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College of Engineering

## Mission/SOW

**Project Goal:** Develop a high-quality training tool for rocket assembly and loading.

### Project Parameters:

- Adjustable center of gravity
- Streamlined rocket body
- Weight range: 2300-2400 pounds
- Easy assembly by two people
- Electronic alignment sensor

### Training Objectives:

- Rocket assembly using current transport vehicle
- Loading procedures from RTV to launch rail

### Rail Alignment System (D.WOBBLER):

- Keeps the rocket aligned with the launch rail
- Lowers misalignment risk during training

## Research

### Black-Oxide Alloy Steel Hex Drive Flat Head Screw 1/2"-20 Thread Size, 1-1/2" Long

- Tensile Strength: 130,000 psi
- Hardness: Rockwell C39

### Quikrete 80lb Concrete Mix

- High-Strength 4000 psi concrete
- Meets ASTM C 387 compressive strength requirements

### Carbon Steel

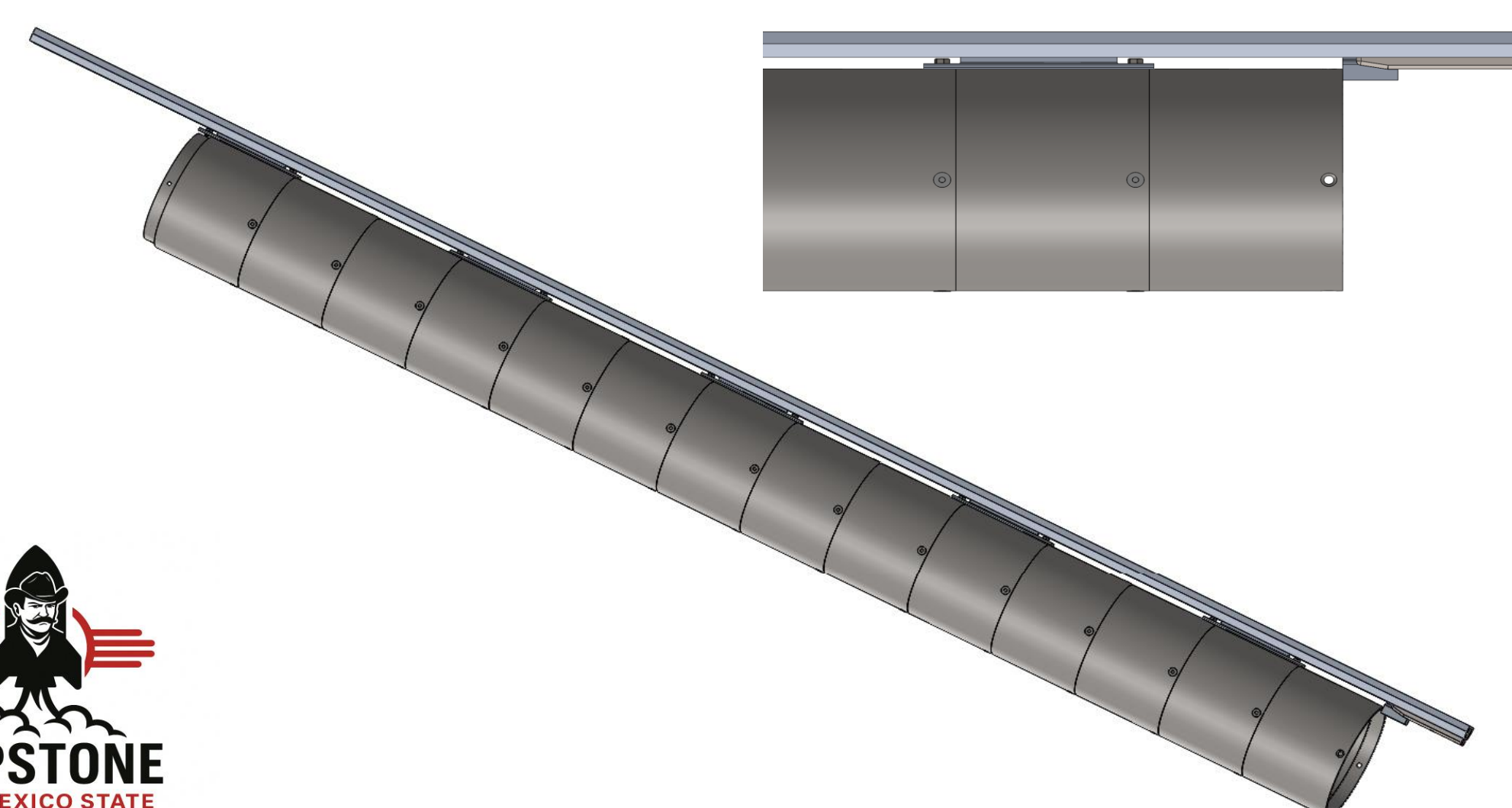
- Tensile Strength: 60200 psi
- Hardness: Rockwell B84

### Black Brant IX

- CG is generally located at the midpoint of the body
- Empty weight: 1,980 lbs

### Electronics (Arduino)

- 9 DoF IMU with Arduino & ESP32 Development kit
- 9V battery holder
- Will detect any tilt, movement, and coordinates



## Design and Fabrication of a Mockup Rocket for NMSA

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## Spaceport America

## Final Design



### Final Design:

#### (1) Mockup Rocket Shell:

- 14" OD x 12.75" ID Carbon Steel Tubing
- Each section weighs roughly 80 lbs and is 12 inches long
- A step was incorporated to ensure tubes will sit evenly on one another
- No additional holes are needed for rail guides, as they can be installed using the existing countersunk holes

#### (2) Rail Alignment System (D.WOBBLER):

- Accelerometer, Magnetometer, Gyroscope
- Leveled with surface and magnetic poles
- Detection of angular velocity & displacement
- Bluetooth compatibility

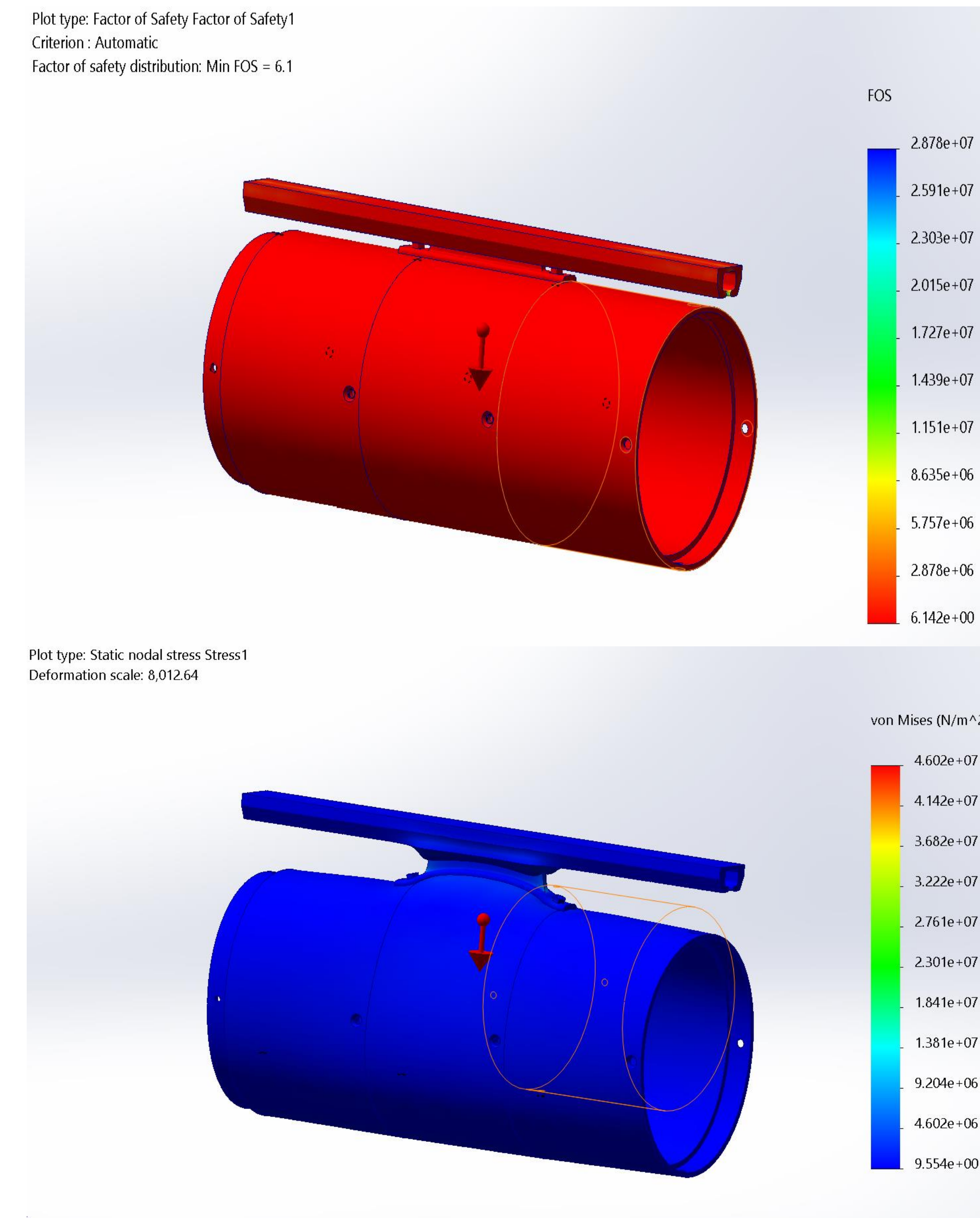
#### (3) Rail Guides:

- Attach directly to pre-existing countersunk holes
- Designed to hold 600 lbs each
- Light weight yet durable

#### (4) Concrete Weights:

- Total of 28 weights
- Each weighing from 38-41 lbs
- Designed to be easily moveable by one person and meet weight requirements

**Total Project Cost: \$9,761**



### Rail Alignment System (D.WOBBLER)

#### Design Phase:

##### Objectives

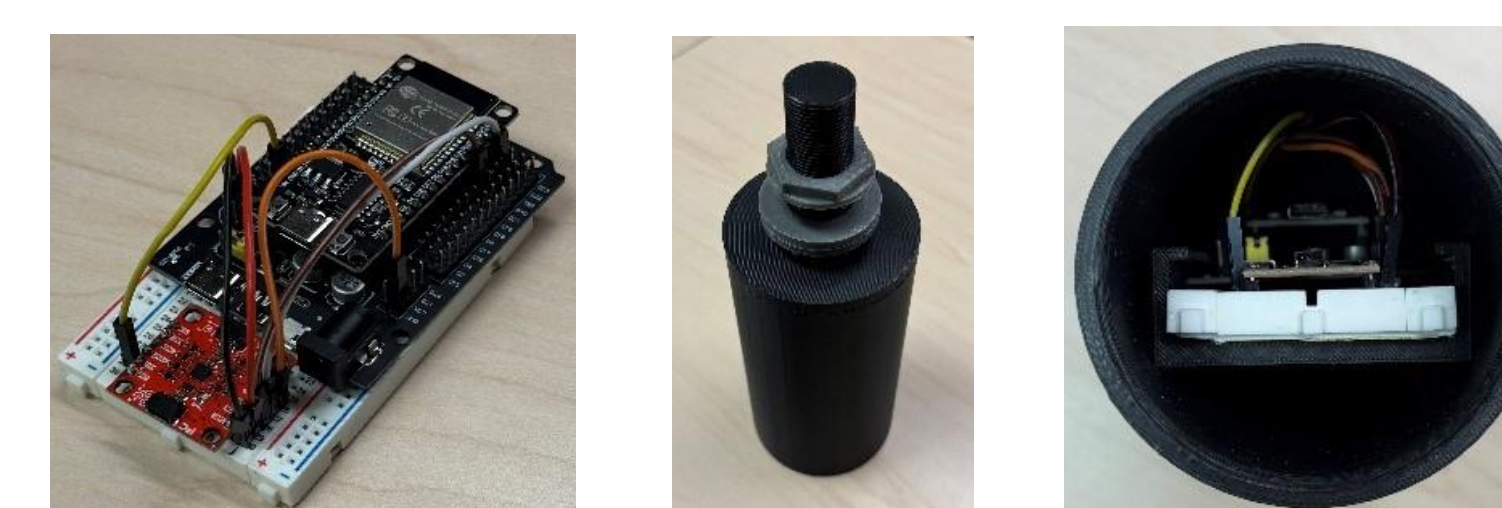
- Read and transmit coordinates
  - X, Y, Z position & acceleration
- Position to desired path
- Predict landing through coordinates
  - Predict State Vector in 3D Space
- Easy to assemble and troubleshoot

##### Preliminary Design:

- Weatherproof
- Aligned with rail
- Compacted and mounted
- Simple circuit
- Simple one-dimension reading
- Specific orientation

##### Design Concept

- Round and screw-in top
- Flat surface to mount on rail
- Screw-in to hole on top of rail
- Internal mount for Wobbler system



(2)



## Concept Development

### Mockup Rocket Shell

#### Design Phase:

##### Objectives

- No more than 90 lbs a piece
- Maneuverability
- High Strength
- Easy to machine

##### Preliminary Design:

- Cylindrical body to mimic rocket shape
- Simple assembly
- Meets weight requirements
- Too much material needed
- Poor machinability

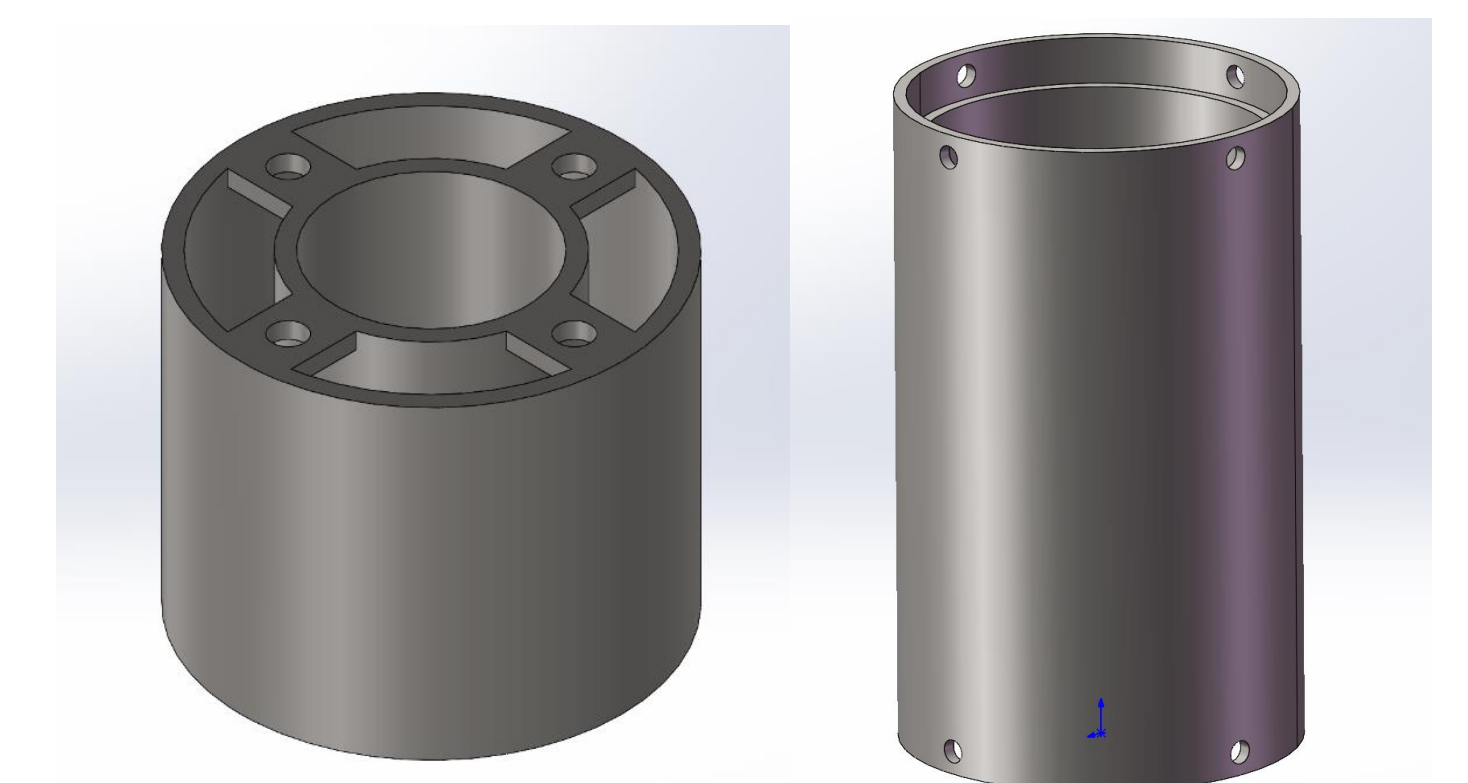
#### Design concepts considered:

##### Concept 1

- 12" OD x 0.25" Wall
- Pros:
  - Met weight requirement with concrete weights
  - Aligned the sections well to prevent shifting
- Cons:
  - Required more machined parts
  - Would require welding

##### Concept 2

- 10.75" OD x 0.365" Wall
- Pros:
  - Smaller/Lighter easy to handle
  - Appropriate size to be machined in house
- Cons:
  - Required more material
  - 25+ pieces would need to be machined



## References

- Black Brant v Launch Vehicle (21.XXX)*, sites.wff.nasa.gov/code810/vehicles/Black\_Brant\_V.pdf. Accessed 10 Feb. 2025.
- <https://forum.arduino.cc/>
- Carbon Steel Round tubing*, Carbon Steel Round Tubing | Carbon Steel | Totten Tubes. (n.d.).