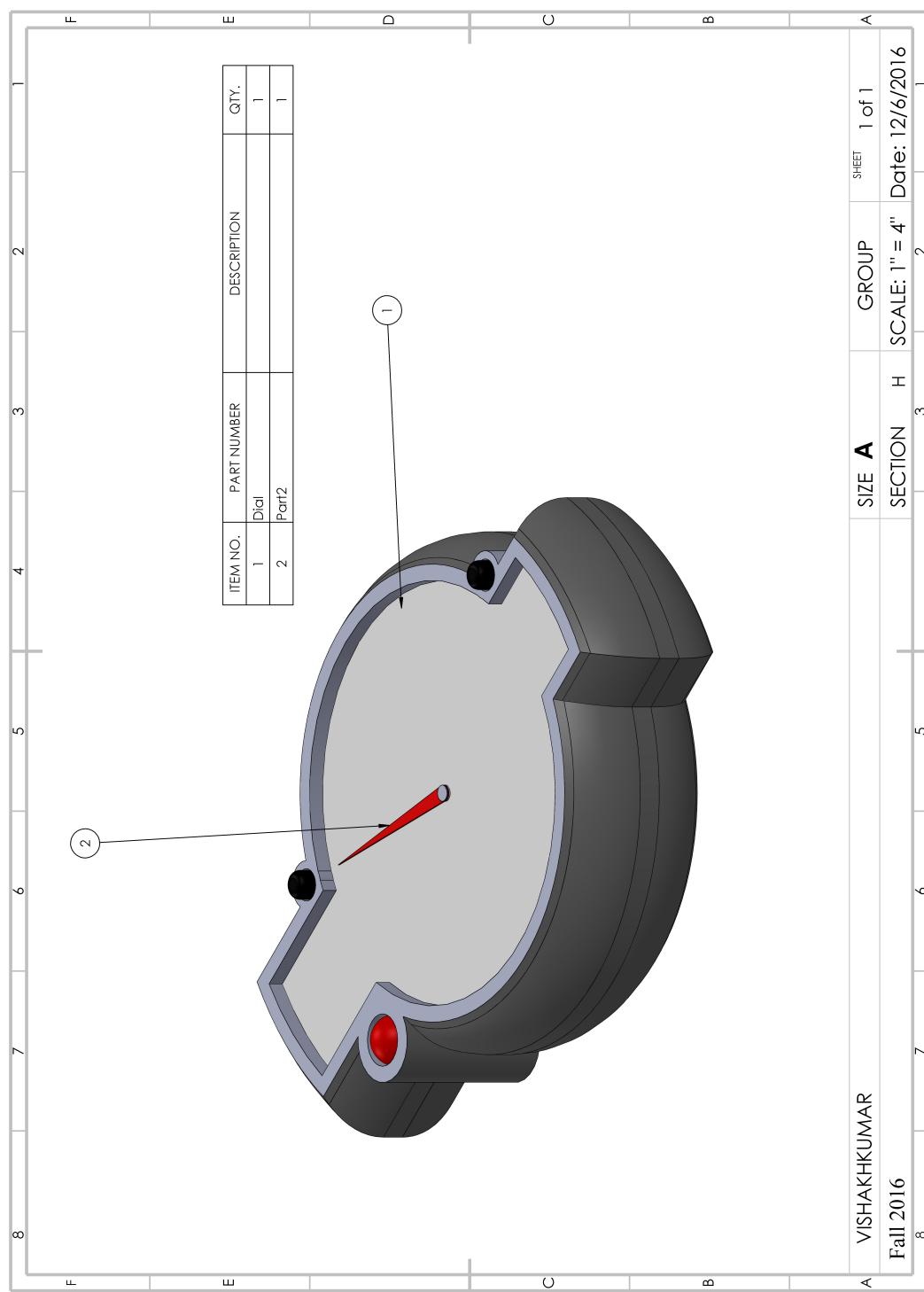


FIGURE 4.93: Kumar, Vishakh: MechanicalDisplay



## Chapter 5

# Check For Functionality

We shown how a few parts in our product can move, save for the obvious parts like wheels.

### 5.1 Mechanical Display

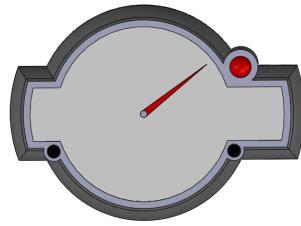
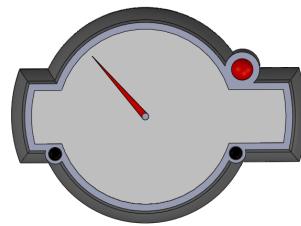


TABLE 5.1: Kumar, Vishakh: Mechanical Dial

The mechanical display has a pointer that can rotate via a constrained mate. In real life, this would be connected directly into critical subsystems of the Mars ATV - the astronaut would receive data even in the event of an electrical failure.

## 5.2 Antenna

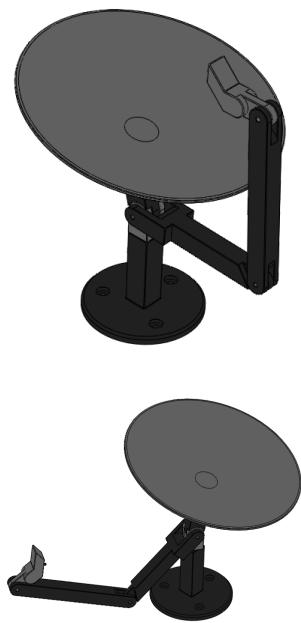


TABLE 5.2: Rodriguez, Juan: Antenna

The Antenna can rotate and change its shape. This aids in both storage and pointing the receiver at Earth.

### 5.3 Grabbers



TABLE 5.3: Sackett, Justin: Grabbers

The claws of the grabber can open and close.

## 5.4 Emergency Button

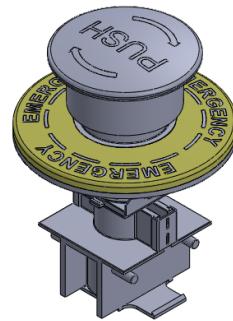
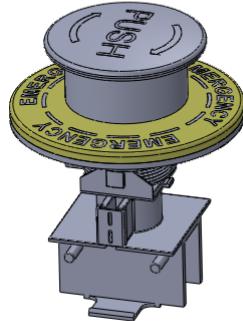


TABLE 5.4: Kumar, Vishakh: Emergency Button

The top of the emergency Button can move up and down. This serves as a mechanical way for the astronaut to shut down any system should the need arise.

## Chapter 6

# Summary And Concluding Remarks

### 6.1 Objective And Goal

The objective of our project was to create a functional high quality mars rover. However, we desired to create a rover much different than the current rovers. To do this we created a rover that was larger and had a higher impact strength. Additionally, our rover has better vision than previous rovers used by NASA. To accomplish this we designed a new and innovative cockpit that uses high performance glass which can survive in typical mars conditions. Additionally, we used grabbers on the front for moving debris out of the way and pick up large objects as necessary. There is a comprehensive joystick in the cockpit that controls the grabbers and the vehicle for a full 3D range of motion. Additionally, the science compartment is retrofitted with its own 3D printer for impromptu part creation as needed while on Mars. Our antenna is used for long distance communication back to earth. All in all, we feel that we achieved our goals of a realistic rover that is a viable option to create.

### 6.2 Course Comment

Throughout this project we faced many challenges in the SolidWORKS program. Each challenge needed a unique solution and helped us all to learn about many different features of SolidWORKS that we did not know prior to the project. For example, we gained experience and figured out how to work with subassemblies within a larger assembly. The problem we faced with this aspect was the fact that when subassemblies are placed into a final assembly they are unable to move within the subassembly unless they are made to be flexible. We went through a complex process to figure out how to make a subassembly flexible and also be able to be animated. During Visakh's creation of the cockpit, he learned a great deal on surface modeling techniques and how to best implement the different tools that surface modeling has to offer. Justin learned a great deal on how to create a functioning ball joint in SolidWORKS by using a axis to axis advanced angle mate.

Juan learned everything there is to know about 3d sketches with weldments. Asim figured out the intricate workings of suspensions. Also, Auston figured out how to use surface modeling as well which was taught to him by Visakh.

### **6.3 Team Experience**

We developed as a team as the project progressed. When we began the project we did not have any team meeting outside of class and did not have the communication network that we needed to complete the project proficiently. However, through team communication and organized team meeting we were able to get everyone on the same page and organized. This organizational structure of the group chat and team meeting are what made this project a great team experience. We were all passionate about our individual subassemblies, and strived to create the best project possible.

### **6.4 Course Suggestions**

The only suggestion we have about this project is to perhaps move the deadline for the group project a couple weeks prior to exam week to avoid conflicts amongst classes. This also helps group members be at group meetings as group members may need to study for another class.

## Appendix A

# Meeting Minutes

As a team, we used meetings to inform each other about our individual progress rather than use the time to develop our models. As such our meetings were often short and straight forward.

We've added an abridged version of our meeting notes. For a more complete version of the meeting notes, please refer the notes and log stored at <https://www.github.com/vishakhkumar.ME1770>

TABLE A.1: Meeting Minutes

DATE	MINUTES	DELIVERABLES FOR NEXT MEETING
11/3/16	Decide on Project Ideation and decide on division of labour.	<p>3 sketches per part</p> <ul style="list-style-type: none"> <li>– Conceptual</li> <li>– Isometric</li> <li>– Multiviews</li> </ul>
11/10/16	Sketches of all parts due and reviewed by Dr. Pucha	<ul style="list-style-type: none"> <li>– Begin modelling in Solidworks. Create basic subassemblies.</li> <li>– Communicate with adjoining subassemblies to discuss attachment structures.</li> </ul>
11/17/16	Finish all subassemblies. Request help from other members should such a need arise.	Finish final assemblies by Sunday.
11/24/16	Combine all subassemblies into final assembly.	Submit all subassemblies to Juan and Vishakh.
12/1/16	Finish solidworks drawings, renders and animation.	<p>Each team member must deliver (for each subassembly and part):</p> <ul style="list-style-type: none"> <li>– Solidworks Engineering Drawings</li> <li>– Part Renders</li> <li>– Animation</li> </ul>
12/8/16	Finish Final Report	Push final report to github and print before Friday.