Collegiate Wind Competition Mechanical Team

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Project Description

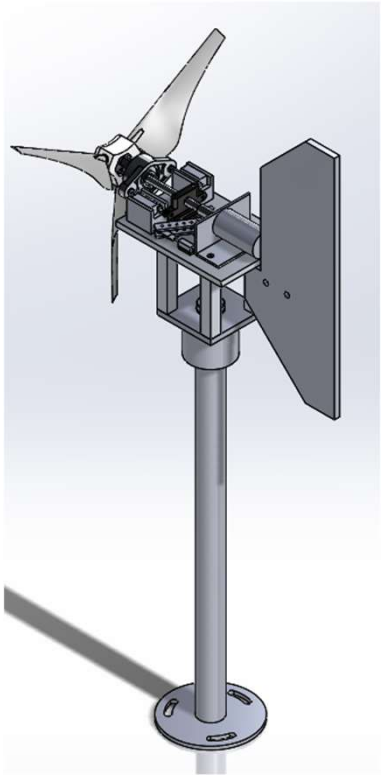
Project Review

Collegiate Wind Competition (CWC)

- Sponsors: U.S. Department of Energy (DOE) & National Renewable Energy Laboratory (NREL)
- Client: David Willy & Karin Wadsack
- **Build and test a small scale wind turbine**

Mechanical Components

- Active Pitching Hub
- Blades
- Braking Mechanism
- Bearing
- Direct-Drive Shaft
- Nacelle
- Shaft
- Yawing Mechanism
- Tower

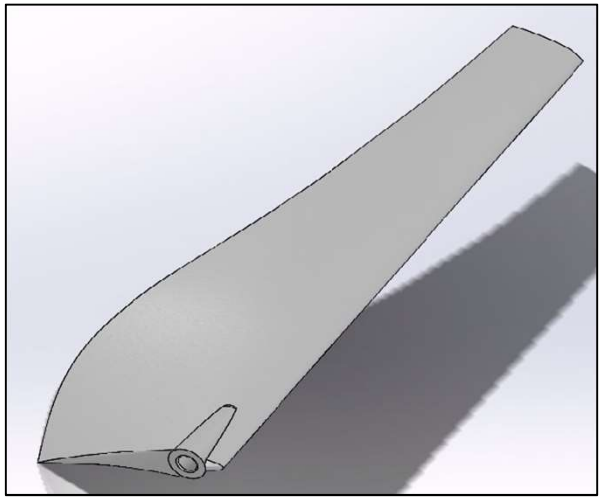


Sub-System Updates

Blades and Blade Roots

Blades

Final material: ULTEM 9085
Max deflection: 2.07 mm



Blade Roots

Final material: Stainless Steel T304
Length: 3.5 cm
Diameters: 1, ½ cm

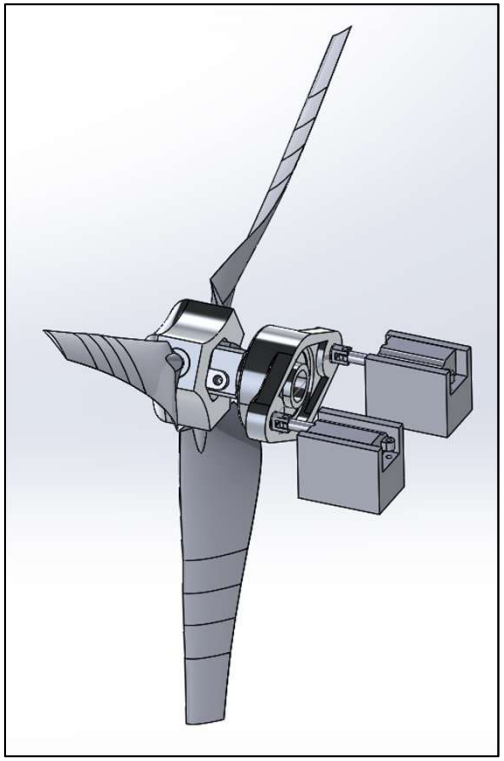
Hub

6061 T6 Aluminum

- Bearing shaft (Round to triangle)
- Arm linkages (length)
- Blade mounts (No bushing)

3D Print PLA 40% infill

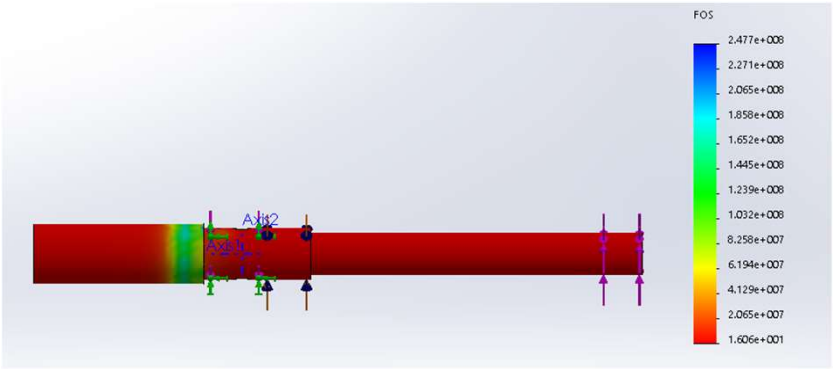
- Hub body (Shape change)



Shaft

Direct-Drive Shaft

- Still supplements surrounding components
- Aluminum 7075
- Lowest FOS w/ expected loads → 16
- M10x1 thread/loctite glue connection to the rotor
- Brake hex pinned to the shaft
- Interference fit/loctite glue connection to generator



Brake/Shaft Bearing

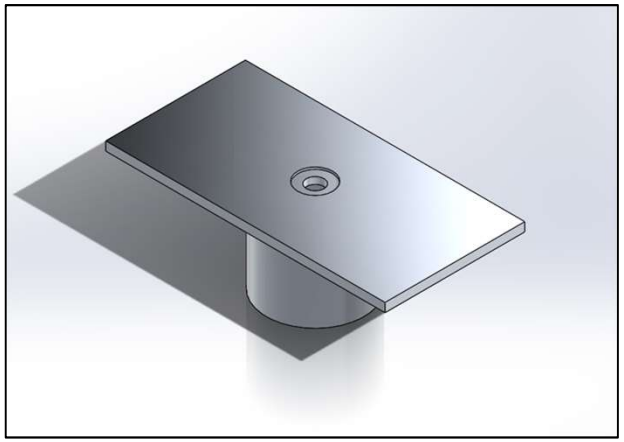
Braking System & Shaft Bearing (now one system)

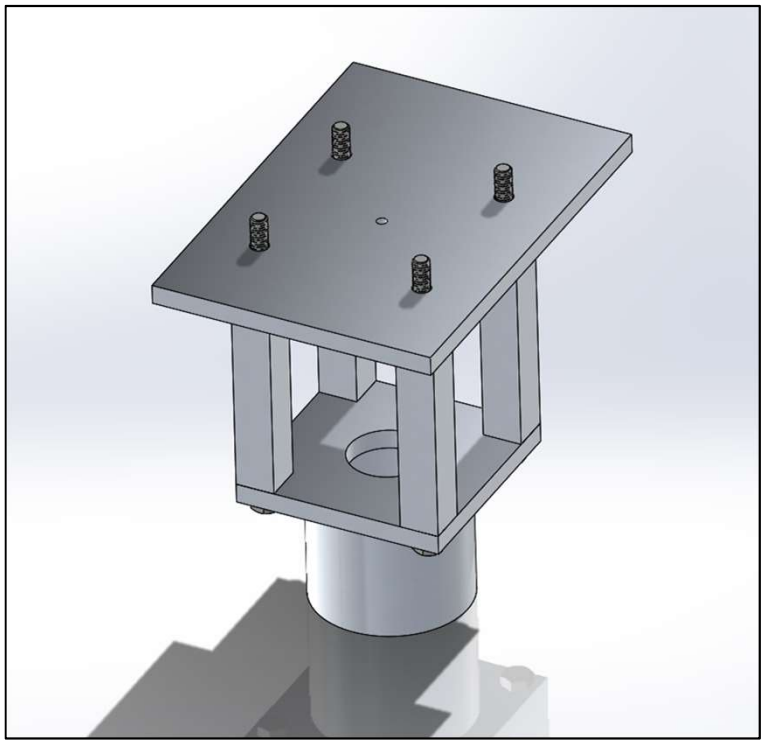
- Ease of manufacturing for brake implementation
  - Shaft bearing is a part of brake system assembly
- Braking torque adequate for one pad set → 12Nm
  - Rotor torque → 3Nm
- Pin connection between brake hex and shaft
  - Shear FOS based on weakest aluminum → 1.4
- Bearing can handle shaft rotation & expected loads
  - Manufactured to handle high rpm and moderate load applications

Nacelle

Raised frame nacelle

- Allows for larger slip ring capabilities
- Adds extra space for subsystems connections





Manufacturing Progress

What's Left to Manufacture:

- Tail plate
- Main Nacelle
- Brake Brackets
- Generator Mount
- Tail mount
- Shaft
- Blade mounts
- HUB

Material waiting to arrive:

- 20 x 20 x ⅛ inch plate (tail plate)
- 10 x 10 x ⅜ in plate (main Nacelle)
- 1 x ¼ inch angle iron 6 inches long (tail mount)
- 2 ½ x ¼ inch angle iron 6 inches long (generator mount)

Moving Forward

Plans for manufacturing

Get the parts approved and drawing files made/approved

Order the raw materials

Plan how each component is going to be manufactured

- Mill, Lathe or CNC
- What order, what processes are needed
- What fasteners are needed
- What and how are each parts are going to be connected

Each part is different and needs to be machined differently

Plans For Testing

Preparations for competition tests to be completed

- Achieving a consistent output power at integer speeds ranging from 5 - 11 m/s
- Providing a power level, consistent with that of an 11 m/s wind, at varying wind speeds between 15 - 20 m/s
- Producing a 5 sec positive amperage level at startup between wind speeds of 2.5 - 5 m/s.
- Maintaining a 5 V load while experiencing a varied wind speed between 6 - 20 m/s
- Shutting down the wind turbine at any wind speed up to 20 m/s and restarting without manual actions by the team

Blade Redesign Contingencies

If blades fail during testing and pitching system does not function

Blades failure

1. Increase thickness
2. Use new airfoil design

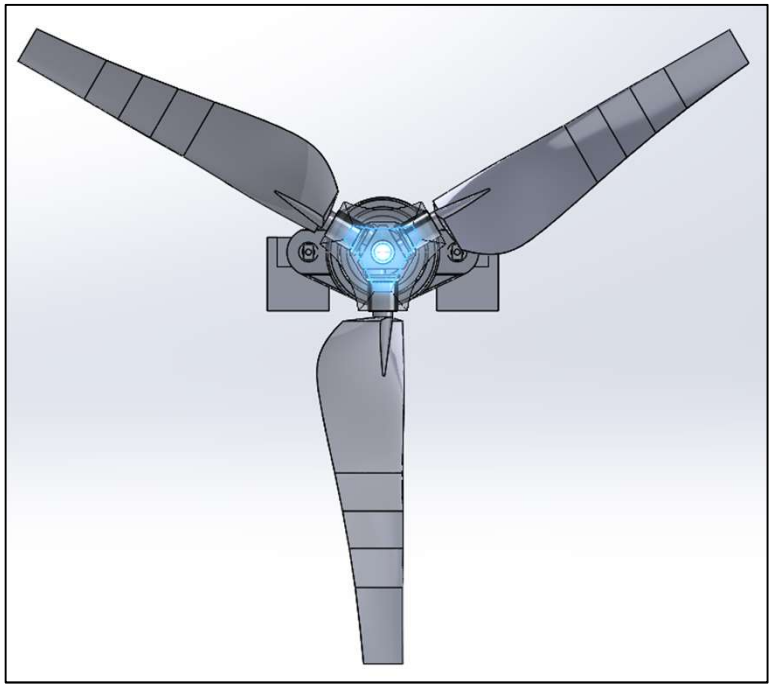
Pitching system failure

1. Lock pitching mechanism in pitched position
2. Blade root redesign for fixed blade operation
3. Mating will be a press fit into hub

Hub Redesign Contingencies

HUB

- Only actuate once
- Fix actuators
- Replace Hub with fixed pitch



Shaft Redesign Contingencies

Root Cause Analysis

- Failure Location? (Rotor/Braking System/Generator)
- Why did it fail? (High Loads/Fatigue/Unexpected Situations)

Redesign Based on Cause:

- Increase Shaft Diameter
- Decrease Shaft Length
- Decrease Number of Connected Components
- Redesign Component Connections

Brake Redesign Contingencies

Possible Locations of Failure:

- Hub/pin connection to the shaft
- Disk
- Pad actuator

Redesign Options

- Manufacture brake hub onto the shaft
  - Less parts = less chance of failure
- Use disk/spacer/disk assembly from King Motor
- Use different actuator material/increase size

Previous Expectations

Responsibilities of project

- Soud/Kory - Shaft Implementation
- Devon - Blades and manufacturing
- Jacob - Braking mechanism and yaw fin
- Spencer - Hub with Pitching mechanism
- Dakota - Structural components and Subsystems connections

Original Plan

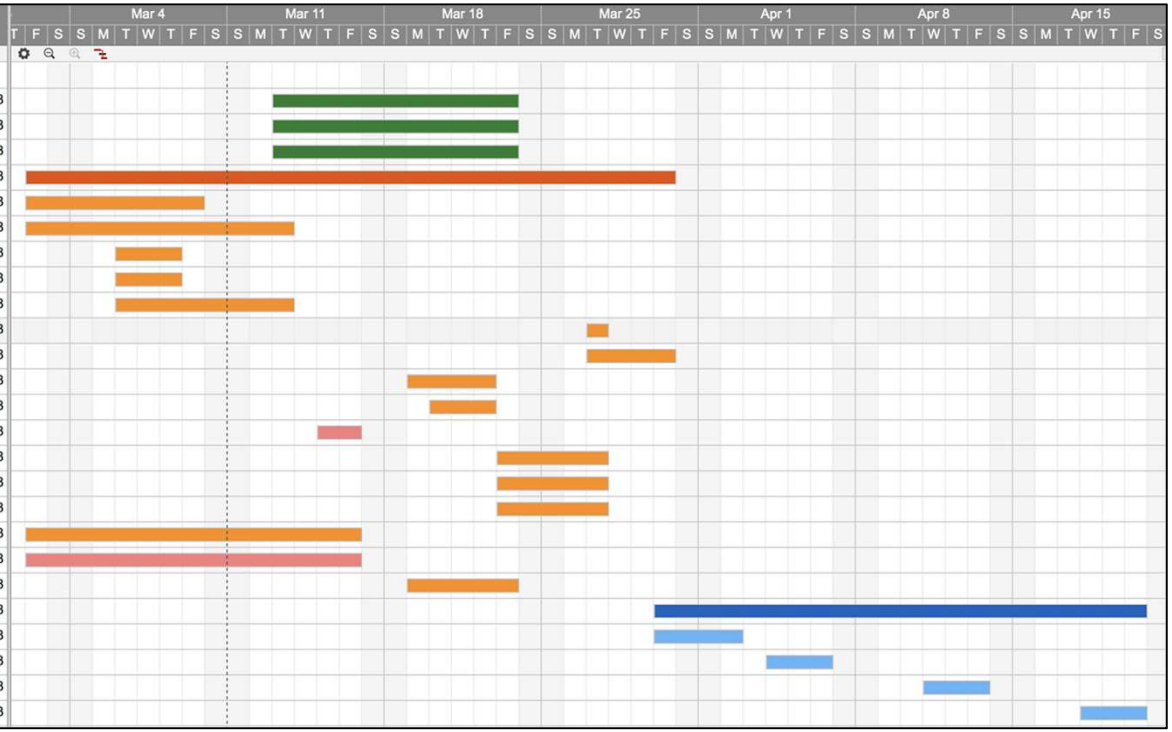
- Finish manufacturing by March 1
- Begin testing march 2

Current Standings

- The team is behind by several weeks
- Expecting to have final approvals within the week

Schedule for Completion

	Process	Task Name	Duration	Start	Finish
1	Part Order				
2		Top Mainframe Material	9d	03/13/18	03/23/18
3		Yaw Material	9d	03/13/18	03/23/18
4		Hub Material	9d	03/13/18	03/23/18
5	Manufacturing		21d	03/02/18	03/30/18
6		Baseplate	6d	03/02/18	03/09/18
7		Tower	8d	03/02/18	03/13/18
8		Bearing Spacer	3d	03/06/18	03/08/18
9		Tower Sleeve	3d	03/06/18	03/08/18
10		Lower Mainframe	6d	03/06/18	03/13/18
11		Mainframe Spacer	1d	03/27/18	03/27/18
12		Top Mainframe	4d	03/27/18	03/30/18
13		Tail Fin	4d	03/19/18	03/22/18
14		Brake Mechanism	3d	03/20/18	03/22/18
15		Hub Body	2d	03/15/18	03/16/18
16		Actuator Shaft	3d	03/23/18	03/27/18
17		Actuator Arms	3d	03/23/18	03/27/18
18		Blade Mounts	3d	03/23/18	03/27/18
19		Blade roots	11d	03/02/18	03/16/18
20		Blades	11d	03/02/18	03/16/18
21		shaft	5d	03/19/18	03/23/18
22	Testing		16d	03/30/18	04/20/18
23		1st Test	2d	03/30/18	04/02/18
24		2nd Test	3d	04/04/18	04/06/18
25		3rd Test	3d	04/11/18	04/13/18
26		4th Test	3d	04/18/18	04/20/18



= Material Shipping Time = Machining Time = 3D Printing Time Time = Testing Opportunities

Budget

Upcoming Fundraisers:

- Fundraiser tomorrow at Bigfoot Barbeque 4 to 9 PM
- Tuesday (27 March) at Pay'n Take

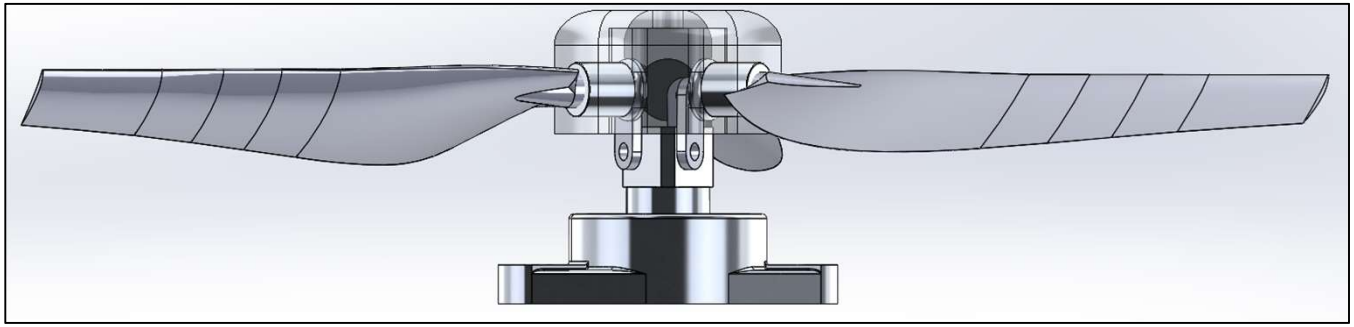
Total Income/Expenses	Amount ($)
Income	1300.00
Expenses	266.80
Total	1033.20

Income Source	Amount ($)
Gore	1300.00
Fundraisers	TBD
Total	1300.00

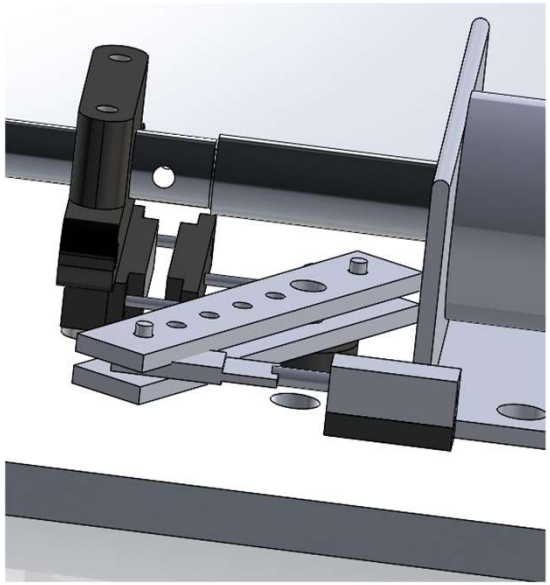
Hardware Review 2

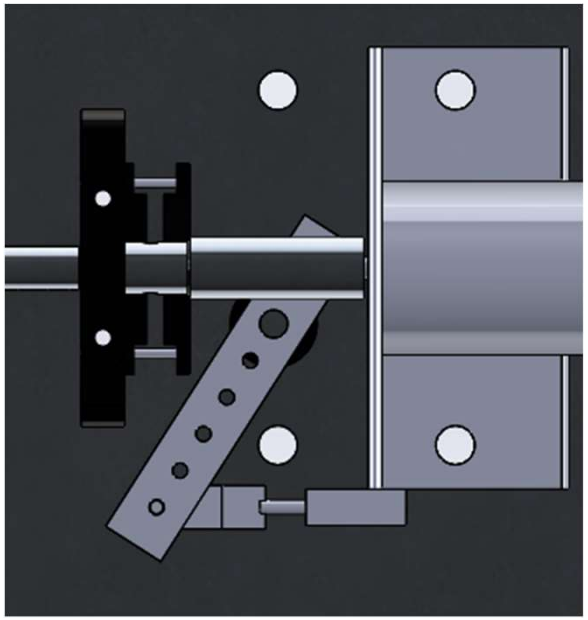
Subsystems: Active Pitching Hub

- Industry pitching systems
  - Swash plate
  - Camshaft assembly
- CWC 18 Design
  - Combination of both the swash plate and camshaft designs

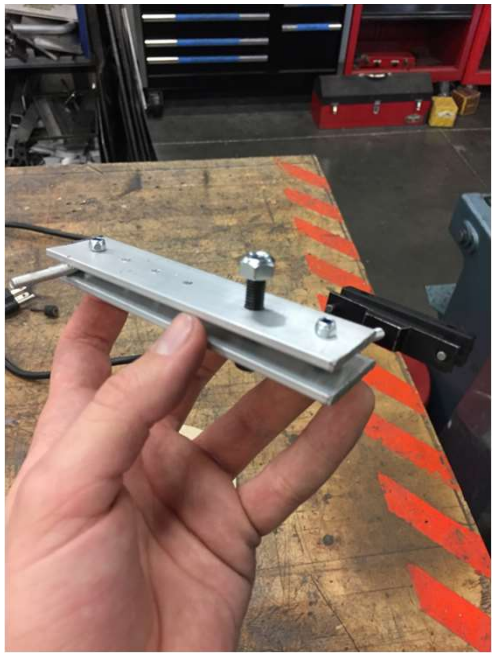


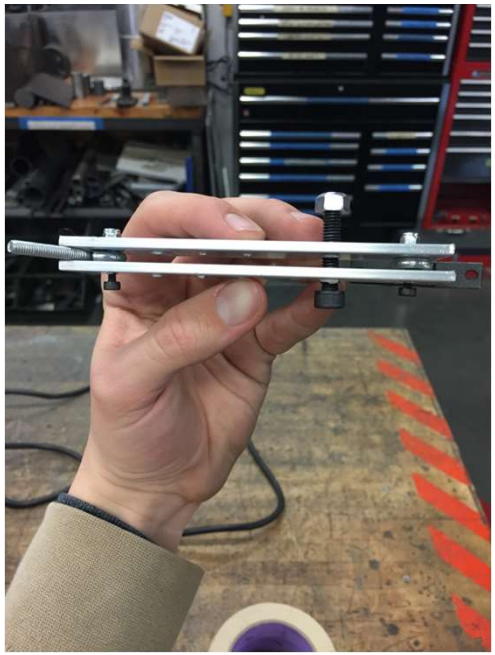
Subsystems: Braking Mechanism



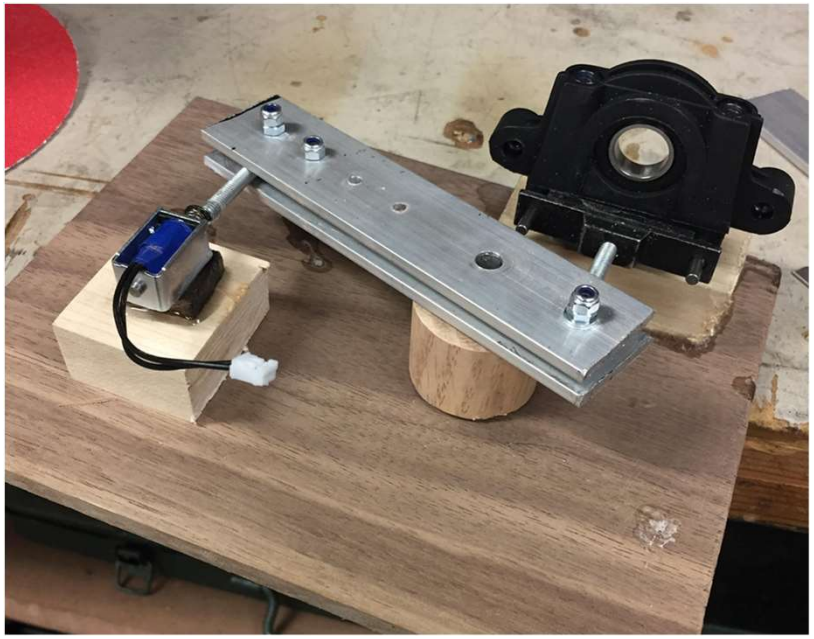


Braking Mechanism





Braking Mechanism

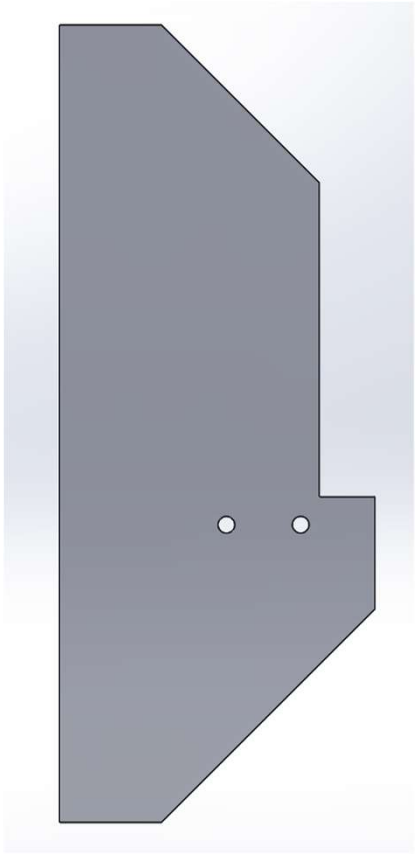


Subsystems: Yaw Mechanism

Current State:

Maximizing available area

Reducing the weight



Thank You

Any Questions?