Midpoint Presentation: Collegiate Wind Competition 2019

Team 18F07
3/12/19

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Product Description

- U.S. Department of Energy is the sponsor
- Collegiate Wind Competition
    - Competition held in Boulder, Co. May 6th-9th .
    - Fifth team representing NAU at the Competition.
    - Collaboration with Electrical Engineers.

Proposed Design

- CAD model of our proposed design.

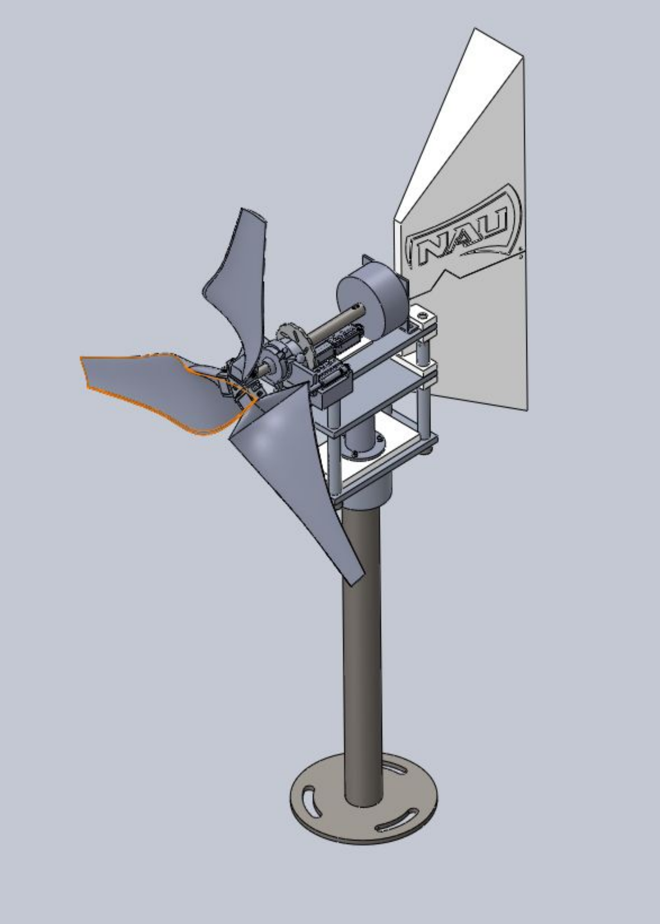

Figure 1: CAD model

Current State of Manufacturing

Completed

- Yaw
- Brake Calipers/Bearing Block
- Nacelle (holes need to be drilled)
- Base Plate

In Progress

- Brake Rotor
- Shaft
- Blades/Pitching Mechanism
- Tower

Blades Update

- FEA showed us that the blade material properties will be sufficient
  - Factor of Safety: 3.468
- The team’s generators have high cogging torques-require high rotor solidity

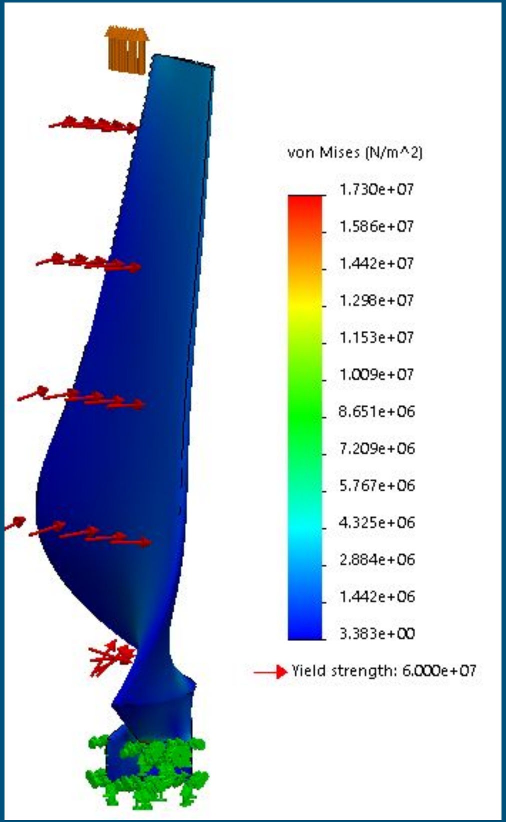

Figure 2: Blade FEA

Hub Update

- The hub was redesigned for the new pitching mechanism layout
- Modifications to the swashplate will be necessary

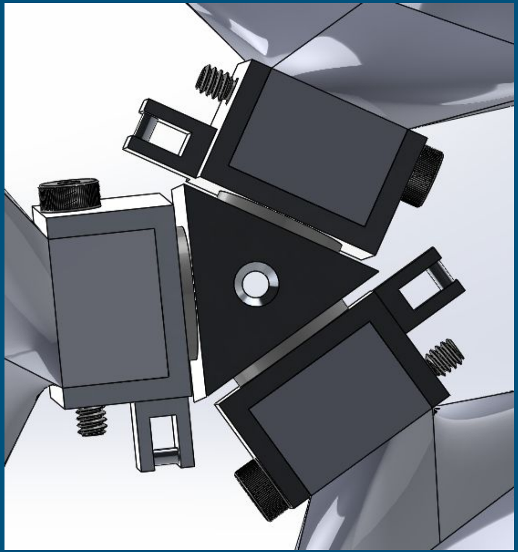

Figure 3: Front view of rotor

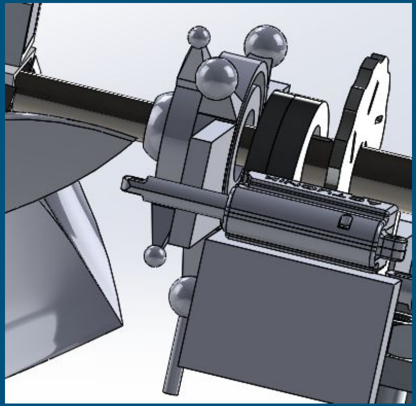

Figure 4: Swashplate mechanism

Hub Safety

- FEA was run on the hub
  - Identified stress concentrations
  - Showed locations of failure
- The hub was modified to have higher thickness and larger radii in corners
- The claws were found to not fail under loading circumstances

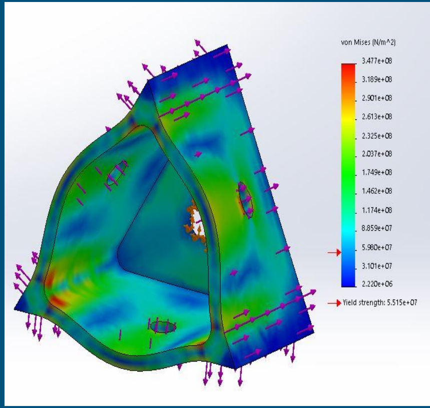

Figure 5: Initial Hub FEA

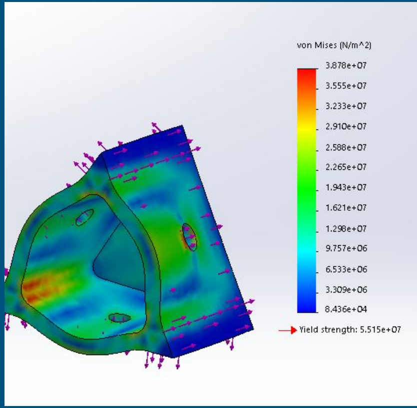

Figure 6: Iterated Hub FEA

Generator Testing

- Rectifier needed to be built for the DC load
- Dyno testing to evaluate motor characteristics
- Gimbal motor shorted during first test

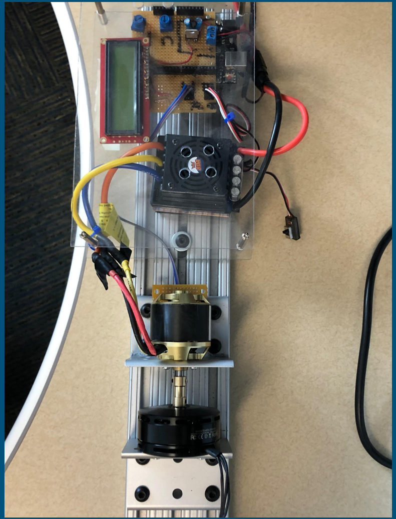

Figure 7: Dynamometer

Figure 8: Generator Testing

MAD 5010 motor results

- Linear Relationship with Power
- Output power remains below the motor power output
    - Turbine will have access to all of the generator’s potential power

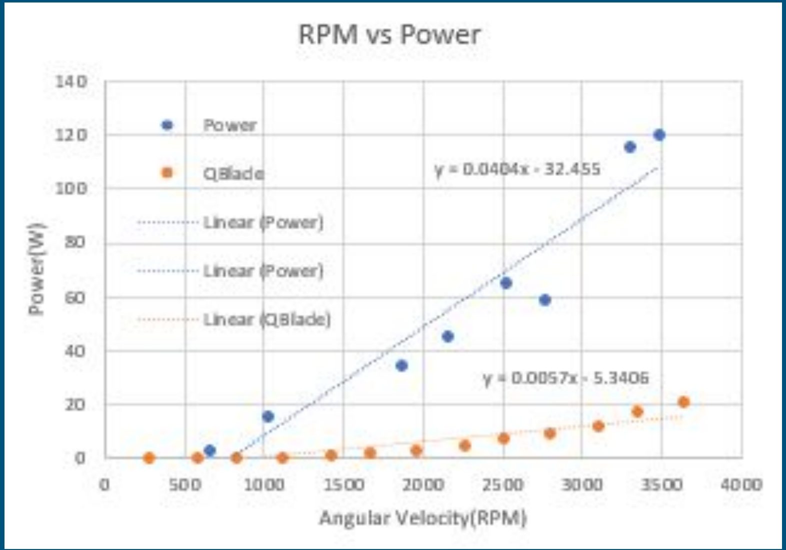

Figure 9: MAD motor results

Tail - Yaw Update

- We showed you last update

- We wanted to use aluminum but it would be too hard to manufacture
- Because of this we changed our design

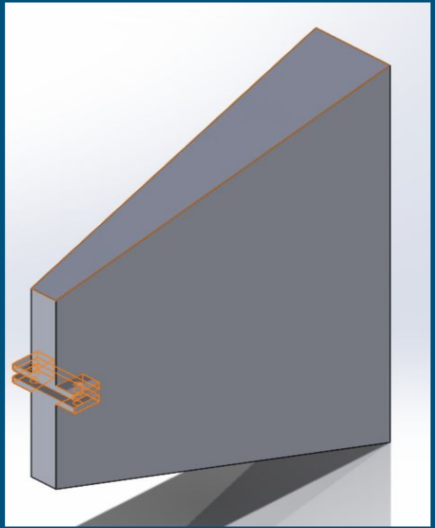

Figure 10: Initial Tail design

Tail - Yaw Update

- We made it bigger (We need to maximise surface area)
- Split it two pieces with a logo NAU (It was too big to make in one piece)
- We 3D printed with abs plastic (It's less heavy than aluminum and easier to manufacture)

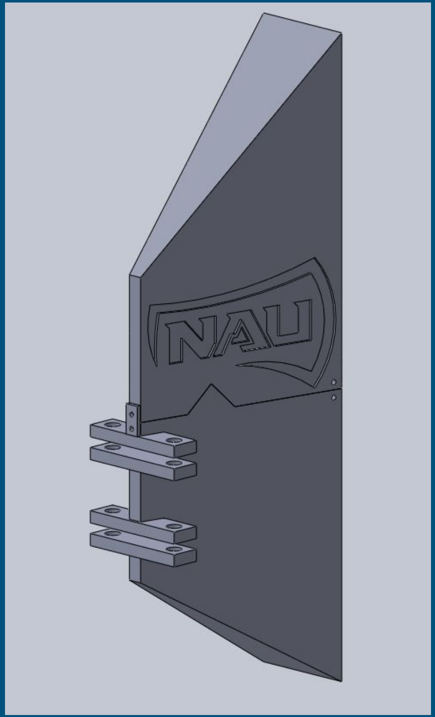

Figure 11: Final Tail Design

Shaft Update

- Shaft for last semester
- Material Used for testing

Carbon steel, alloy steel, Stainless steel

The length 125mm and diameter ⅜ in

- Design torque = 3.8877N.m
- Bending moment = 0.4905N.m
- Three lengths were used

L=10 cm , L=15 cm and L=20 cm

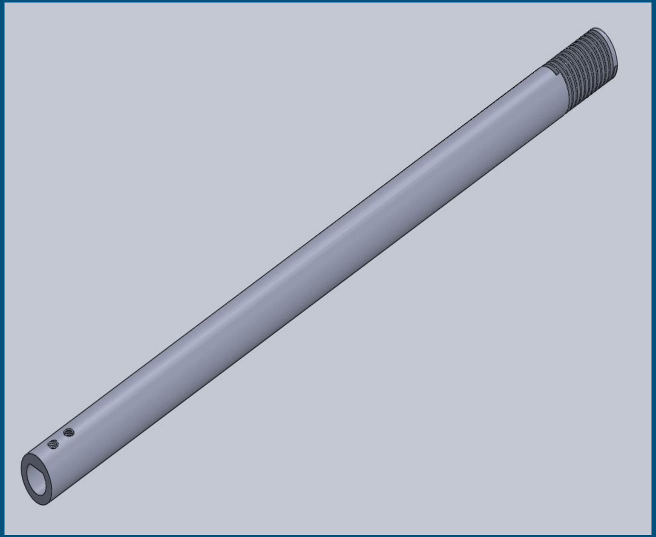

Figure 12: Previous Shaft Design

Shaft Update

- We use two flat surfaces instead of keyway
  - Based on the individual analysis we decided that will be best.

- The material is 1018 steel .

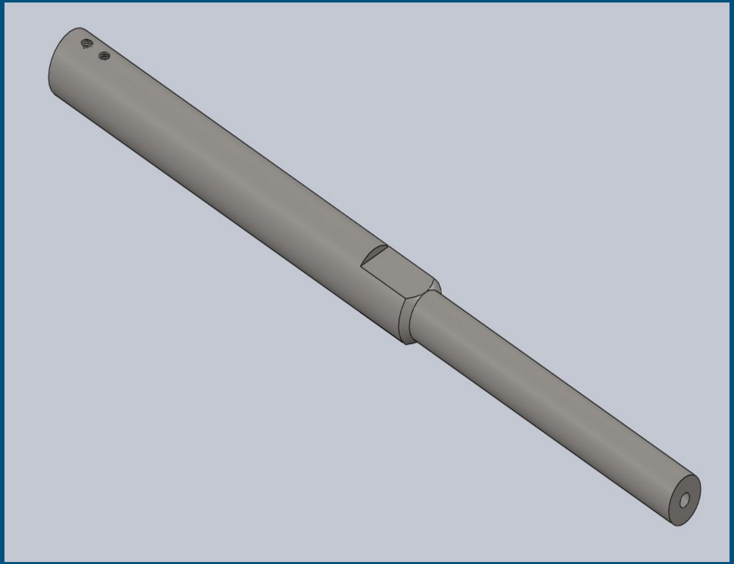

Figure 13: Current Shaft Design

Brakes Update

Last Update

- Linear Actuator on paper could apply the most pressure for braking
  - Testing needed to be done

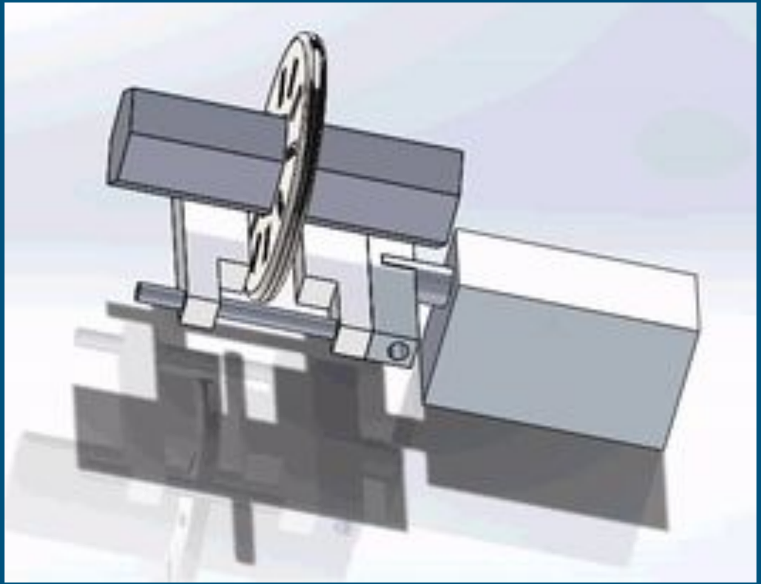

Figure 14: Initial brake design

Brakes Update

Current Update

- Testing
  - Required force estimated with wind speed, mass of braking system, and time to stop
  - Each device was tested 10 times and averaged
- Linear actuator proved to be the best design

Table 1: Brake Strength Comparison

	Required Clamping Force (N)	Rated Force (N)	Average Tested Force (N)
Linear Actuator	15	22	21.68446
Big Stepper Motor	15	15.13513514	14.88718
Servo Motor	15	6.5908	6.26024
Small Stepper Motor	15	1.666666667	1.69344

Brakes Update

Brake Design Iteration

- Designed a couple iterations that work for linear actuators

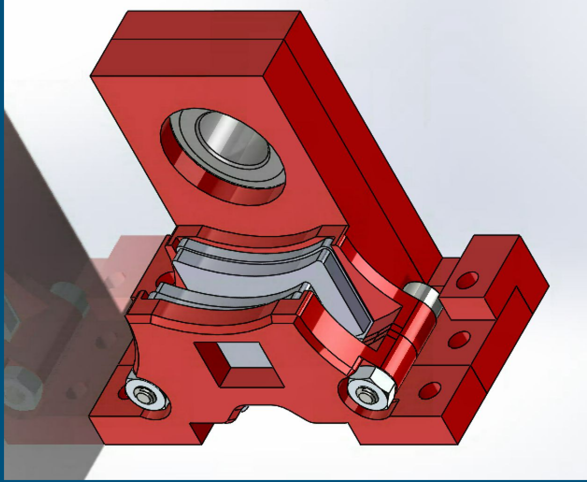

Figure 15: Previous Brake Design

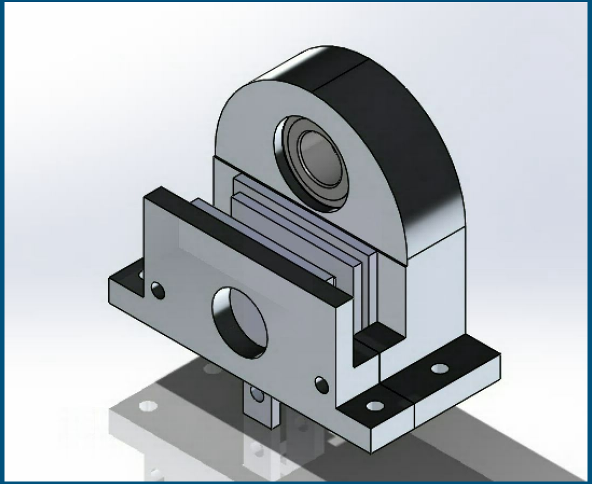

Figure 16: Final Brake Design

Tanner

Tower, Base Plate, and Yaw Bearing Update

Last Update

Tower	Base Plate	Yaw Bearing
• Tower was tapered and not easy to manufacture	• Had no changes from design given by the DOE	• No design was made last semester

Current Update

Tower	Base Plate	Yaw Bearing
• 1018 Steel • Finalized at 17” tall, OD 1.5”	• Added slots for connecting during competition	• Added two bearings to allow the turbine to turn into the wind

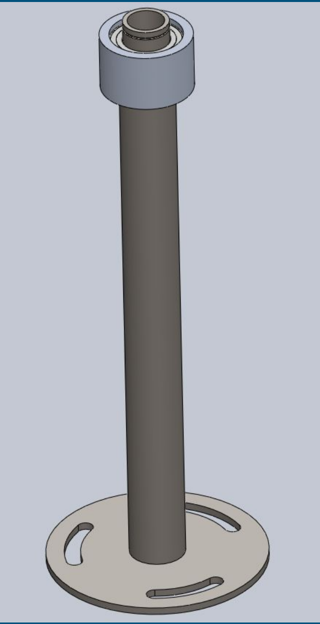

Figure 17: Current Tower Design

Nacelle Update

<u>Last Update</u>

- There was only two levels to the nacelle

<u>Current Update</u>

- Made 3 levels to accommodate for storing electrical components

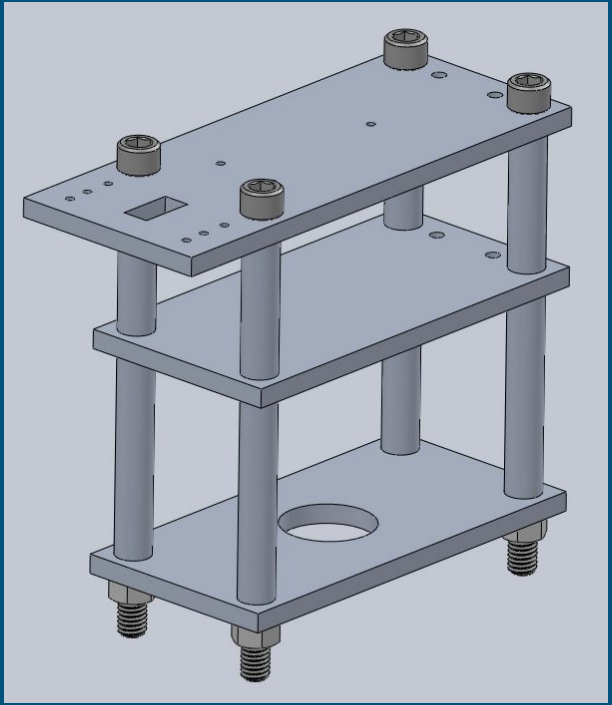

Figure 18: Nacelle Design

Testing the Design

- The team will use a local wind tunnel to test the design
- The objectives of tunnel testing will be:
    - Ensuring proper operation
    - Validating safety
    - Charging a battery similar to competition standards

Schedule

The schedule need to update.

We will build a wind turbine on 3/29/219 .

Table 2: Gantt Chart

Gantt Chart

Period Highligh

ACTIVITY	Person Responsible	PERCENT COMPLETE
Website Setup	Naser / Faisal	100%
Website Update(s)	Naser / Faisal	80%
Designing	Everyone	85%
Blade Design	Riley	85%
Brake Design	Tanner	100%
Yaw Design	Faisal	100%
Nacelle	Tanner	95%
Tower/Baseplate	Tanner	85%
Shaft	Naser	75%
Midpoint Report	Everyone	60%
Full Turbine Build	Everyone	60%
Testing Turbine	Everyone	0%
Final Report	Everyone	0%

Budget

- This is the stuff we bought
- We do not plan on purchasing anything els at the moment

Table 3: Current Budget Sheet

	Budget		
	Part	Cost	Reference
Bought:	Blade 2B4:C630s Blade Swashplate	$ 10.88	https://www.amazon.com/gp/product/
	4x8x3mm Rubber Shielded Ball Bearings	$ 10.88	https://www.amazon.com/4x8x3mm-R
	EL-Kit-003 UNO Project Super Starter Kit	$ 38.12	https://www.amazon.com/EL-KIT-003-P
	Carbonx Fiber Reinforced Nylon	$ 68.00	https://www.3dxtech.com/carbonx-car
	1018 Steel Tubing: 1.5" OD, L=36"	$ 61.56	https://www.speedymetals.com/p-3469
	6061 Aluminum Tubing: 2.5" OD, L=6"	$ 12.10	https://www.mcmaster.com/7392t14
	Retaining Rings 1.25"	$ 6.83	https://www.mcmaster.com/97633A34
	1.25" ID Bearings	$ 26.72	https://www.mcmaster.com/60355K82
	3/8" ID Bearings	$ 26.67	https://www.mcmaster.com/60355K45
	J-B Plastic Weld	$ 10.14	https://www.amazon.com/J-B-Weld-50
	Push Button	$ 12.59	https://www.amazon.com/Nxtop-Positi
	Disc Brake Pads	$ 10.88	https://www.amazon.com/Shimano-Re
	Stepper Motor	$ 17.86	https://www.amazon.com/uxcell-Stepp
	Servo Motor	$ 19.95	https://www.amazon.com/FEETECH-FS5
	Linear Actuator	$ 87.97	https://www.actuonix.com/L12-R-Linea
	6061 Aluminum Plates	$ 35.00	https://www.industrialmetalsupply.cor
	1018 Steel Plate	$ -	Donated
	Aluminum Tubing Spacers	$ -	
	DH 8 channel Slip Ring	$ 38.80	https://www.dhgate.com/product/wir
	8 Channel 10A Slip Ring	$ 34.42	https://www.aliexpress.com/snapshot/(
	Micro-Linear Actuator (x2)	$ 161.61	
	SunnySky X6215S kv: 170	$ 81.37	https://sunnyskyusa.com/collections/xs
	MAD5010 kv: 200	$ 115.00	https://www.alibaba.com/product-deta
	Turnigy 5206 Gimbal Motor kv: 42	$ 43.43	https://hobbyking.com/en_us/turnigy-h
	Travel and Competition costs	N/A	Department of Energy is covering the cos
	Total:	$ 930.78	

Future Work

- Communicate with DOE about which contests the team will participate in
- Presentation and Report due to the DOE
- Poster for presentation due upon arrival

Questions?