# REEF Subsonic Wind Tunnel Articulating Robotic Arm


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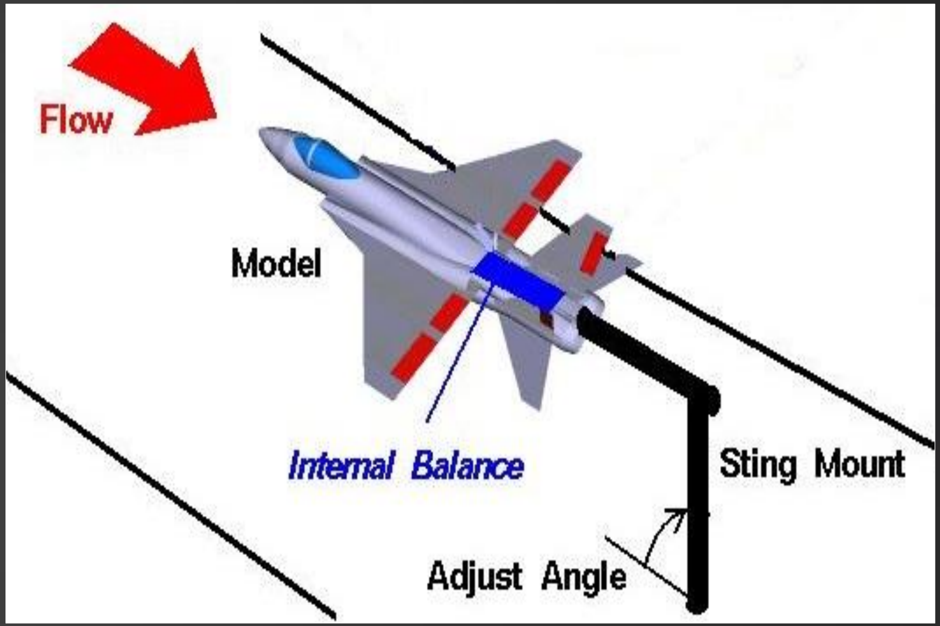
# Problem Statement

- The design and production of a cost effective mechanism that would hold and adjust the orientation of a specimen being tested in a subsonic wind tunnel
- The current arm and mount are being removed, therefore a new system is needed in order for testing to continue
  - Quotes from companies that will design/build systems exceed $100,000
  - Working budget of $2,000

# Wind Tunnels

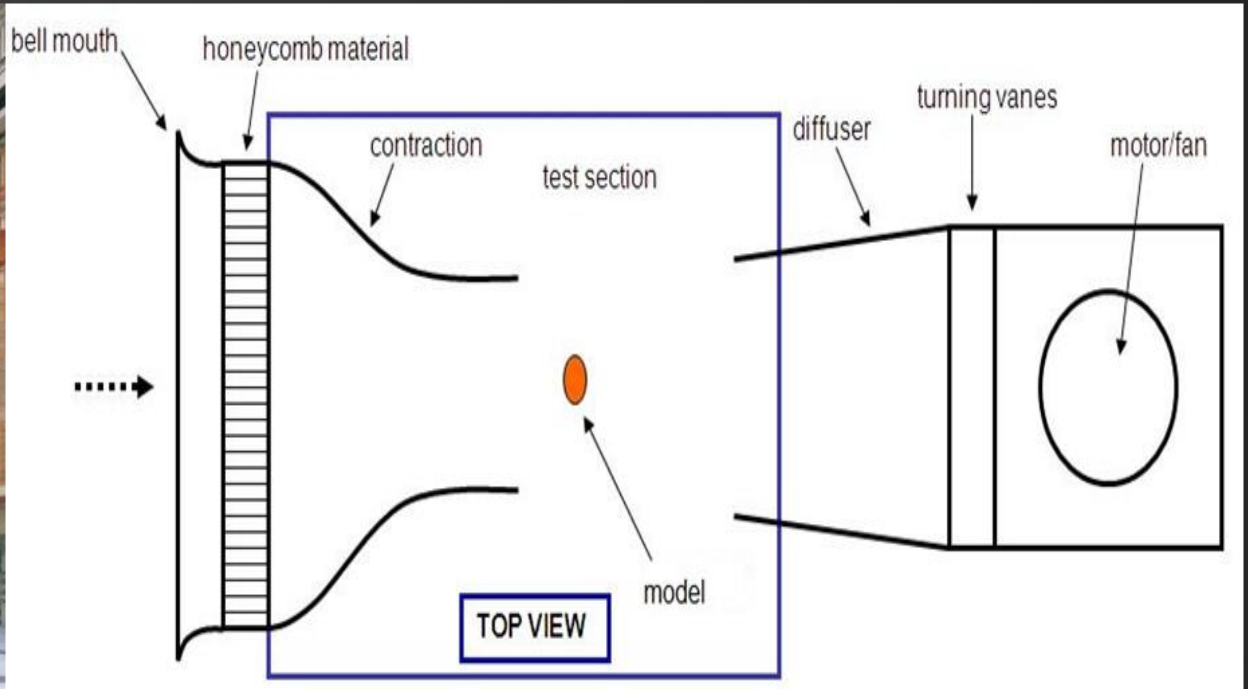
- Research tool to recreate flight conditions
- Cost effective, controlled environment
- Models scalable through the use of dimensionless properties




Sting Mount in Wind Tunnel

# The Test Section

Open Test Section




Overhead View of REEF Center Wind Tunnel

# Project Objective

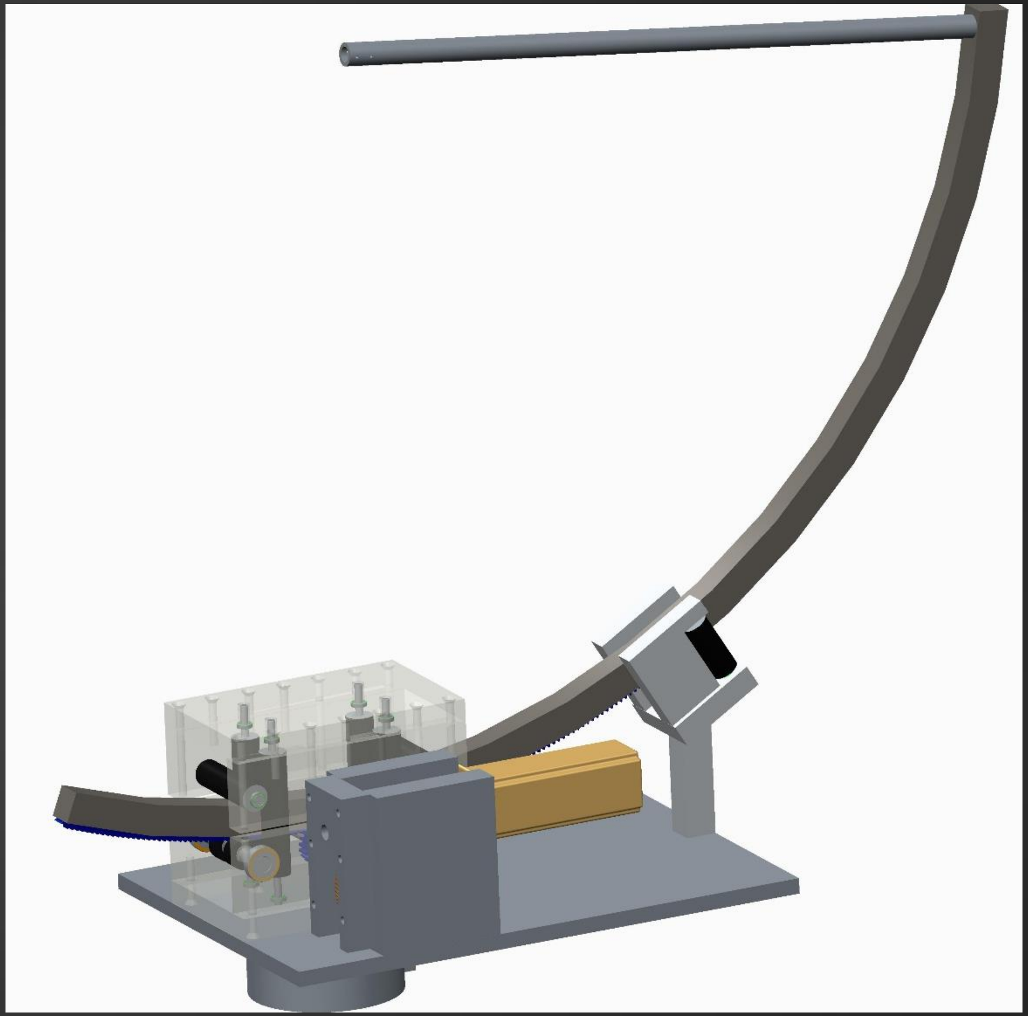
- Arm able to withstand maximum force generated by wind tunnel
  - Maximum Velocity: 22 m/s
- Center of mass of specimen must not change during manipulation
- Adjustable pitch range: -5° to +20°
- Adjustable yaw range: ±10°
- Model must not move when in set position
- User interface to control motion of arc

# Design Constraints

- User interface using LabVIEW
- 0.25° orientation accuracy
- Maximum deflection of 0.25 in.
- Factor of safety of 5
- $2,000 budget

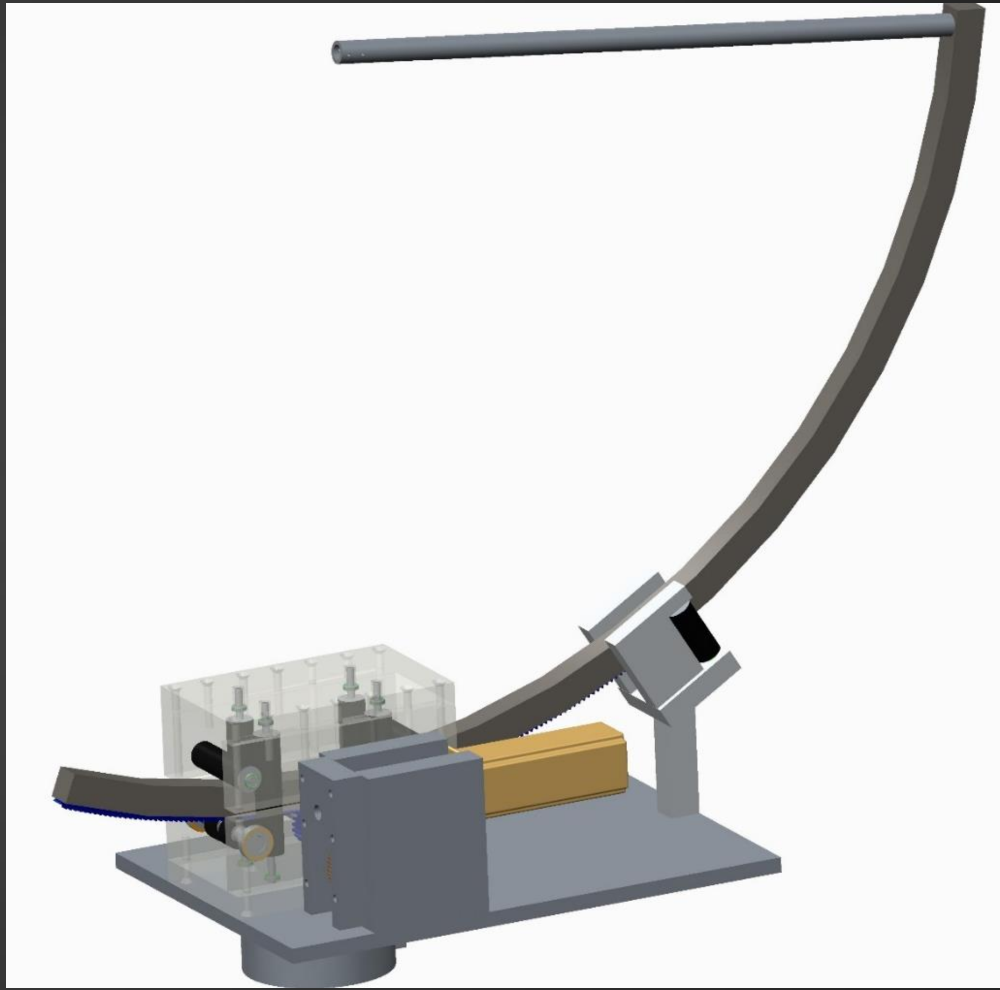
# Review

- Purchase Orders
  - Drafted but not official
- Dimensioning
  - Finalized drawings for machining
- Machining
  - Drawings sent to machine shop
- Detailed assembly discussion

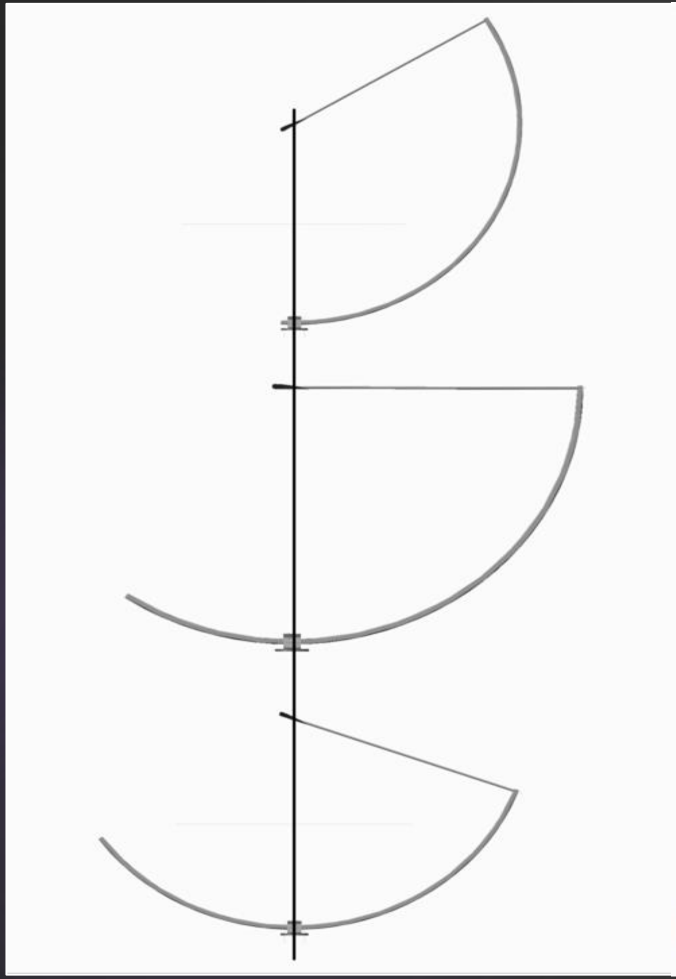


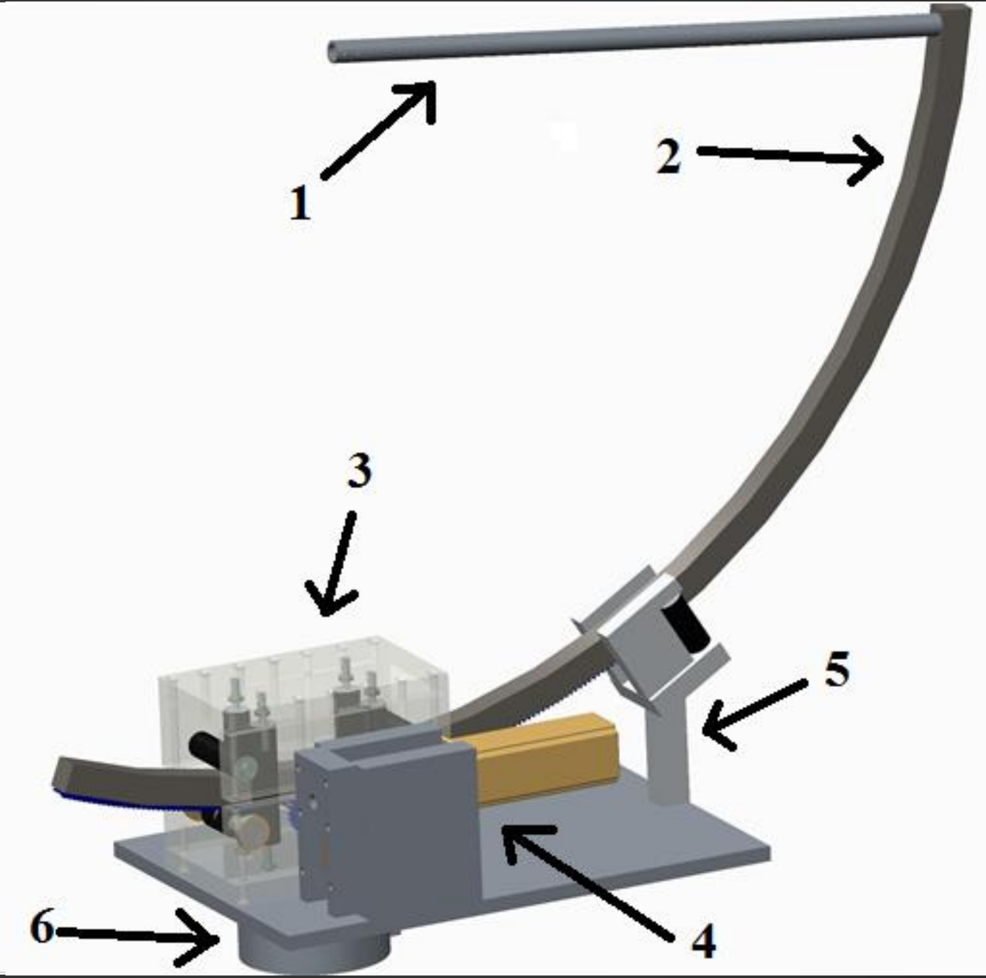
# Updates

- Design
  - Sting Mount
  - Turntable Plate
- Procurement
  - Majority of parts received
  - Machining in progress
- Hardware Constraints
- Programming
  - Communication between LabVIEW and Galil software



# Design Concept

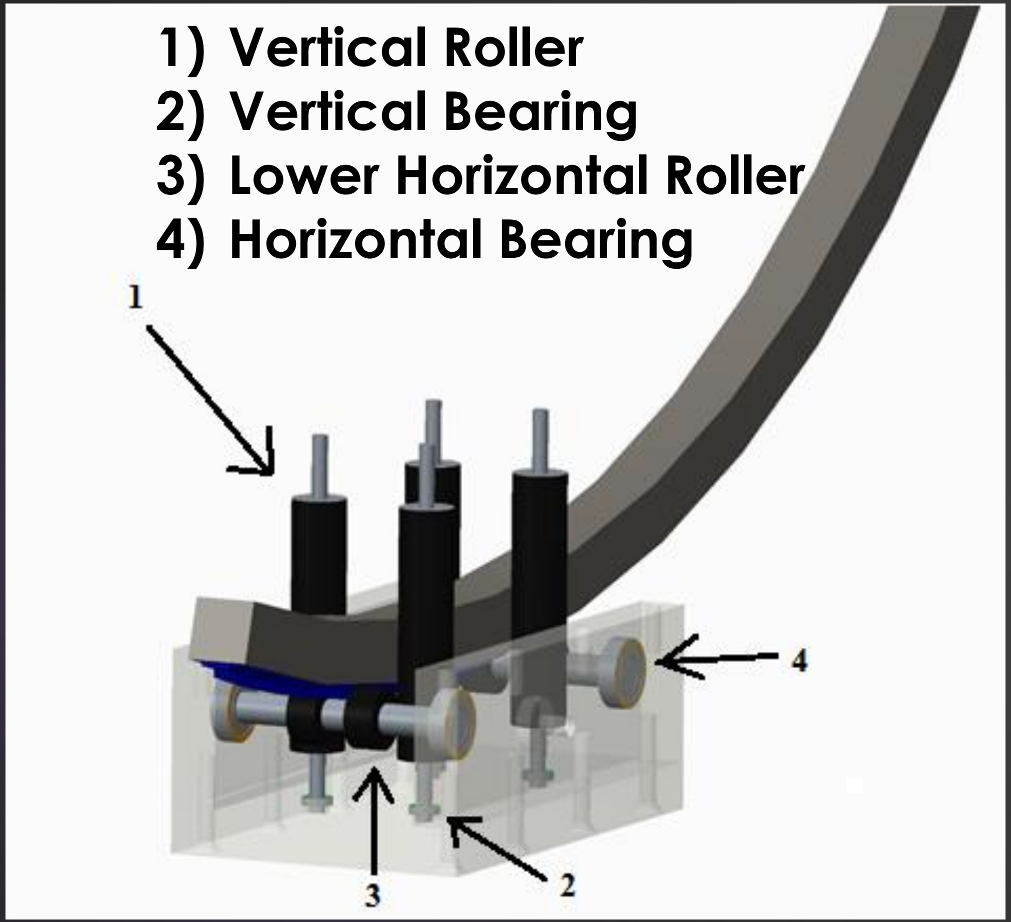


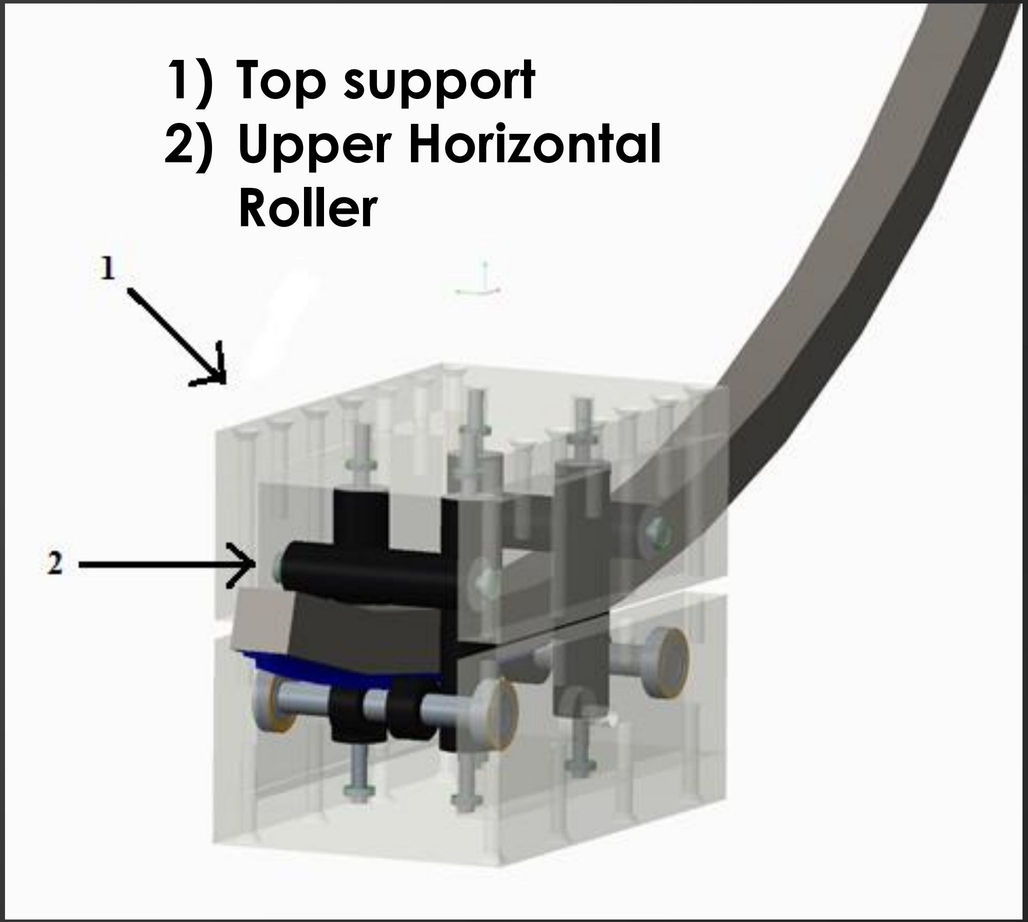



**Legend**

1) Sting Mount
2) Arc
3) Mounting System
4) Drive Train
5) Follower
6) Turn Table

# Mounting System - Assembly



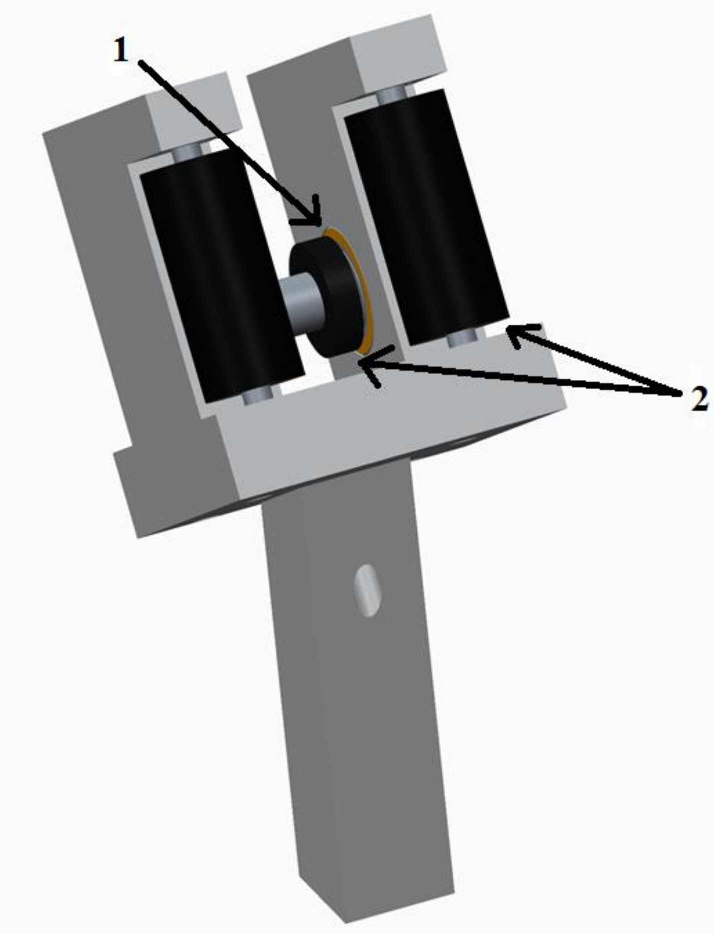



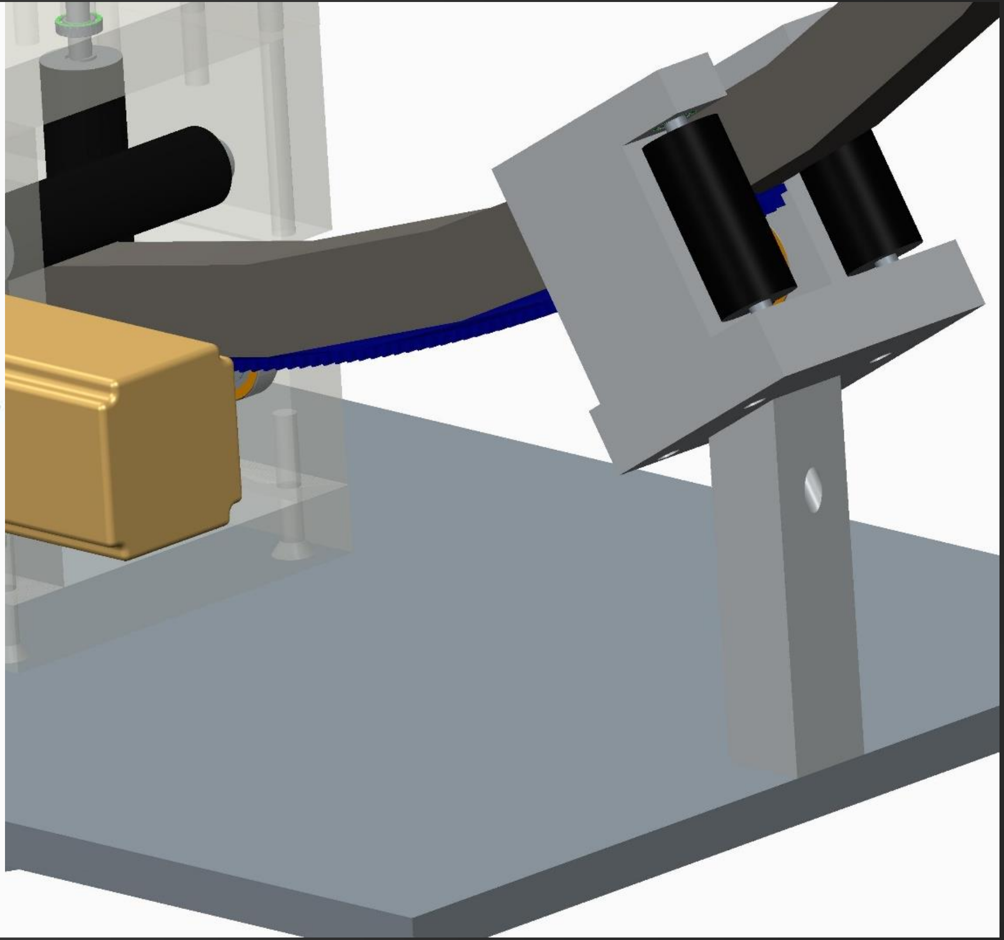
# Mounting System - Constraints

- Bolts needed: Flathead ¼-20, lengths 1.25” and 3.25”
- Top and bottom housings
- Horiz. Bearings, shafts and rollers between sides
  - C Clips constraints
- Sides bolted to top/bottom (1.25”)
- Vert shafts and rollers constrained by housings
- Top and bottom housings bolted together (3.25”)
- Bottom plates centered over turntable post
  - Bolts up through turntable

# Follower - Assembly

**Legend**
1) Bearings
2) Rollers



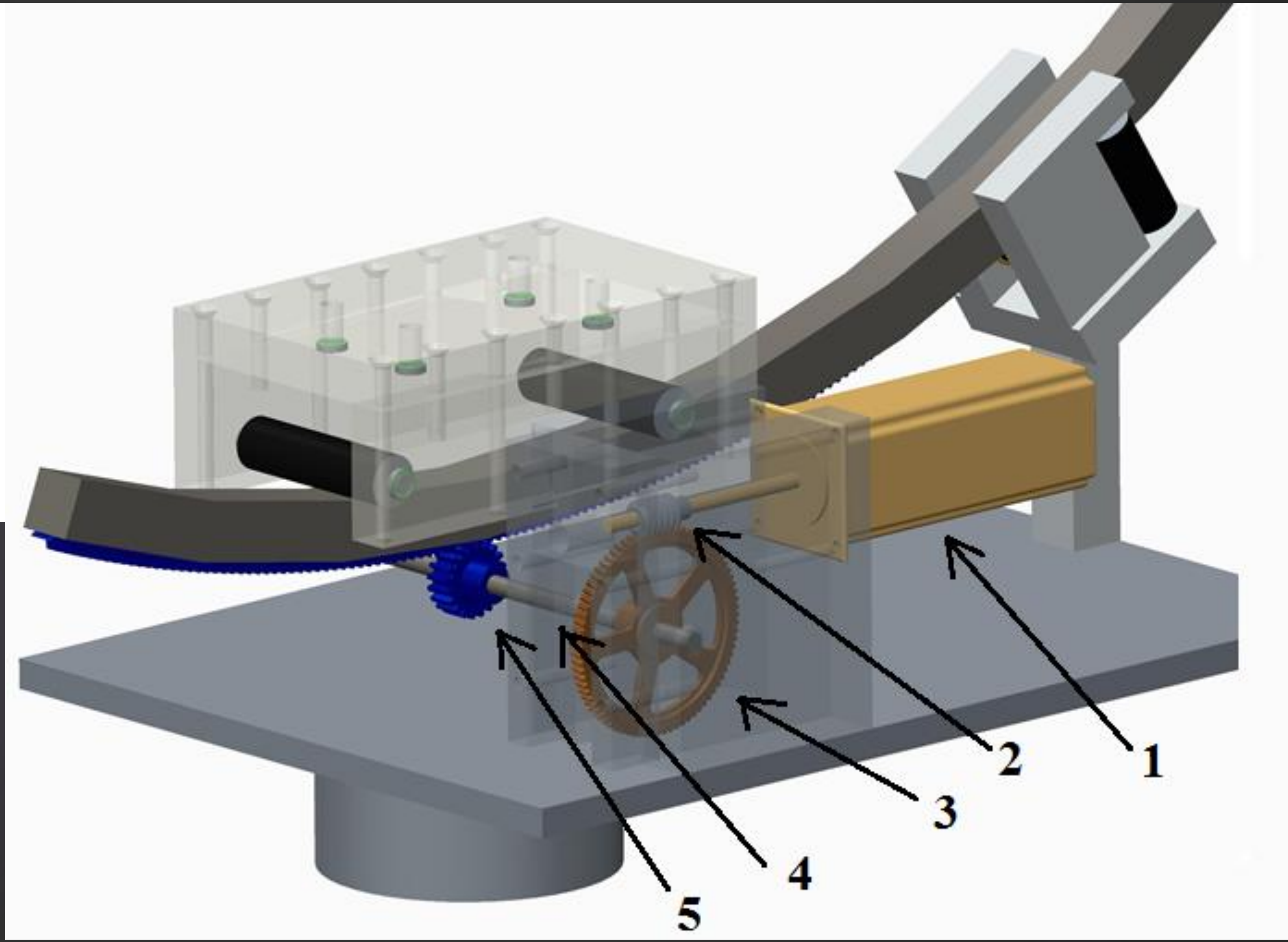
# Follower - Constraints

- Bolts needed: ¼-20, length 1.25”
- Bearings placed in side plates
- Shafts and rollers constrained between sides
- Side plates bolted to bottom follower plate
  - Vertical shafts and rollers placed at same time
  - C Clips used to restrain roller movement
- Bottom follower plate bolted to post
- Bolt up through turntable to vertical post

# Drive Train - Assembly

**Legend**

1) NEMA 23 Motor
2) Worm
3) Worm Gear
4) Drive Shaft
5) Spur Gear



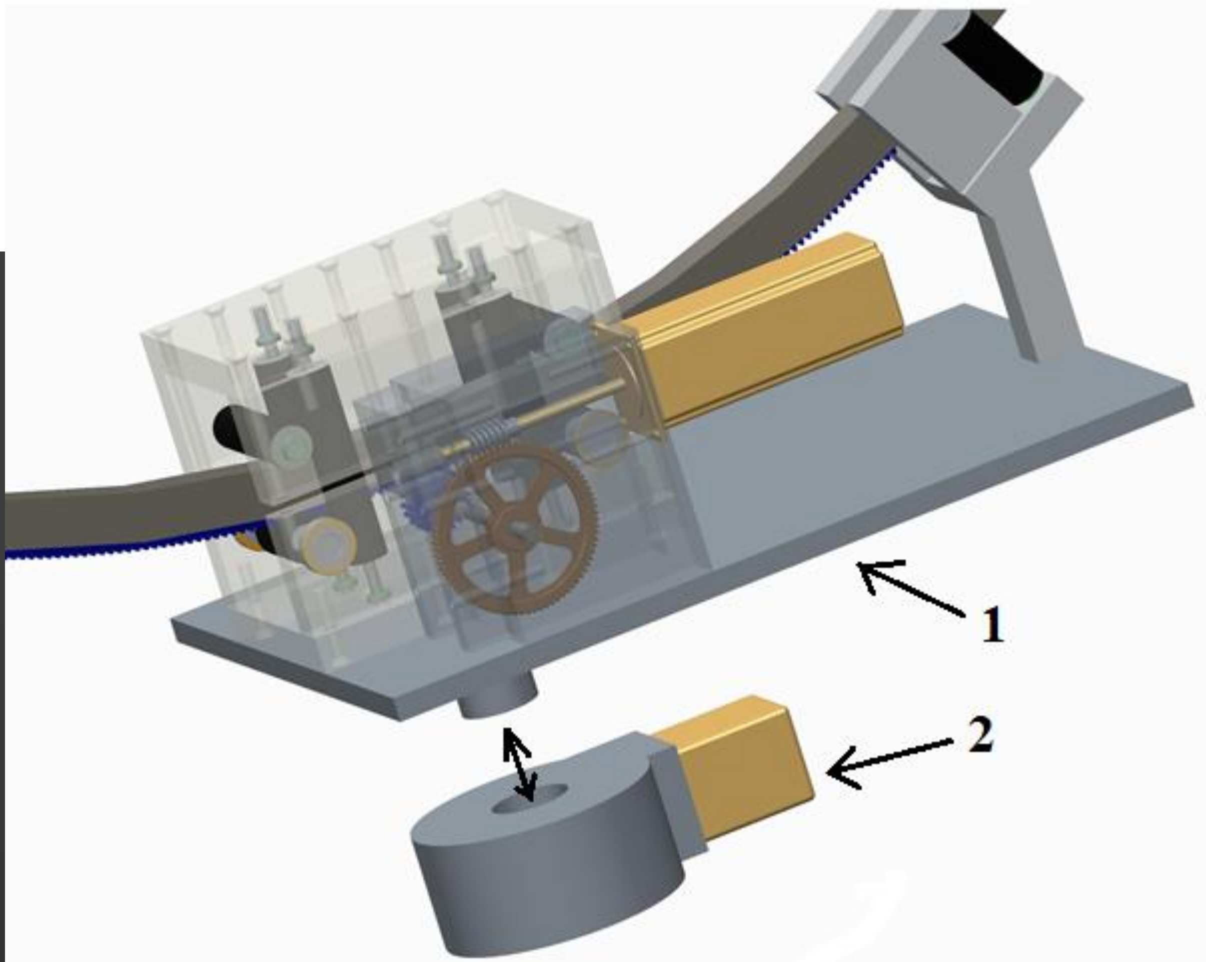
# Drive Train - Constraints

- Gears
  - Set screws and JB weld
- Drive Shaft
  - Housing Bores with bearings
- Motor
  - 4 x ¼-20 bolts

# Rotary Table - Assembly

**Legend**

1) Rotary Table
2) Rotary Table Motor



# Rotary Table - Constraints

- Bolts needed: 10-32 UNF
- Post on turntable aligned over motor
- Bolts fed through turntable from top
  - Align with holes in motor

# Electrical Components

**Procured**

- Motion Controller
- NEMA 23 Motor
- Motor Driver
- 1000 Line Encoder
- Turntable Motor

**To be selected**

- Power supply
- Inclinometer

# Programming and Circuitry


User Interface → Logic Application

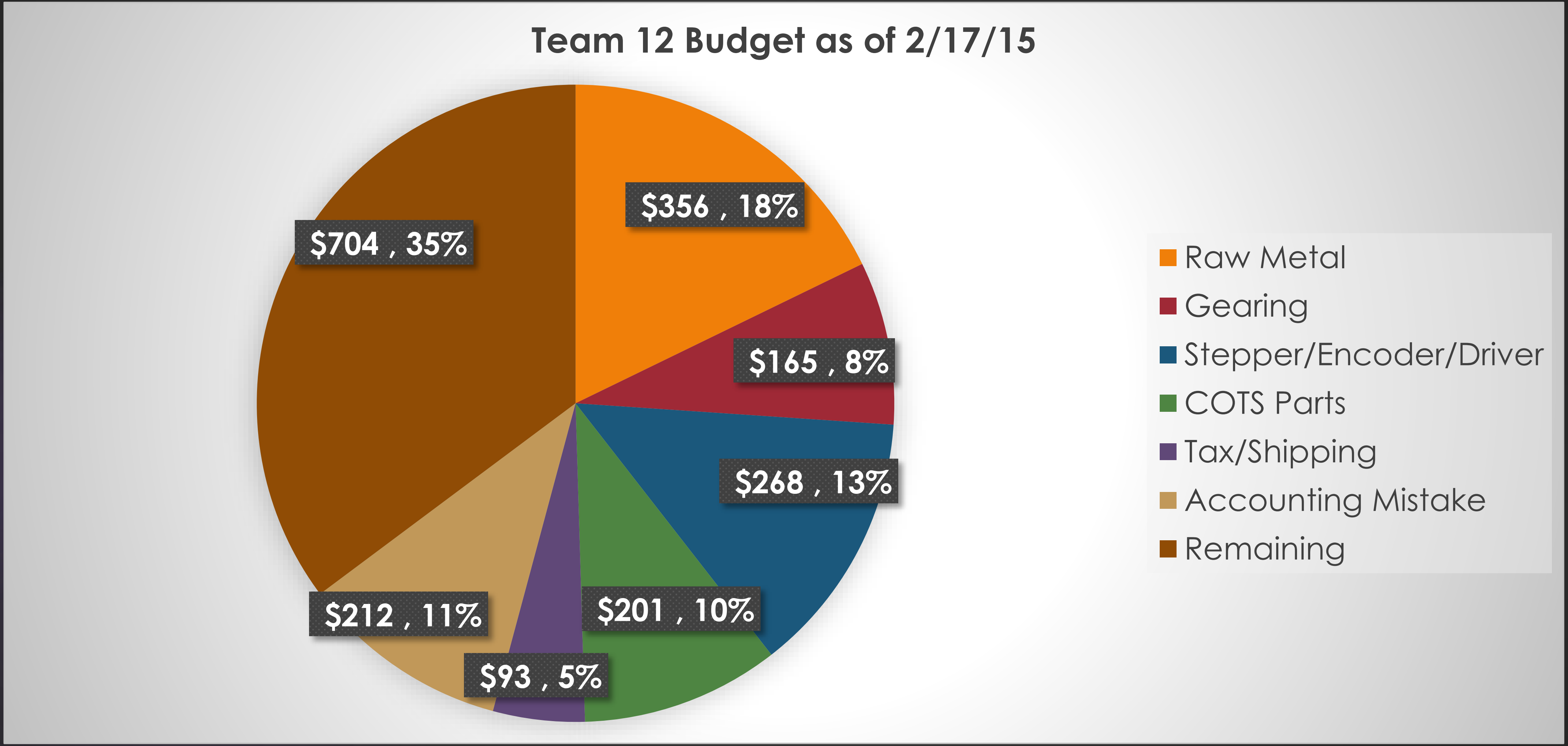
Logic Application → Motor Driver 1 → Turntable Motor

Logic Application → Motor Driver 2 → Stepper Motor

# Ideal Logic Configuration

- LabVIEW prompt for user input of angles
  - System will have a “reset”
- Input communication and processing
- Motors actuate the arc to the specified angles
  - New angles will not be able to be entered while the arc is in motion
- Encoders feedback to controller
- Return to LabVIEW interface that actuation is completed

# Project Budget





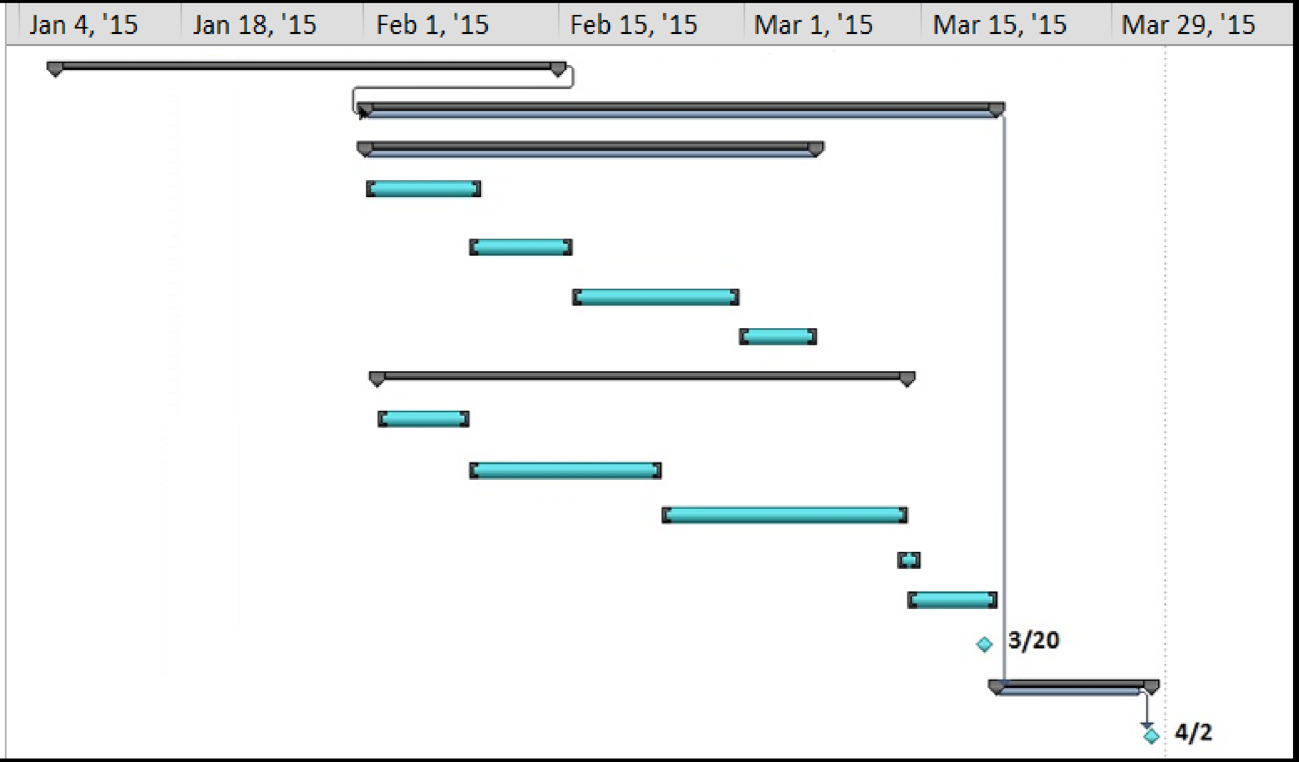

Caitlan Scheanwald

# Future Work

- Design
  - User Interface using LabVIEW
  - Circuitry
- Purchasing
  - Power Supply and Minor Circuitry Components
- Machining – Follower Assembly
- Prototype Assembly
- Testing and Troubleshooting

# Spring Schedule

| Task Name | Duration | % Complete |
|---|---|---|
| **Gathering of all Materials and Parts** | **28 days** | **100%** |
| **System Assembly** | **37 days** | **50%** |
| **Machining and Construction** | **27 days** | **80%** |
| Plan Machining and Inspect Drawings | 7 days | 70% |
| Machining of Mounting Box | 7 days | 100% |
| Machining of Arc (HPMI) | 11 days | 100% |
| Constuction of Mechanism | 6 days | 30% |
| **Programming and Circuitry** | **31 days** | **34%** |
| Determine Power Requirements | 7 days | 40% |
| Design Circuitry Based on Procurements | 12 days | 50% |
| Program System to Sponsor Specifications | 16 days | 20% |
| Purchase Adaquate Power Supply | 1 day | 0% |
| Assembly of Circuitry with Mechanism | 6 days | 0% |
| Assembly Complete | 1 day | 0% |
| **Testing and Troubleshooting** | **9 days** | **0%** |
| Project Completed | 1 day | 0% |



# Are there any questions?

Would you like to follow our project?
Check out our website!
http://eng.fsu.edu/me/senior_design/2015/team12/