Design Review 5

Kite Generator

Team 16

Jared Gremley

Libni Mariona

Simone Nazareth

Team Introduction

Andrew Barba
Financial Advisor

Jared Gremley
Team Leader

Brian Lyn
Lead ECE

Libni Mariona
Lead CAD

Simone Nazareth
Lead ME

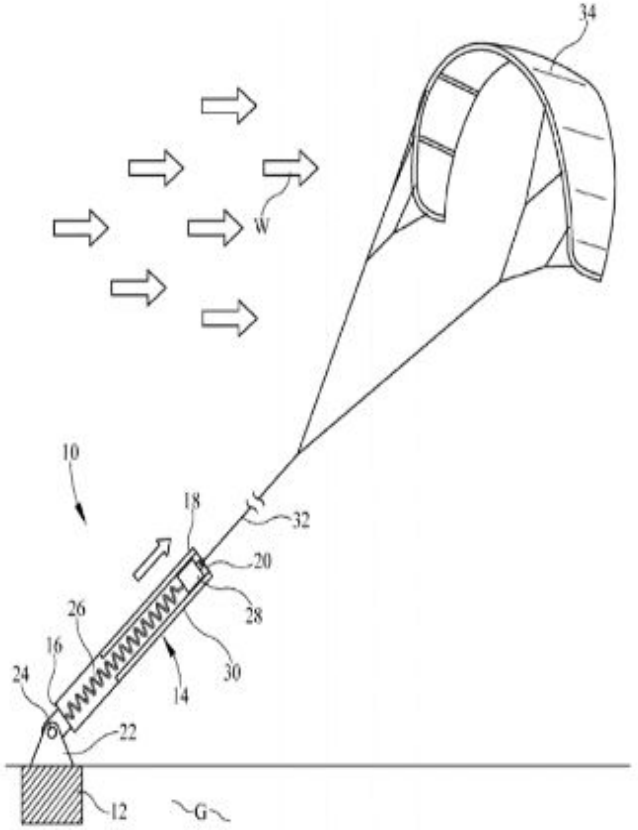
Presenter: Libni Mariona

Simone Nazareth

Project Background & Recap

Project Recap

- Project Definition
  - Harness wind energy with portable system
  - Provide power to off-grid locations
  - Ensure ability to perform in varying wind conditions
- Jeff Phipps Patent
  - Kite based electricity generation system
  - Permanent magnet
  - Slides within housing wrapped in electric coil
- Redefined Project Scope
  - Build and test a model to verify patent
  - Analyze solenoid at varying power levels
    - Gas Generators
    - Makani



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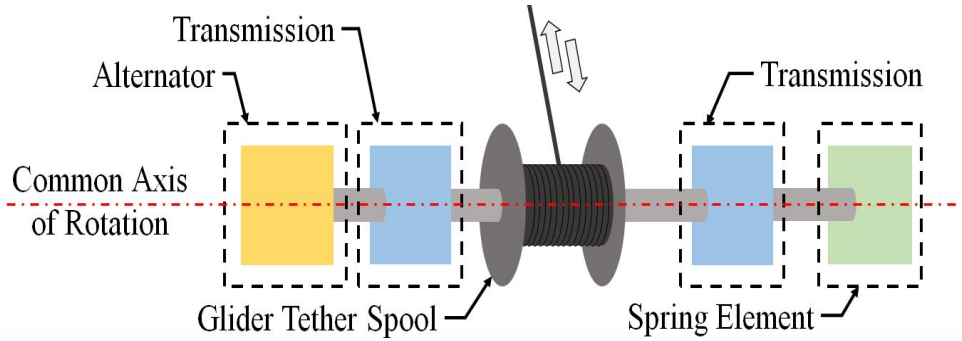
Concept Selection

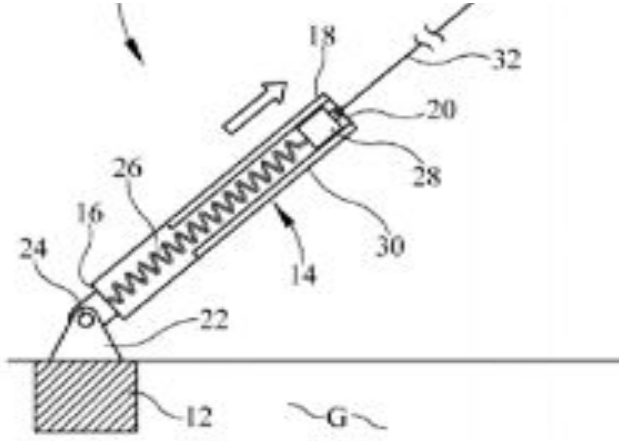
Transmission Power Generator

- Concept generation - Pugh matrix
- Proven concept on the market
  - Off the shelf parts
  - Optimally designed
- Higher efficiency

Solenoid Power Generator

- Unique design
- Utilize sponsor's patent
- Less mechanical components
  - Less expensive





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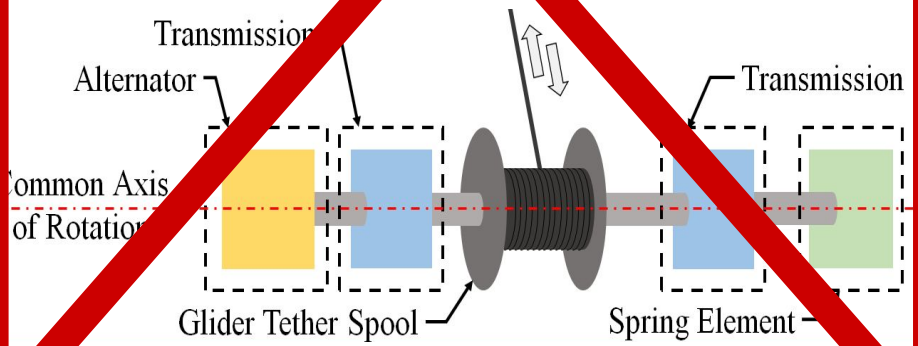

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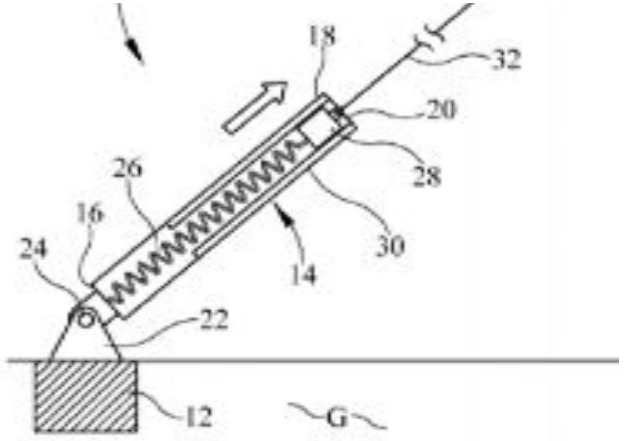
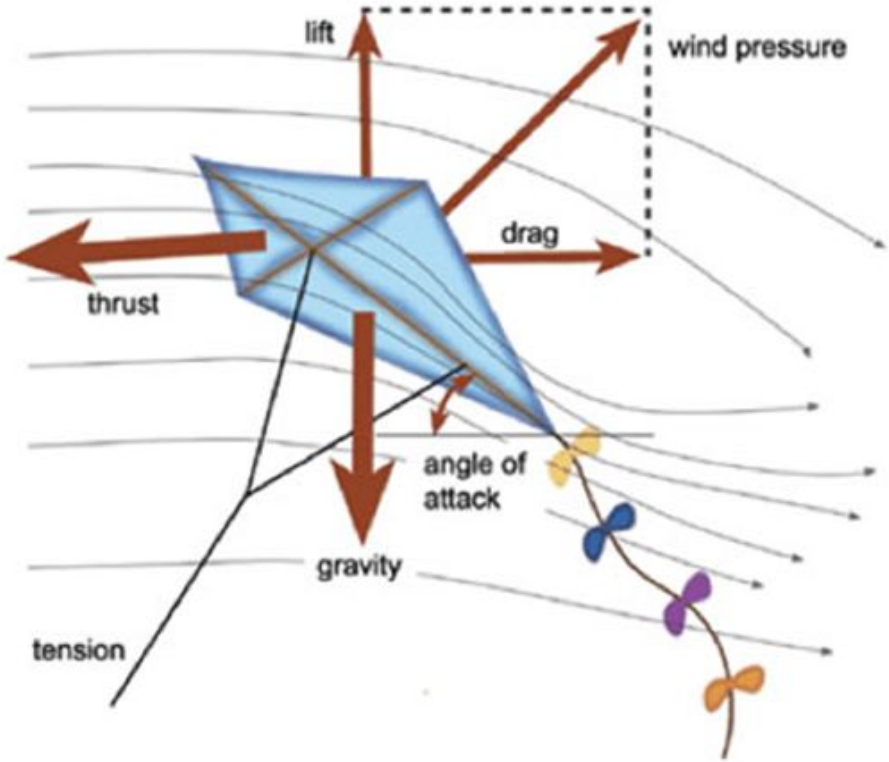


Aerodynamic Analysis

- Match generator output to mechanical motion of the kite

- To fly a kite:
  - Lift must be greater than weight
  - Thrust must be greater than drag

- Kite Movement:
  - Kite will oscillate from varying winds
  - Magnet will translate similar to kite
  - Lift and drag determine magnet velocity by work-energy theorem



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Jared Gremley

Analytical Results

Kite Analysis

Kite Analysis

- Modeled Kite
  - Tantrum 220 Prism Kite
- Velocity Data
  - “Data Experiment Name”
  - 6 min average wind speed
- Determine Resultant Force acting on Kite
  - Iterated over varying angles of attack
  - Solenoid sized from max wind gust
    - Minimum flight velocity
    - Maximum sustained winds
  - Does not factor wind gust

Minimum wind speed	0.49 m/s
Maximum wind speed	15.2 m/s
Maximum speed change	14.6 m/s
Maximum Resultant Force	650 N
Average Solenoid Length	0.25 m

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Power Output Analysis

- Optimize Power Output
  - Maximize Electromotive force
    - Maximize wrappings
  - Minimize resistance
    - Maximize wire diameter
  - Maximize magnet velocity
    - Induce maximum change in magnetic flux
  - Square vs Round Wire
    - Square produces higher power
      - Larger cross-section
      - Decreases resistance

Wire Diameter	7.35 mm
Voltage	0.97 V
Current	136.98 A
Resistance	7.10 mΩ
Wrappings per layer	17
Layers	4
Total Wrappings	68
Projected Power Output	133 Watts

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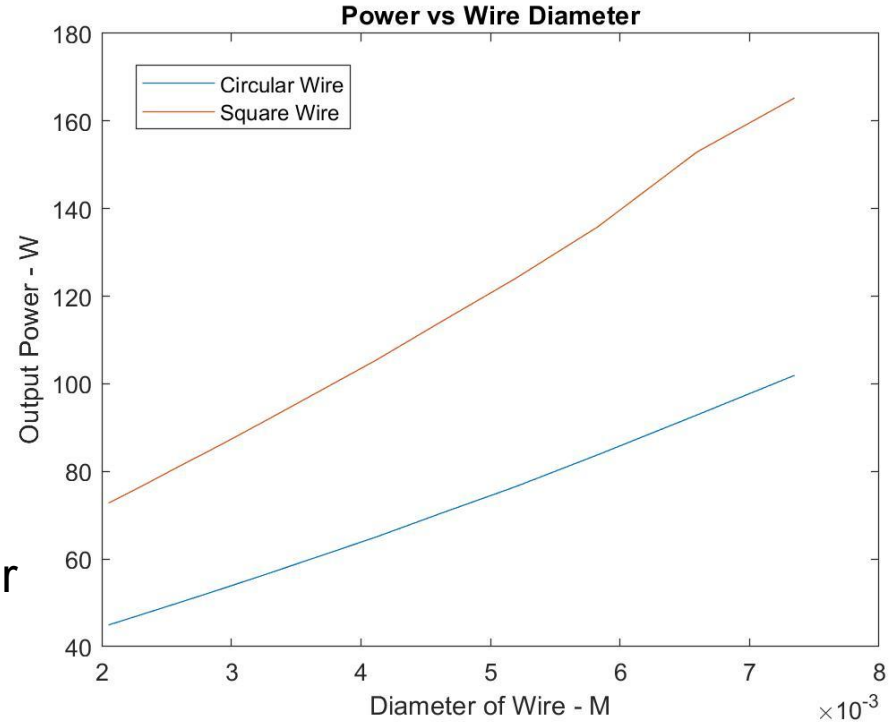

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Parts & Purchasing

- Parts used from previous year
  - (1)* 3” Neodymium Magnet
  - (1)* DC Motor

- All purchase orders have been made

(1)* 26 Pound AWG 1 Magnet Wire	$300
(2)*Sch 40 3.5” x 2’ PVC Pipe	$8
(1)*Multimeter	$50
(2) Springs	$75
(3)Aluminum Plates	$200
(5)Fiberglass Rods	$15
(1)Crank Wheel	$15
(1)Square Eye Plate	$5

- Approximate Budget Spent $668

* indicates parts received

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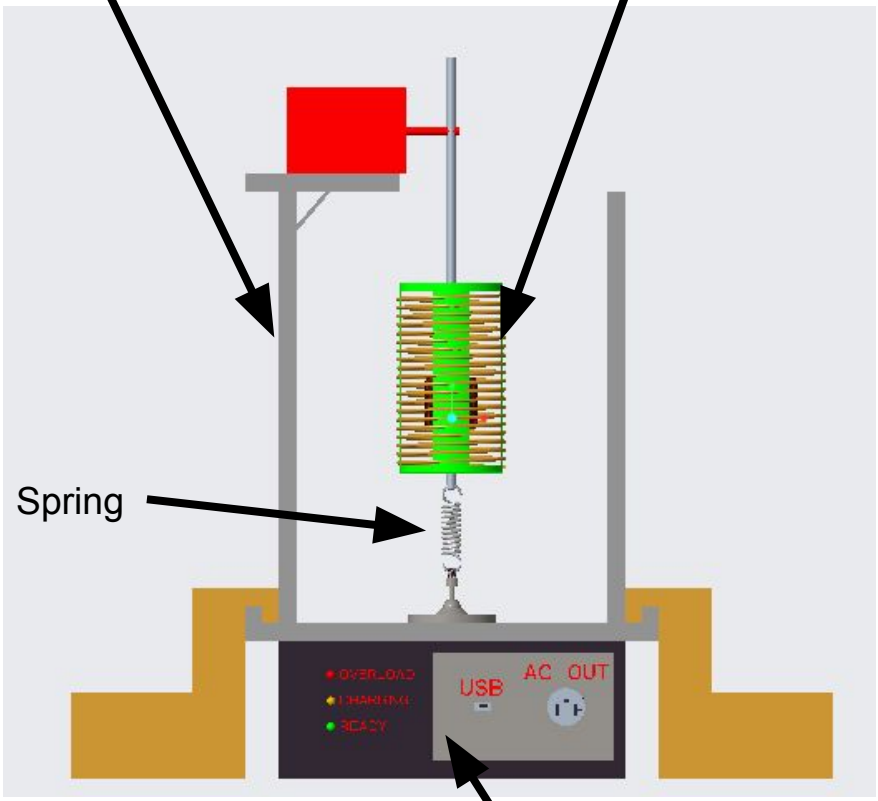
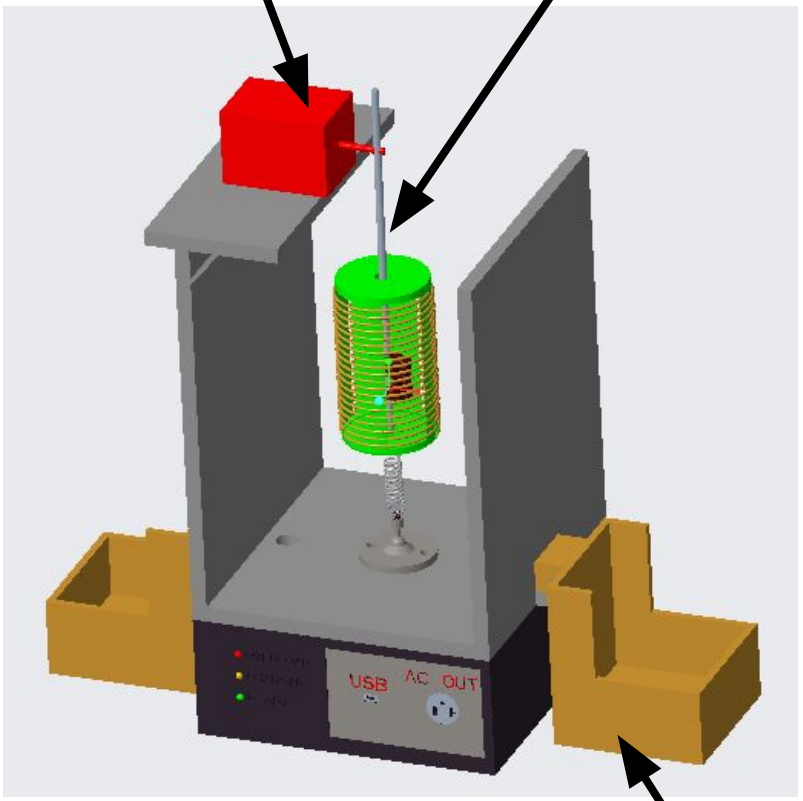
CAD Drawings





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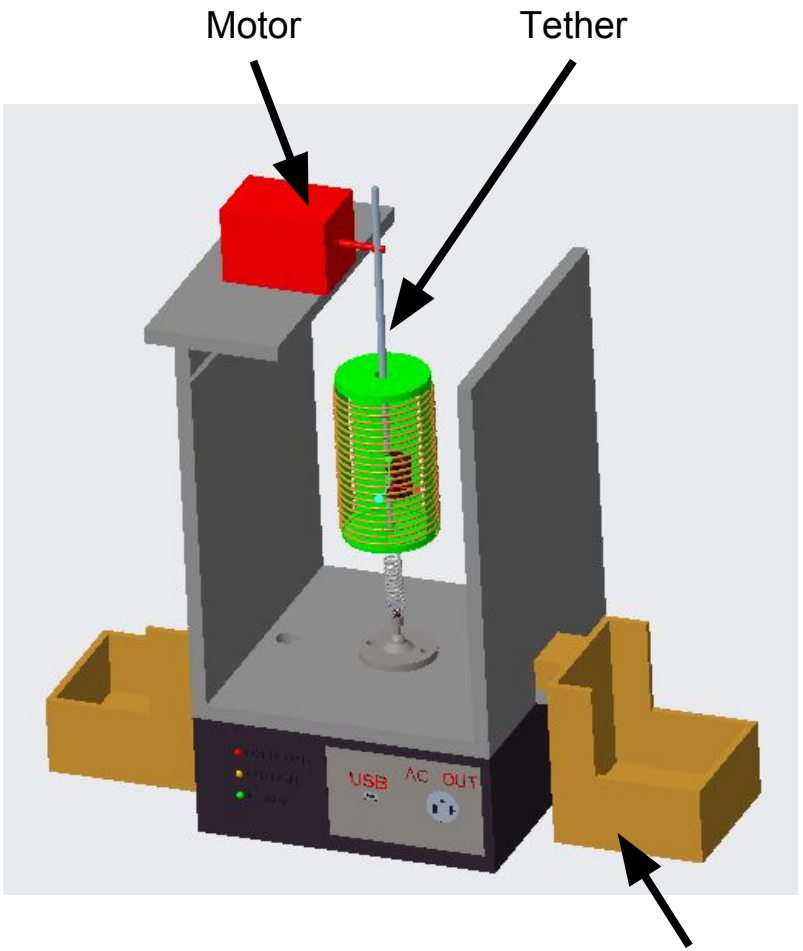
CAD Design Modifications

- 3-D Print Clips
  - Stabilize magnet motion
- Support for Solenoid
  - Housing for the springs
- Issues have been accounted for in the final design and purchasing.



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Libni Mariona

Future Work

Prototype Construction

- Fabricate Solenoid
  - MAGLAB coil wrapper
  - Mr. Larson's mechanical shop

- Assemble Generator
  - Welding of housing
  - Linkage Connection
  - Motor Power Source
  - Motor Controller

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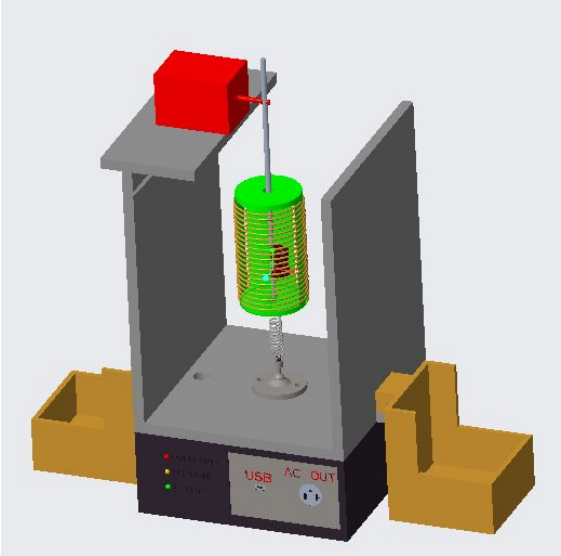
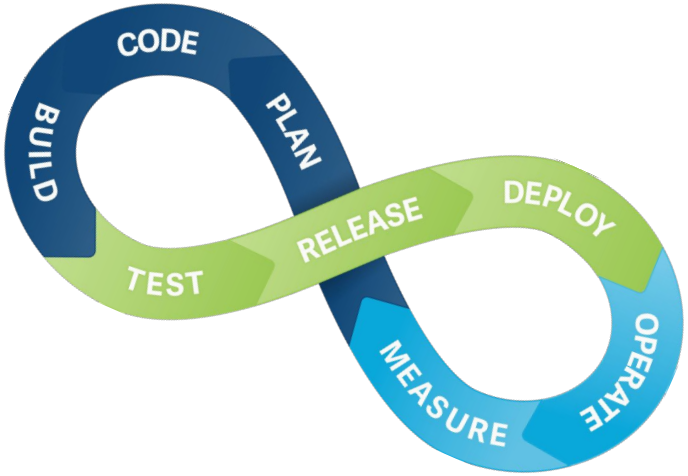
Experimental Procedure and Testing

- Oscillate magnet at varying speeds
  - Measure and observe 6 data sets
    - 2 different motor rpms
    - 3 springs with different constants
- Real-time data measurements of electrical output
  - Voltage
  - Current
  - Resistance
- Compare and contrast datasets and MATLAB code
  - Adjust code to experiment - if needed
- Repeat experiment to confirm results





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Scalability

- Power output dependent on:
  - Kite size
  - Kite motion
  - Wire diameter
  - Coil wraps
  - Magnet speed

- Scale MATLAB code
  - 10 kW output - gas generator
    - Disaster relief, campers, or boaters
    - Portable unit
  - 600 kW output - Makani
    - Base load power on the grid

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Future Work

Remaining Semester

- Finish prototype construction
- Test Prototype
- Validate Results
- Scale different applications:
  - Operating conditions
    - Best kite design
    - Optimal solenoid size
  - Manufacturability
  - Cost

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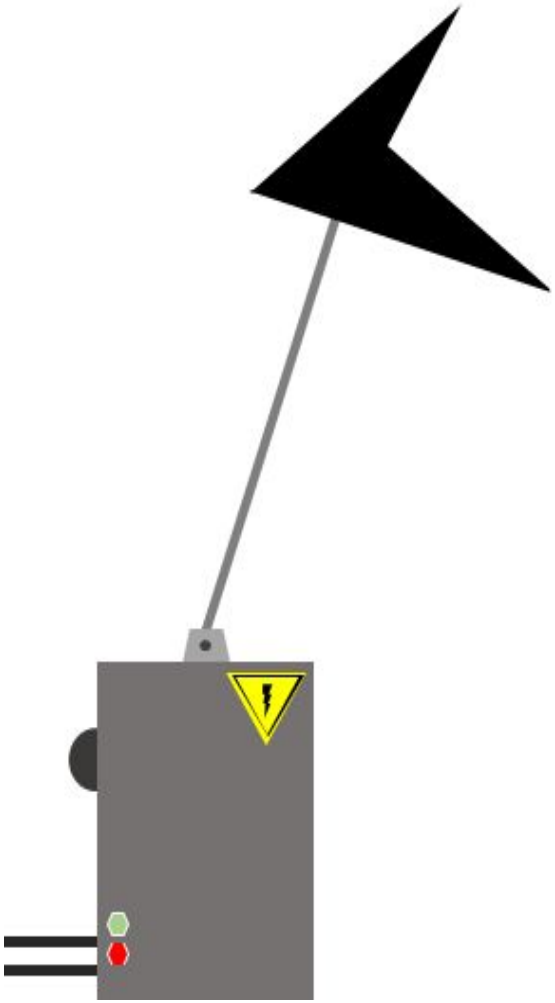
Subsequent Work - Following Senior Design Team

For current prototype

- Optimize Kite Design
  - Maximize resultant force and kite motion
- Link magnet motion to kite motion
  - Reduce friction/drag
- Integrate electrical components to store charge
  - Change ± AC to +DC
- Increase overall system efficiency

For more accurate analysis

- Model kite in wind tunnel
- Model drag of tether
- Obtain instantaneous wind velocity profile



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References

- Phipps, Jeffrey Sterling. Kite System for Generating Electricity. Phipps, assignee. Patent 9,013,055. 21 Apr. 2015. Print.

Questions?
Comments?