

# GEORGIA INSTITUTE OF TECHNOLOGY

## PROJECT REPORT

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### GT Pioneer

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*Author:*  
Vishakh KUMAR

*Instructor:*  
Dr. Raghuram PUCHA

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

*in the*

Group X  
George W Woodruff School of Mechanical Engineering

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## 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>

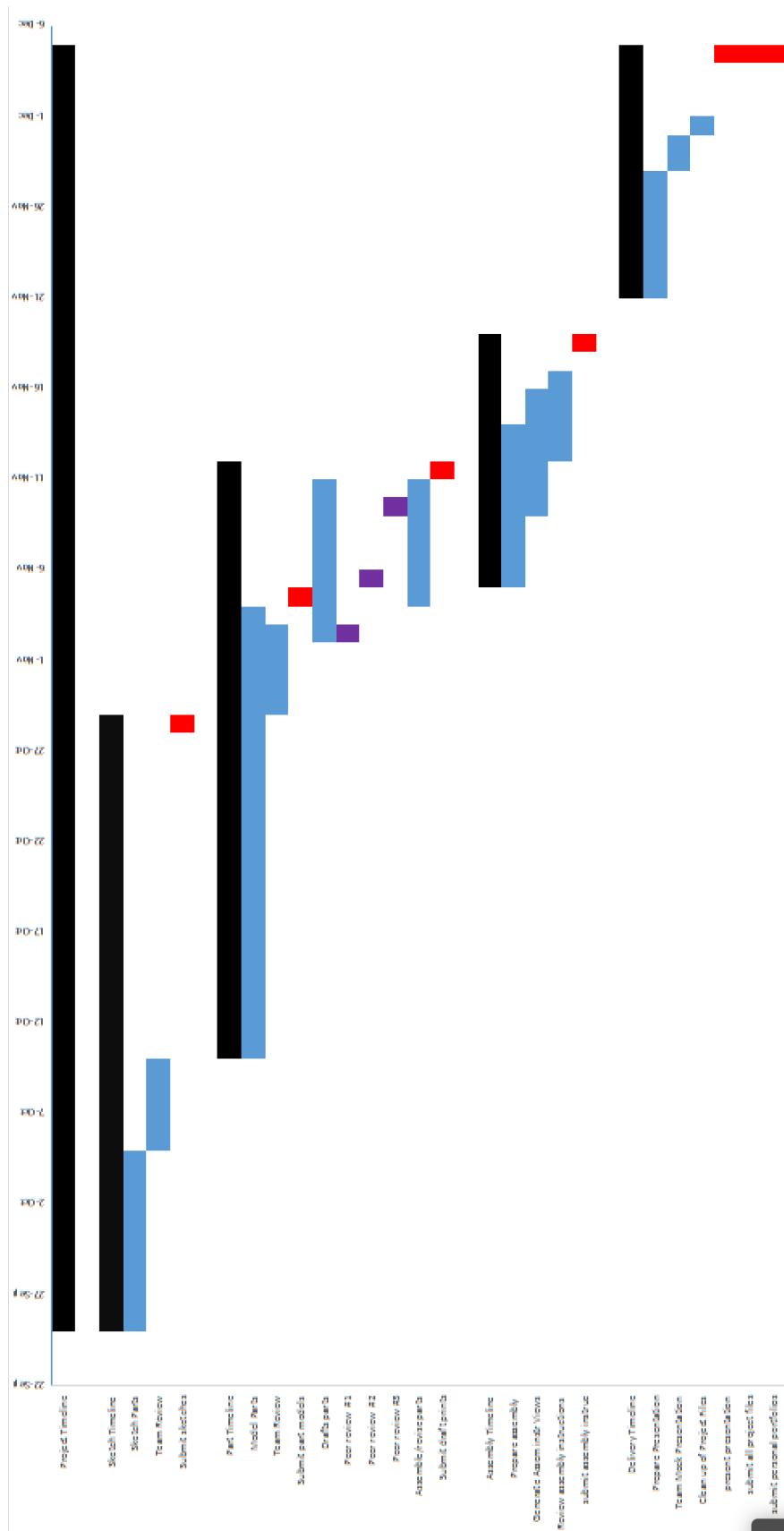


FIGURE 1.3: Gantt Chart



## 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

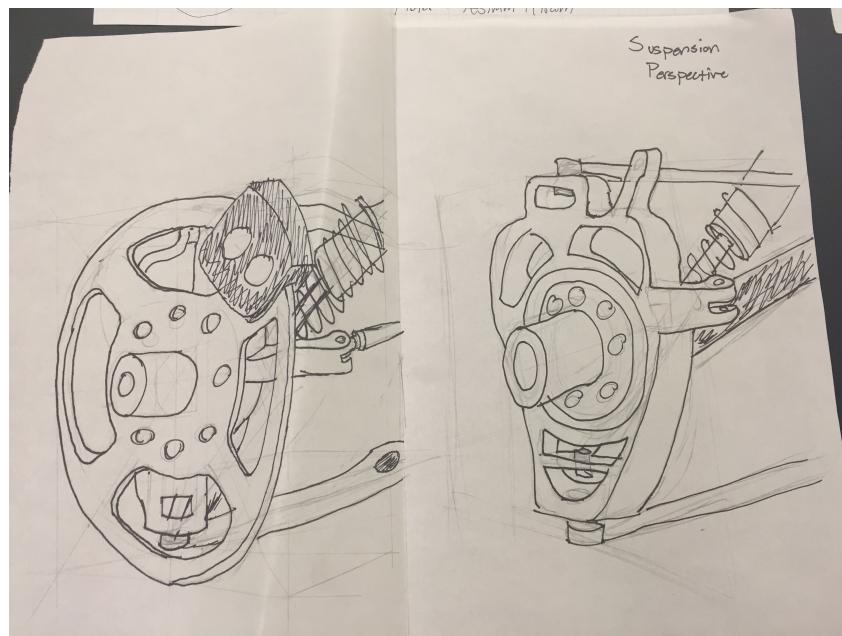


FIGURE 2.1: Hirani, Asimm: Suspension

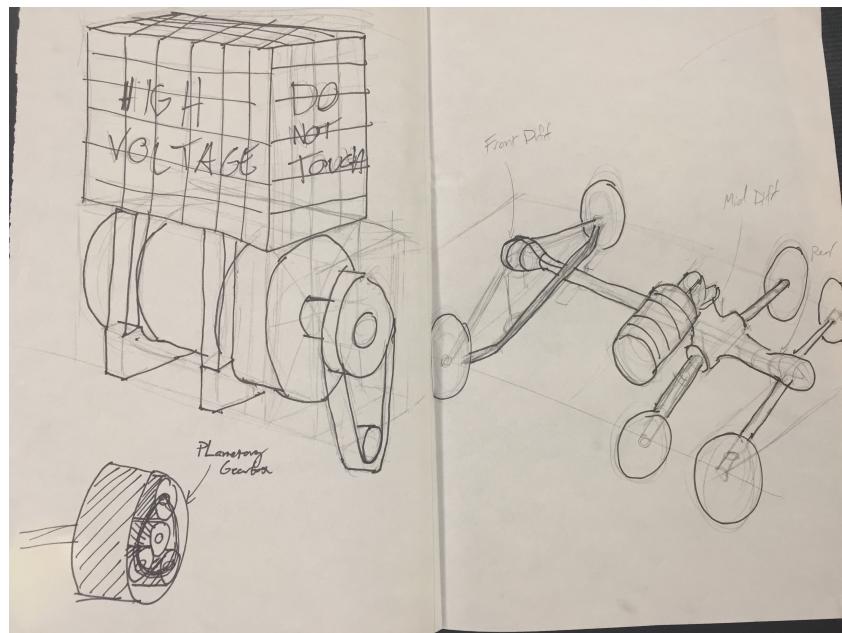


FIGURE 2.2: Hirani, Asimm: Powertrain

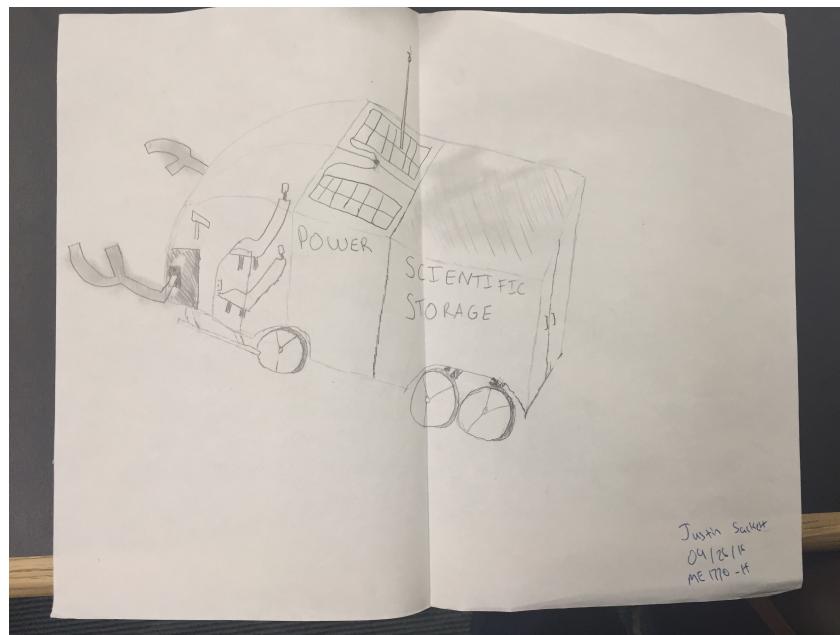


FIGURE 2.3: Hirani, Asimm: Scientiic Storage

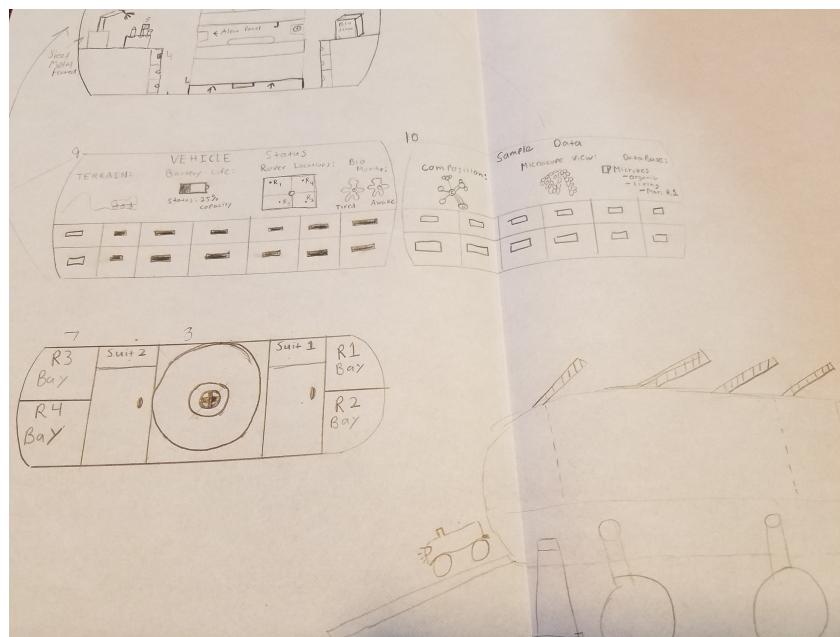


FIGURE 2.4: Kumar, Vishakh: Exterior

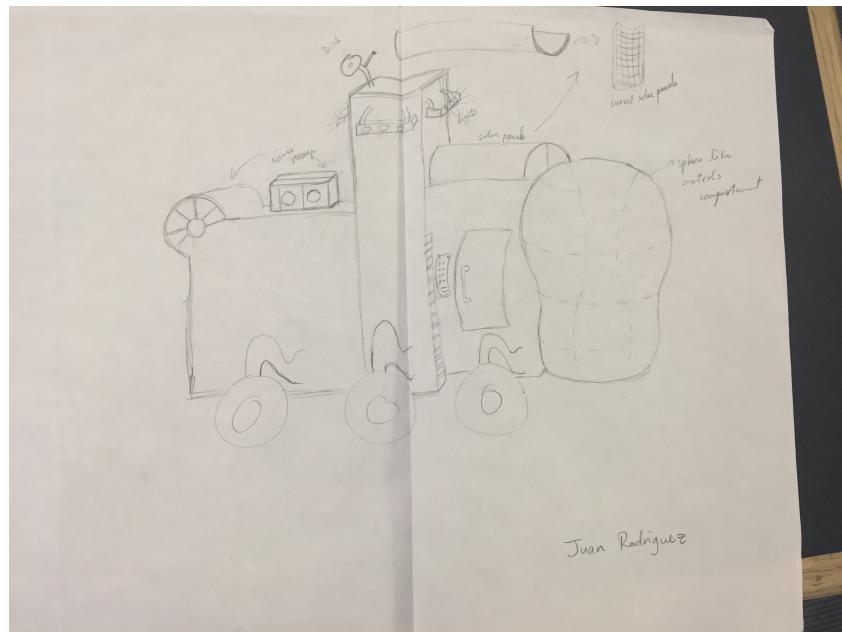


FIGURE 2.5: Rodriguez, Juan: Overview

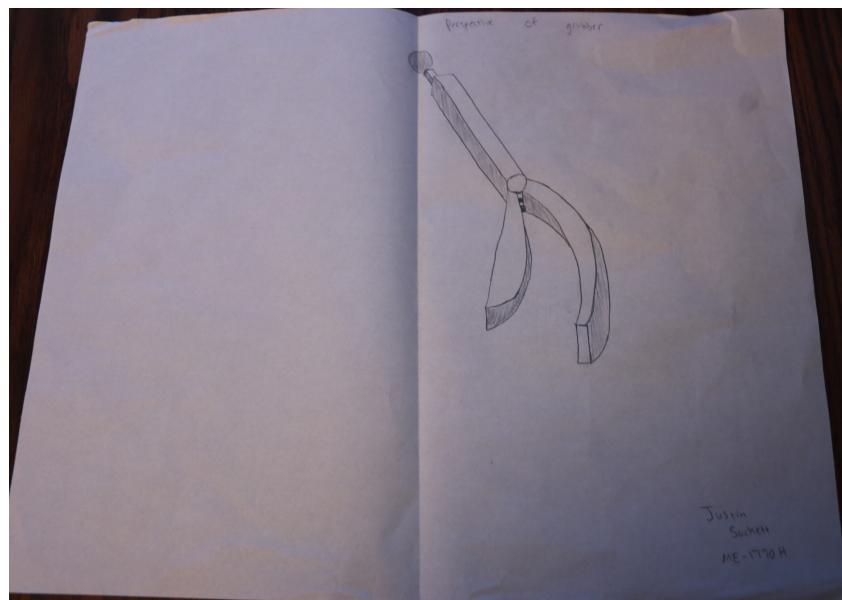


FIGURE 2.6: Sackett, Justin: Grabber

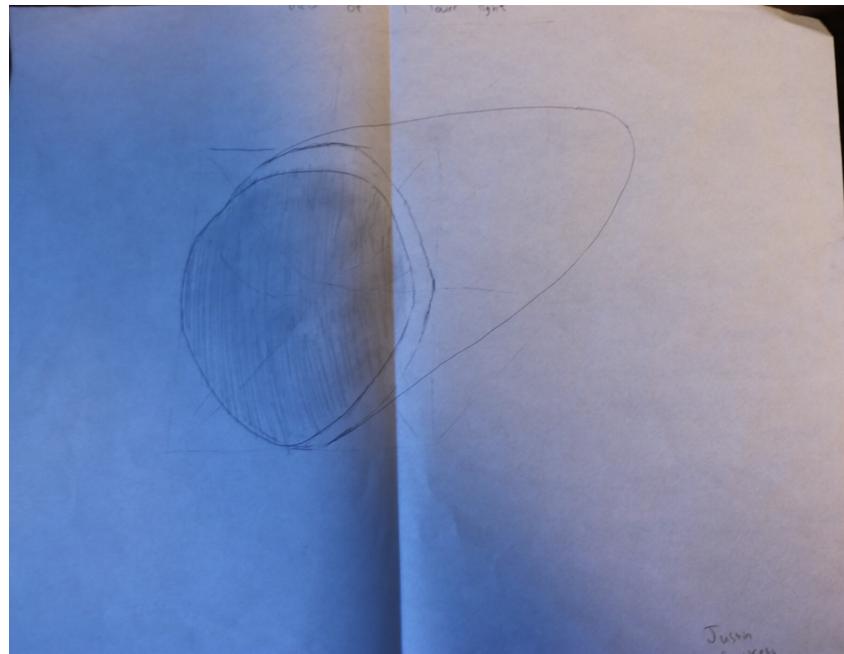


FIGURE 2.7: Sackett, Justin: Lights

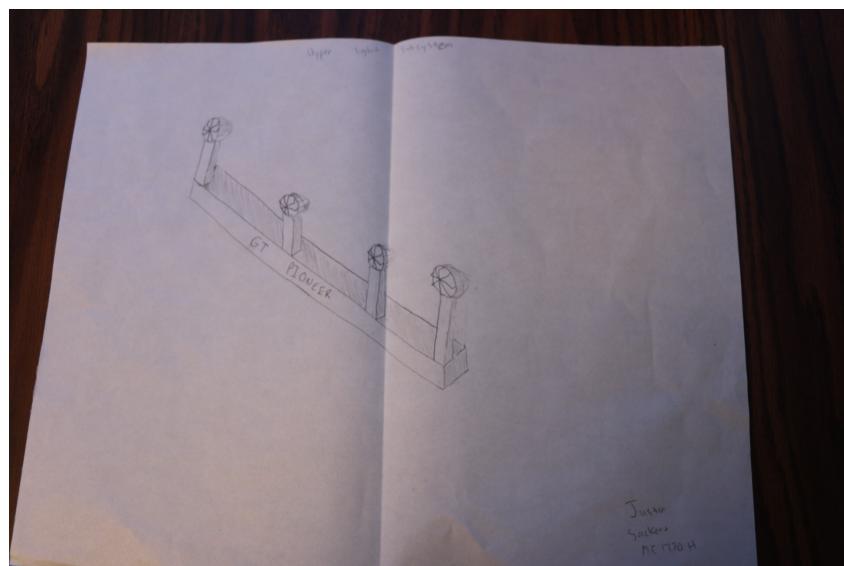


FIGURE 2.8: Sackett, Justin: Light Assembly

## 2.2 Perspective Sketches

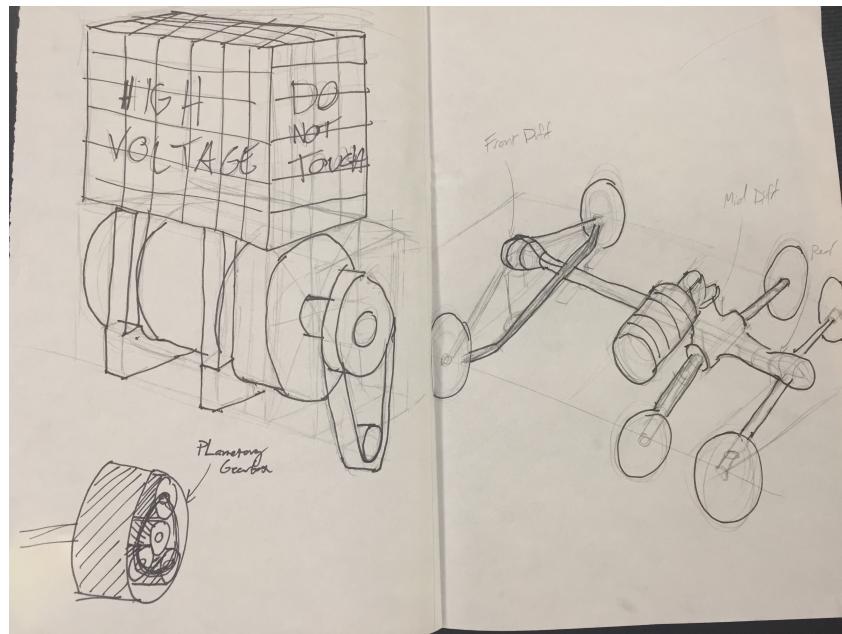


FIGURE 2.9: Hirani, Asimm: Suspension

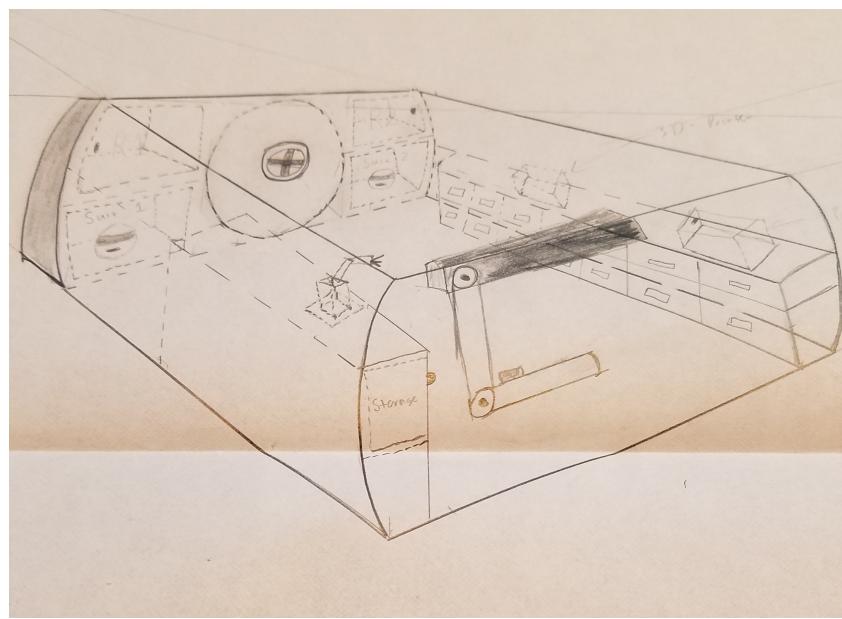


FIGURE 2.10: Ferrarer, Auston: Exterior

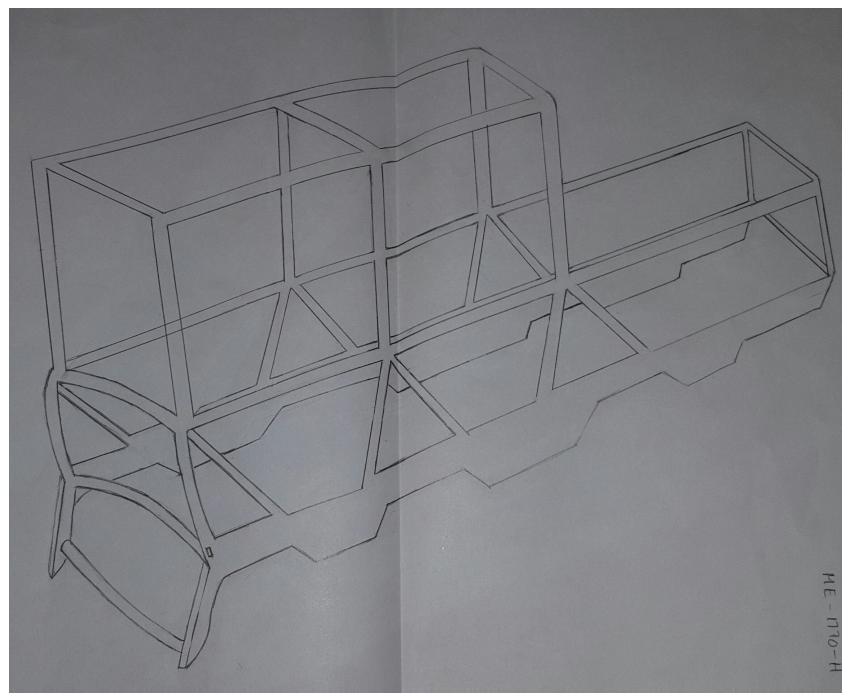


FIGURE 2.11: Rodriguez, Juan: Chassis

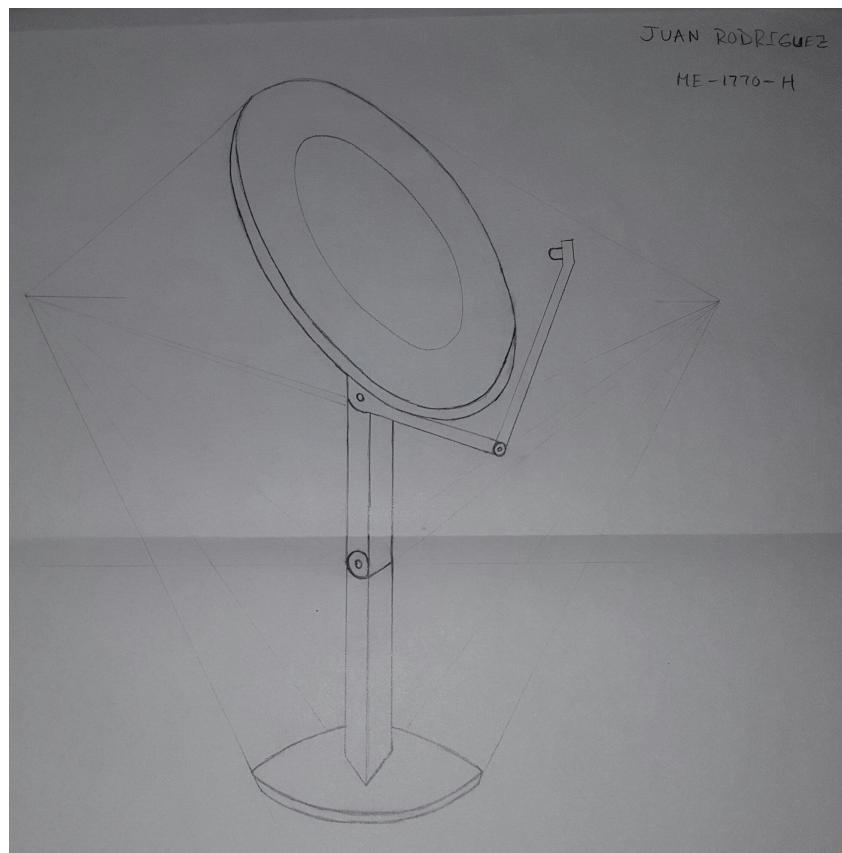


FIGURE 2.12: Rodriguez, Juan: Antenna

## 2.3 Multiview Sketches

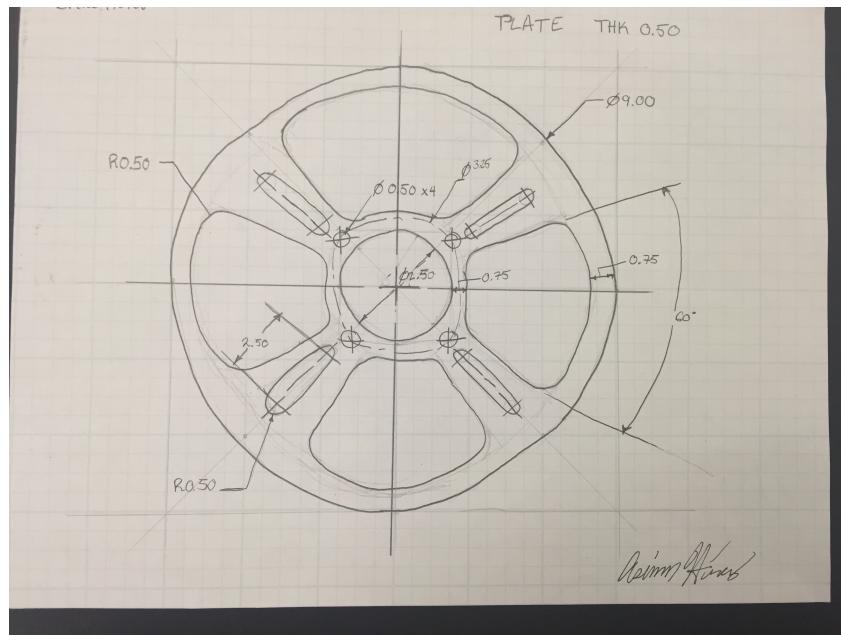


FIGURE 2.13: Hirani, Asimm: Gear One

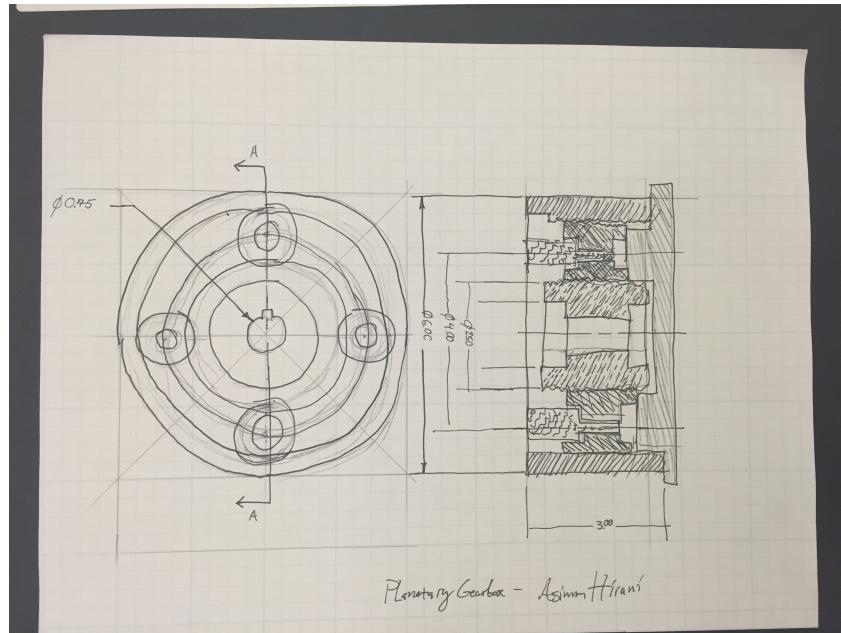


FIGURE 2.14: Hirani, Asimm: Disc Brake

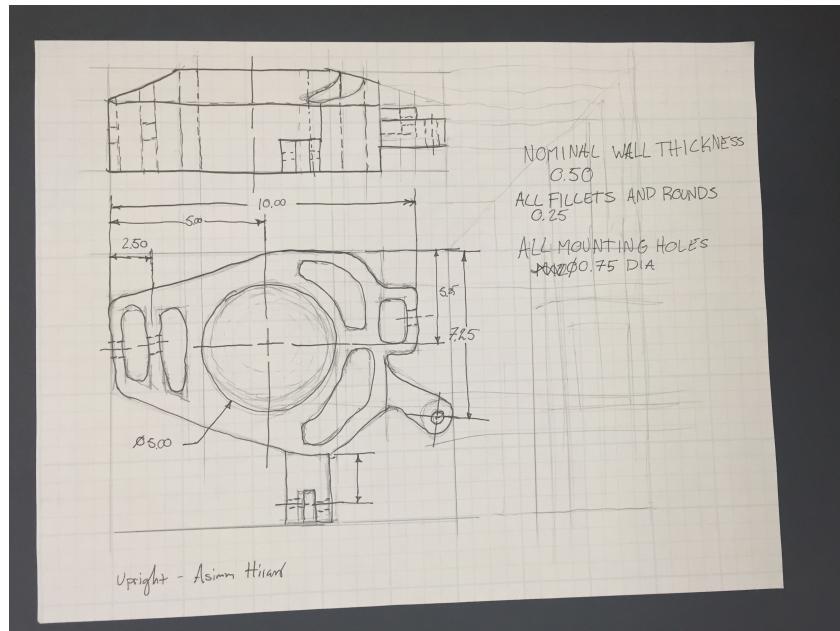


FIGURE 2.15: Hirani, Asimm: Upright

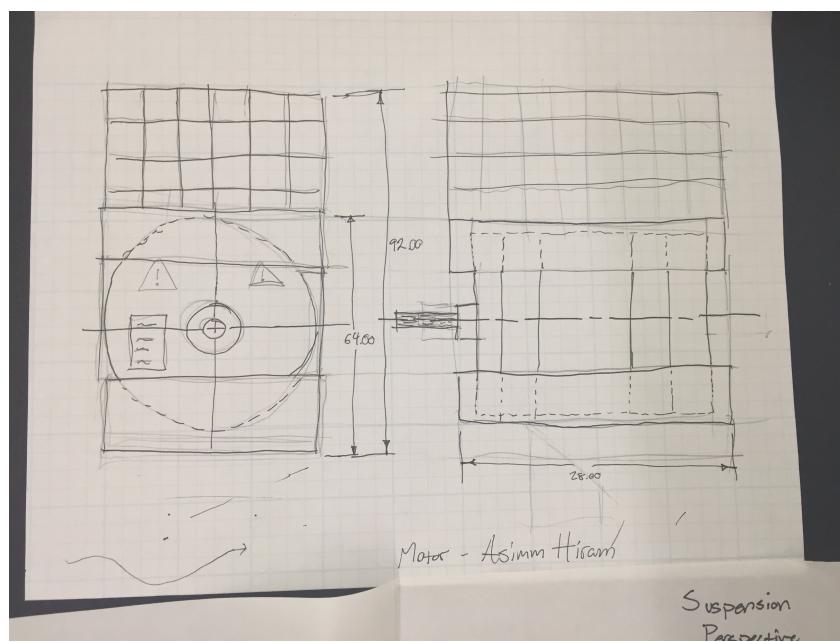


FIGURE 2.16: Hirani, Asimm: Motor

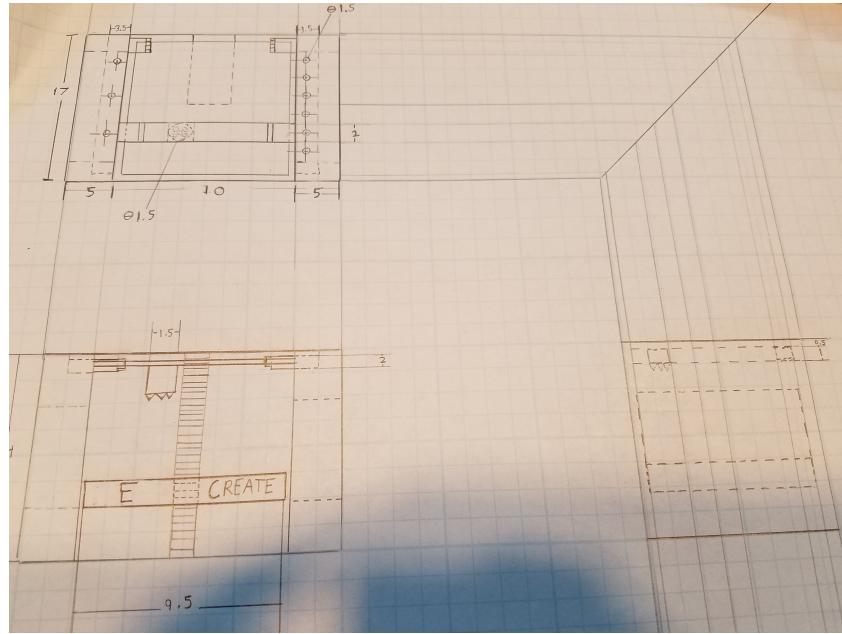


FIGURE 2.17: Ferrarer, Auston: 3D Printer

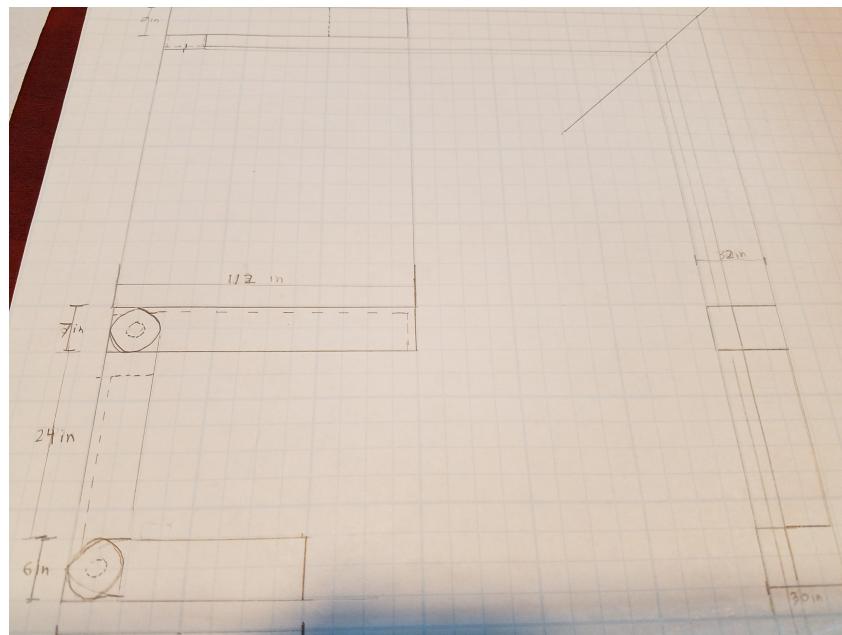


FIGURE 2.18: Ferrarer, Auston: Bed

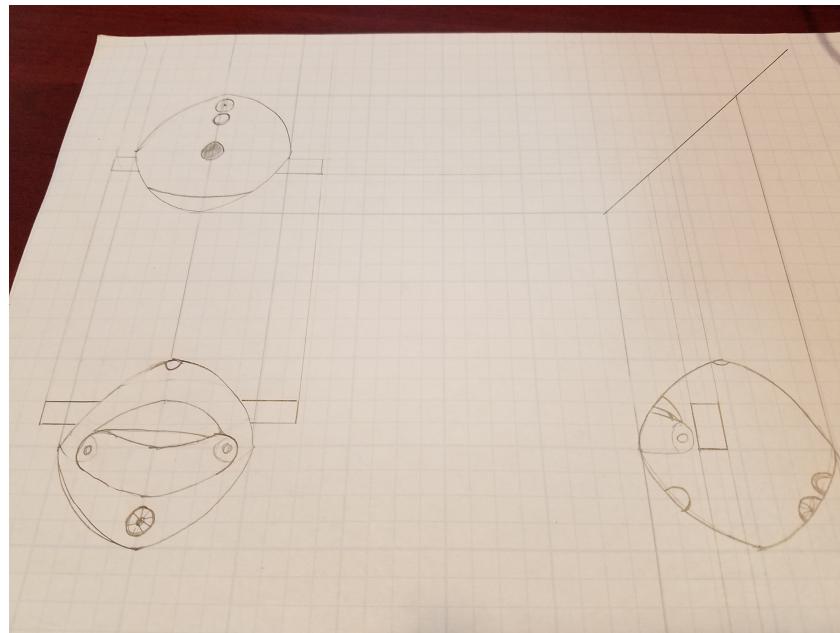


FIGURE 2.19: Ferrarer, Auston: Helmet

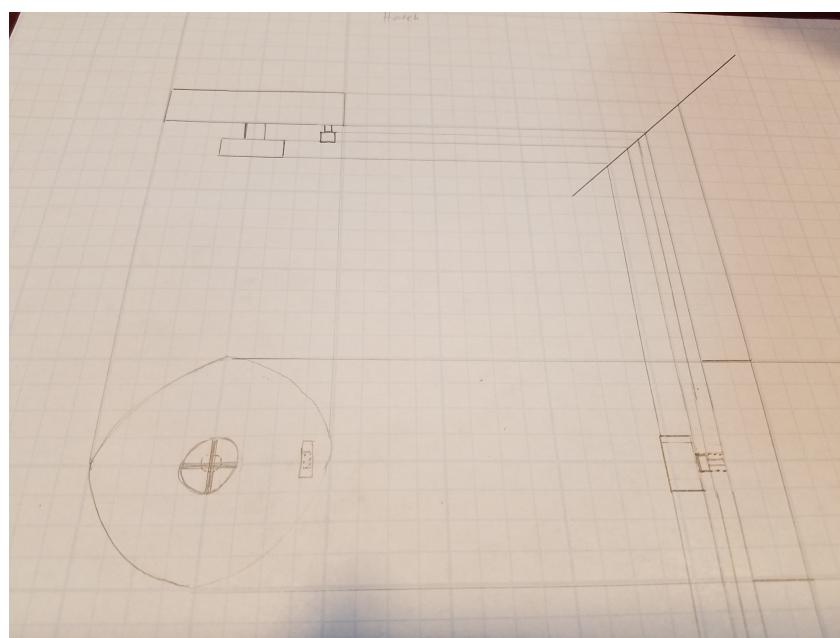


FIGURE 2.20: Ferrarer, Auston: Rear Hatch

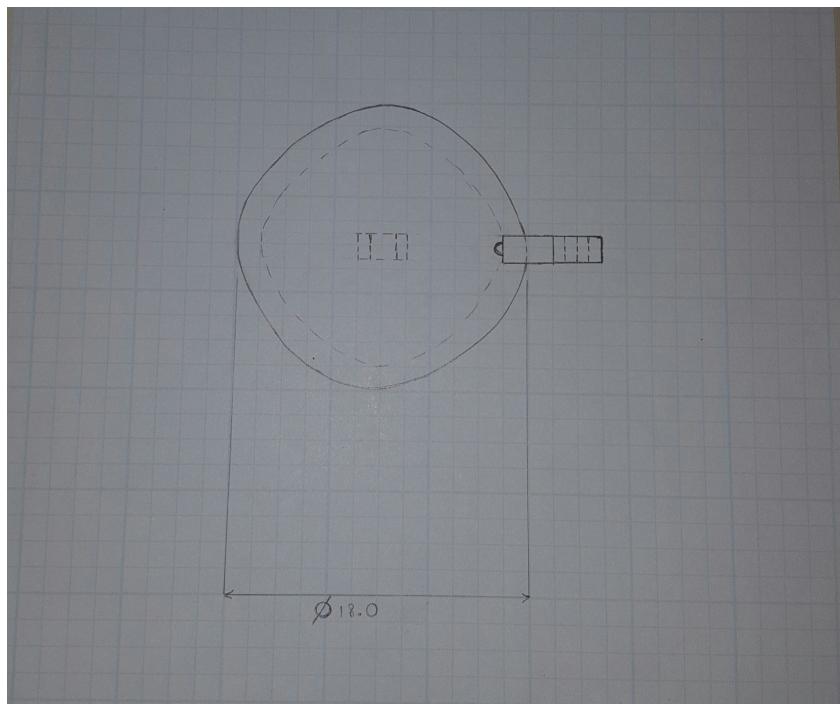


FIGURE 2.21: Rodriguez, Juan: Antenna

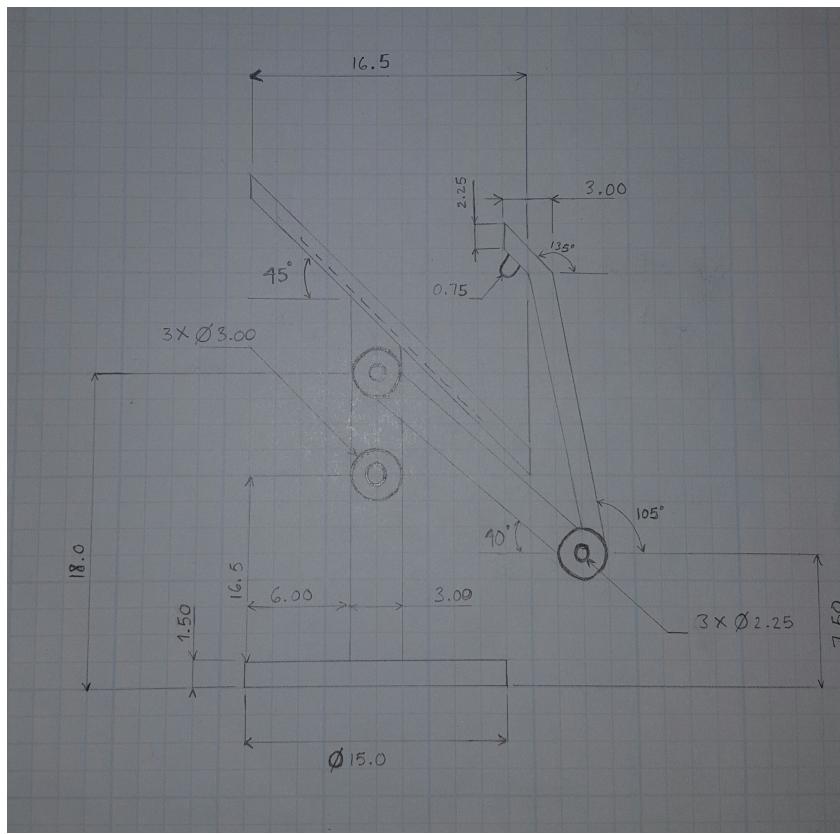


FIGURE 2.22: Rodriguez, Juan: Antenna

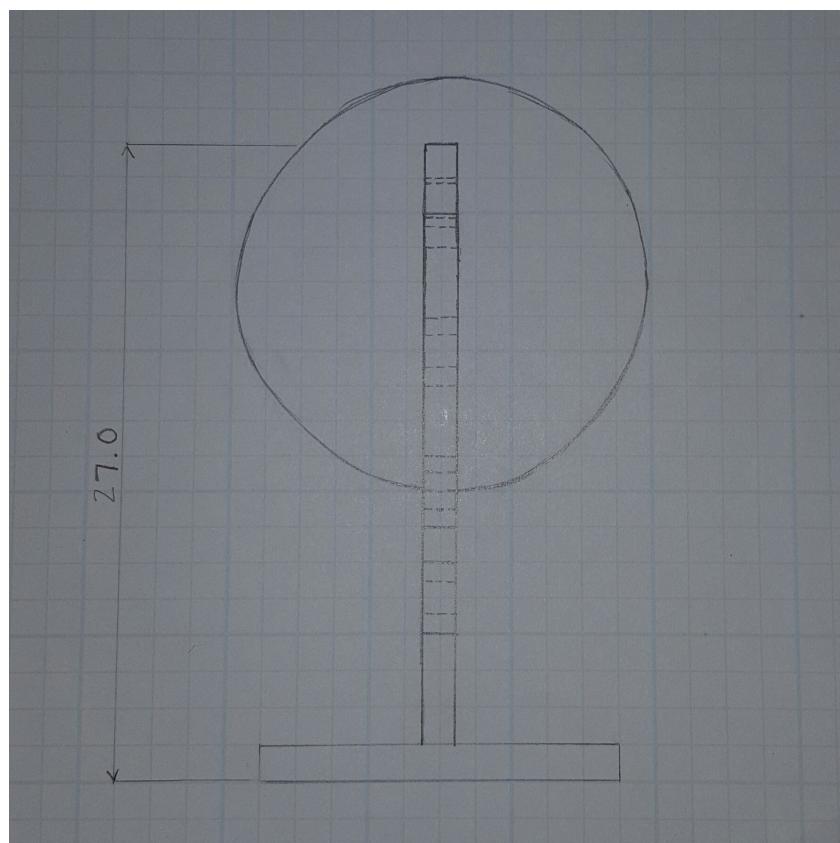


FIGURE 2.23: Rodriguez, Juan: Antenna

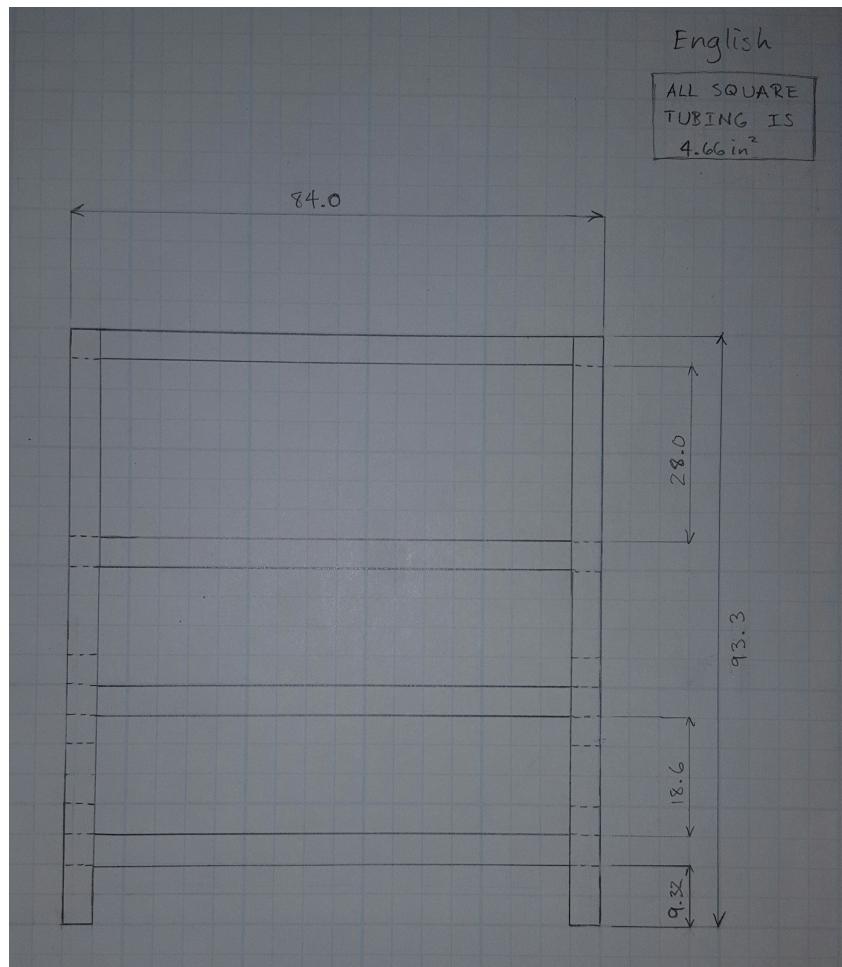


FIGURE 2.24: Rodriguez, Juan: Chassis

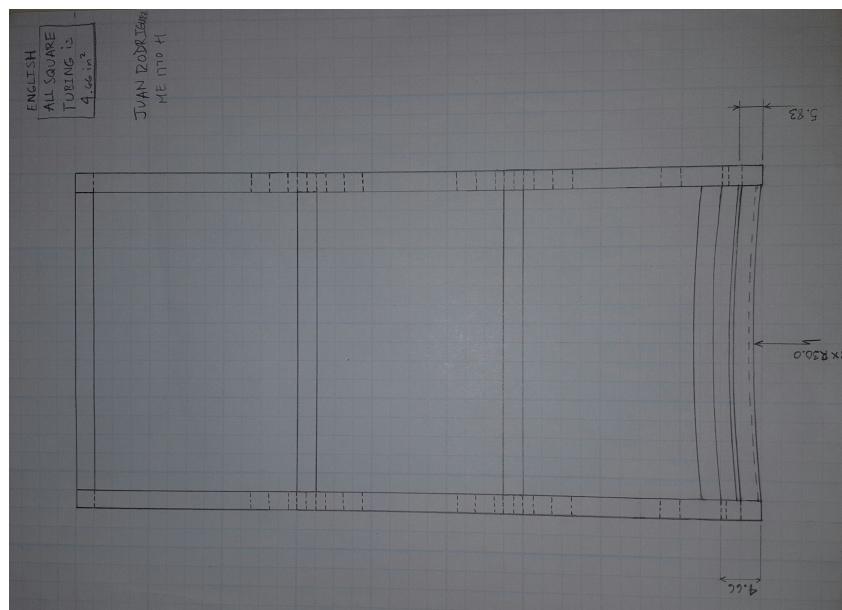


FIGURE 2.25: Rodriguez, Juan: Chassis

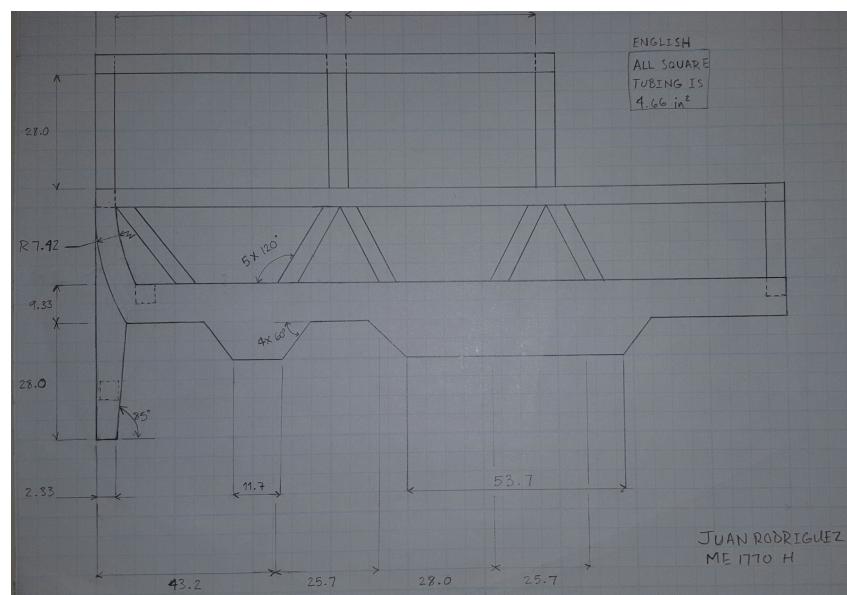


FIGURE 2.26: Rodriguez, Juan: Chassis



## Chapter 3

# Detail Design

### 3.1 Seat



FIGURE 3.1: Kumar, Vishakh: Seat View 1

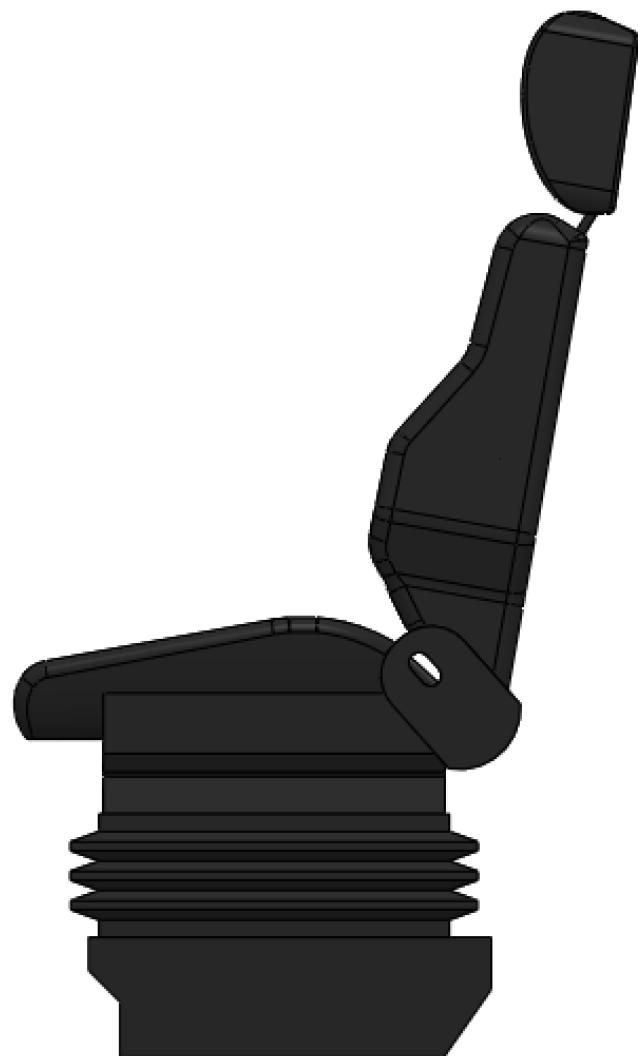


FIGURE 3.2: Kumar, Vishakh: Seat View 2

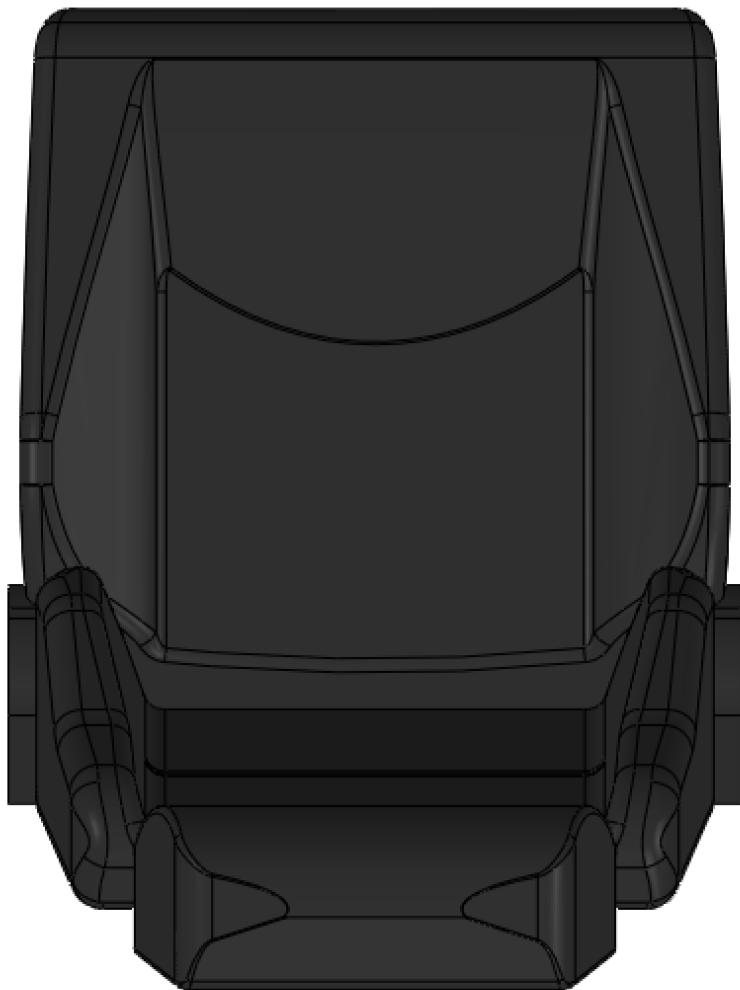


FIGURE 3.3: Kumar, Vishakh: Seat View 3

### 3.2 Bed

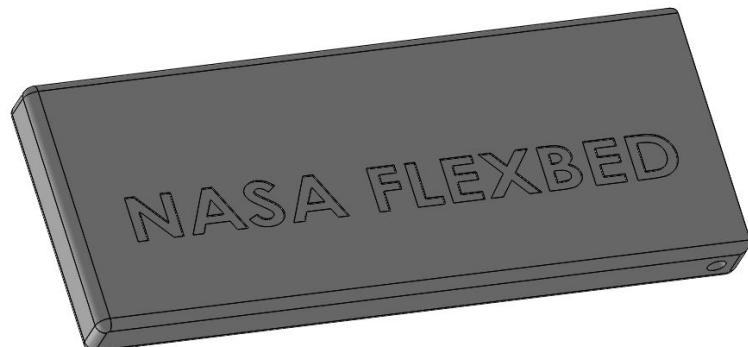


FIGURE 3.4: Ferrarer, Auston: Mattress

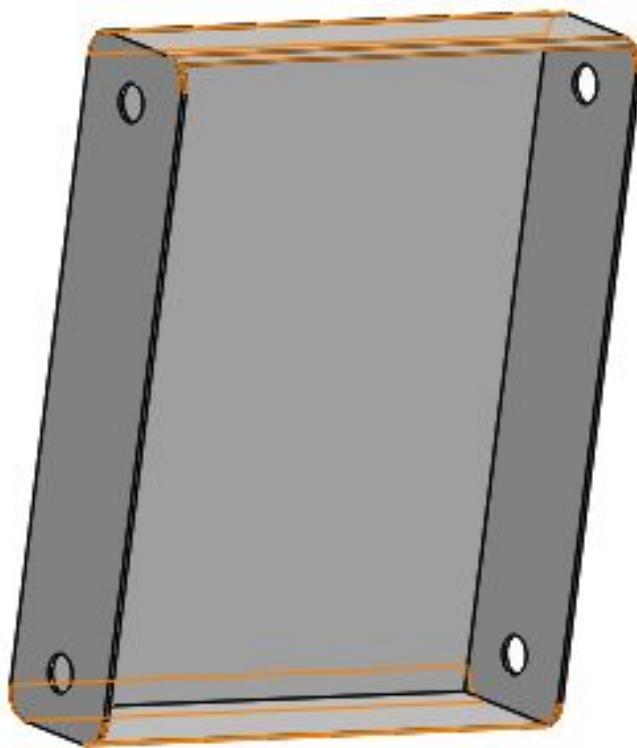


FIGURE 3.5: Ferrarer, Auston: Slide Bracket



FIGURE 3.6: Ferrarer, Auston: Sliding Bolt

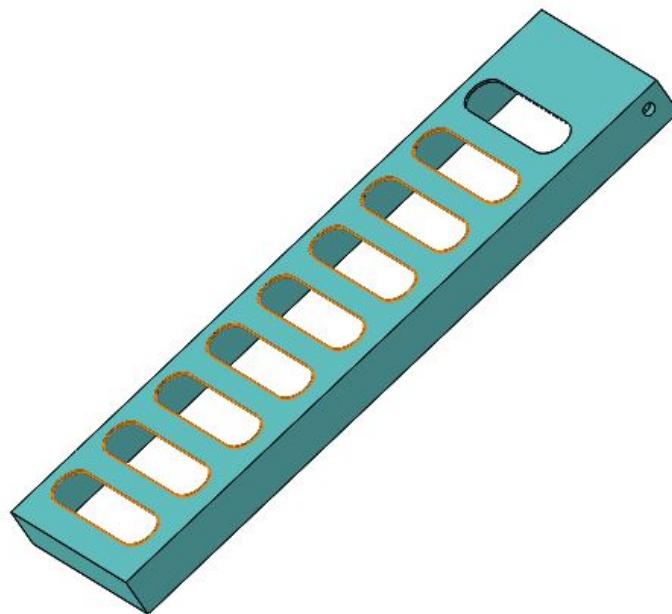


FIGURE 3.7: Ferrarer, Auston: Top Bed Bracket

### 3.3 Door and Exterior

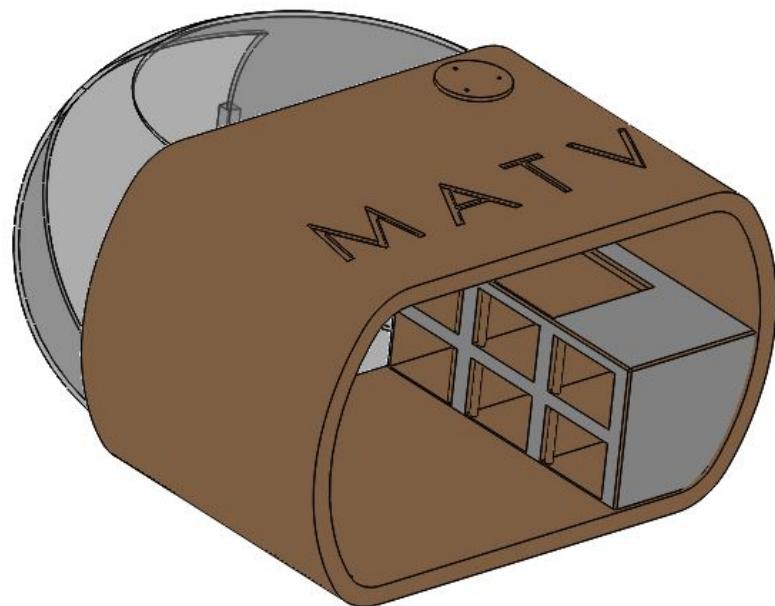


FIGURE 3.8: Ferrarer, Auston: Exterior Structure

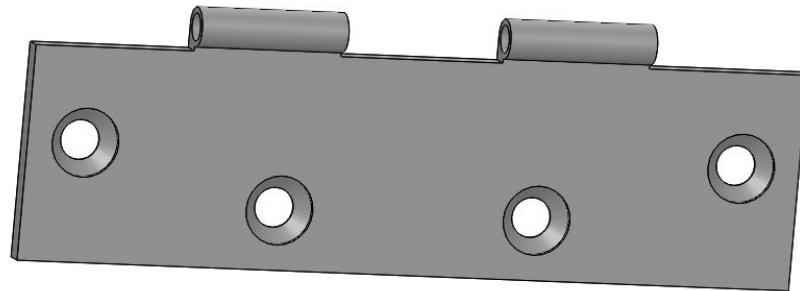


FIGURE 3.9: Ferrarer, Auston: Hinge Right Side

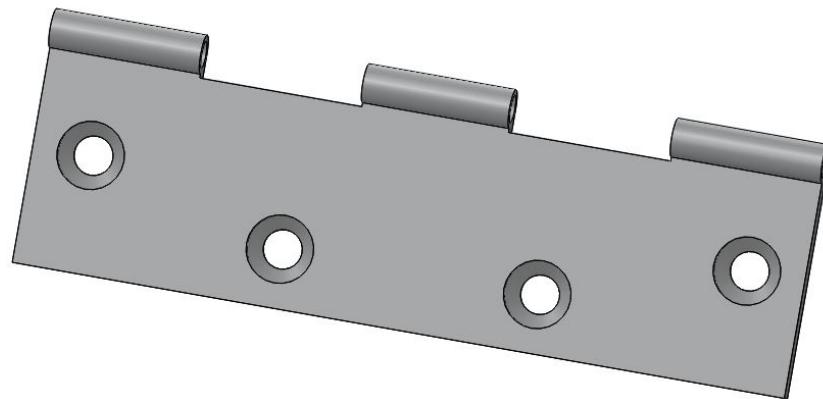


FIGURE 3.10: Ferrarer, Auston: Hinge Left Side



FIGURE 3.11: Ferrarer, Auston: Pin

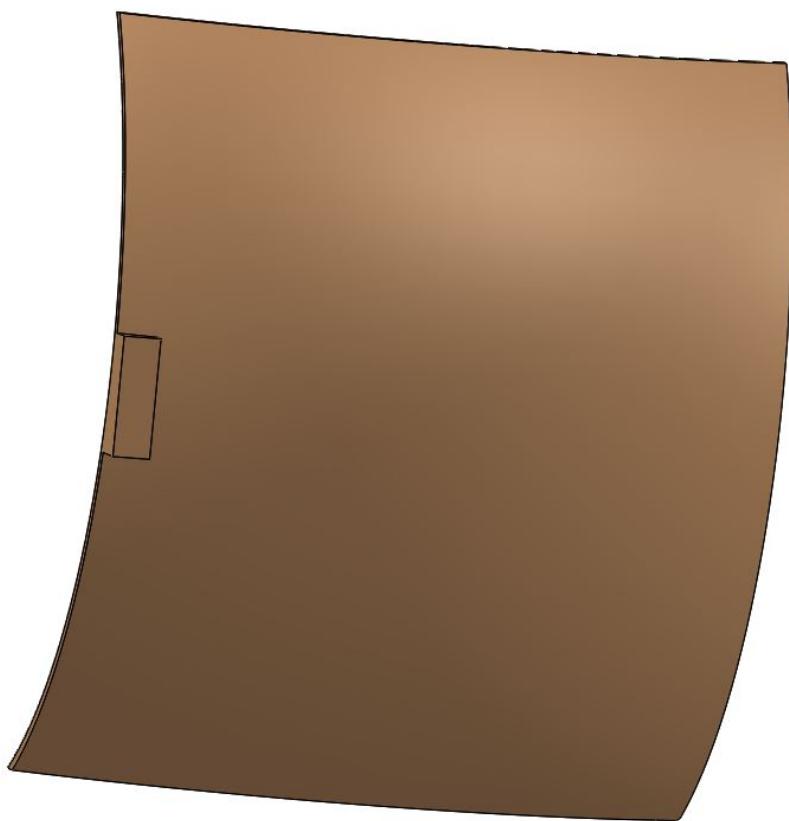


FIGURE 3.12: Ferrarer, Auston: Rear Door

### 3.4 Cockpit

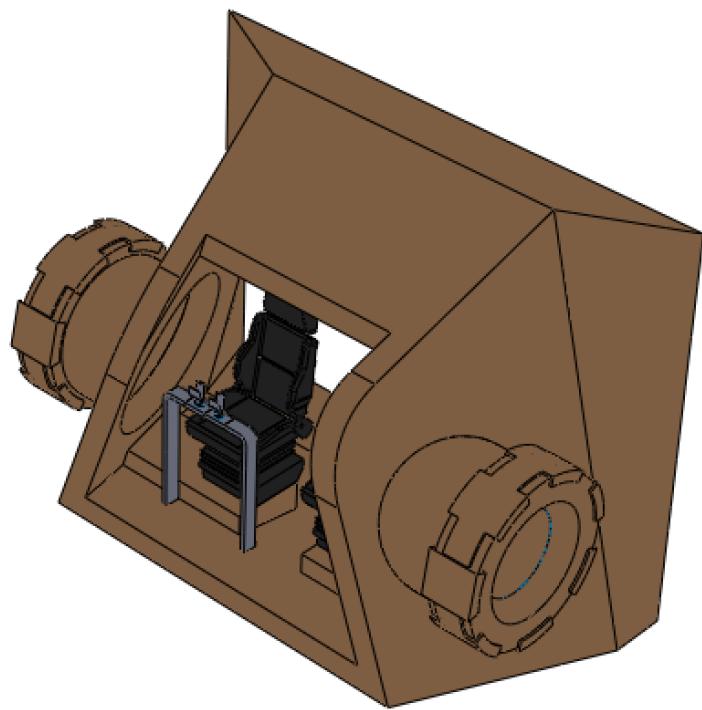


FIGURE 3.13: Kumar, Vishakh: Cockpit View 1

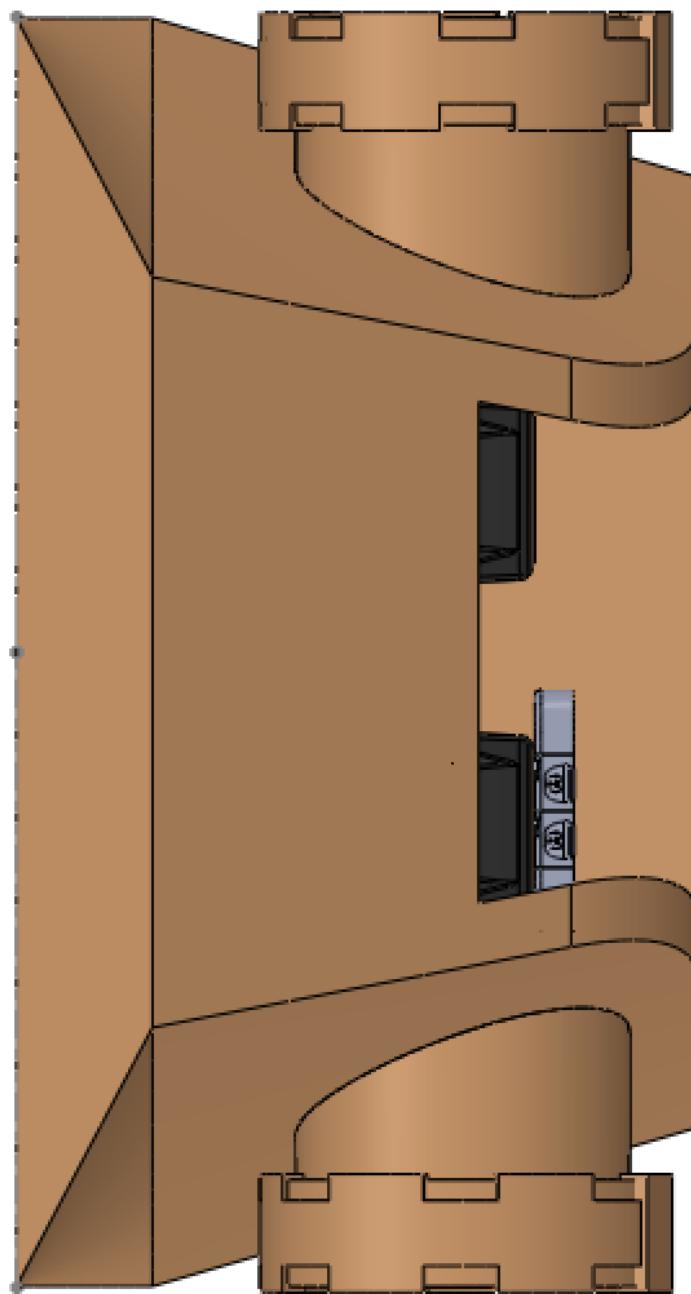


FIGURE 3.14: Kumar, Vishakh: Cockpit View 2

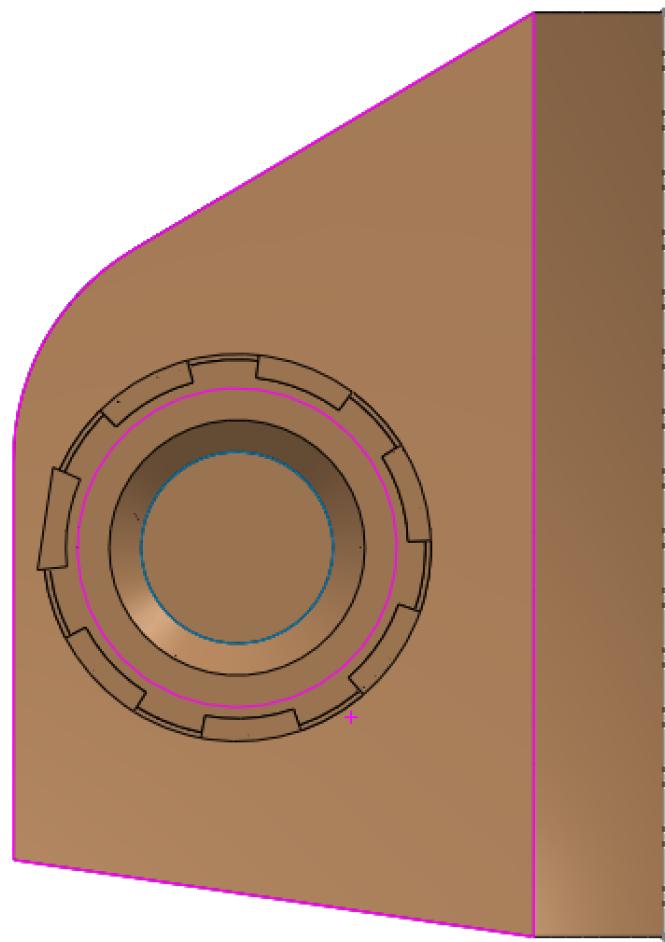


FIGURE 3.15: Kumar, Vishakh: Cockpit View 3

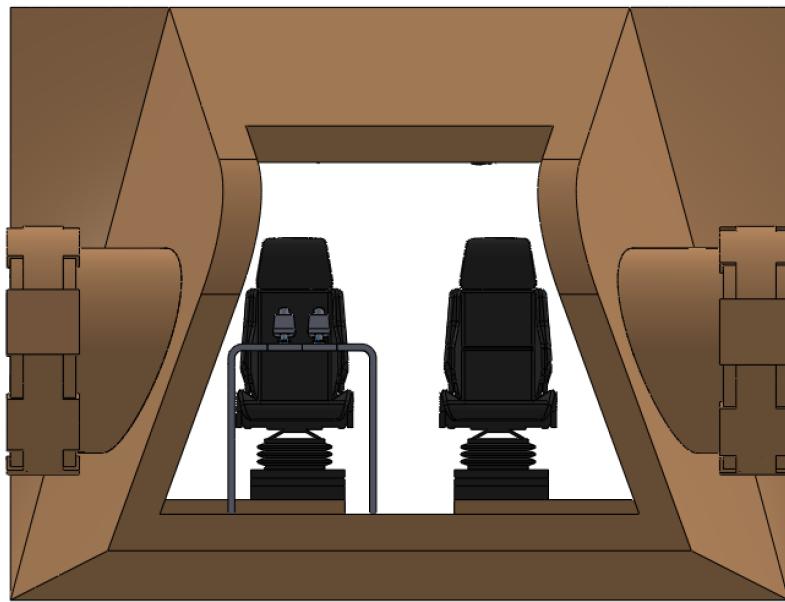


FIGURE 3.16: Kumar, Vishakh: Cockpit View 4

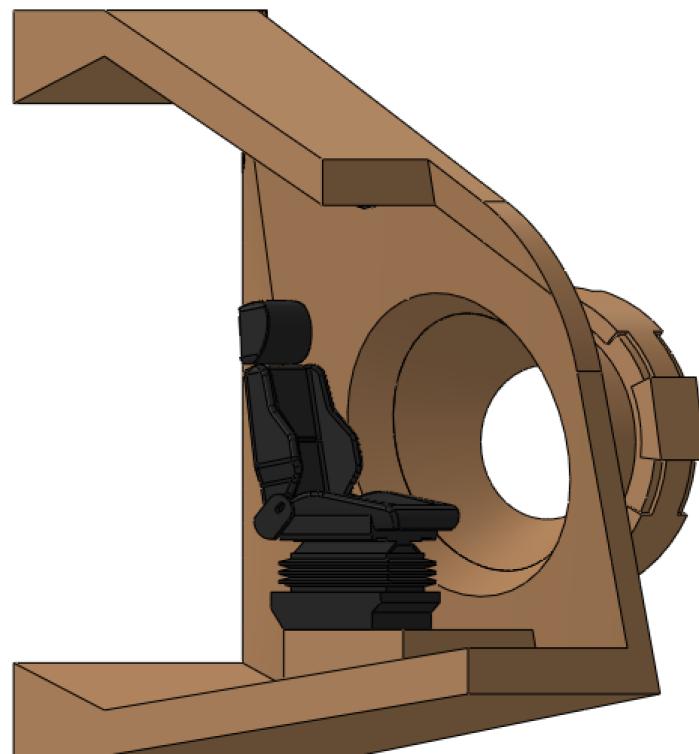


FIGURE 3.17: Kumar, Vishakh: Cockpit View 4

### 3.5 Joystick

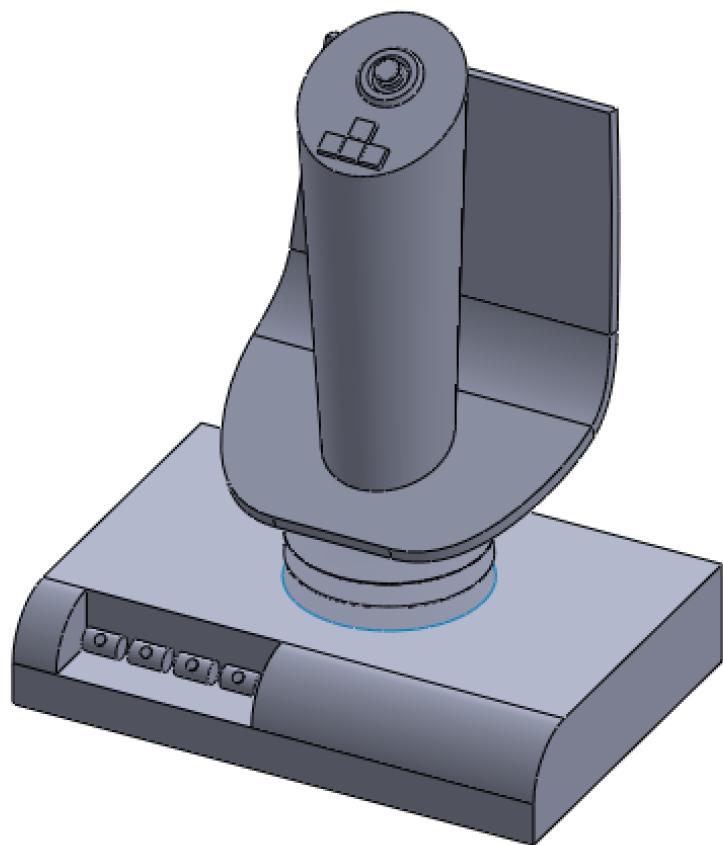


FIGURE 3.18: Kumar, Vishakh: Joystick View 1

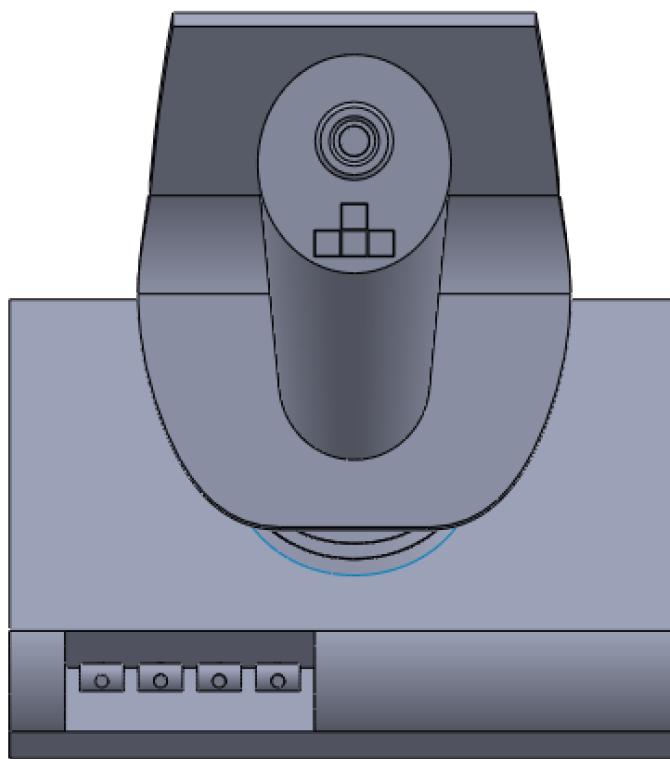


FIGURE 3.19: Kumar, Vishakh: Joystick View 2

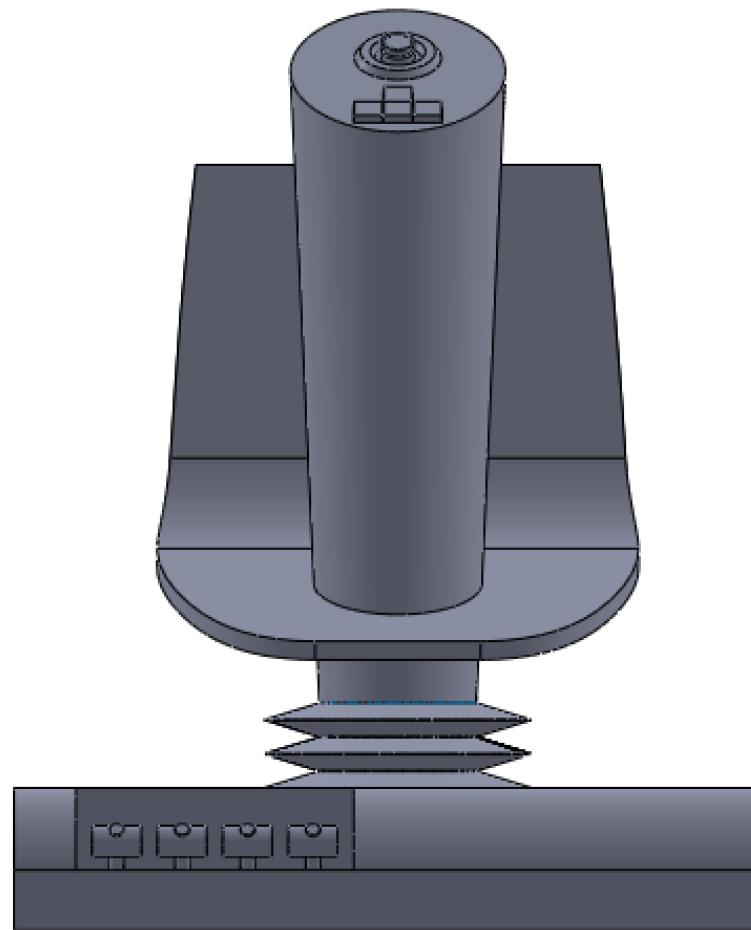


FIGURE 3.20: Kumar, Vishakh: Joystick View 3

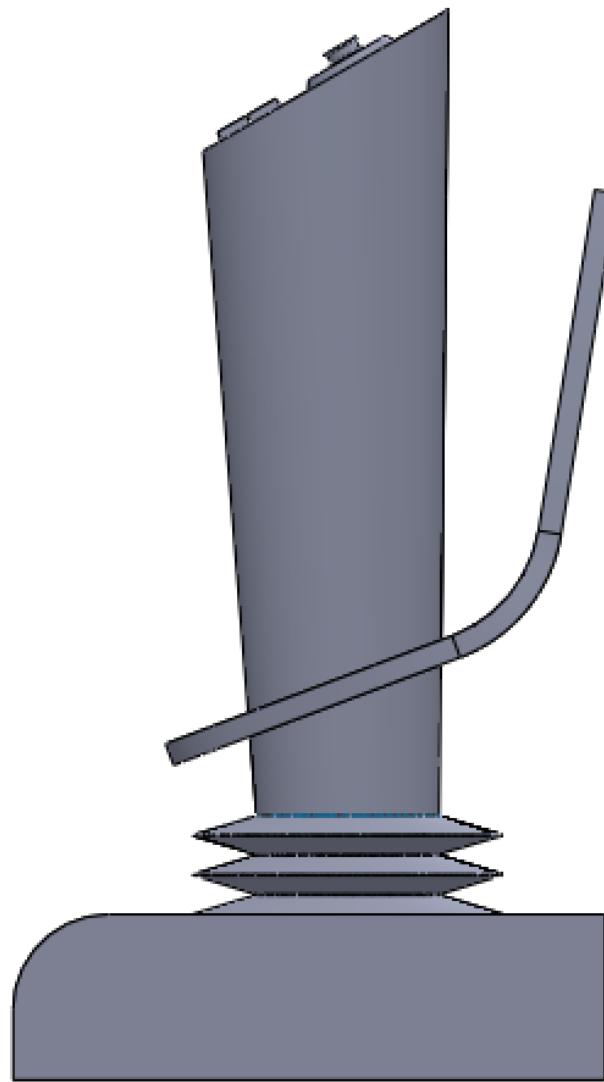


FIGURE 3.21: Kumar, Vishakh: Joystick View 4

### 3.6 CabinetDoor



FIGURE 3.22: Ferrarer, Auston: Cabinet Door

### 3.7 EmergencySwitch

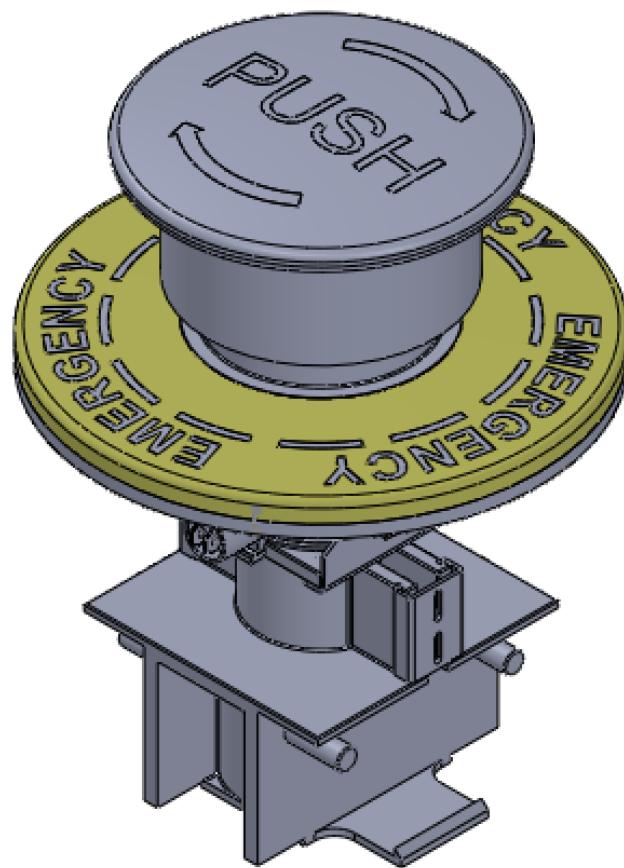


FIGURE 3.23: Kumar, Vishakh: Emergency Switch View 1



FIGURE 3.24: Kumar, Vishakh: Emergency Switch View 2

### 3.8 MechanicalDisplay

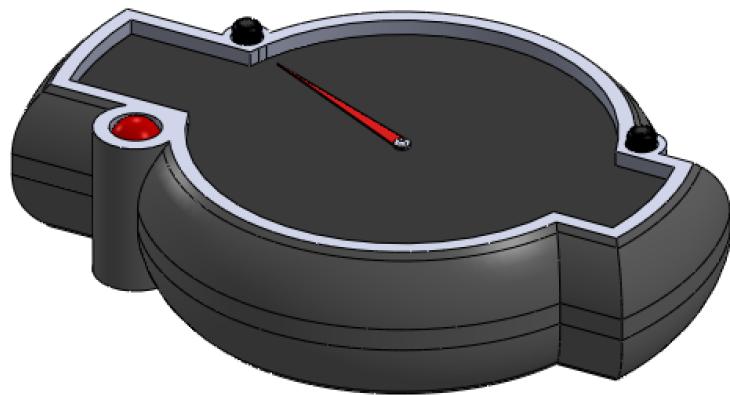


FIGURE 3.25: Kumar, Vishakh: Mechanical Display View 1

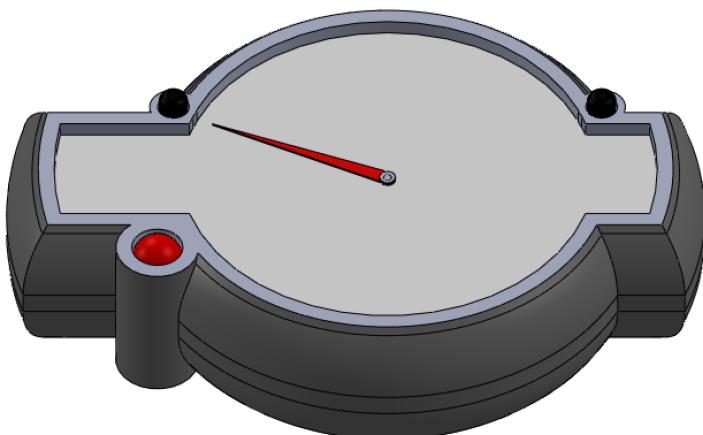


FIGURE 3.26: Kumar, Vishakh: Mechanical DisplayView 2

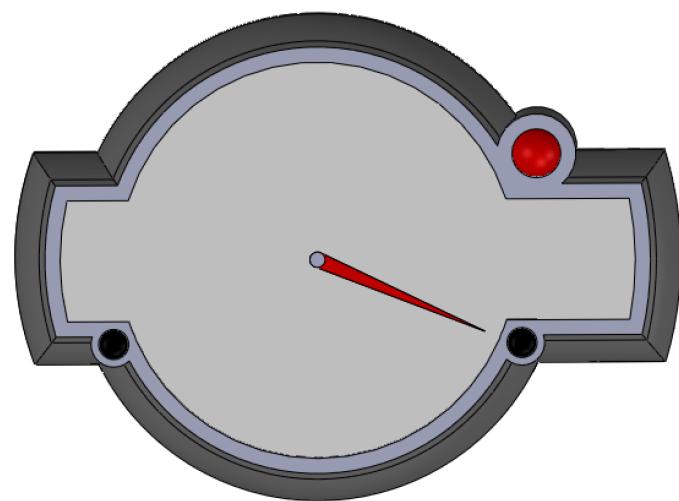


FIGURE 3.27: Kumar, Vishakh: Mechanical Display View 3

### 3.9 3DPrinter

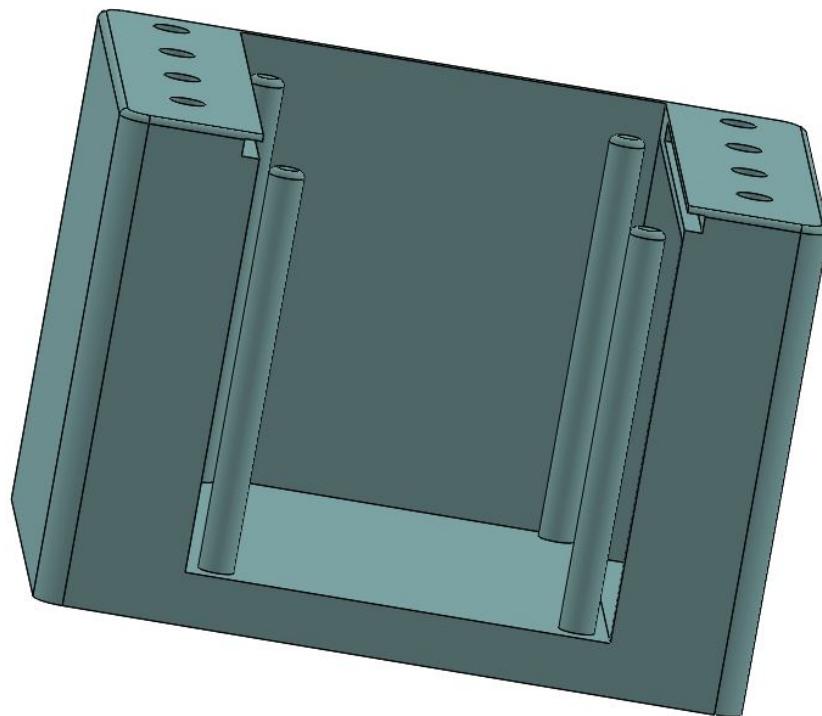


FIGURE 3.28: Ferrarer, Auston: Basic Cut Extrude

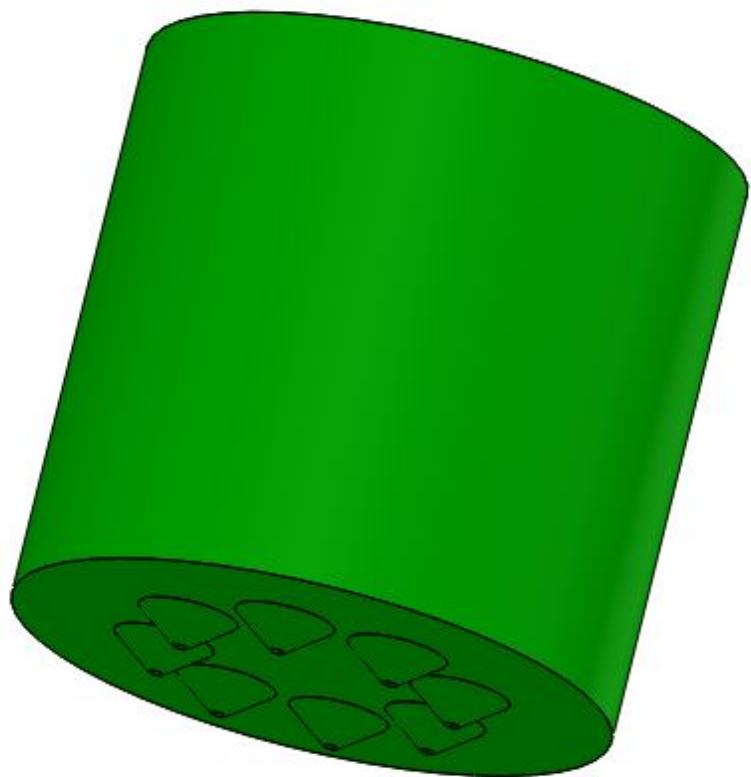


FIGURE 3.29: Ferrarer, Auston: Extruder

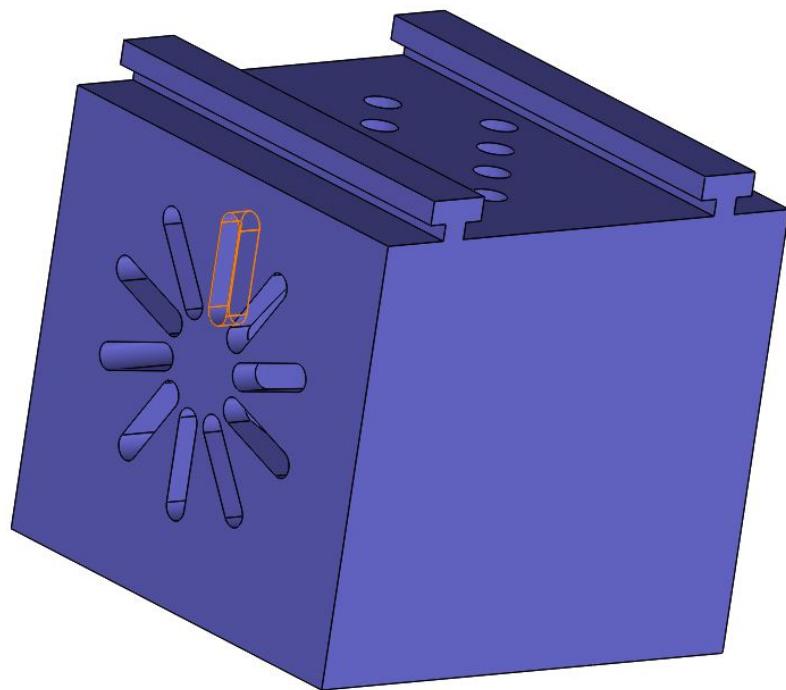


FIGURE 3.30: Ferrarer, Auston: Extruder Housing

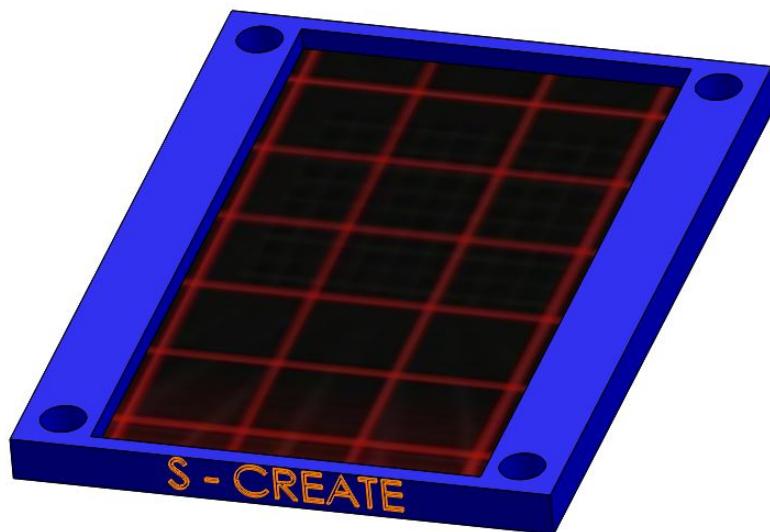


FIGURE 3.31: Ferrarer, Auston: Printing Plate

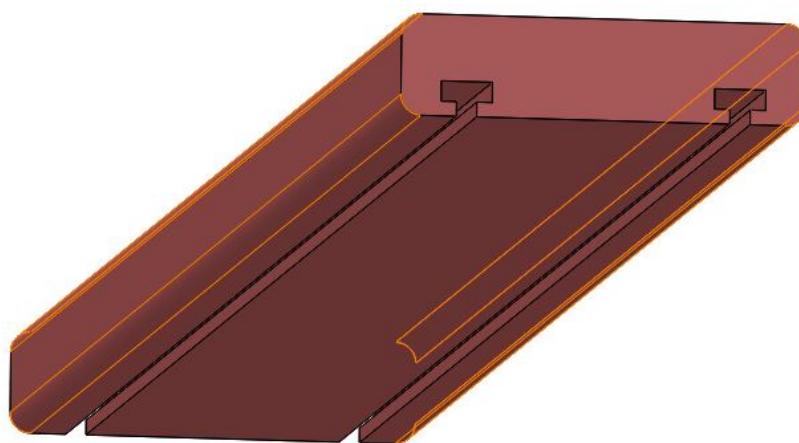


FIGURE 3.32: Ferrarer, Auston: Slide Bar

### 3.10 Chassis

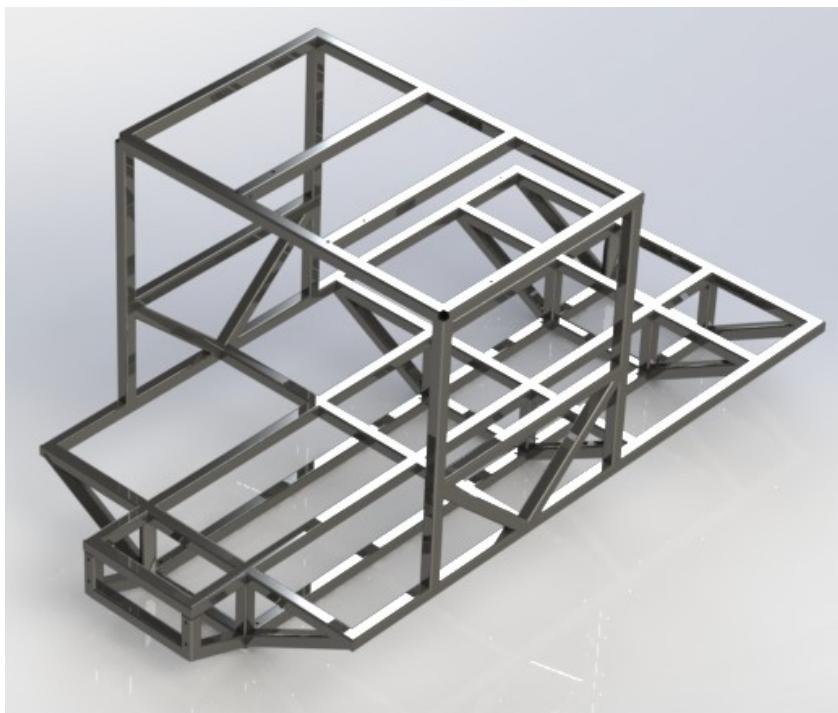


FIGURE 3.33: Rodriguez, Juan: Chasis Render

### 3.11 Helmet

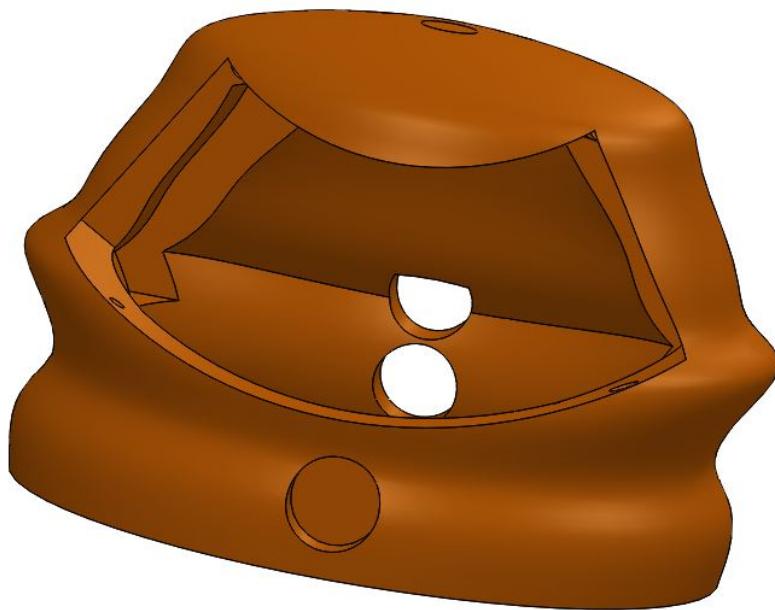


FIGURE 3.34: Ferrarer, Auston: Helmet Shell

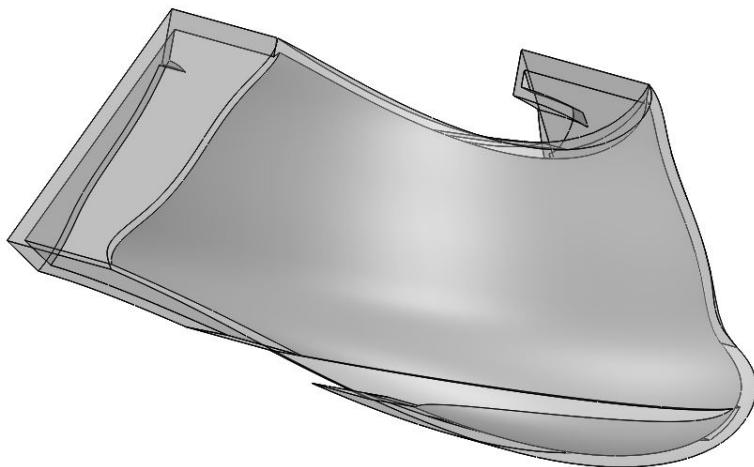


FIGURE 3.35: Ferrarer, Auston: Helmet Visor

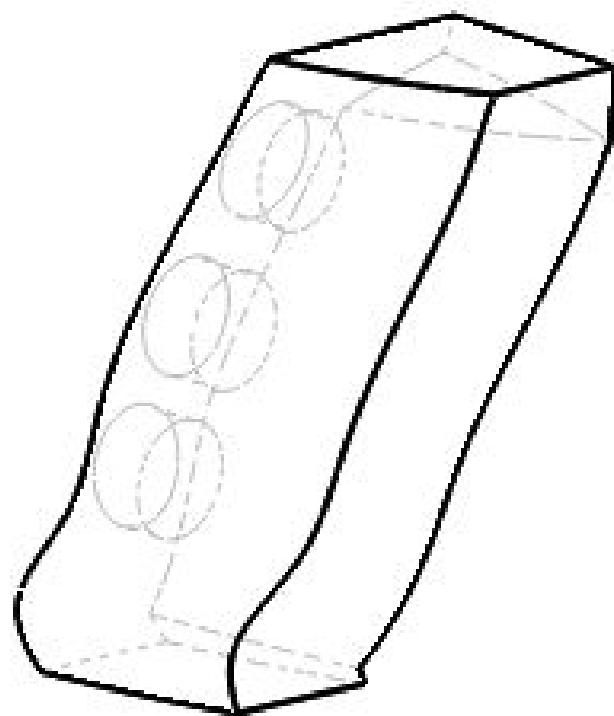


FIGURE 3.36: Ferrarer, Auston: Left light



FIGURE 3.37: Ferrarer, Auston: Right light

### 3.12 Suspension



FIGURE 3.38: Hirani, Asimm: 25 Tooth Gear

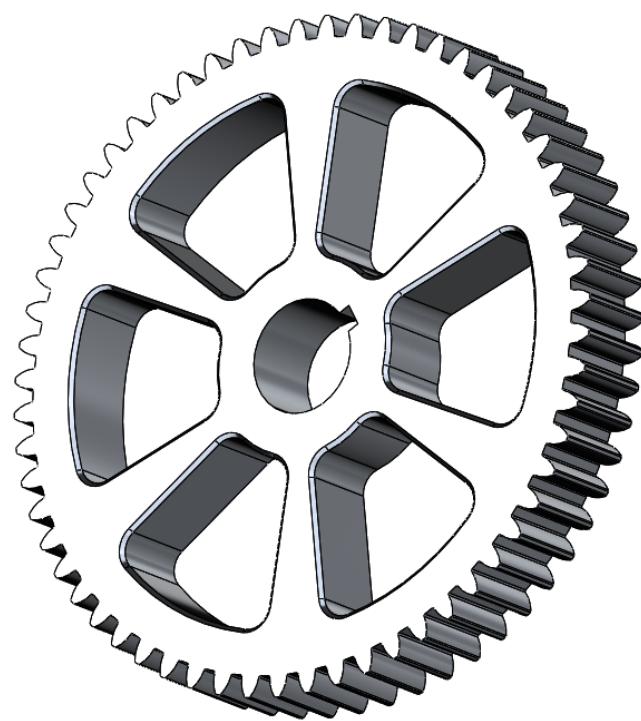


FIGURE 3.39: Hirani, Asimm: 60 Tooth Gear



FIGURE 3.40: Hirani, Asimm:Brake Caliper

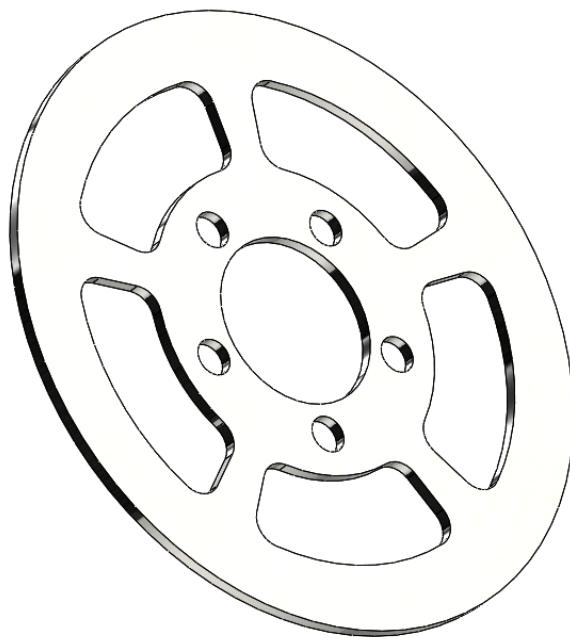


FIGURE 3.41: Hirani, Asimm:Brake Disk

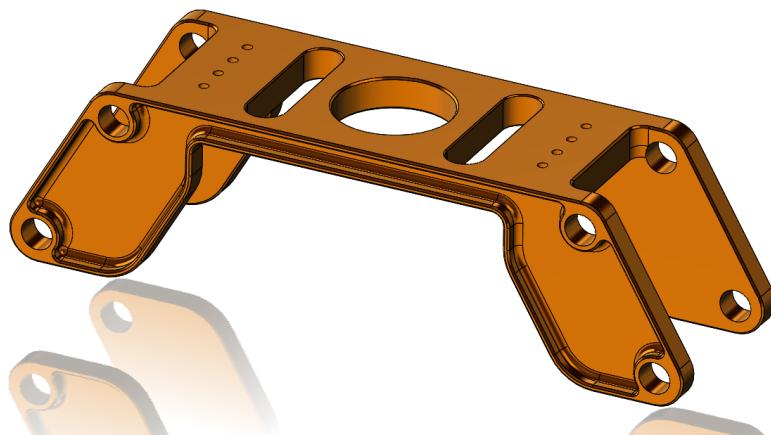


FIGURE 3.42: Hirani, Asimm: Center Frame

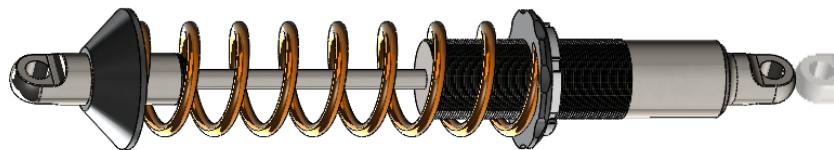


FIGURE 3.43: Hirani, Asimm: Coilover

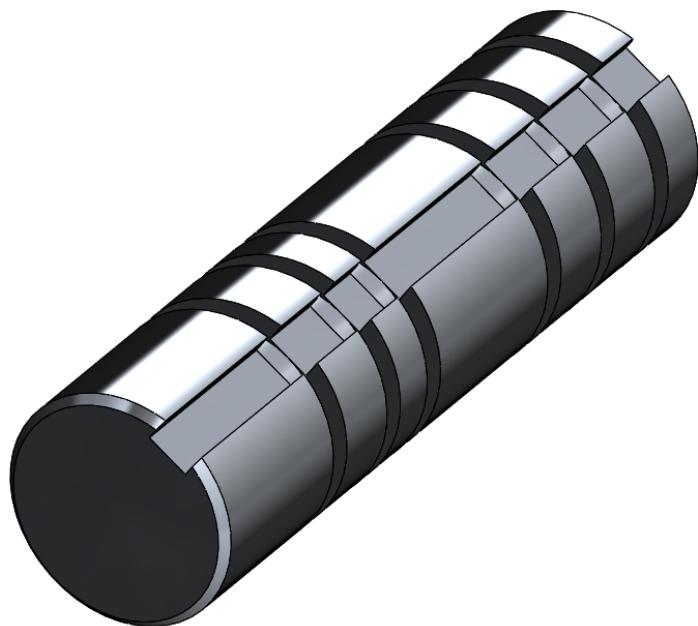


FIGURE 3.44: Hirani, Asimm: Gearbox Drive Shaft

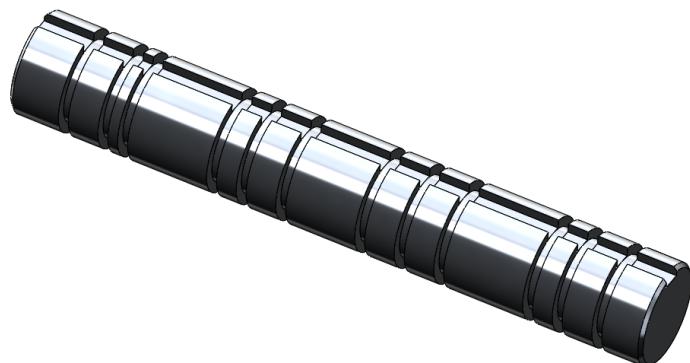


FIGURE 3.45: Hirani, Asimm: Gearbox Idler Shaft



FIGURE 3.46: Hirani, Asimm: Gearbox Output Shaft

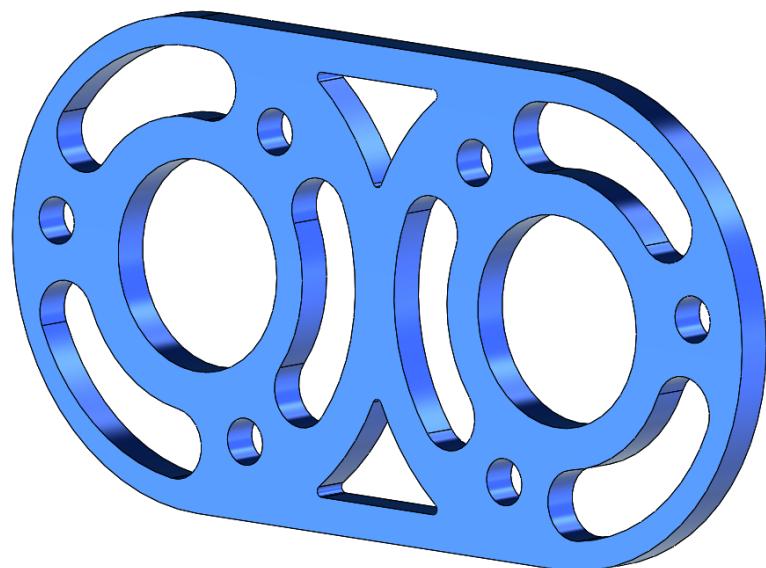


FIGURE 3.47: Hirani, Asimm: Gearbox Steel Plate

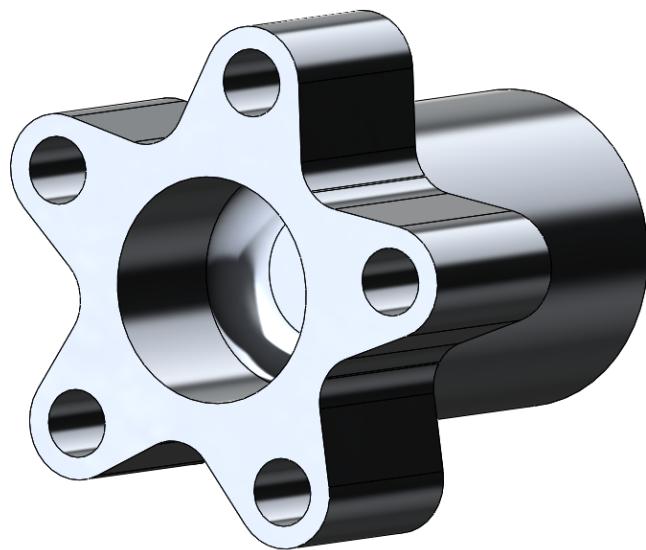


FIGURE 3.48: Hirani, Asimm: Hub

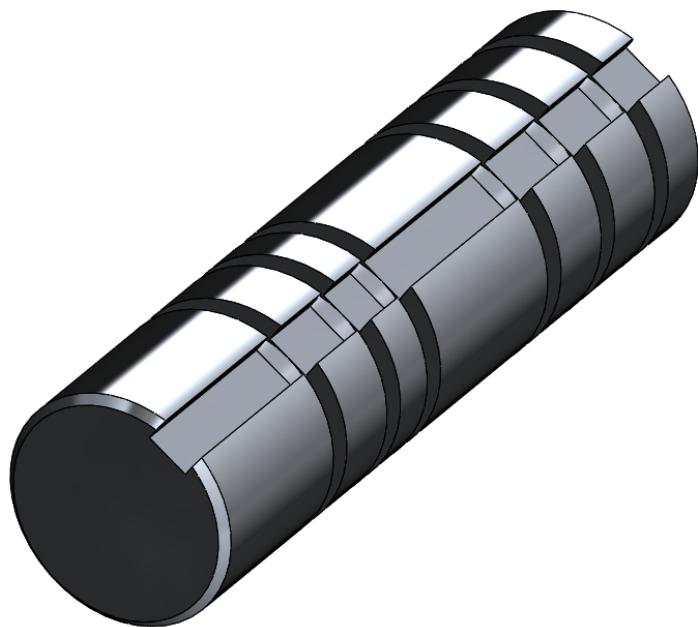


FIGURE 3.49: Hirani, Asimm: Gearbox Drive Shaft

### 3.13 Antenna



FIGURE 3.50: Rodriguez, Juan: Antenna Rendering

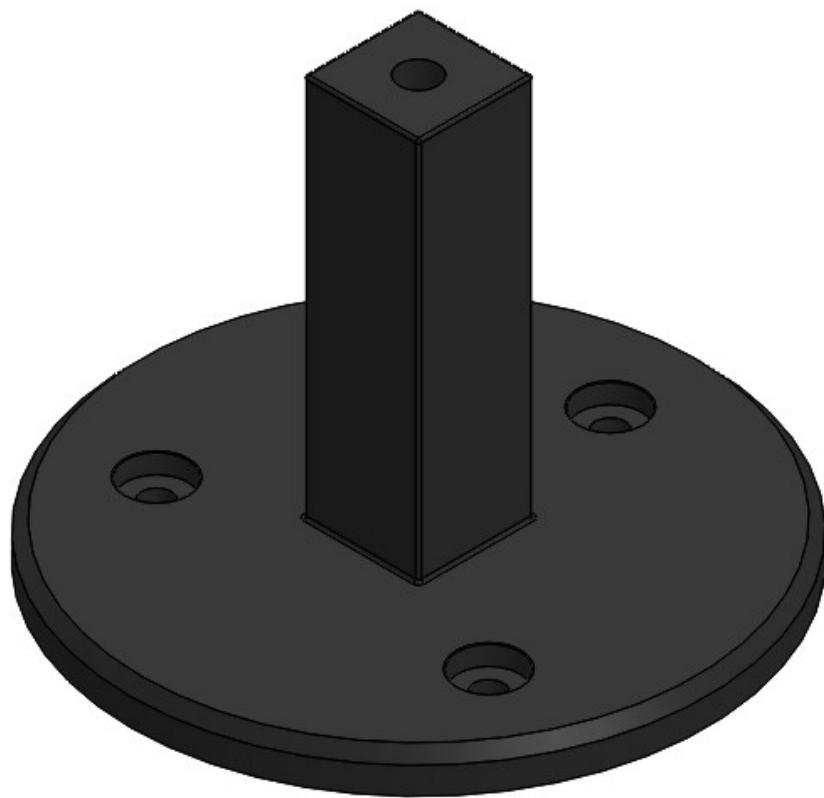


FIGURE 3.51: Rodriguez, Juan: Antenna Base

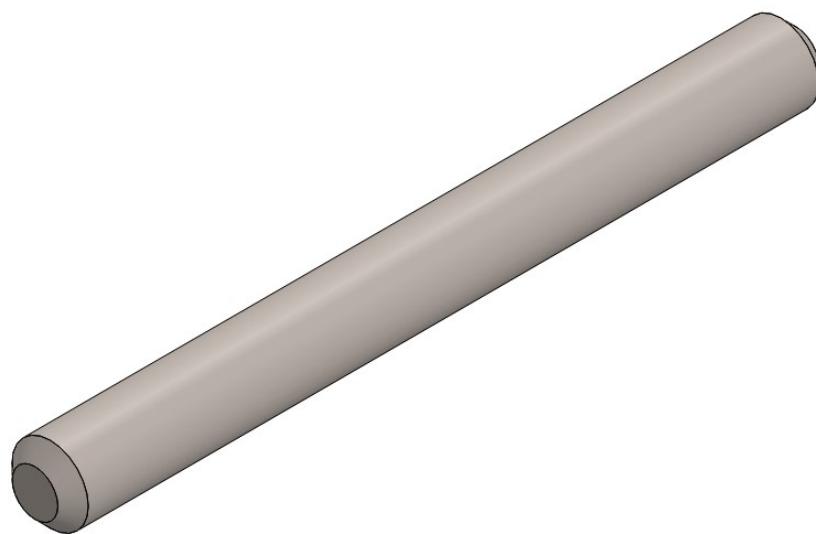


FIGURE 3.52: Rodriguez, Juan: pin A



FIGURE 3.53: Rodriguez, Juan: pin B

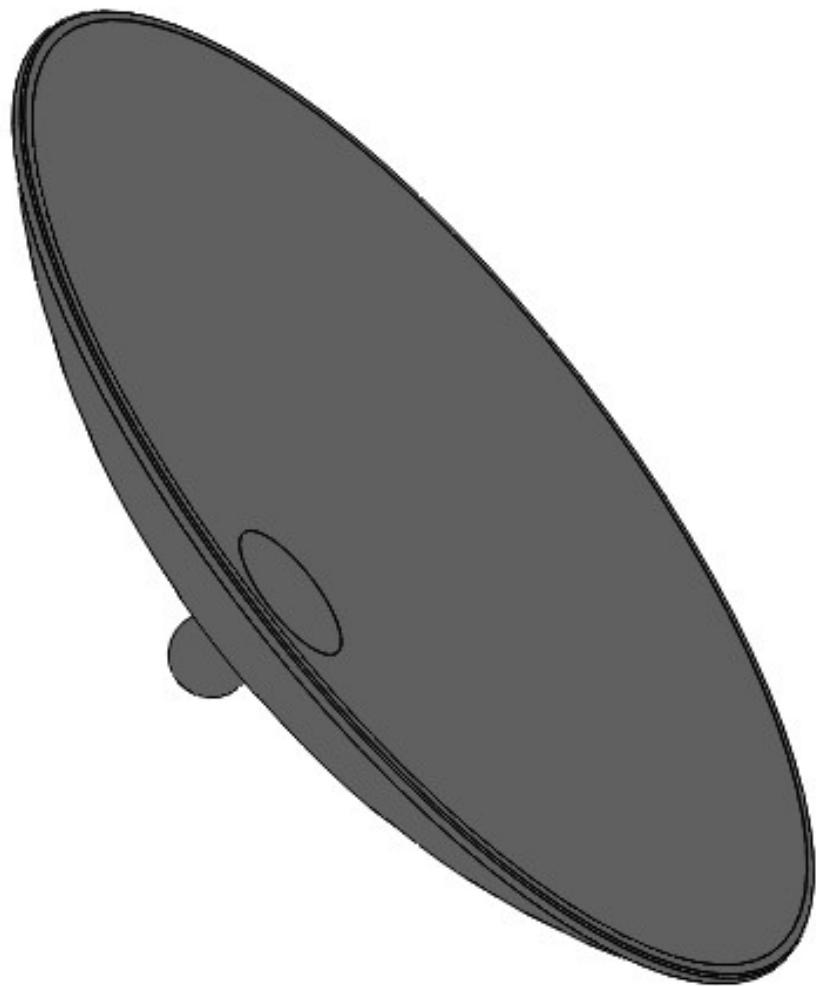


FIGURE 3.54: Rodriguez, Juan: Antenna

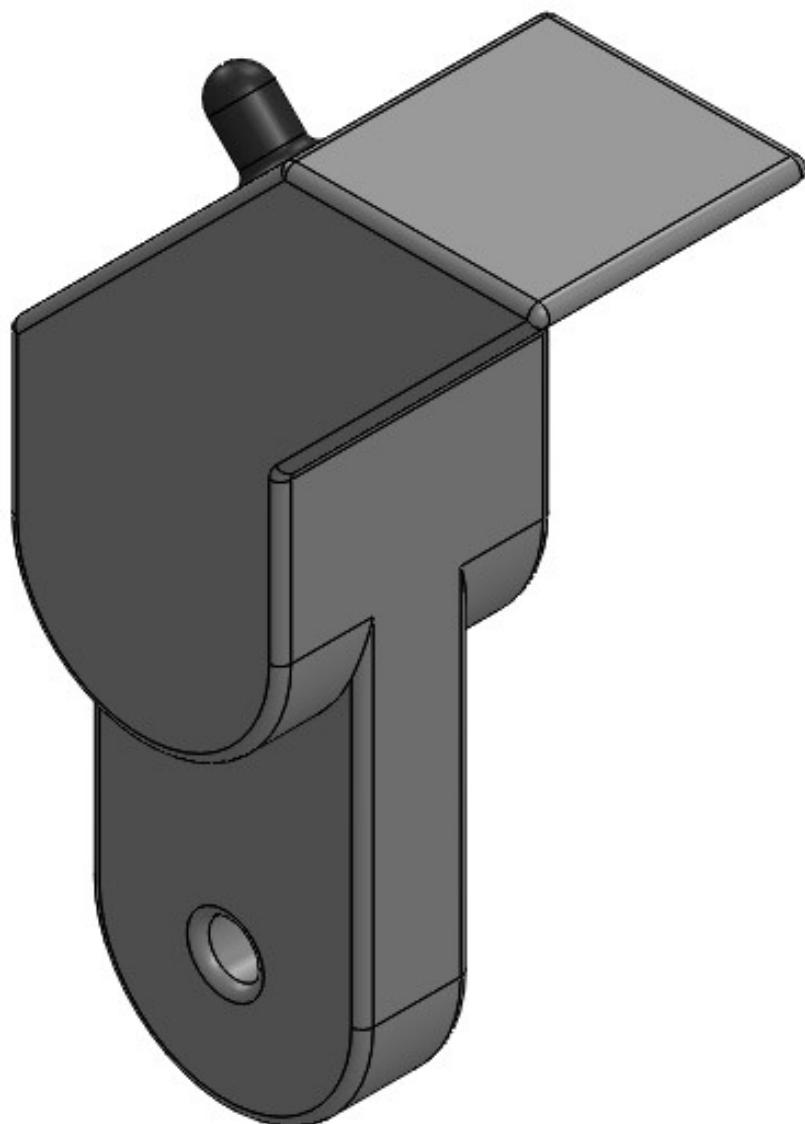


FIGURE 3.55: Rodriguez, Juan: Receiver

## Chapter 4

# Manufacturing Working Drawing

Insert spiel about ManufacturingWorkingDrawing.

- **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**

- **4.4 Part List**

## 4.1 Working Drawings

#### **4.1.1 Joystick**

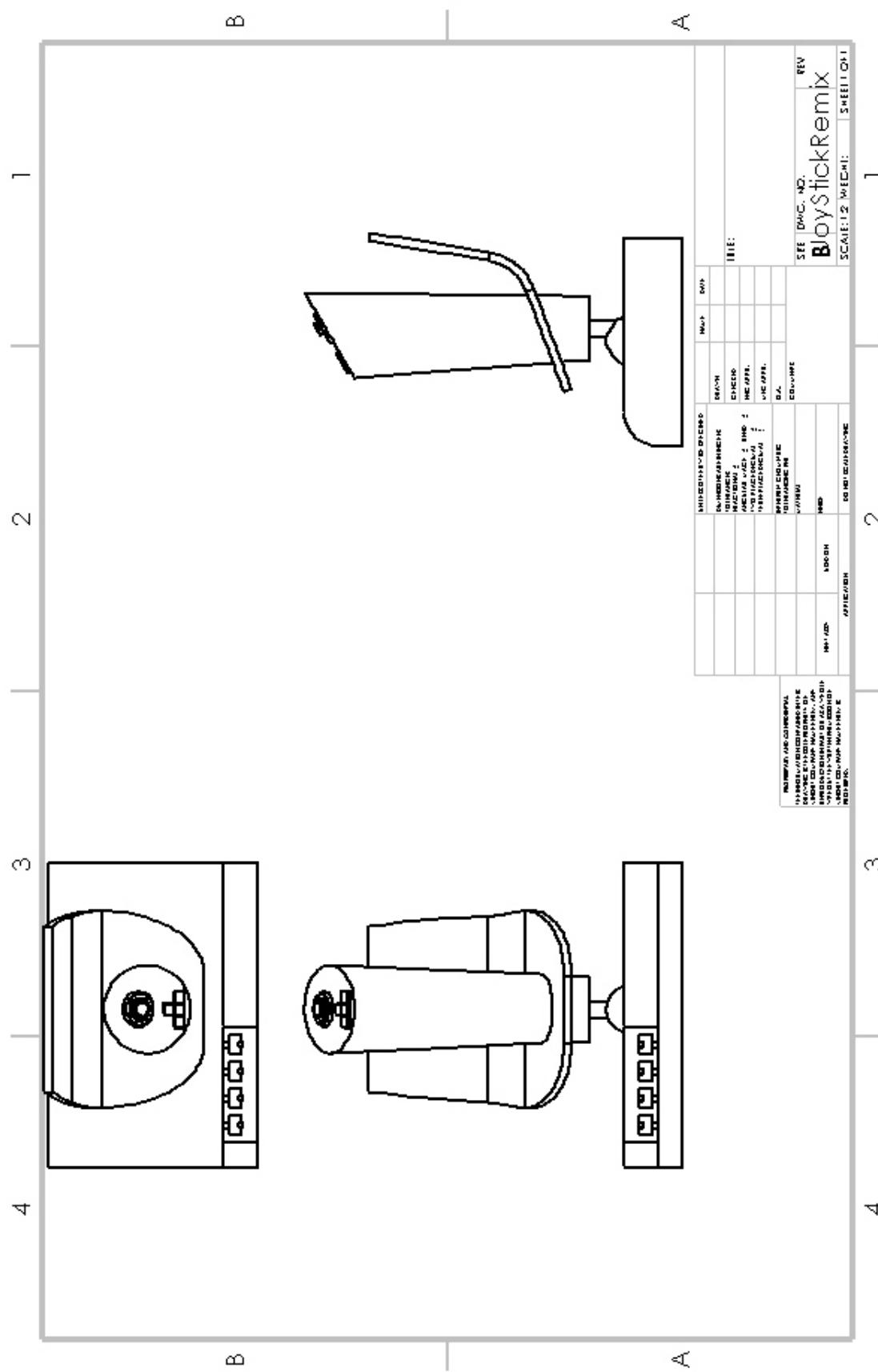


FIGURE 4.1: Kumar, Vishakh: JoyStick Full Assembly

#### 4.1.2 Emergency Switch

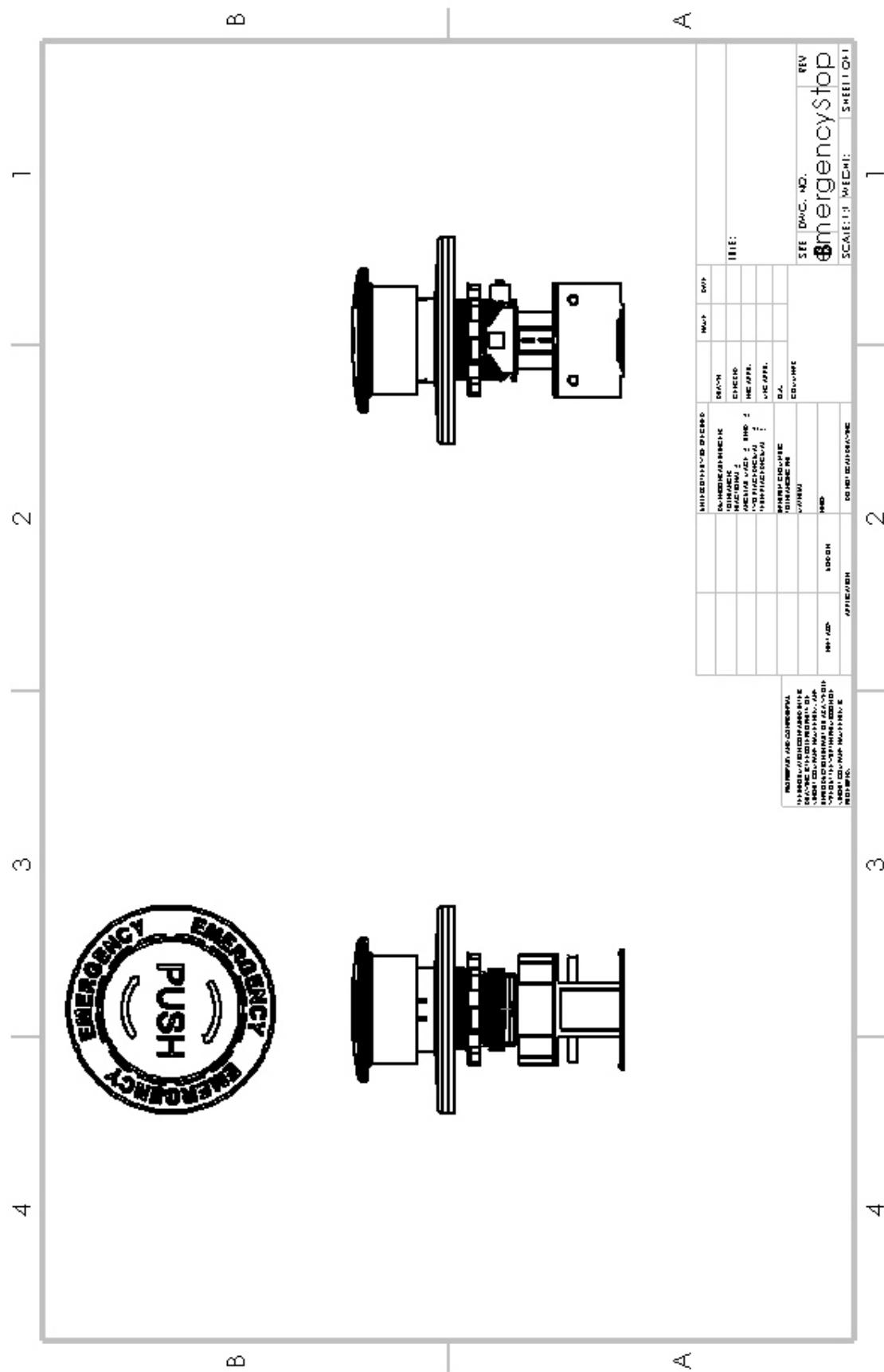


FIGURE 4.2: Kumar, Vishakh: Emergency Switch

#### **4.1.3 Seat**

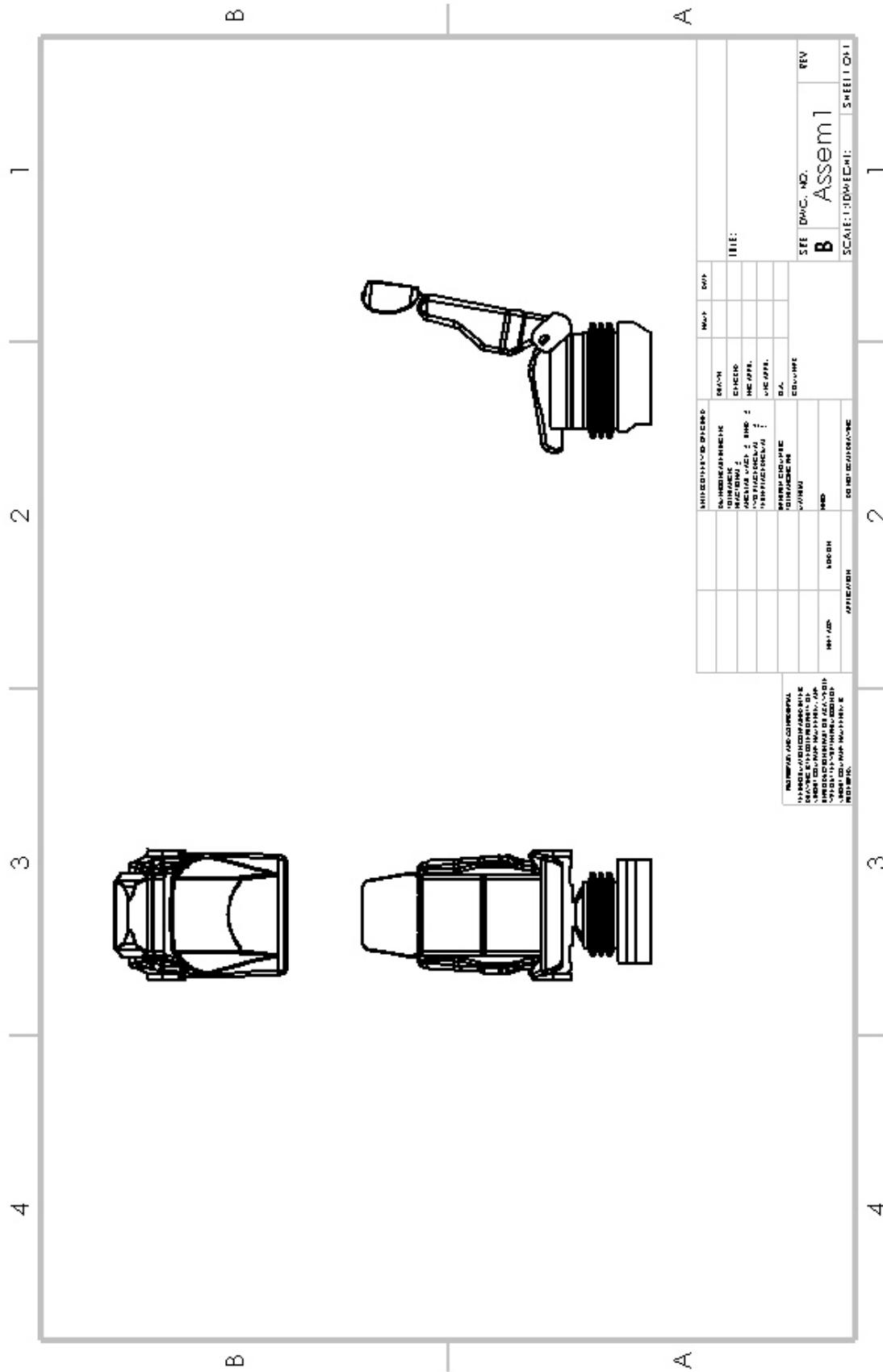


FIGURE 4.3: Kumar, Vishakh: Seat Full Assembly

#### 4.1.4 Antenna

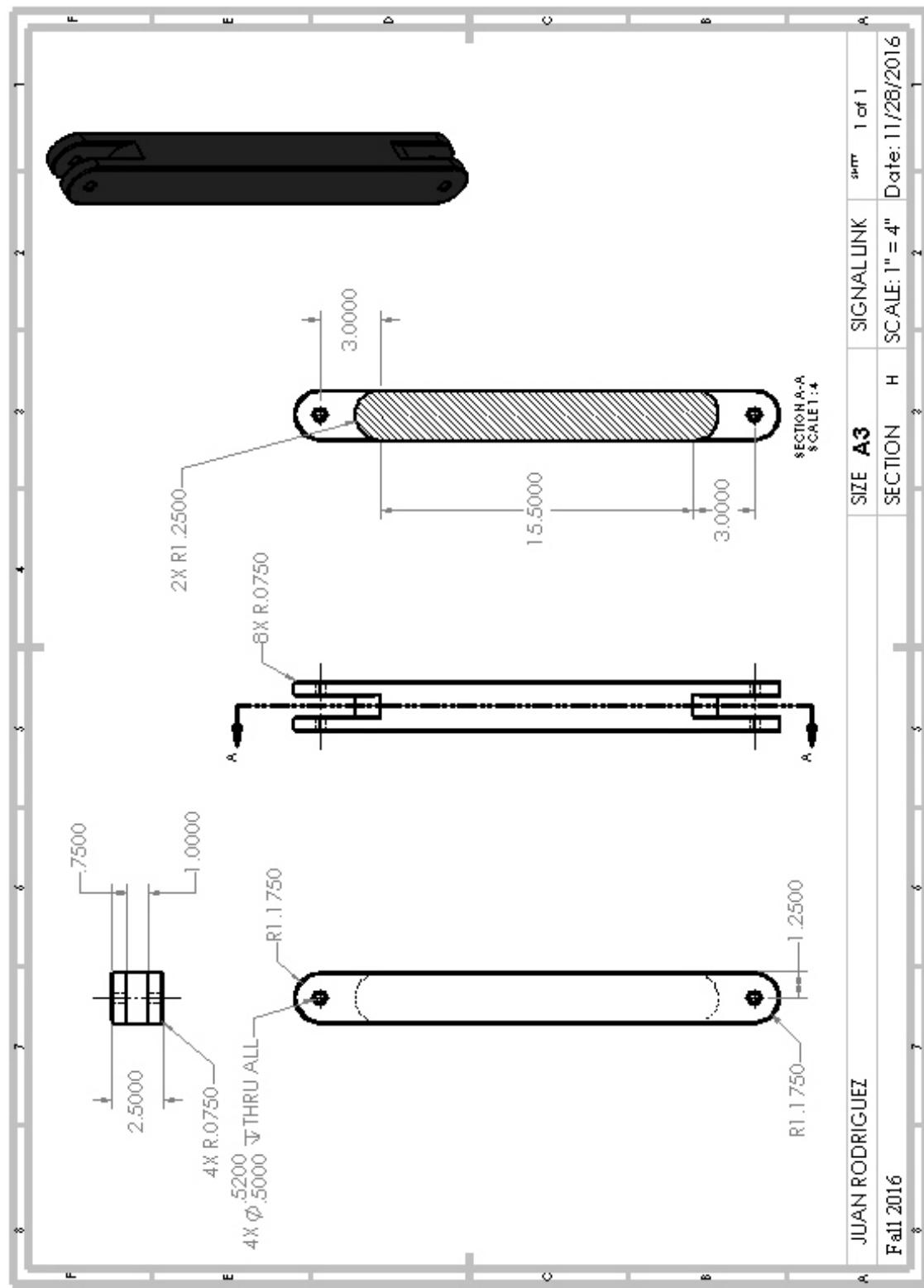


FIGURE 4.4: Signal Bar

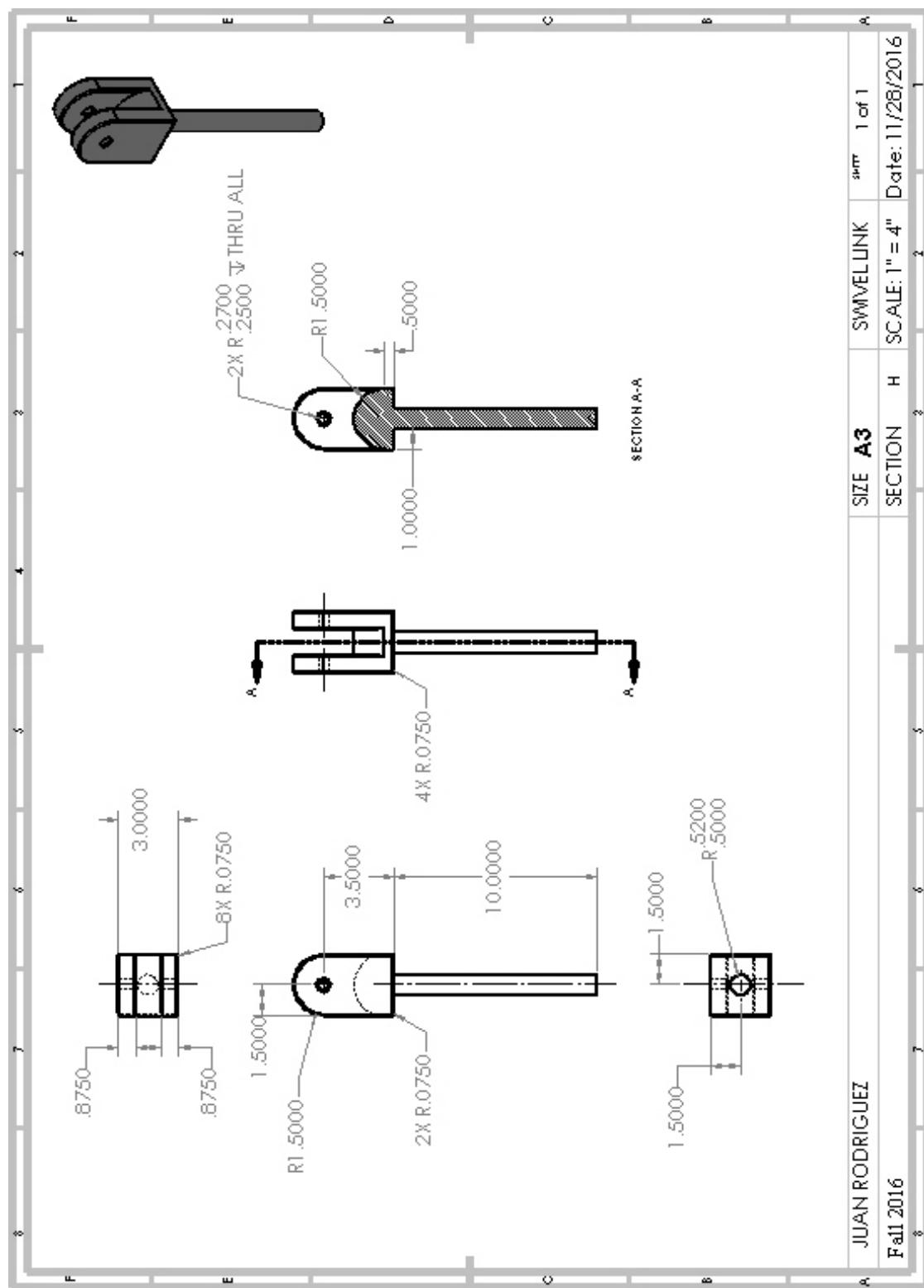


FIGURE 4.5: Swivel Link

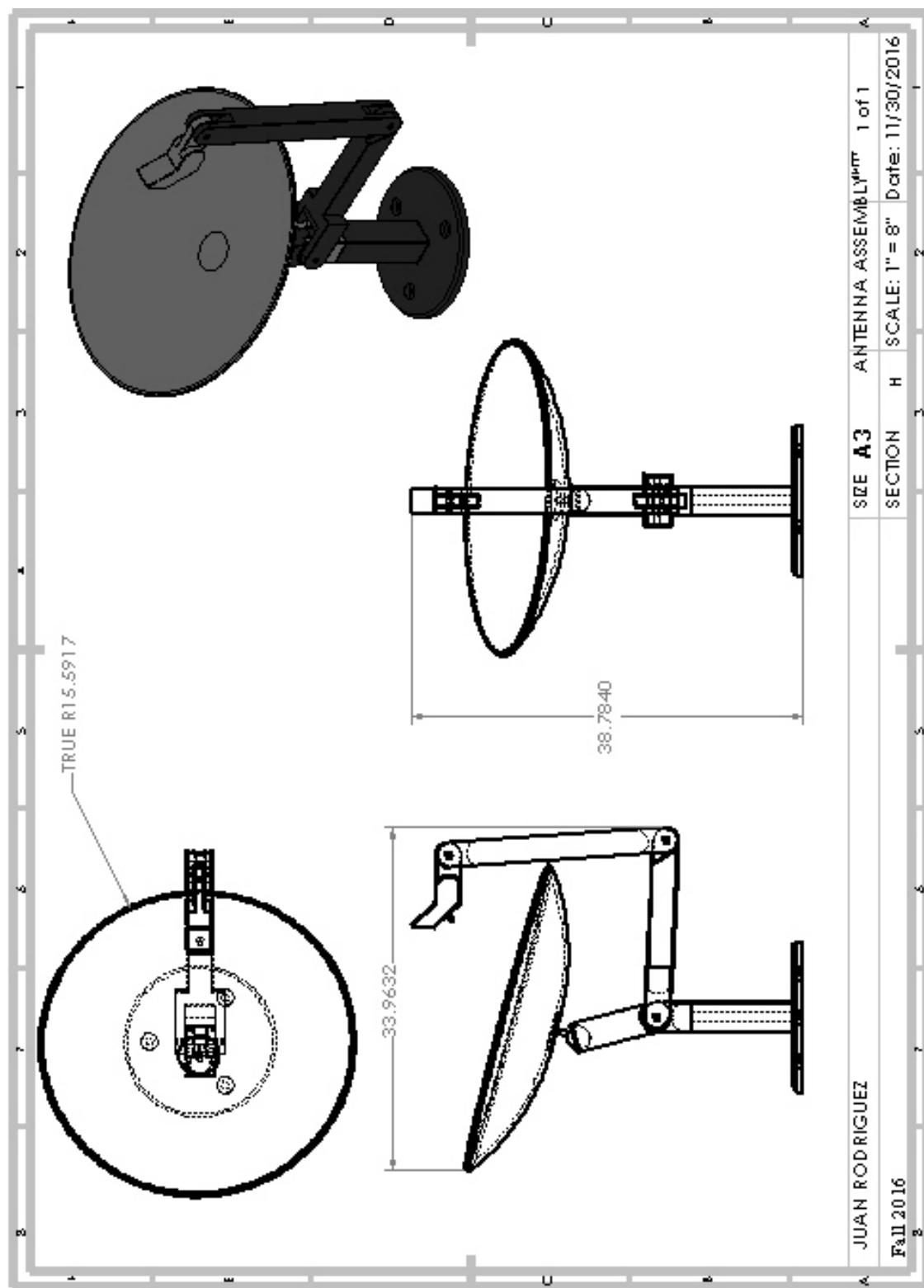


FIGURE 4.6: Antenna Assembly

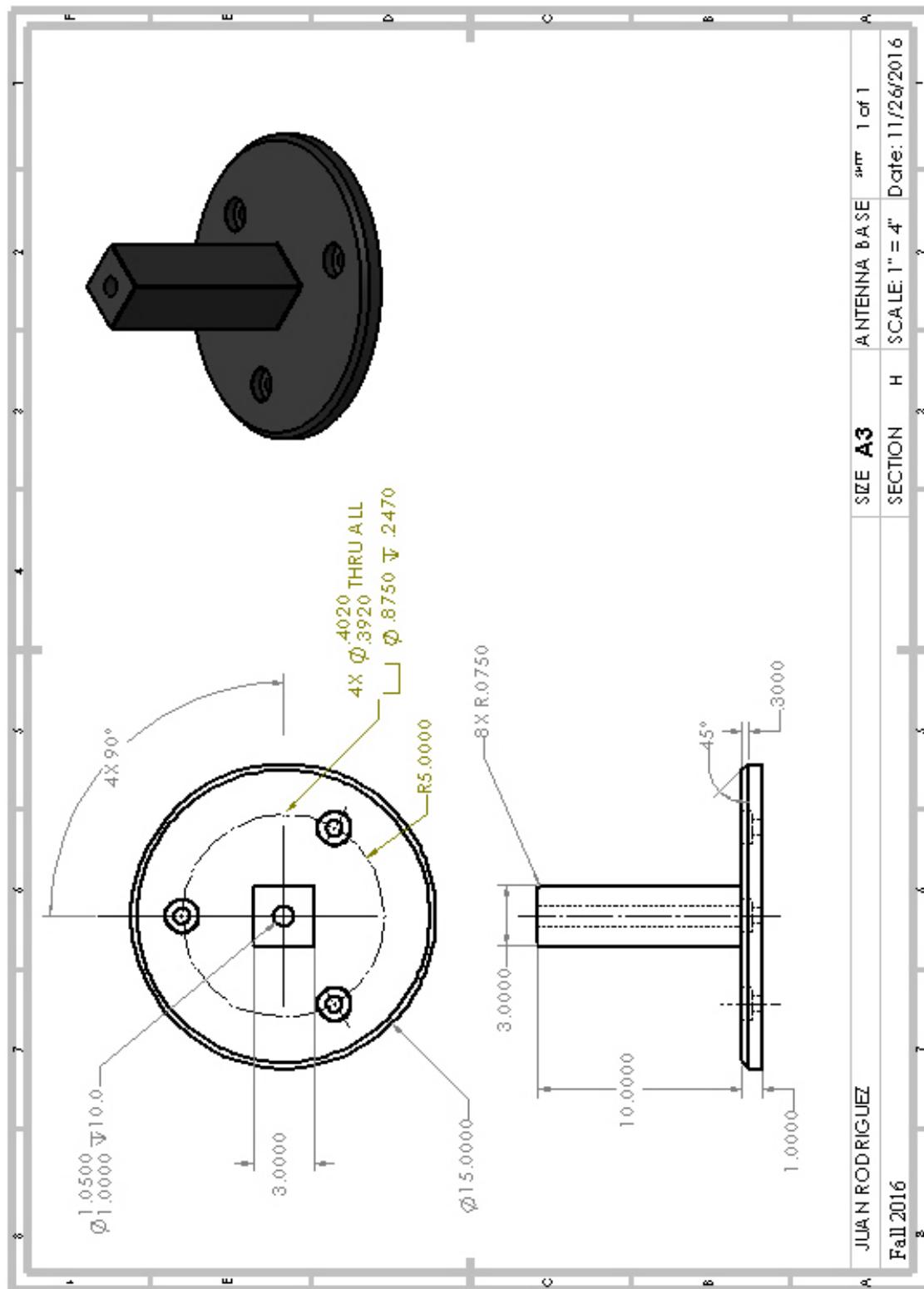


FIGURE 4.7: Antenna Base

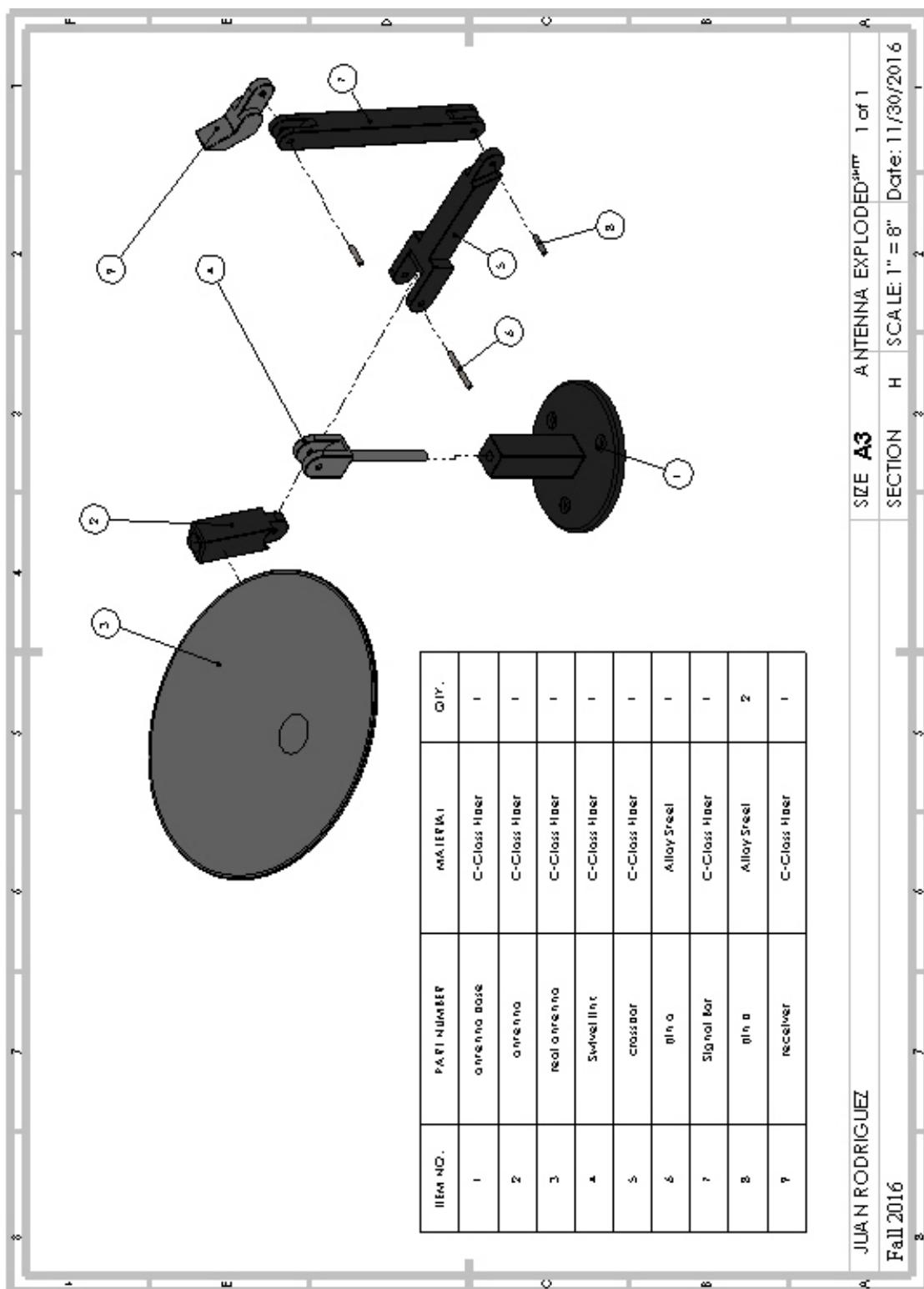


FIGURE 4.8: Antenna Exploded

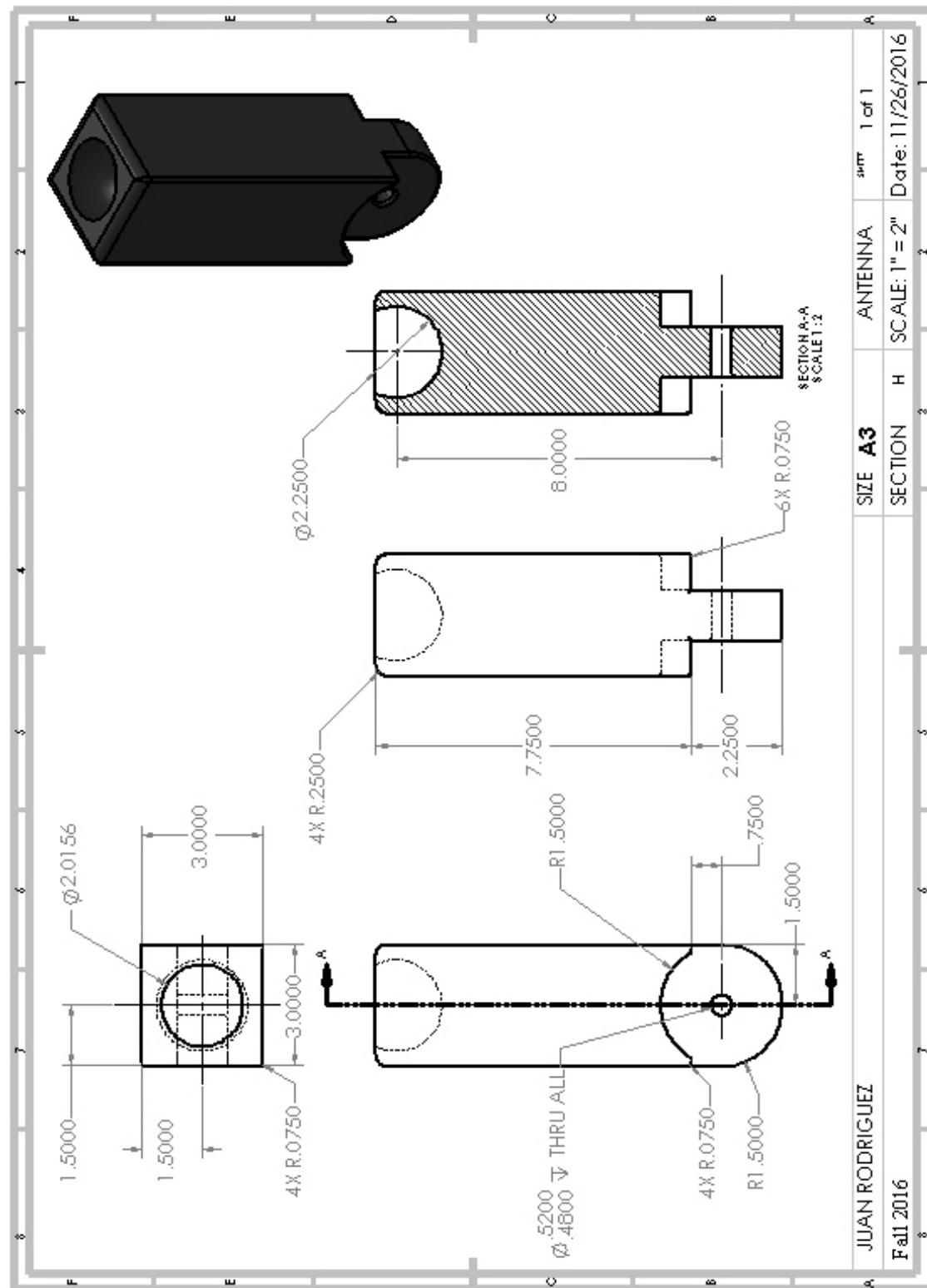


FIGURE 4.9: Antenna Support

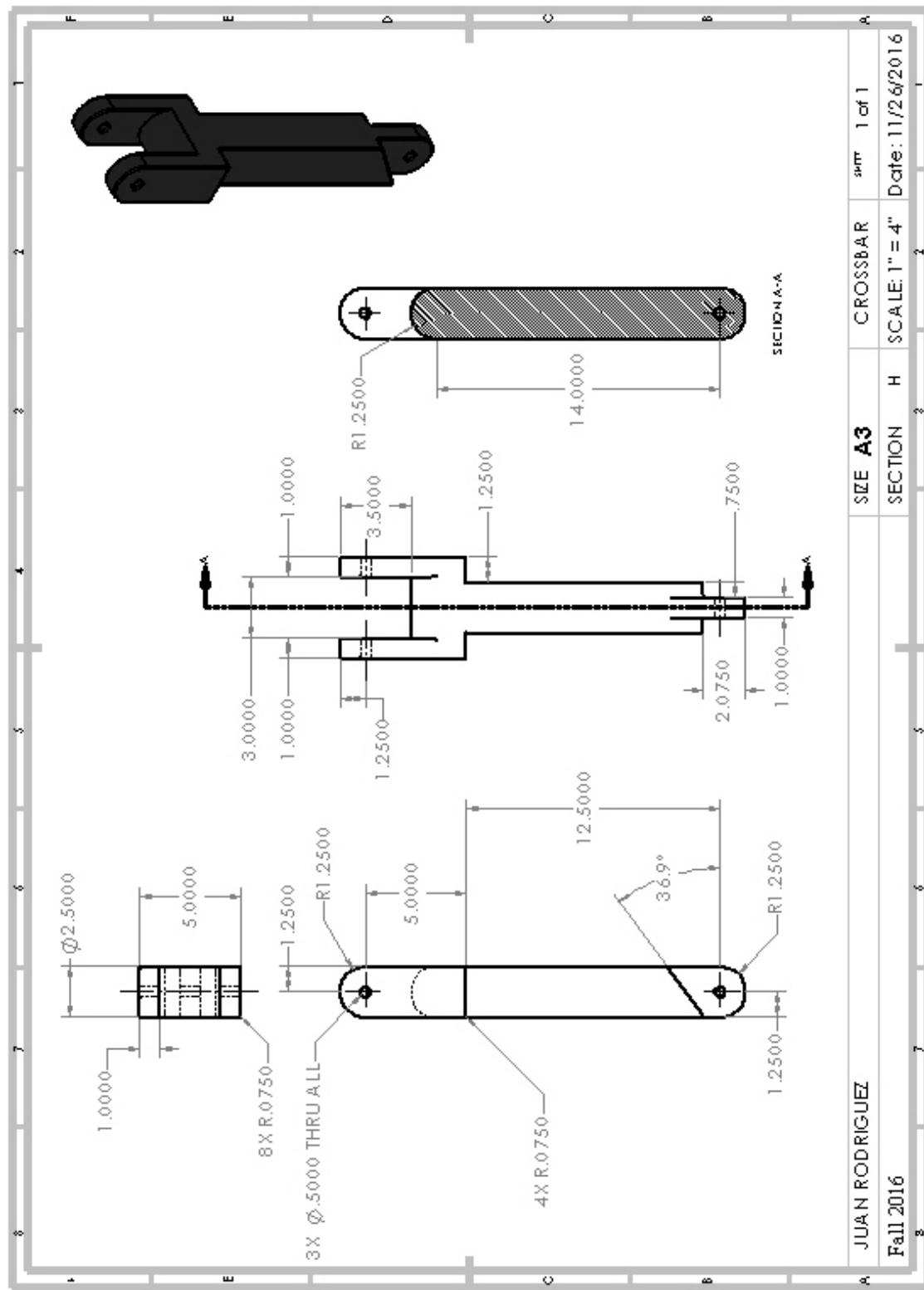


FIGURE 4.10: Crossbar

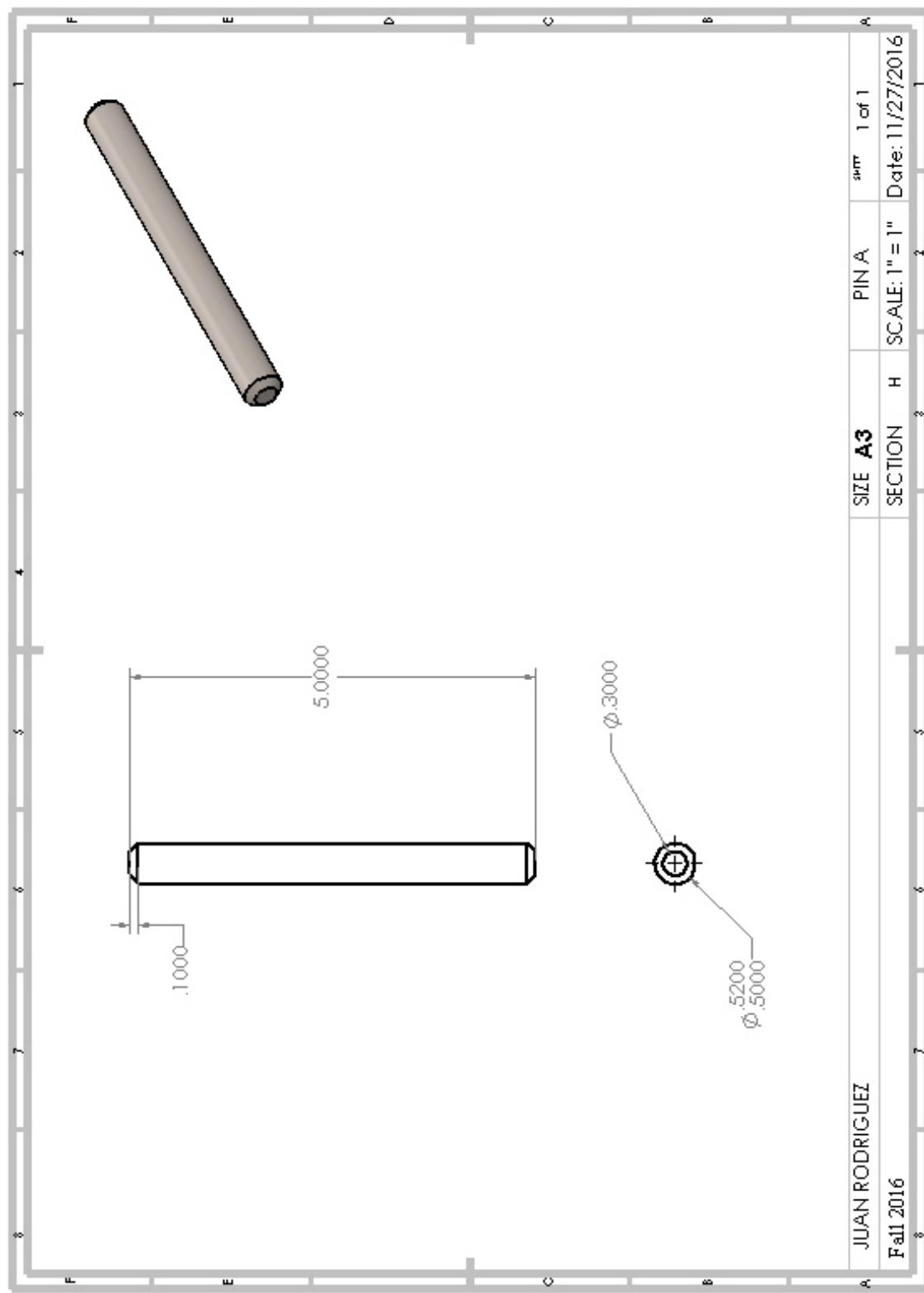


FIGURE 4.11: Pin A

### 4.1.5 Chassis

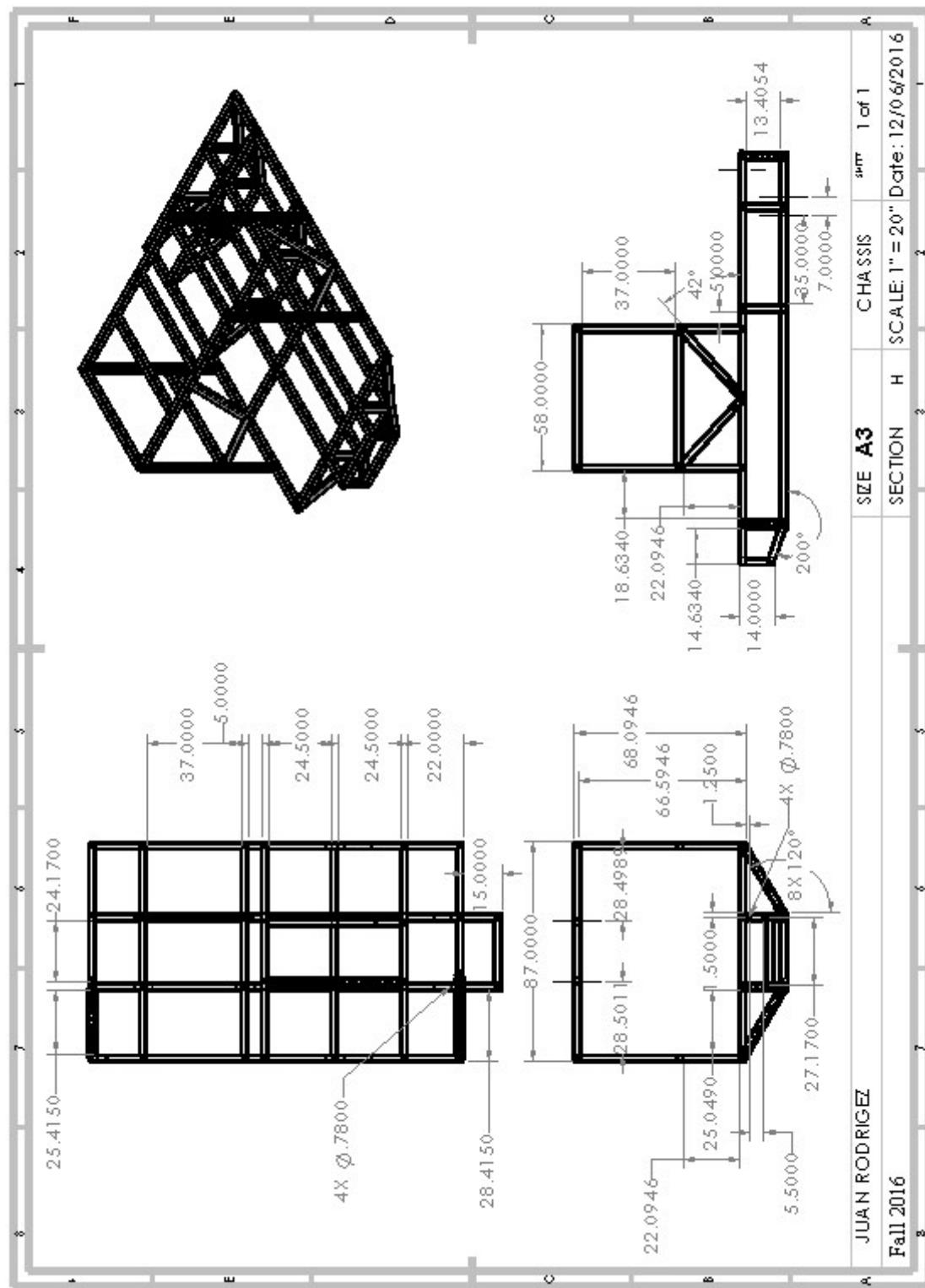


FIGURE 4.12: Rodriguez, Juan: Chassis

#### 4.1.6 Cabinet Drawer

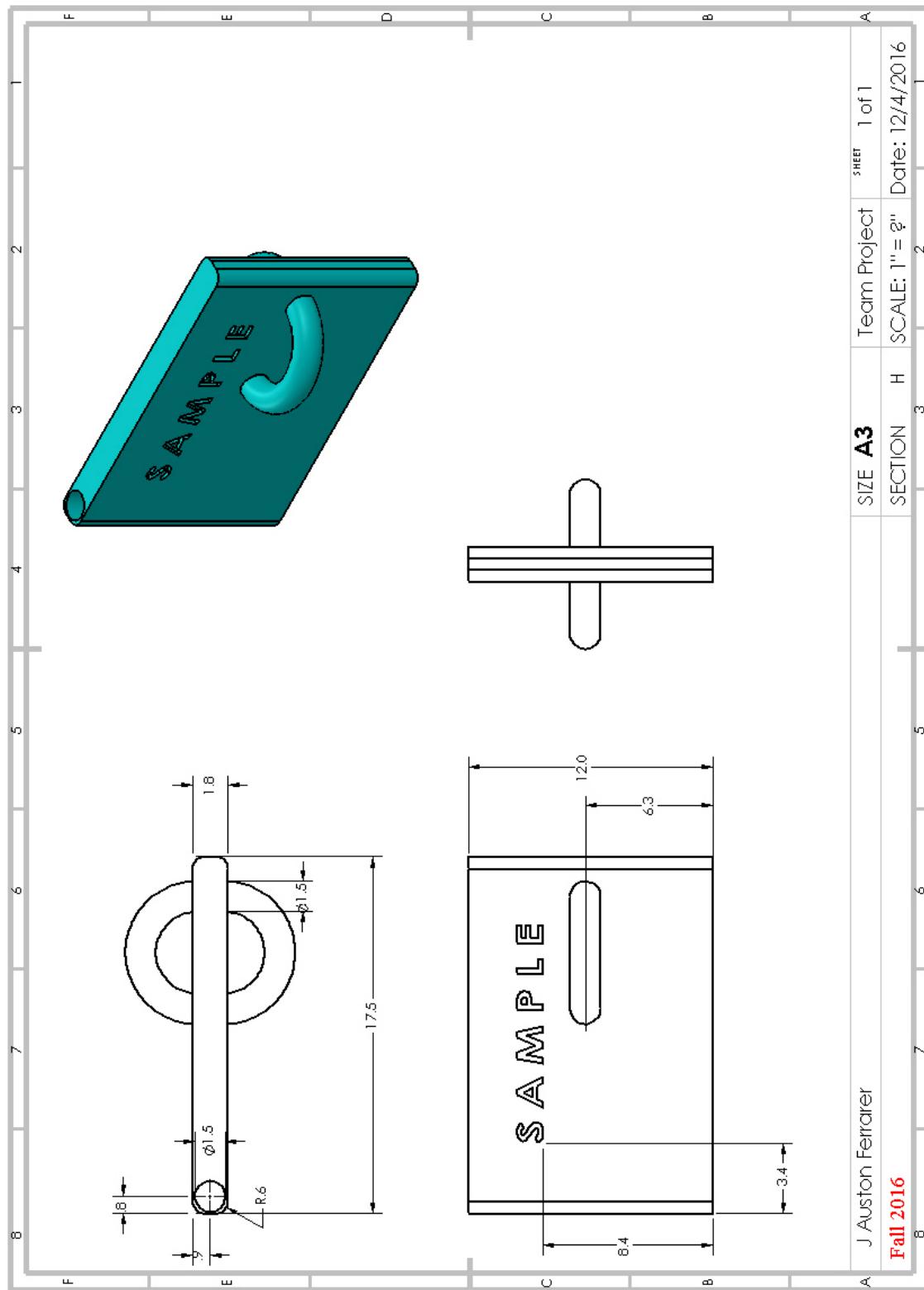


FIGURE 4.13: Rodriguez, Juan: Cabinet Drawer

### 4.1.7 Door and Hinge

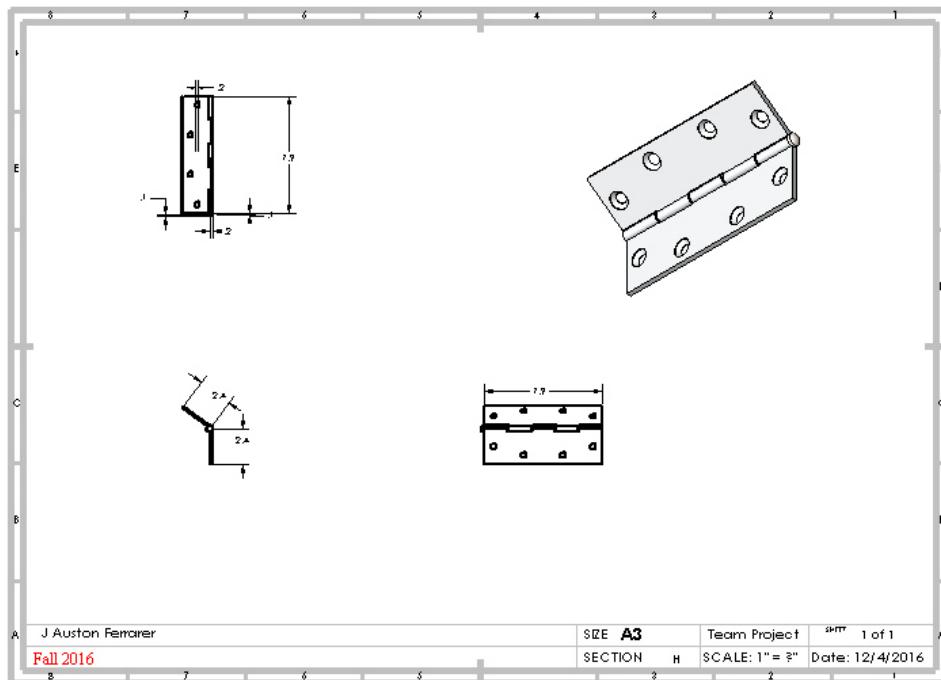


FIGURE 4.14: Ferrarer, Auston: Complete Hinge

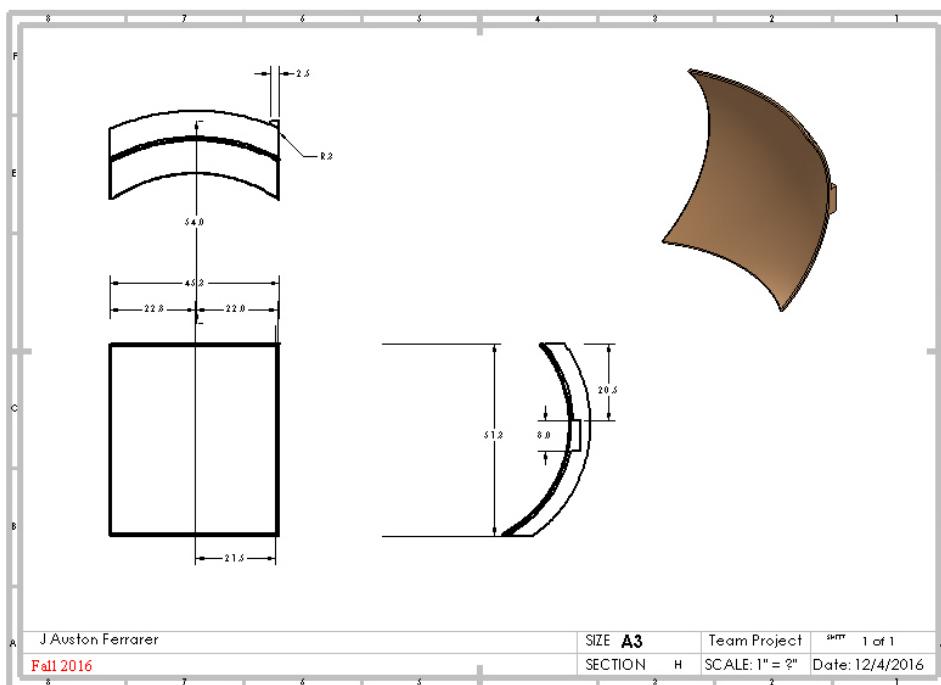


FIGURE 4.15: Ferrarer, Auston: Exterior Door

#### 4.1.8 Exterior Shell

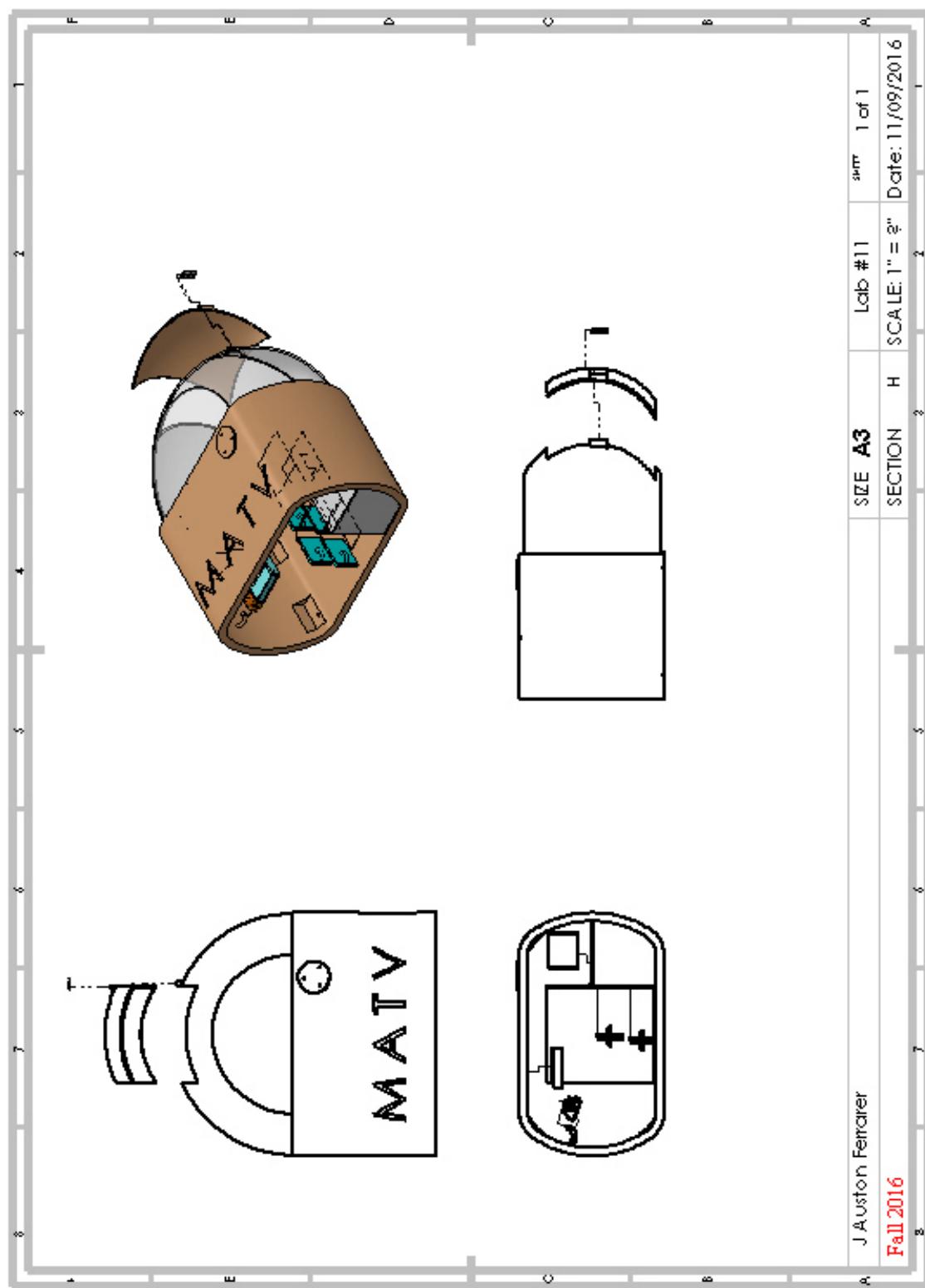


FIGURE 4.16: Ferrarer, Auston: Assembly

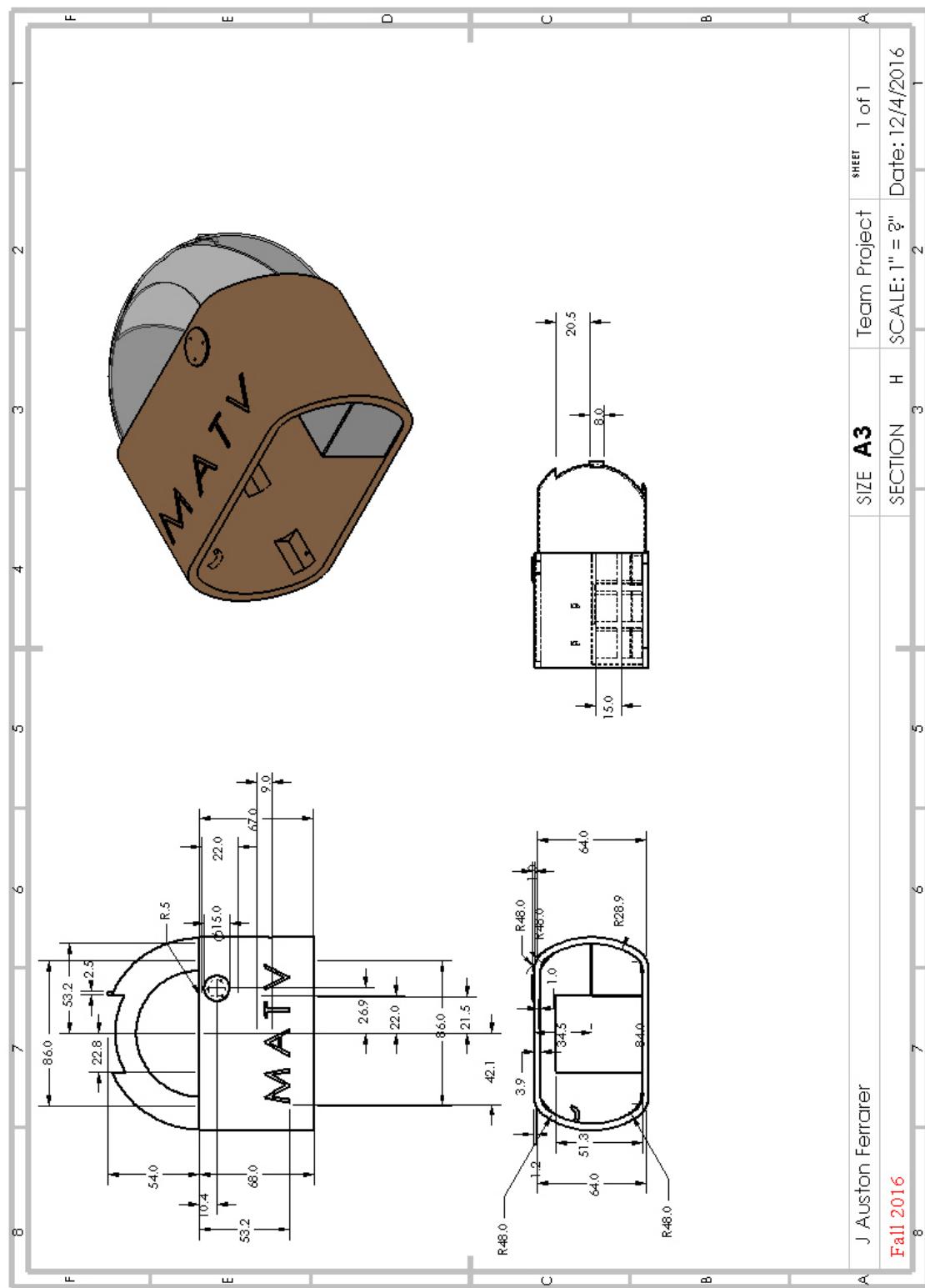


FIGURE 4.17: Ferrarer, Auston: Full Shell

#### 4.1.9 Helmet

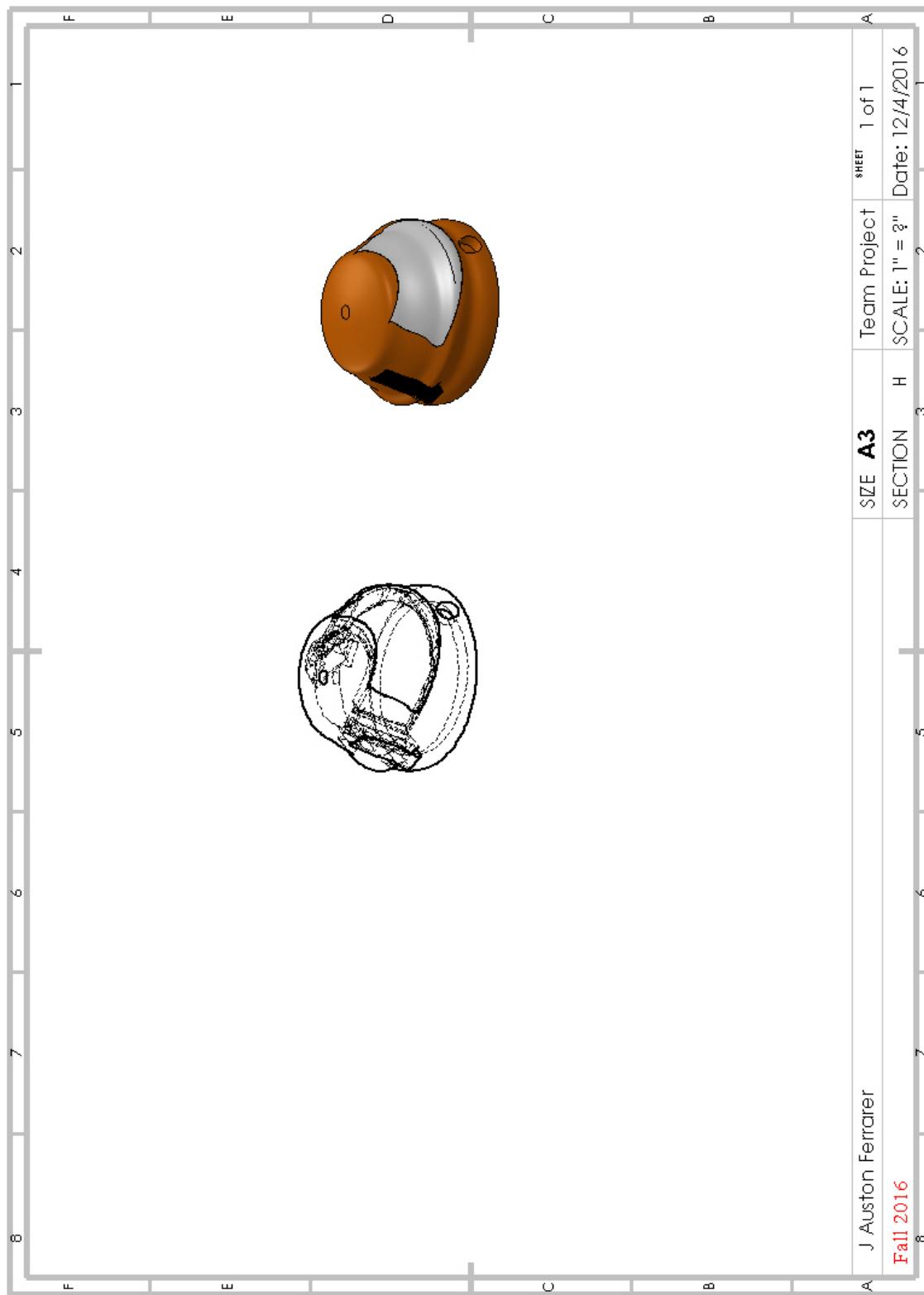


FIGURE 4.18: Ferrarer, Auston: Helmet Full Assembly

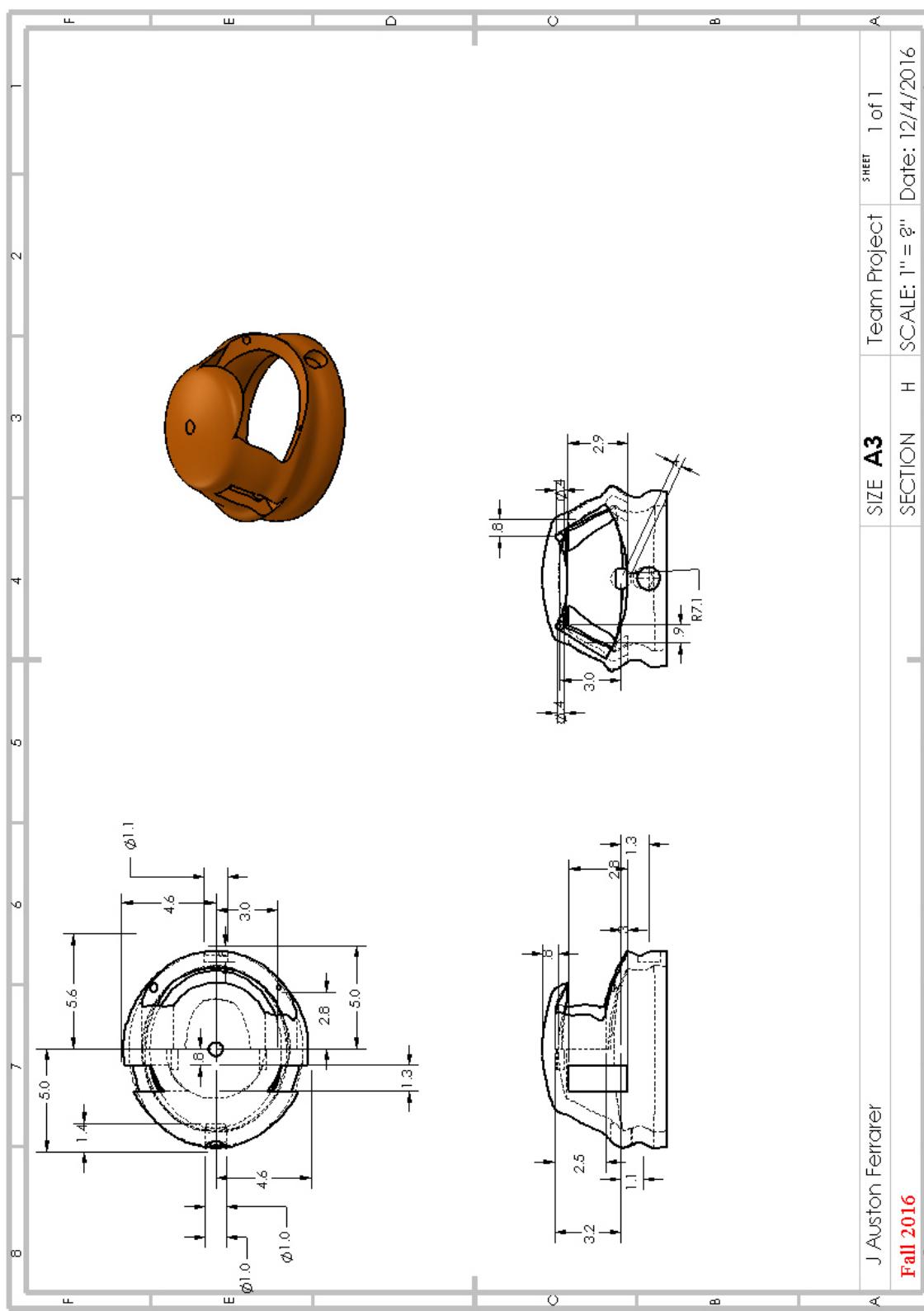


FIGURE 4.19: Ferrarer, Auston: Helmet Shell

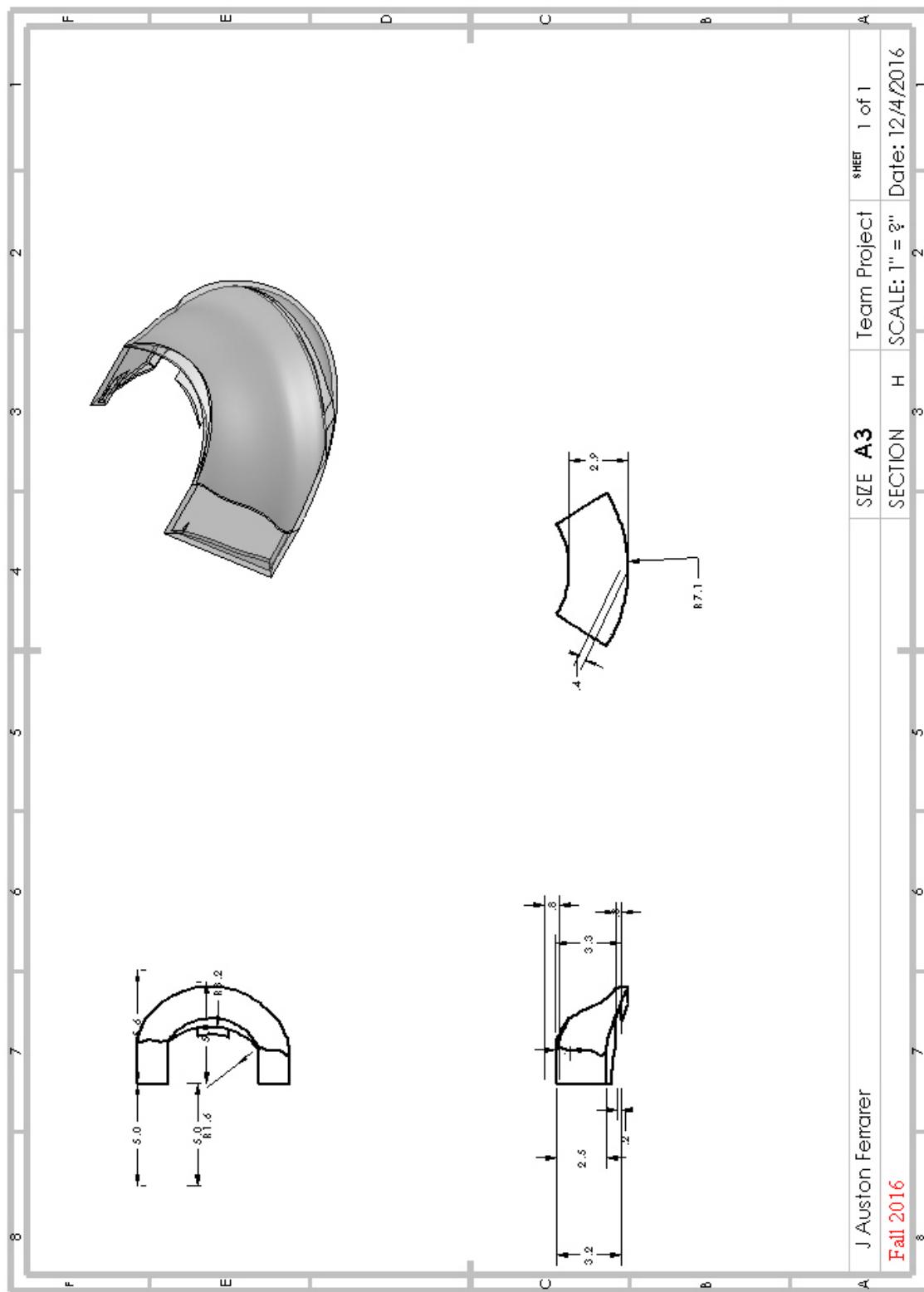


FIGURE 4.20: Ferrarer, Auston: Helmet Visor

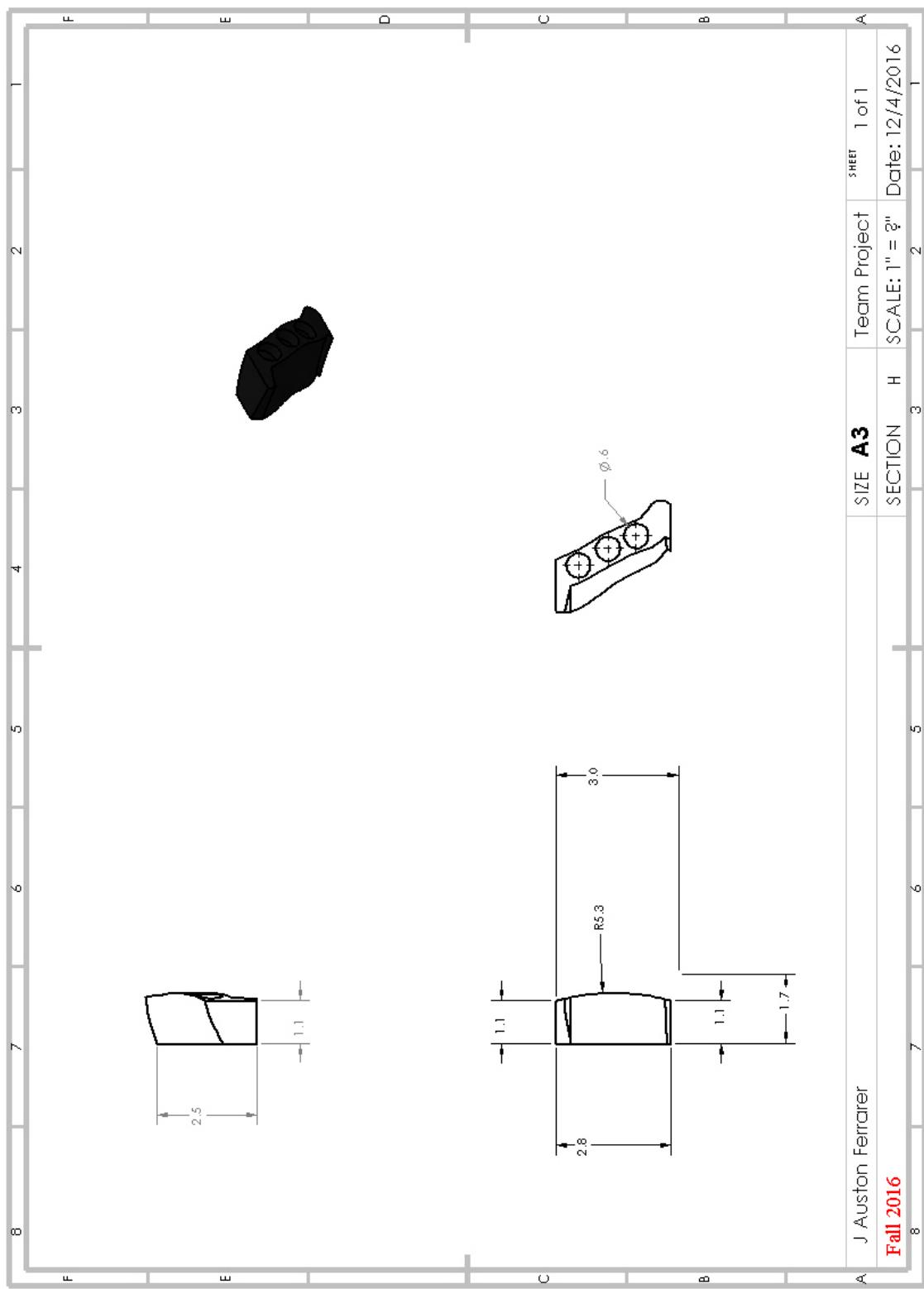


FIGURE 4.21: Ferrarer, Auston: Side Lights

#### 4.1.10 Grabber

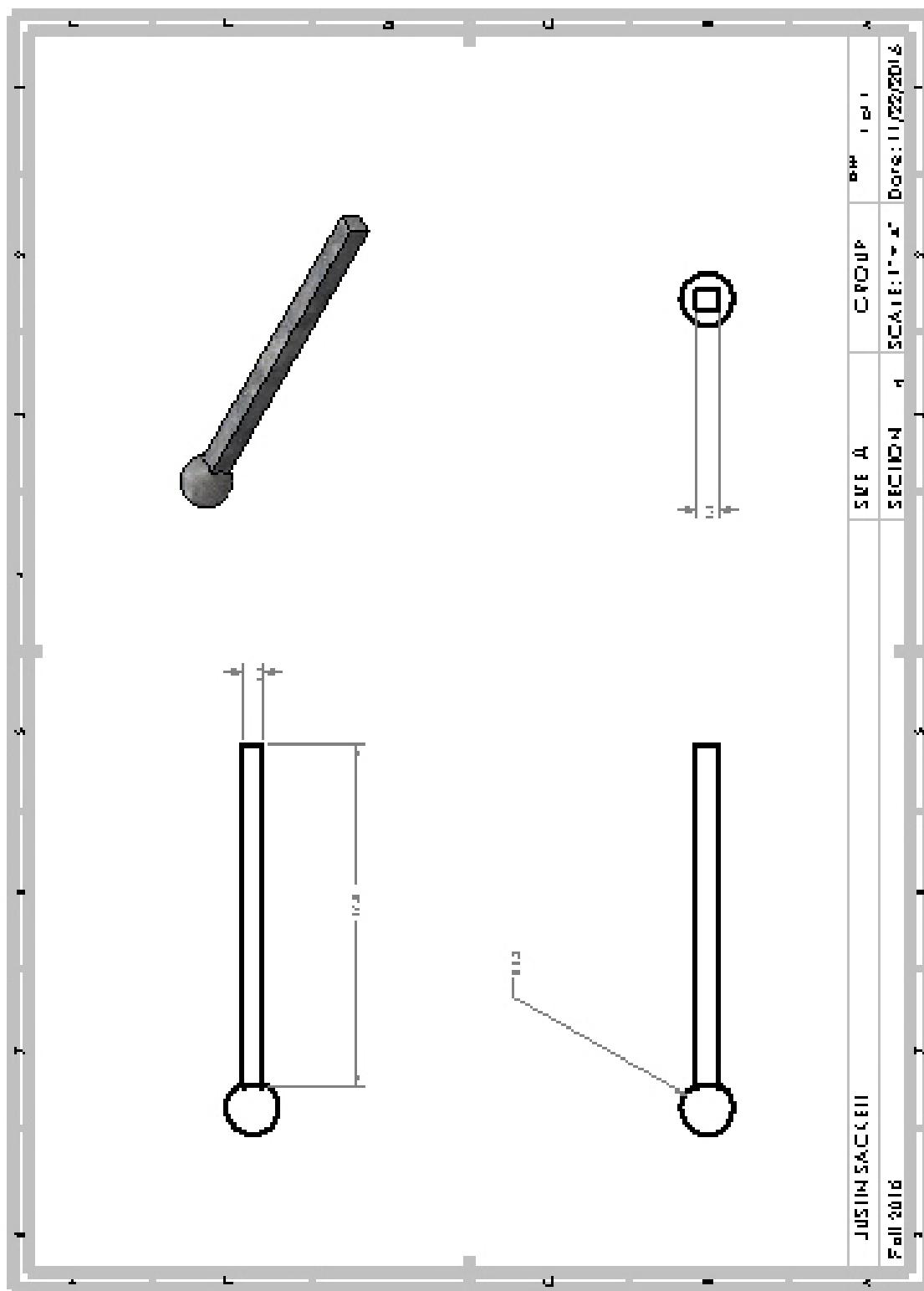


FIGURE 4.22: Sackett, Justin: Ball Rod

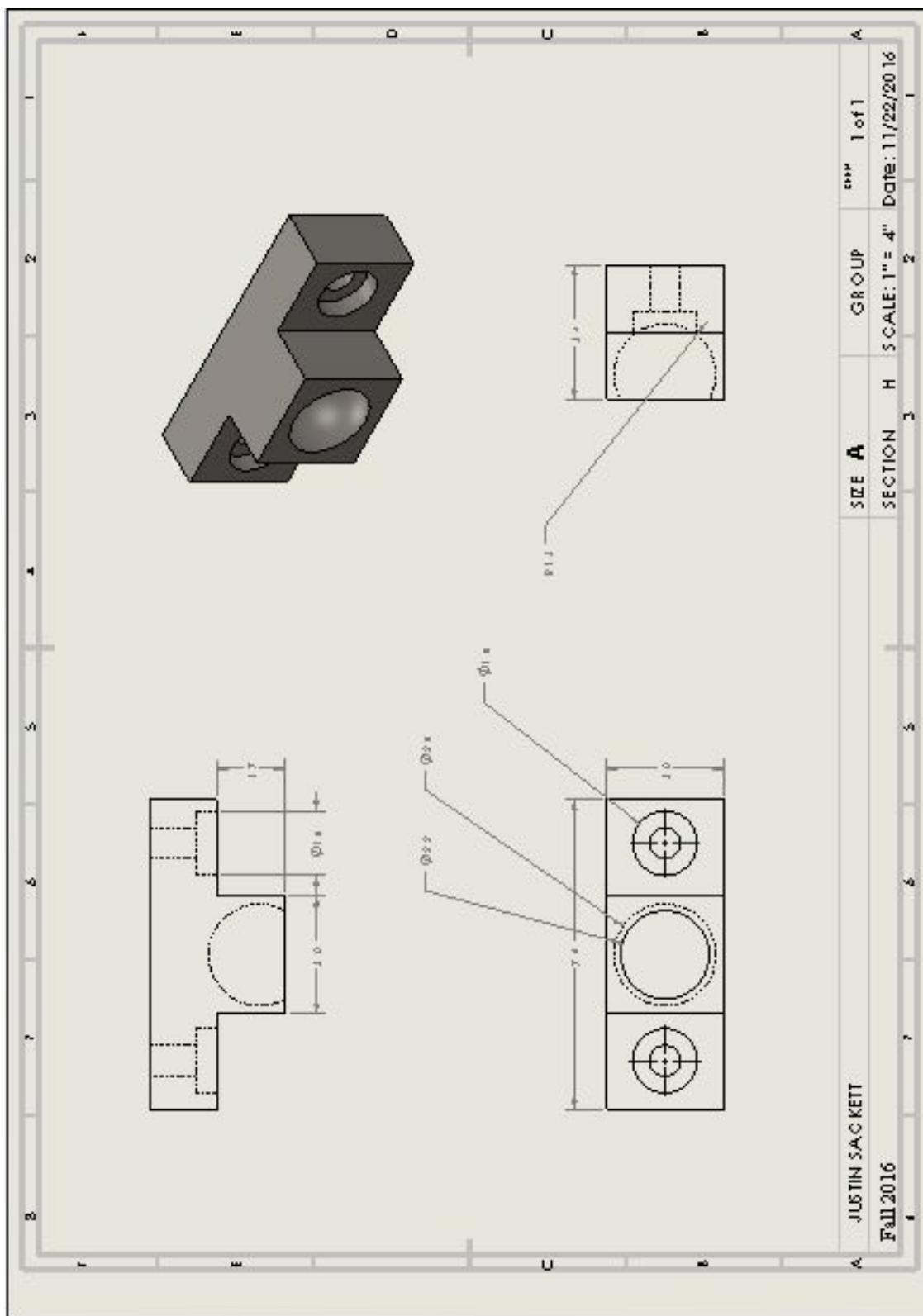


FIGURE 4.23: Sackett, Justin: Ball Socket

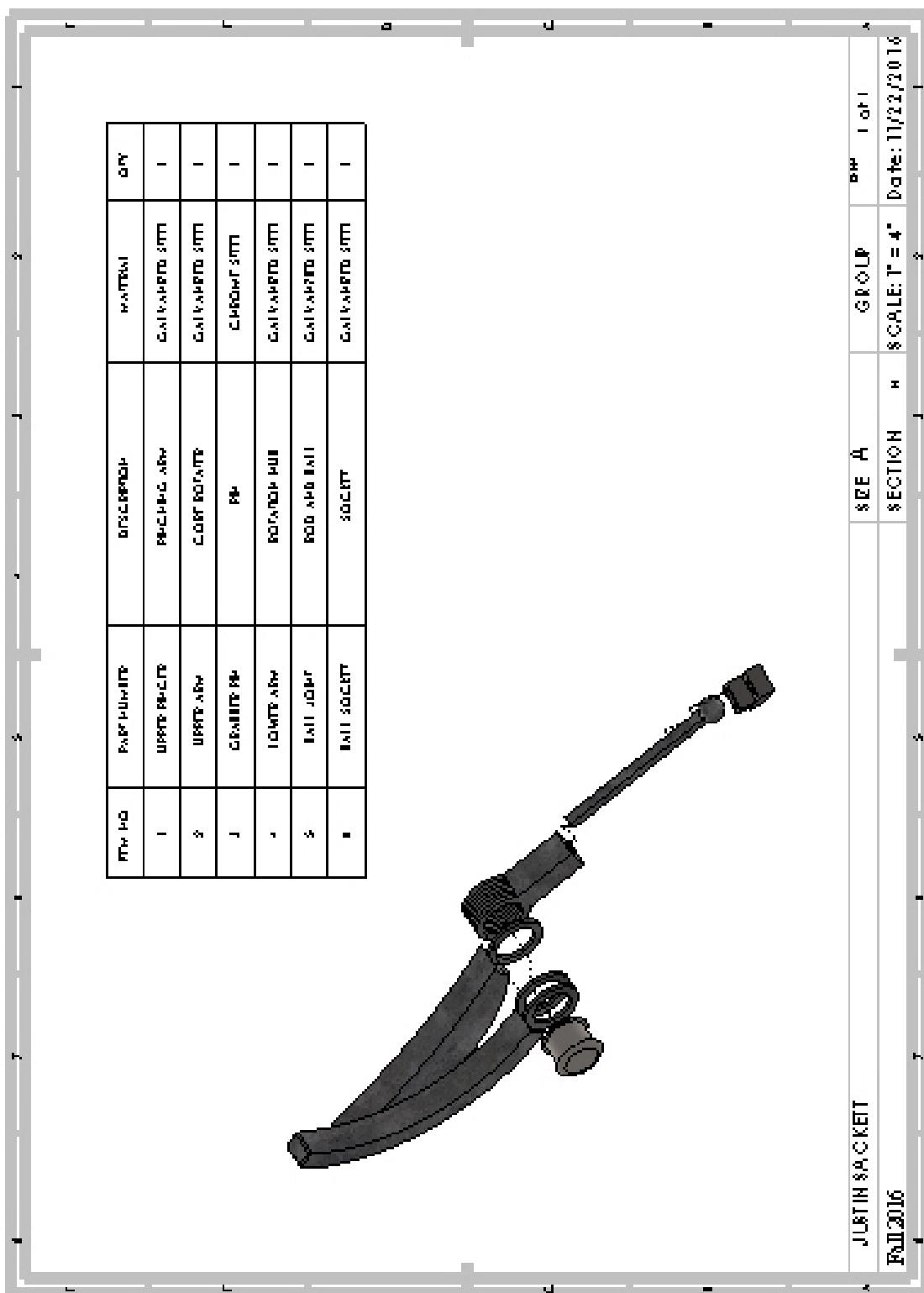


FIGURE 4.24: Sackett, Justin: Grabber Exploded

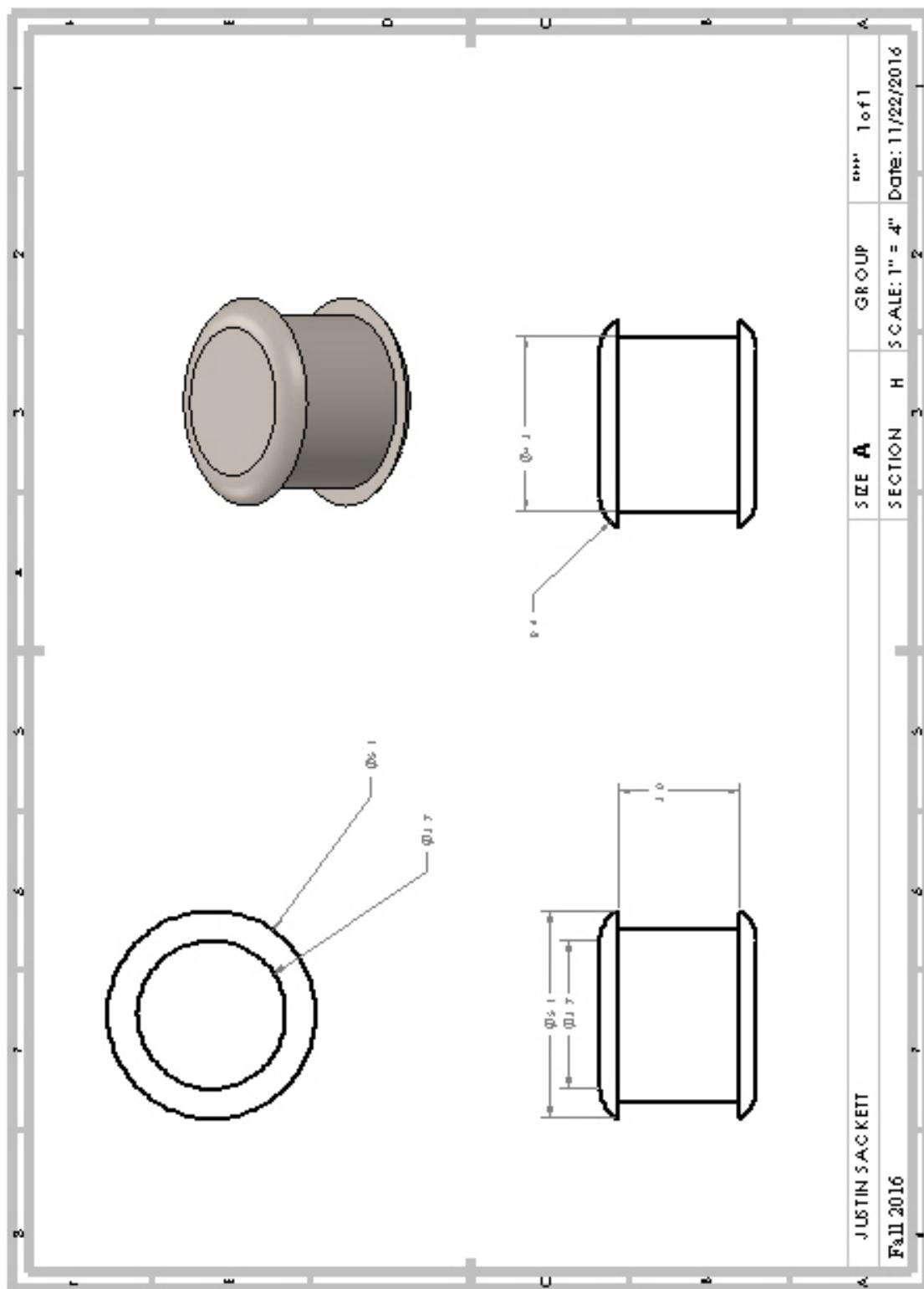
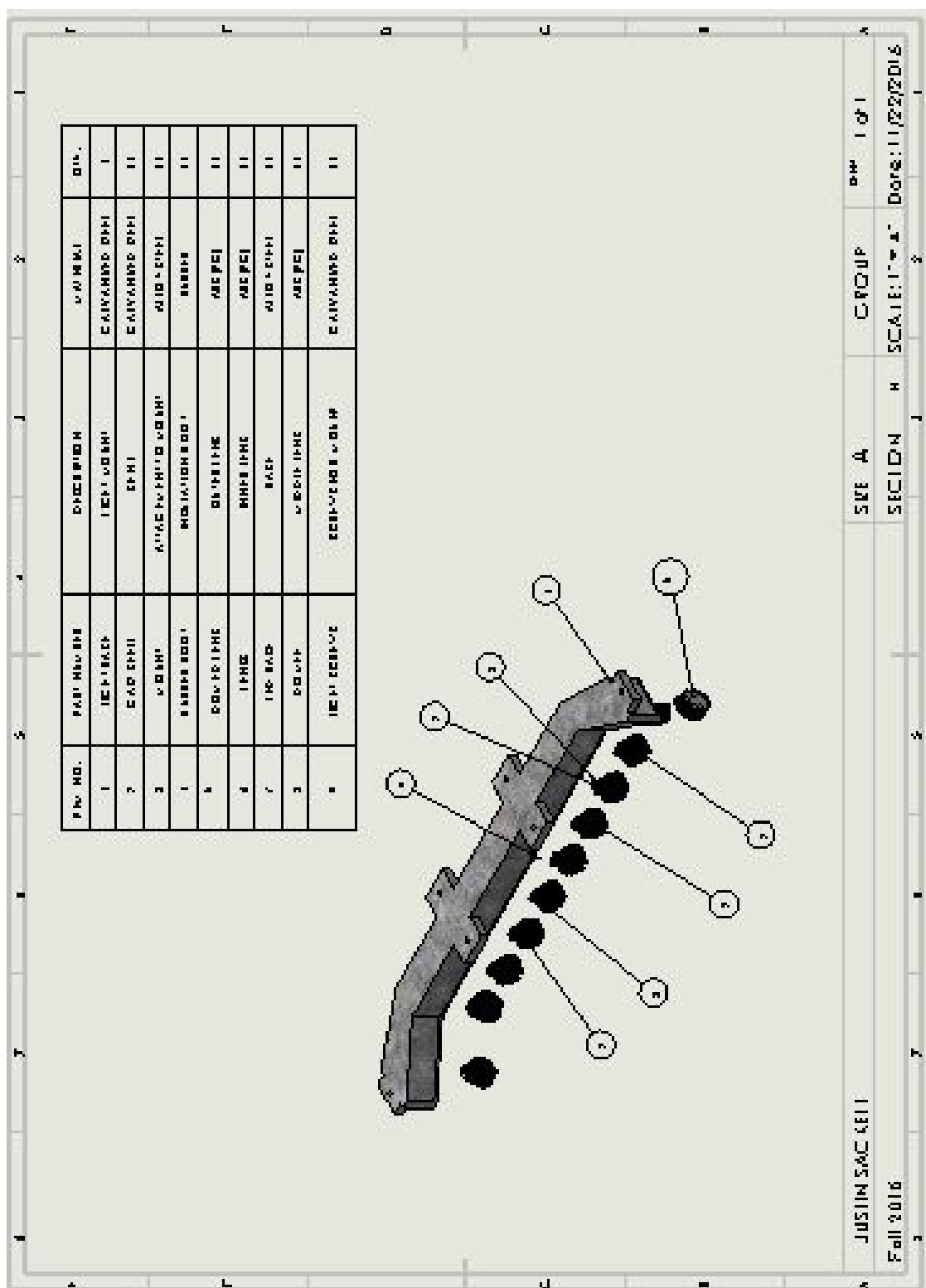


FIGURE 4.25: Sackett, Justin: Grabber Pin



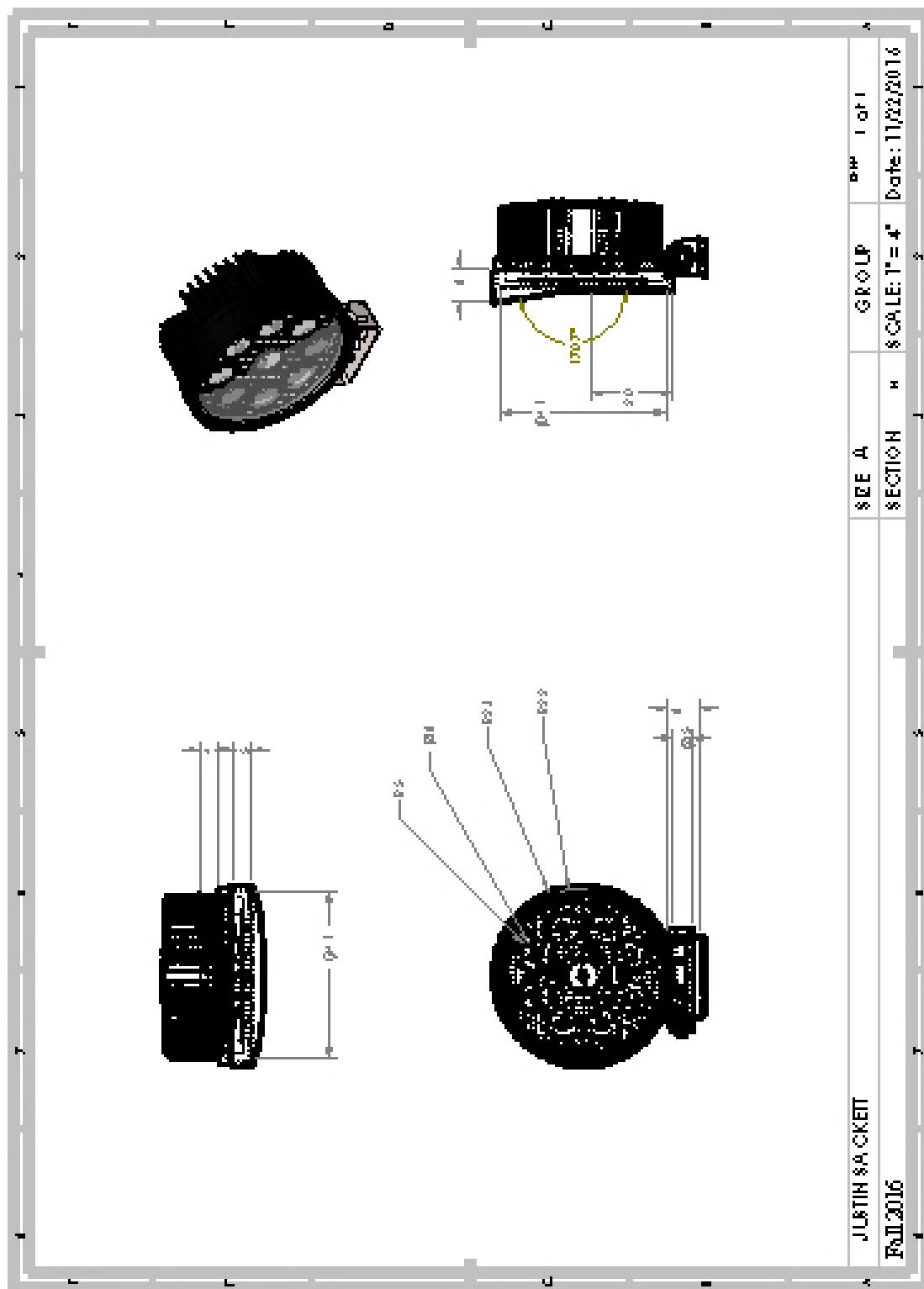


FIGURE 4.27: Sackett, Justin: Light

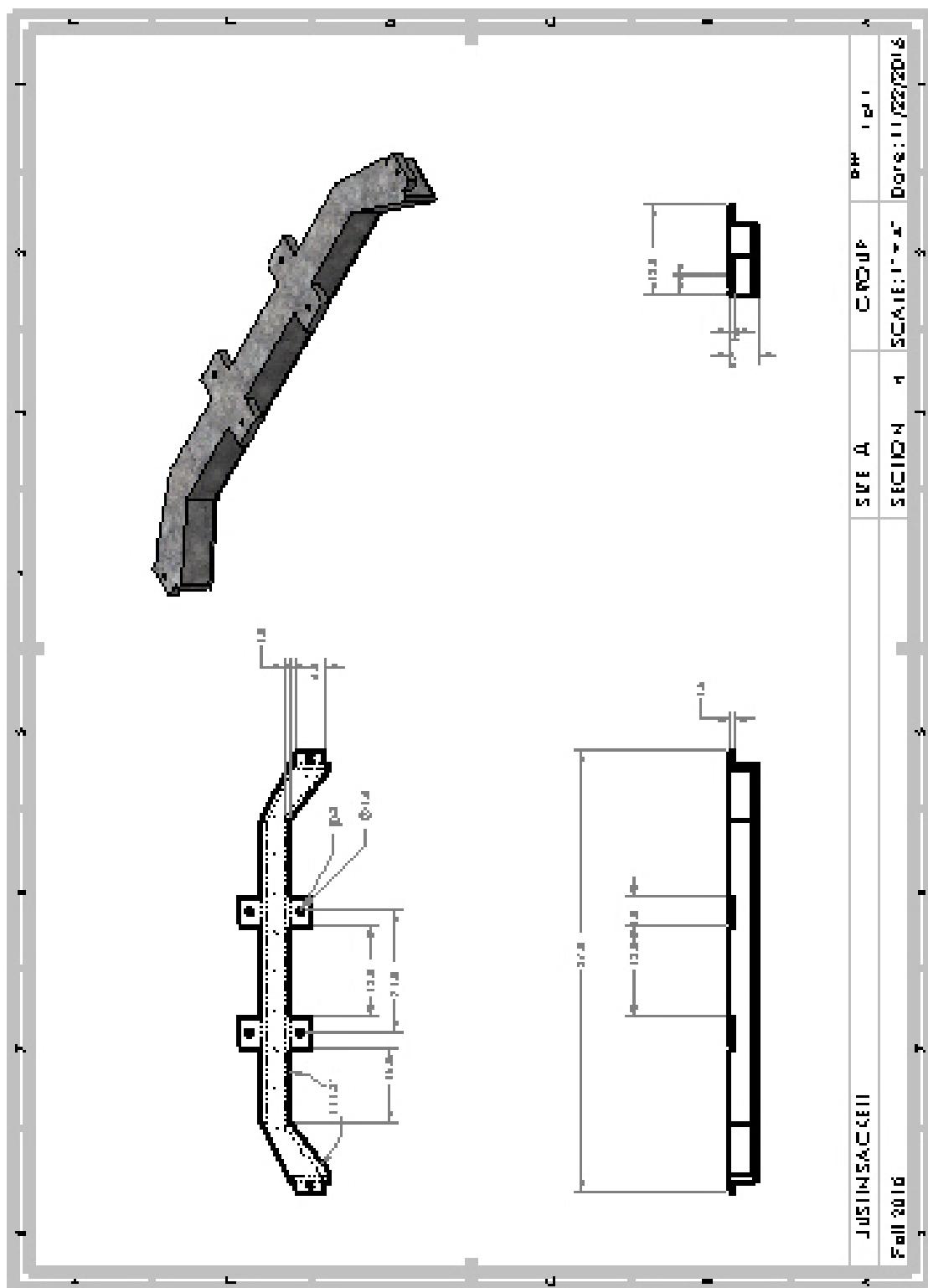


FIGURE 4.28: Sackett, Justin: Light Base

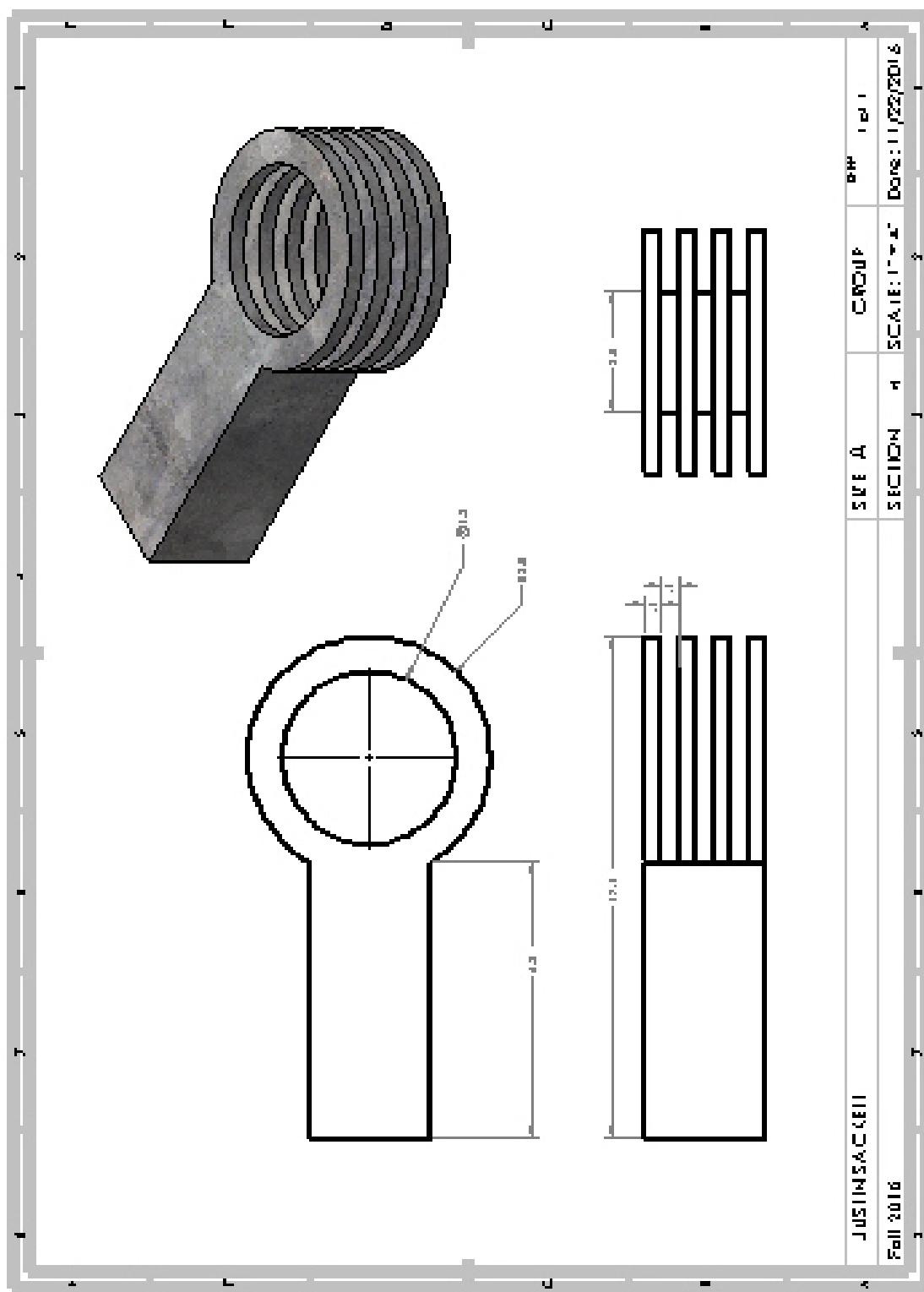


FIGURE 4.29: Sackett, Justin: Lower Arm

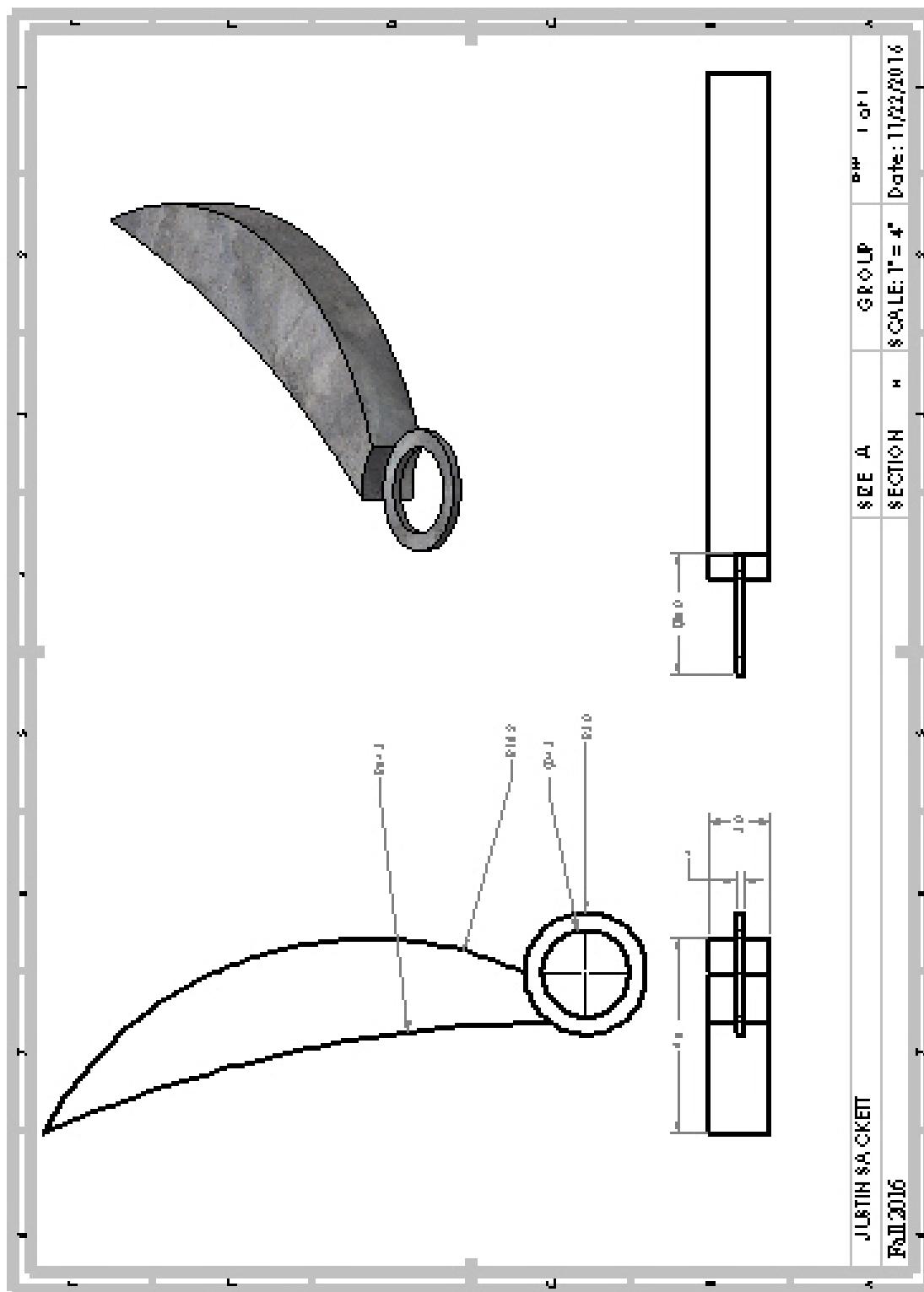


FIGURE 4.30: Sackett, Justin: Upper Pincer

### 4.1.11 Suspension

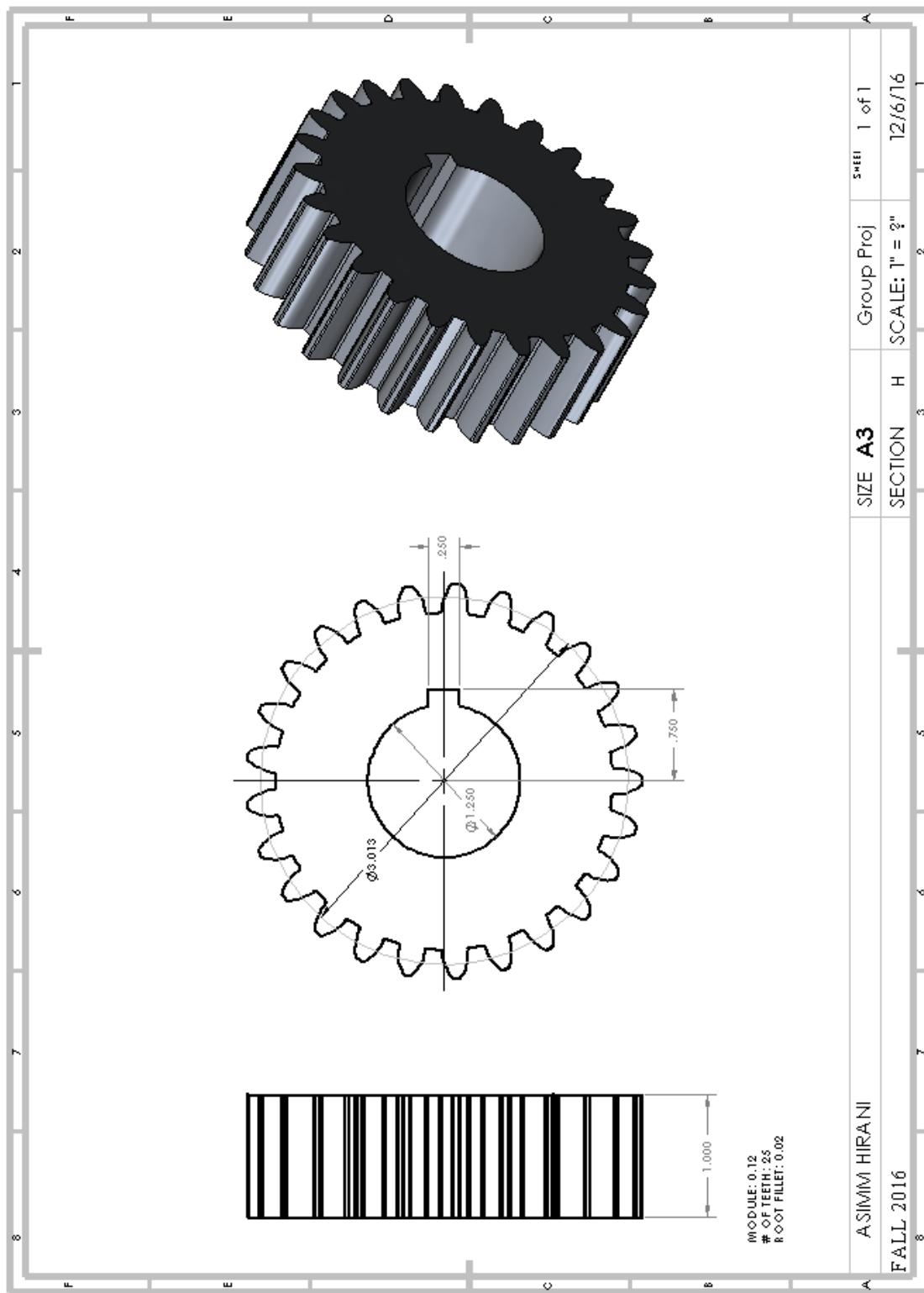


FIGURE 4.31: Hirani, Asimm: 25 Tooth Gear

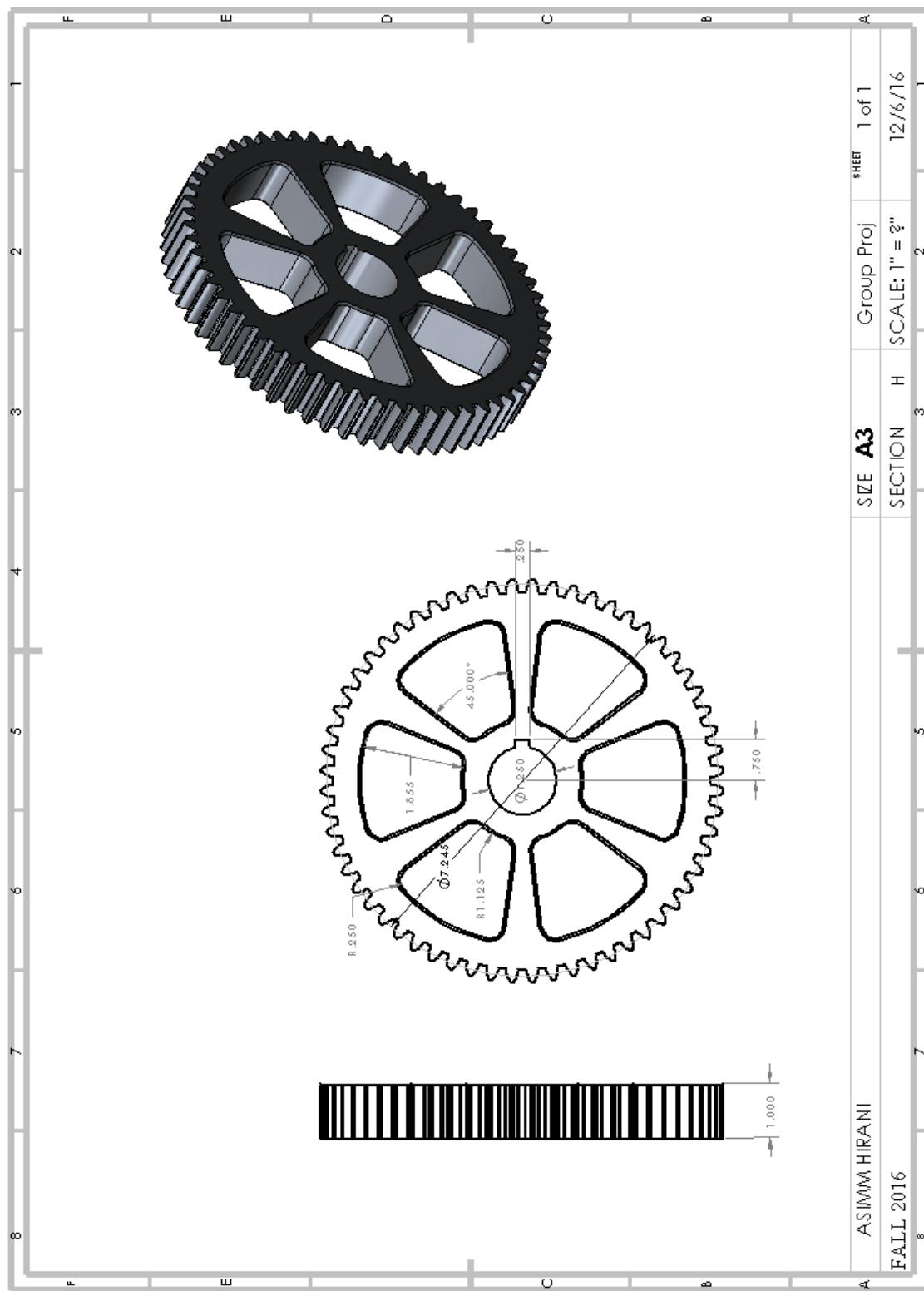


FIGURE 4.32: Hirani, Asimm: 60 Tooth Gear

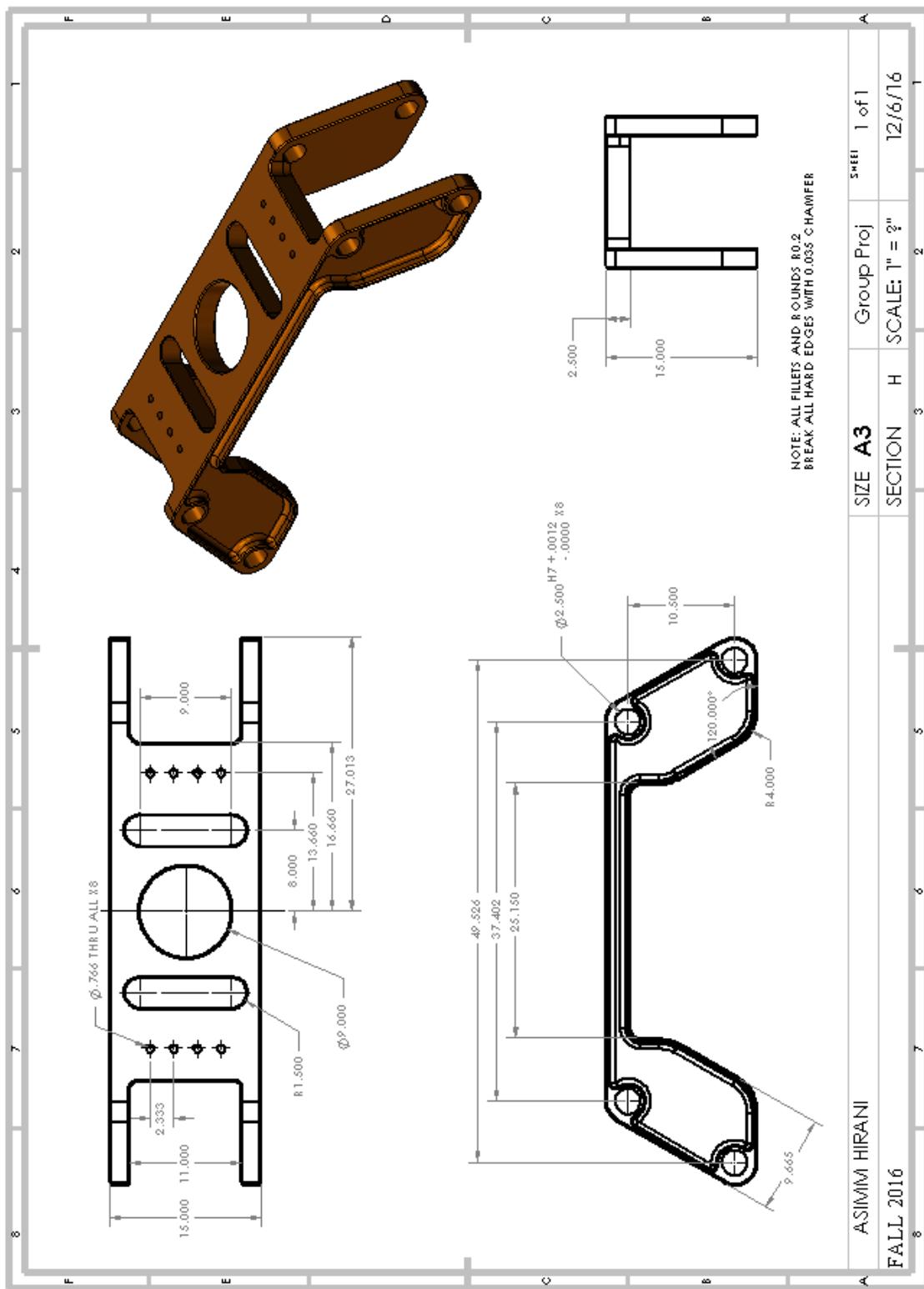


FIGURE 4.33: Hirani, Asimm: Center Frame

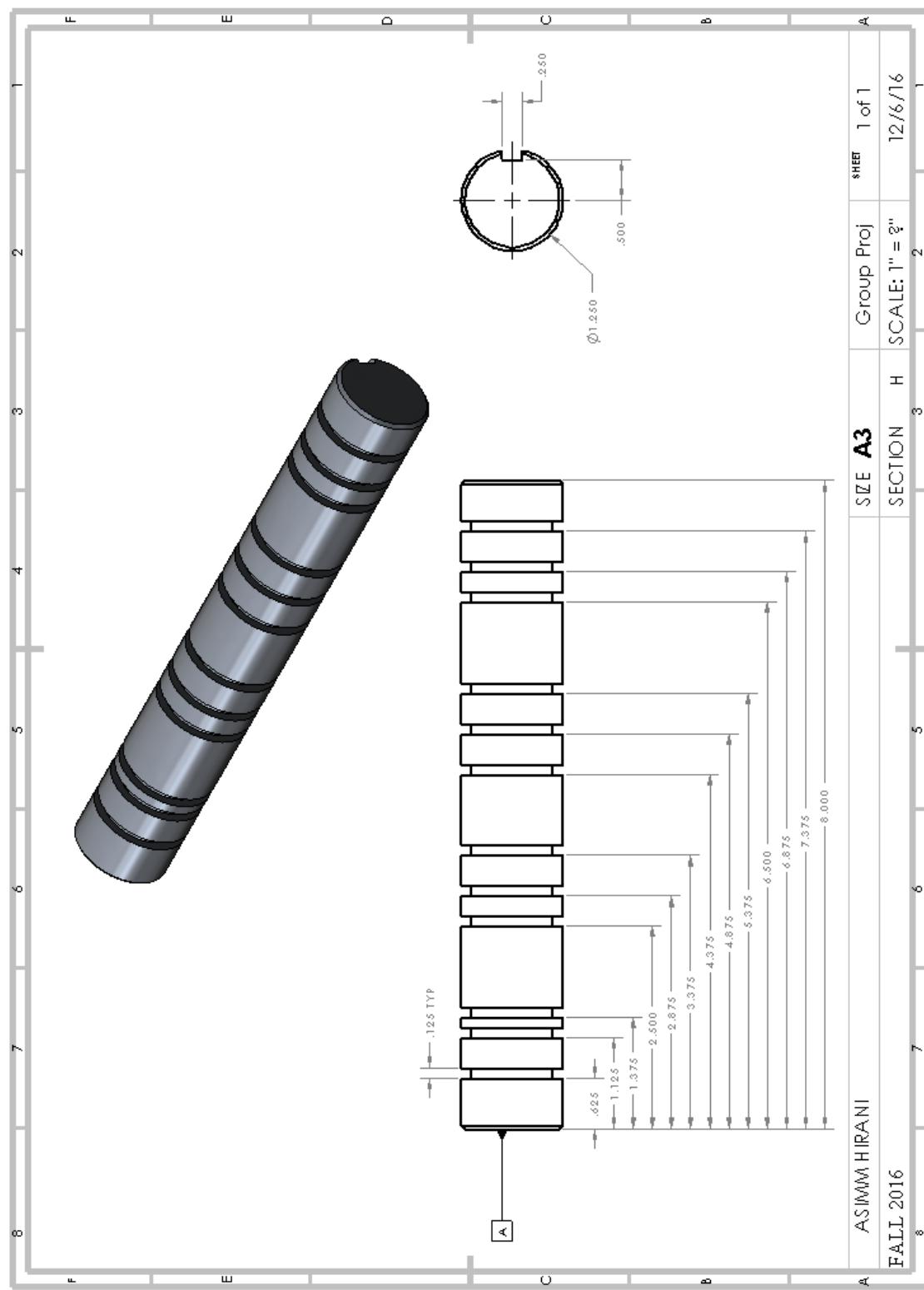


FIGURE 4.34: Hirani, Asimm: Gearbox Idler Shaft

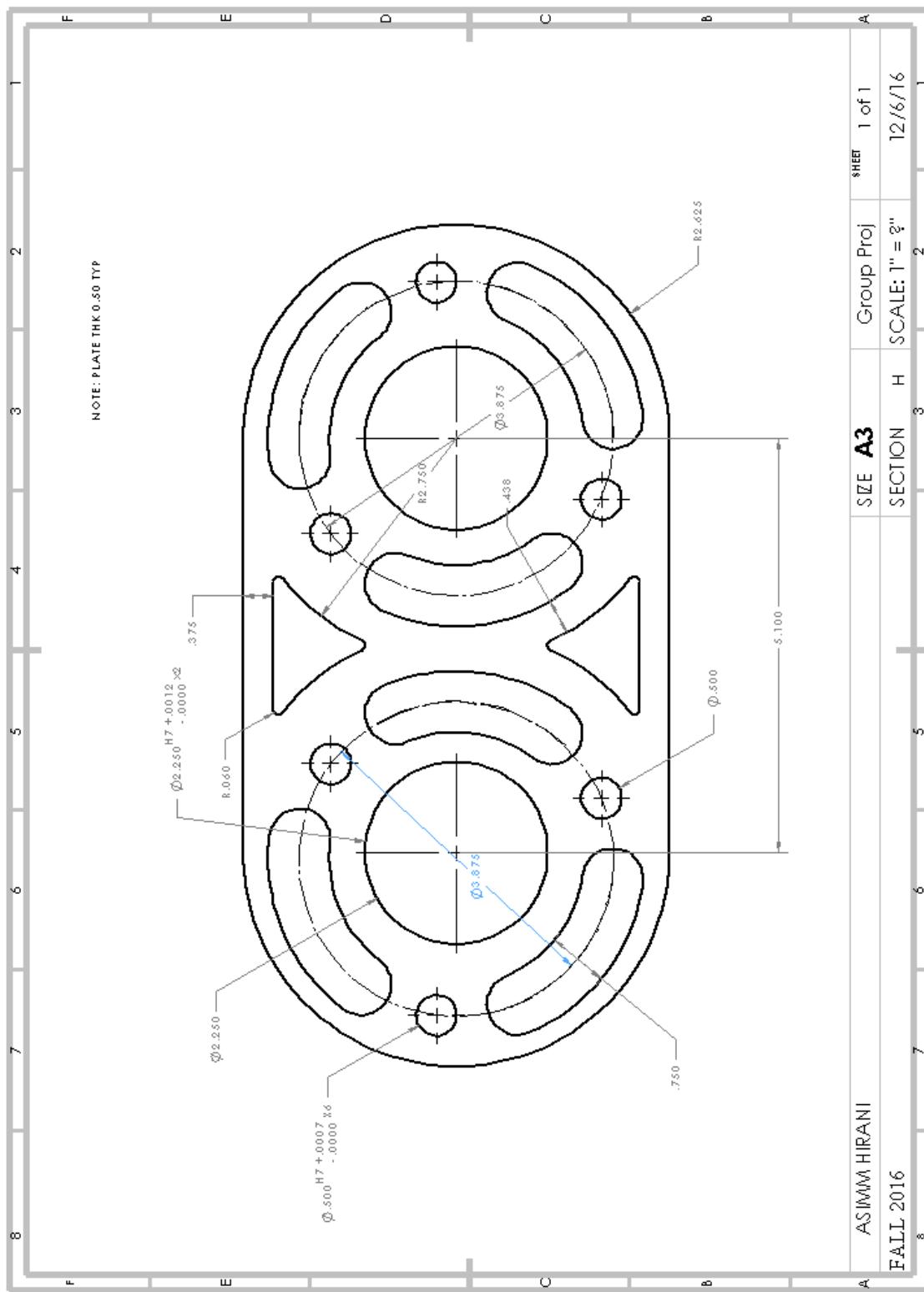


FIGURE 4.35: Hirani, Asimm: Gearbox Plate

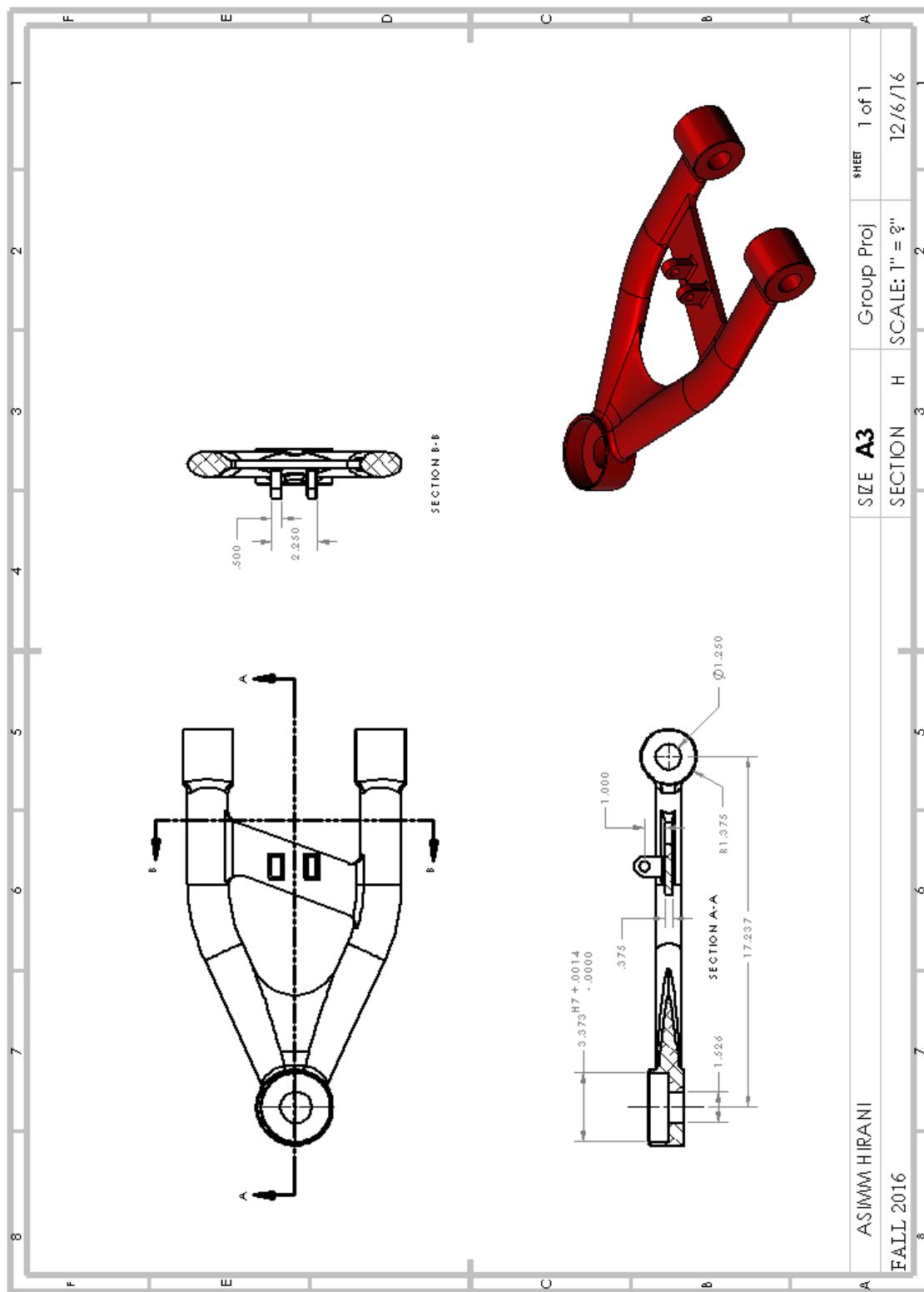


FIGURE 4.36: Hirani, Asimm: LCA

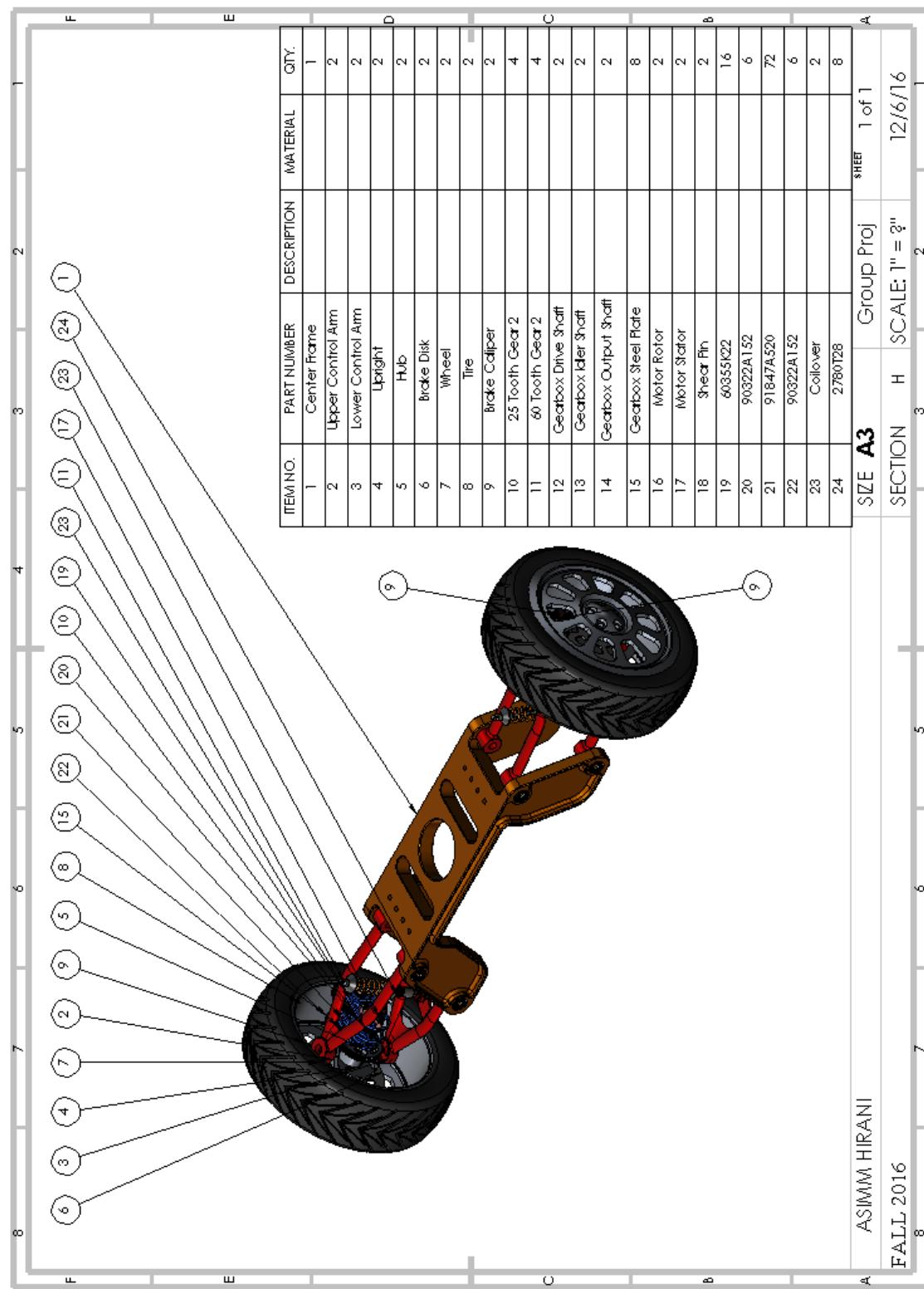


FIGURE 4.37: Hirani, Asimm: Suspension Assembly

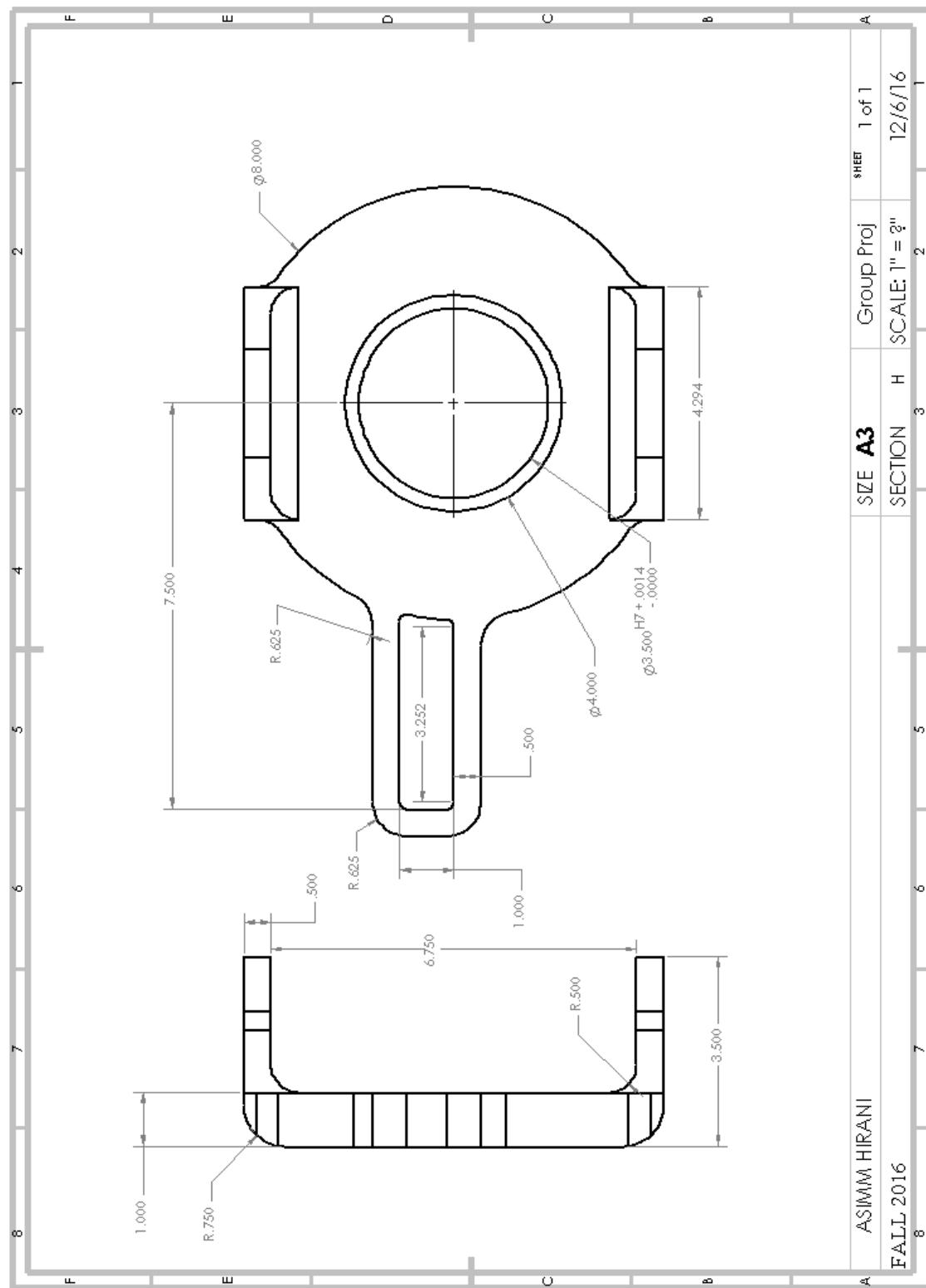


FIGURE 4.38: Hirani, Asimm: Upright

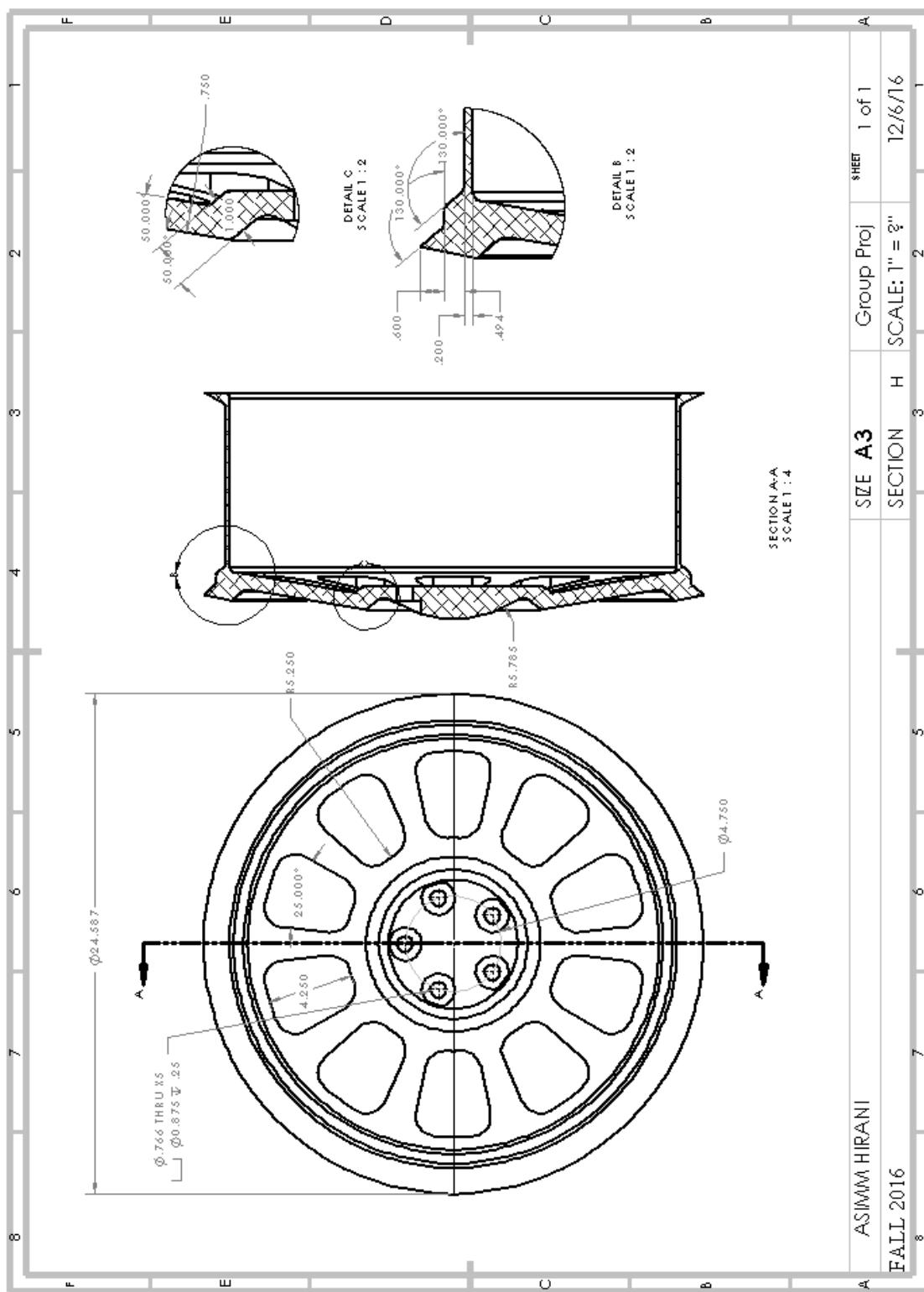


FIGURE 4.39: Hirani, Asimm: Wheel

#### 4.1.12 3D Printer

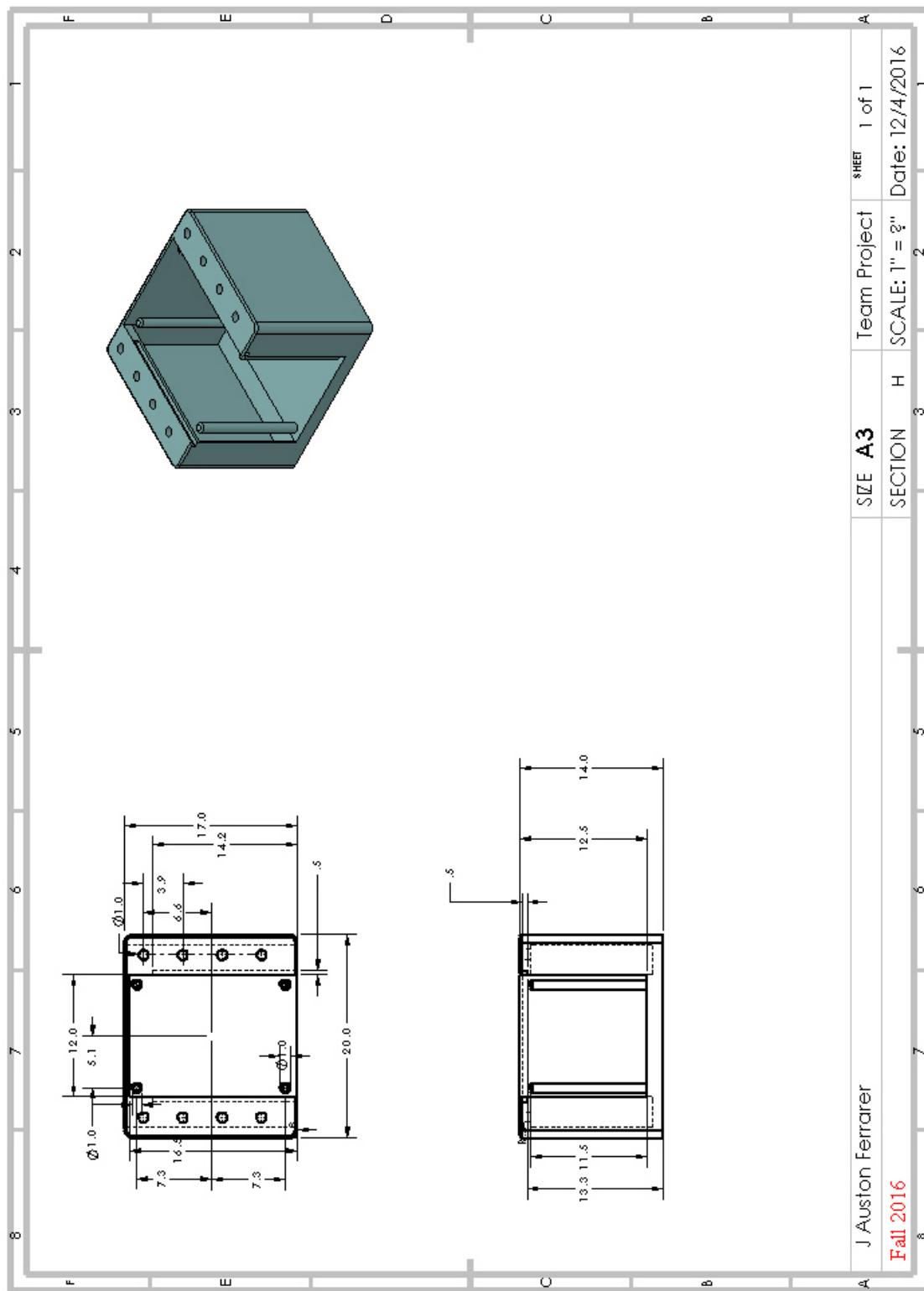


FIGURE 4.40: Ferrarer, Auston: Base Extrusion

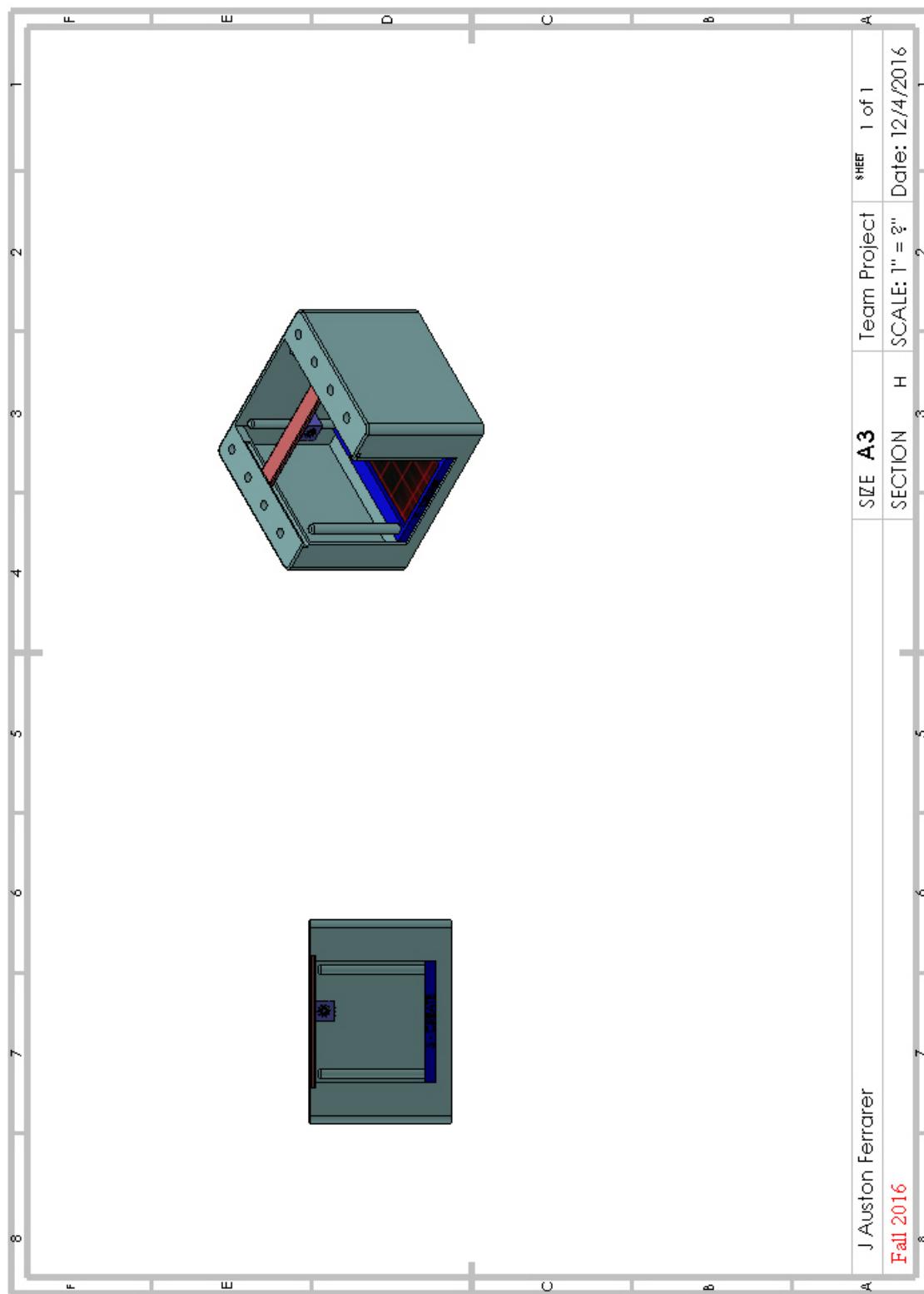


FIGURE 4.41: Ferrarer, Auston: Full 3D Printer

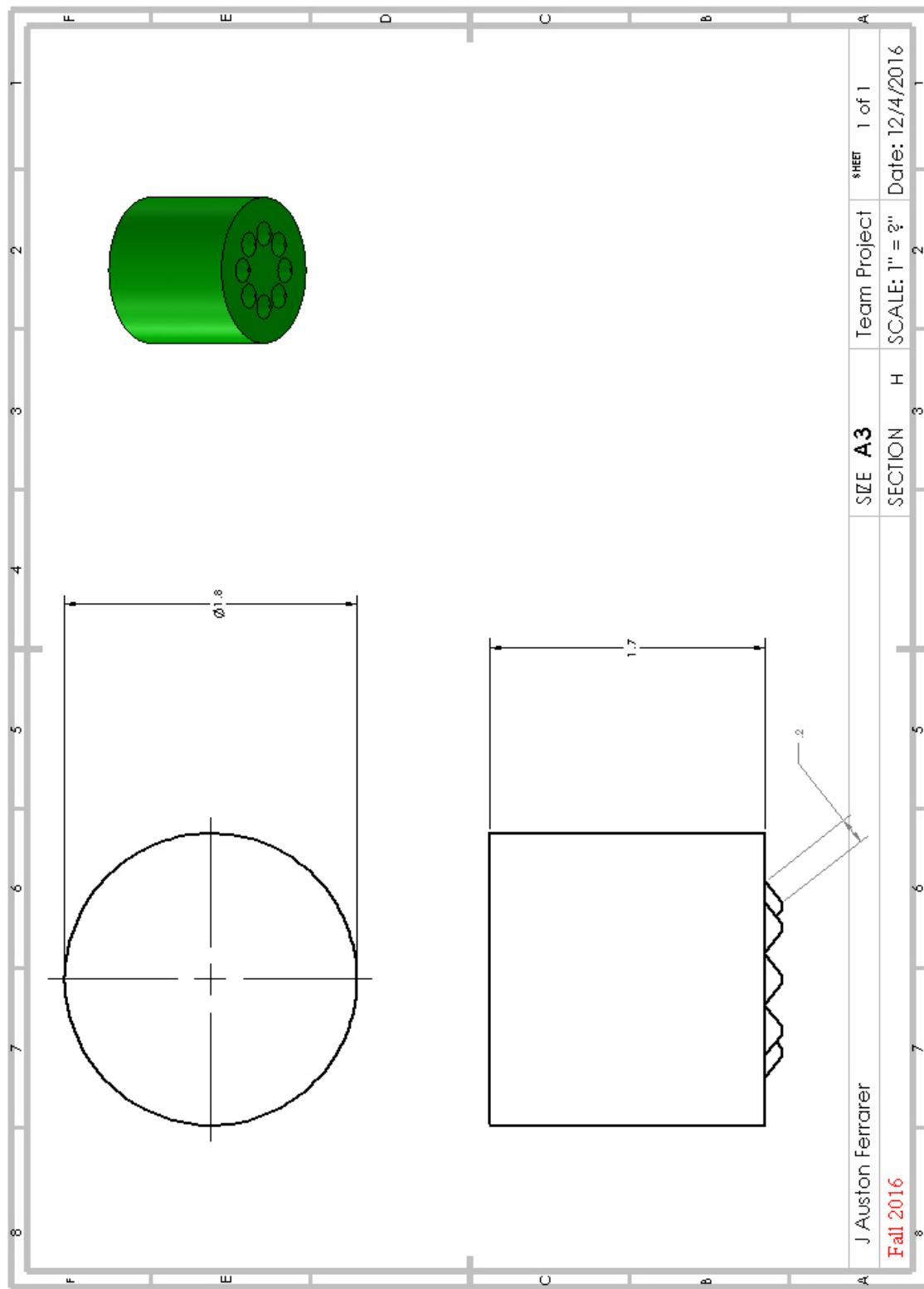


FIGURE 4.42: Ferrarer, Auston: Printing Nozel

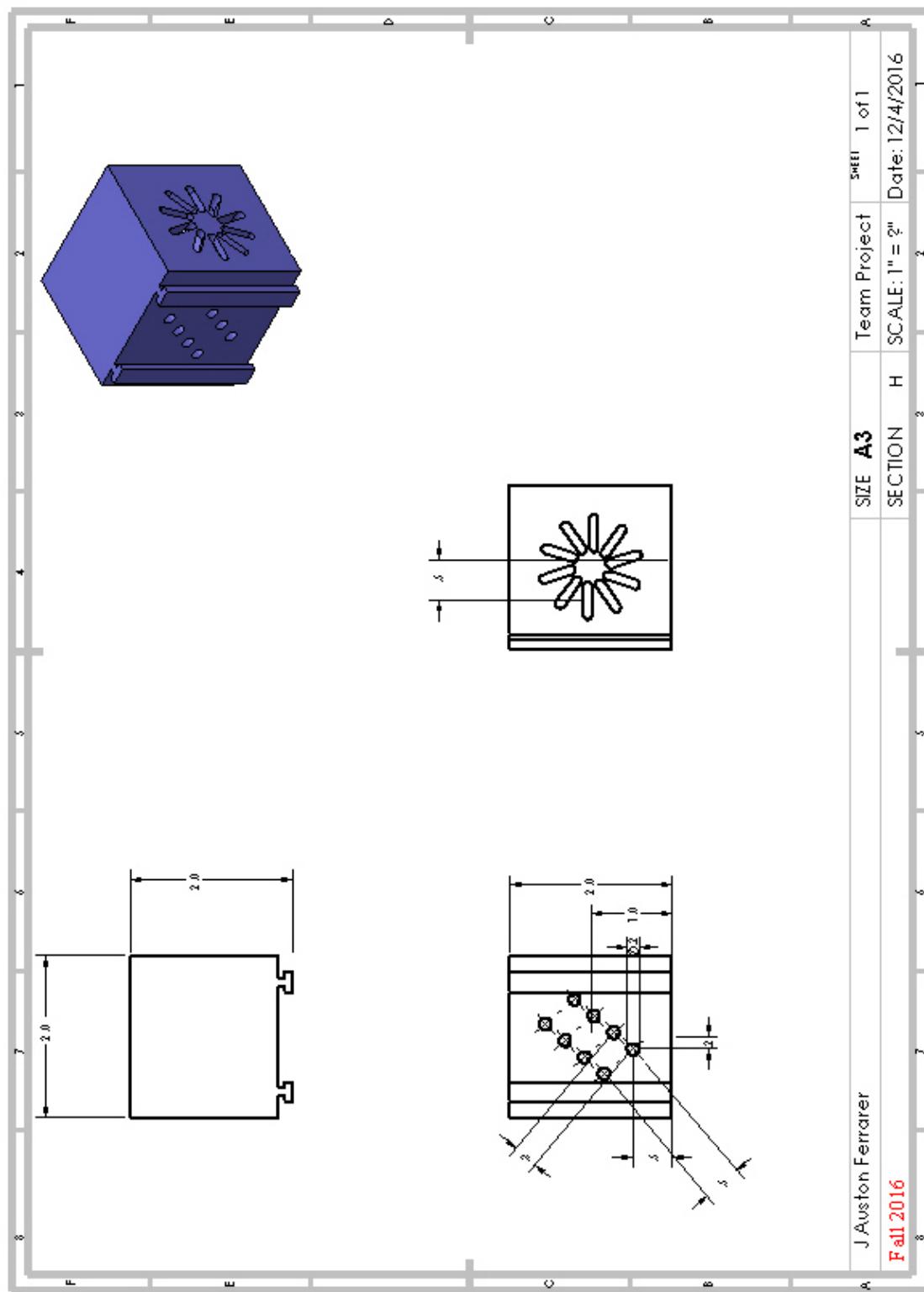


FIGURE 4.43: Ferrarer, Auston: Printing Nozel Casing

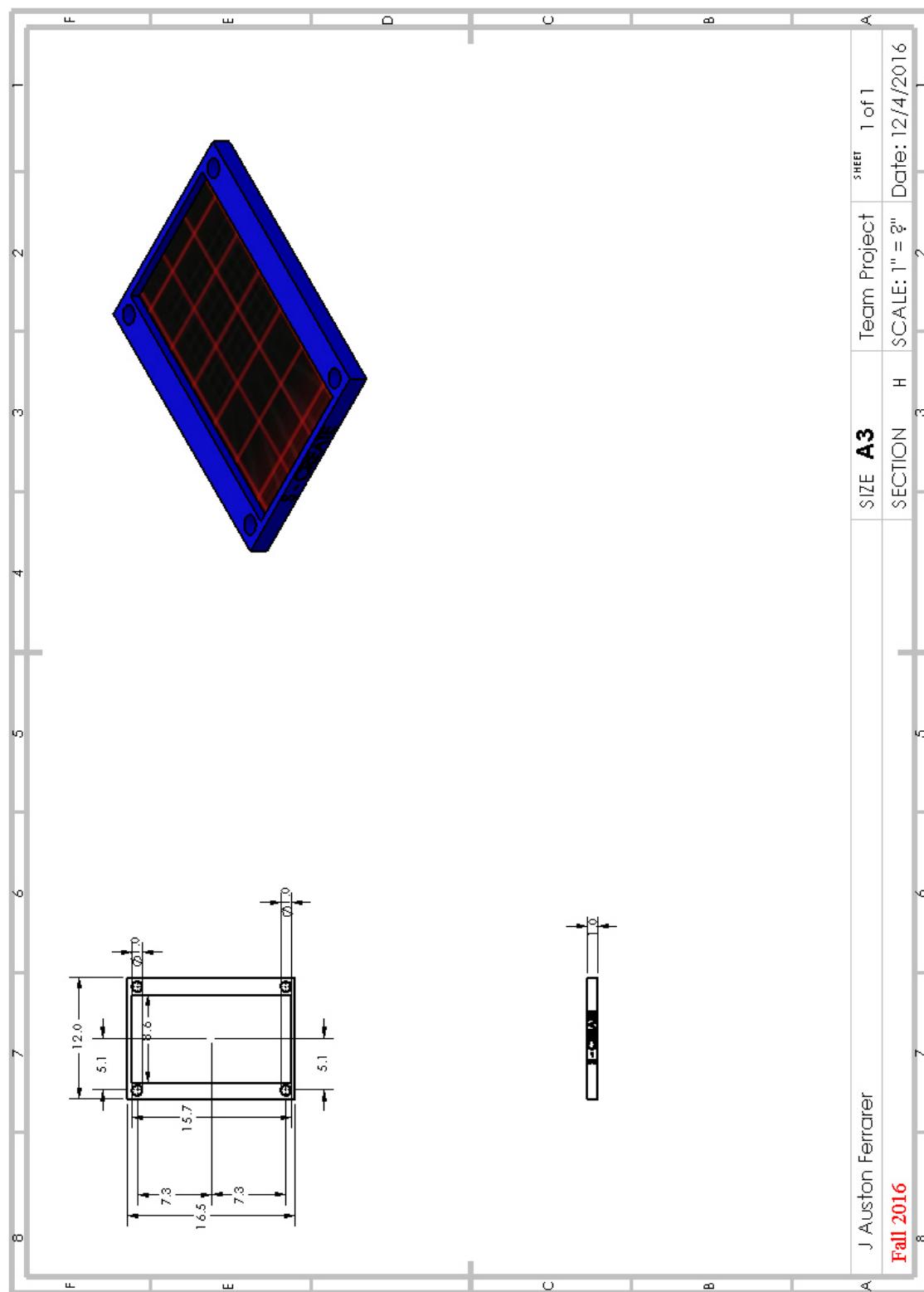


FIGURE 4.44: Ferrarer, Auston: Printing Pad

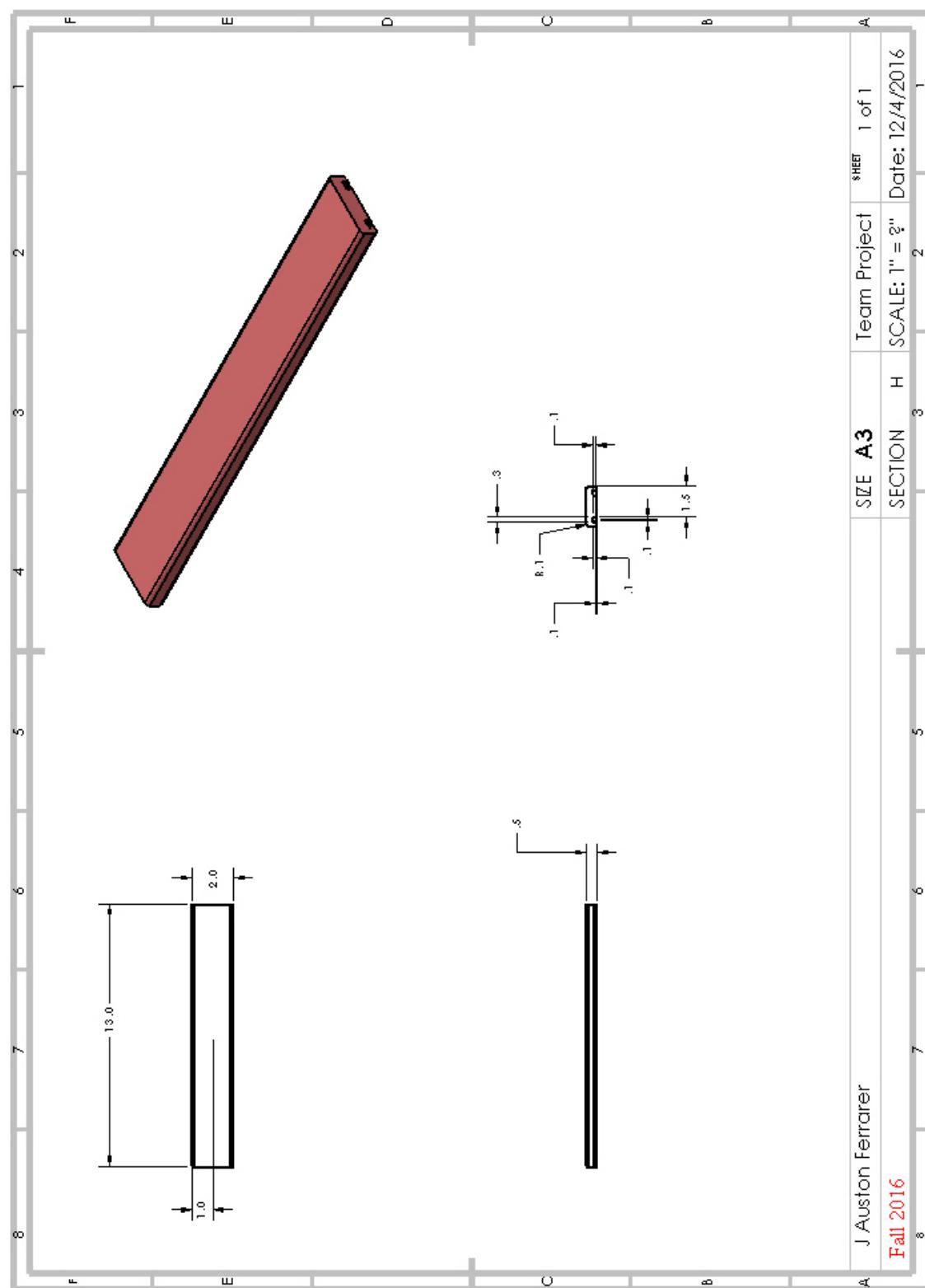


FIGURE 4.45: Ferrarer, Auston: Sidebar for Nozel

#### 4.1.13 Bed

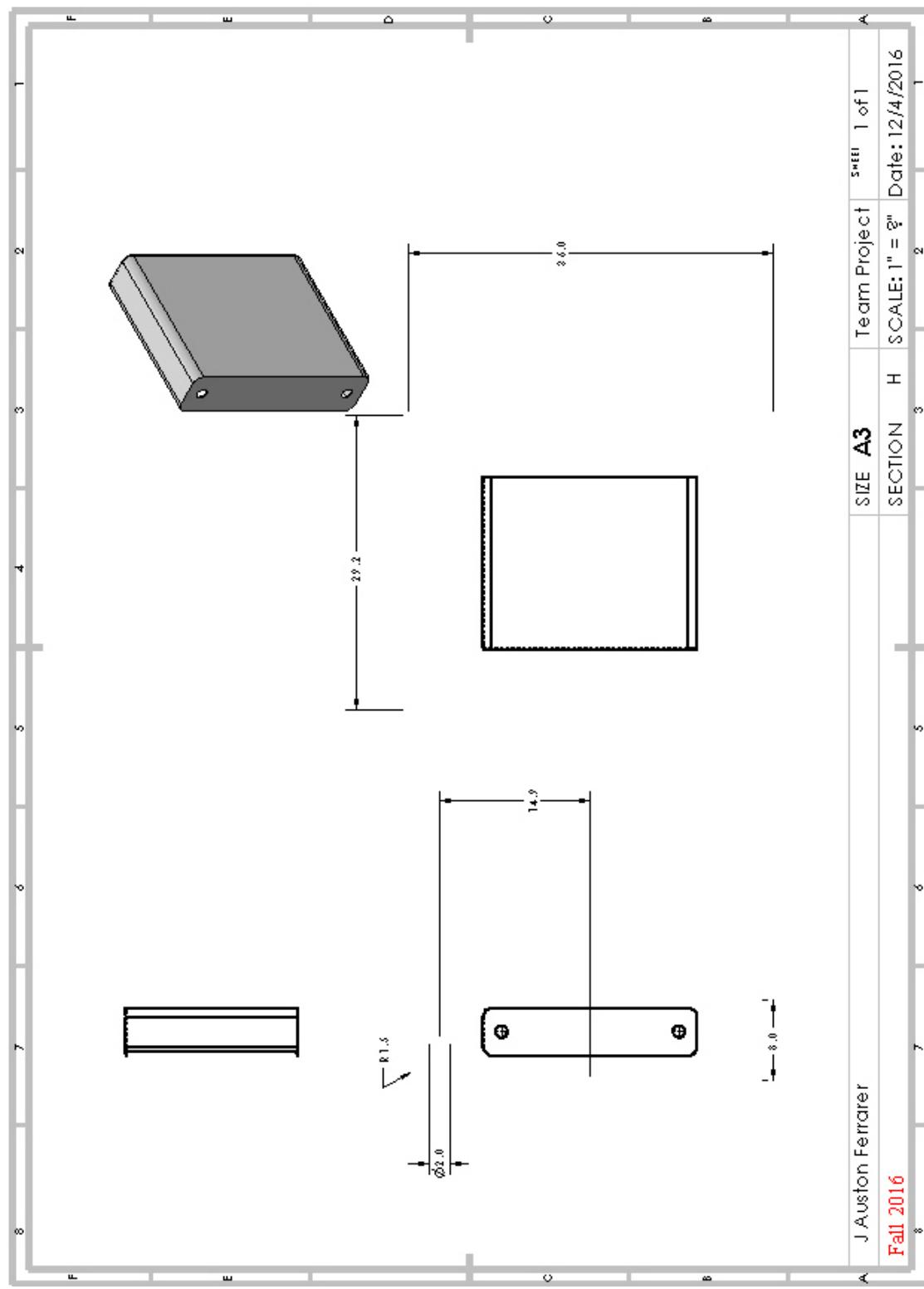


FIGURE 4.46: Ferrarer, Auston: Connecting Side Bracket

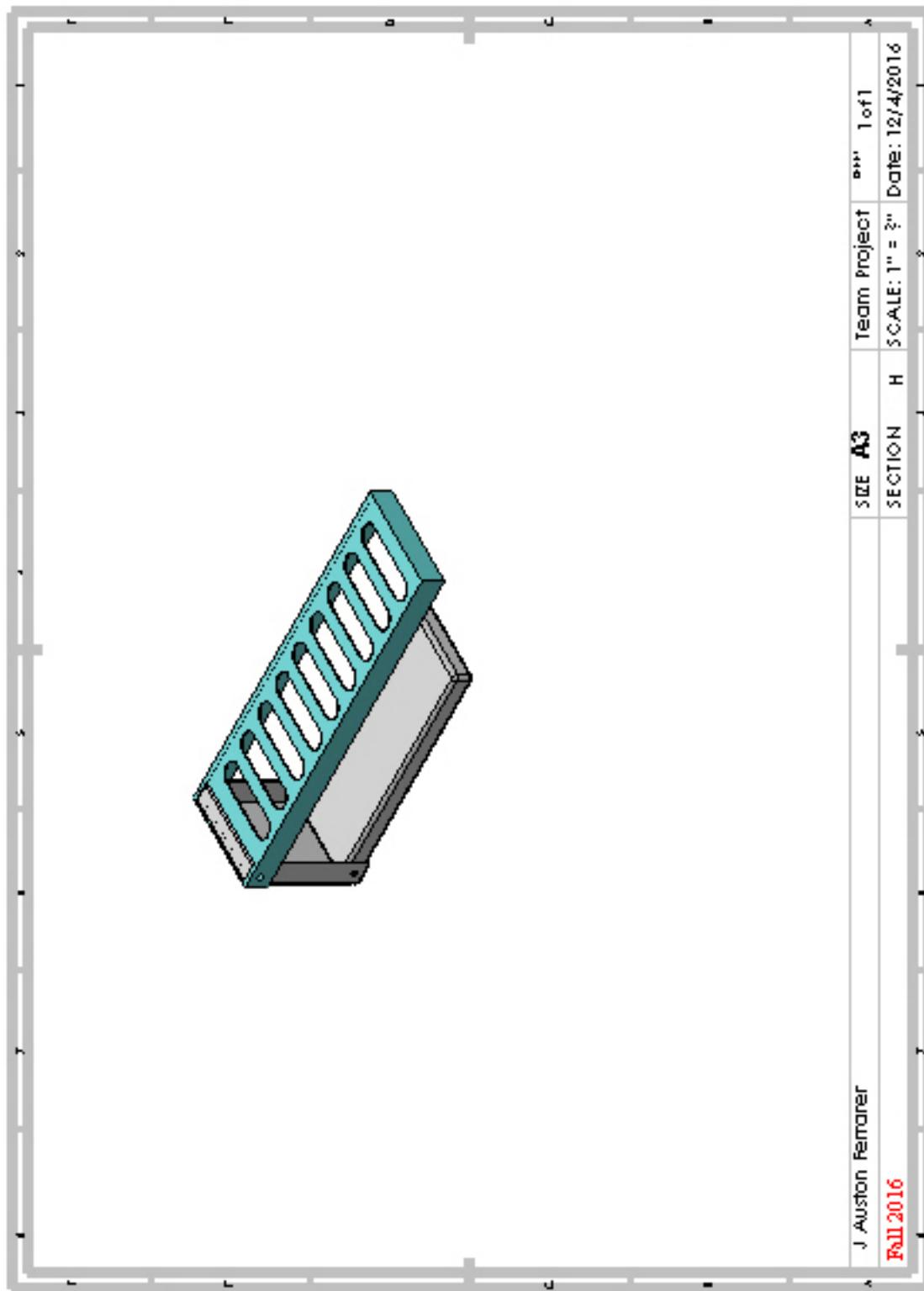


FIGURE 4.47: Ferrarer, Auston: Full Bed

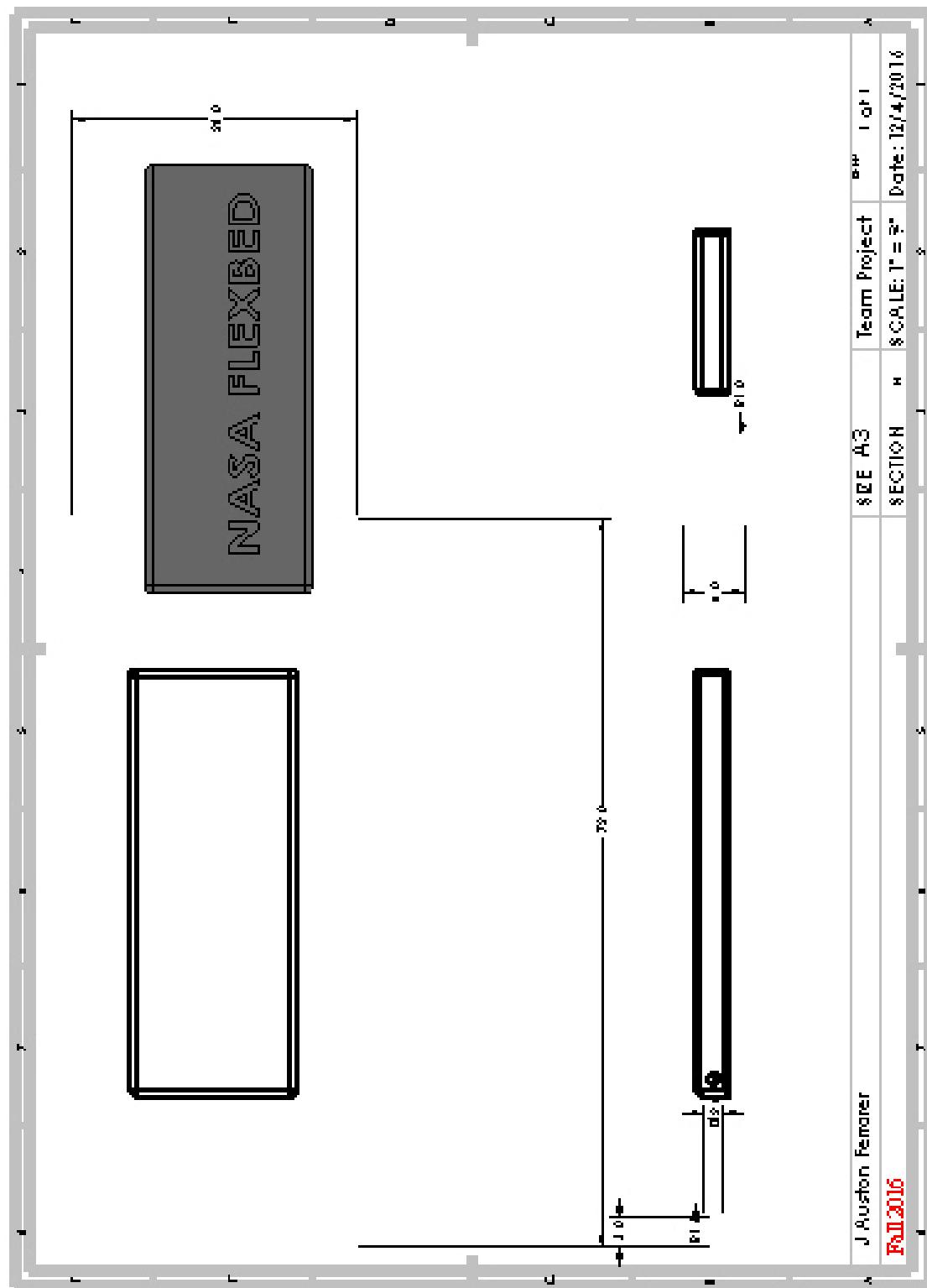


FIGURE 4.48: Ferrarer, Auston: Mattress

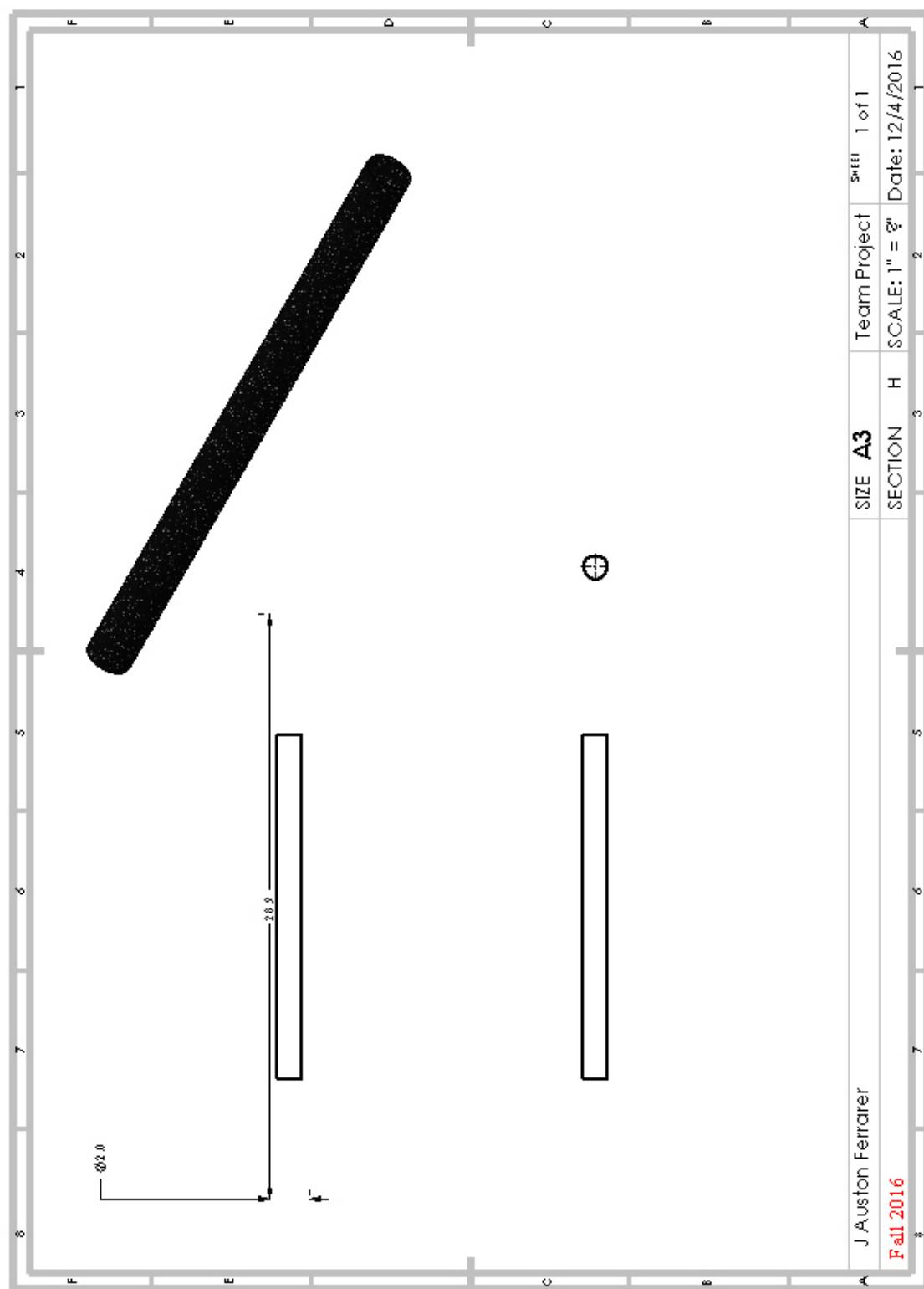


FIGURE 4.49: Ferrarer, Auston: Slide Bolt For Brackets

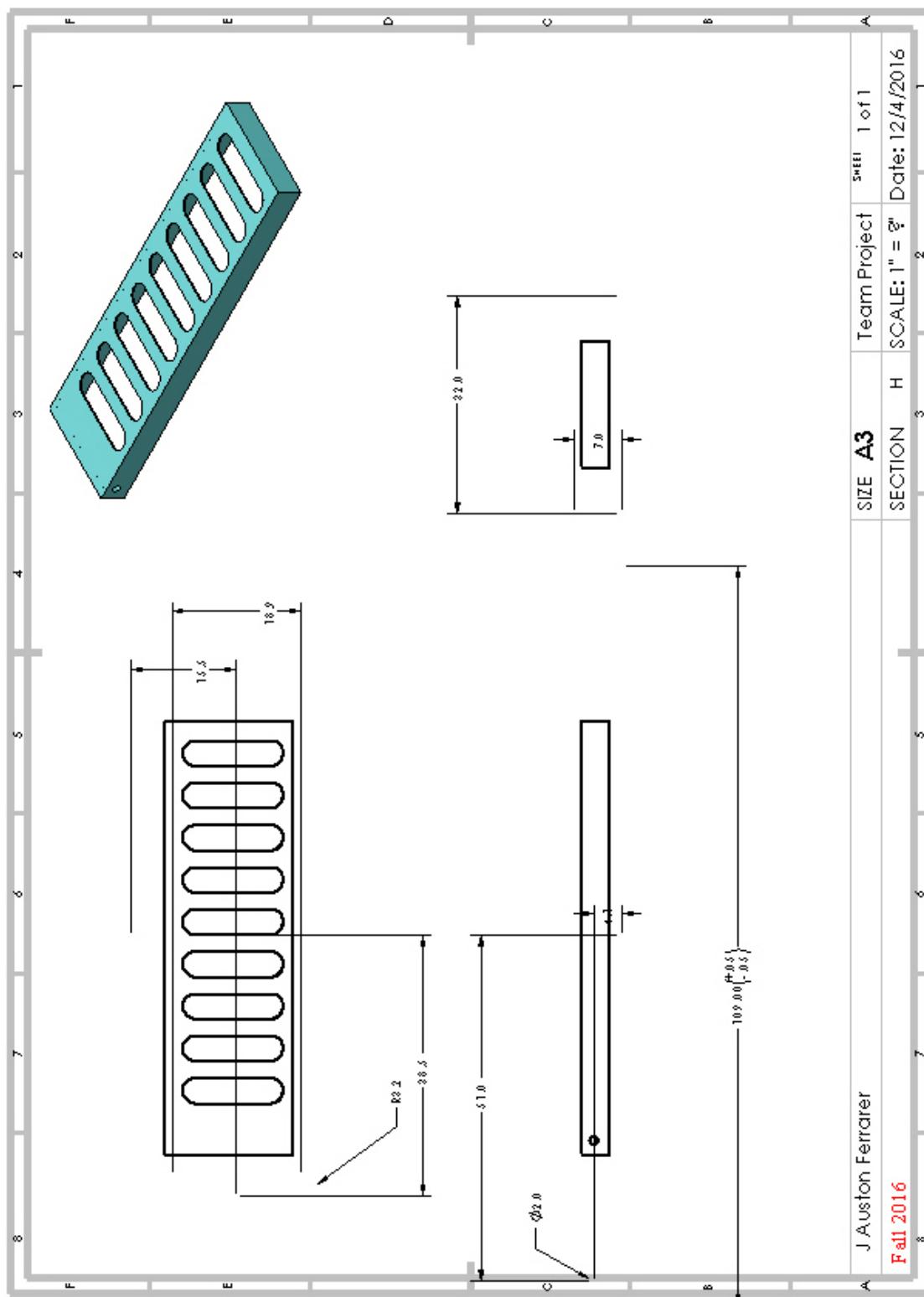


FIGURE 4.50: Ferrarer, Auston: Top Brackets

## 4.2 Assembly Instruction Manual

### 4.3 Exploded View

## 4.4 Part List