Design Review 4

Kite Generator

Team 16

Andrew Barba

Jared Gremley

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Team Introduction

Andrew Barba
Financial Advisor

Jared Gremley
Team Leader

Brian Lyn
Lead ECE

Libni Mariona
Lead CAD

Simone Nazareth
Lead ME

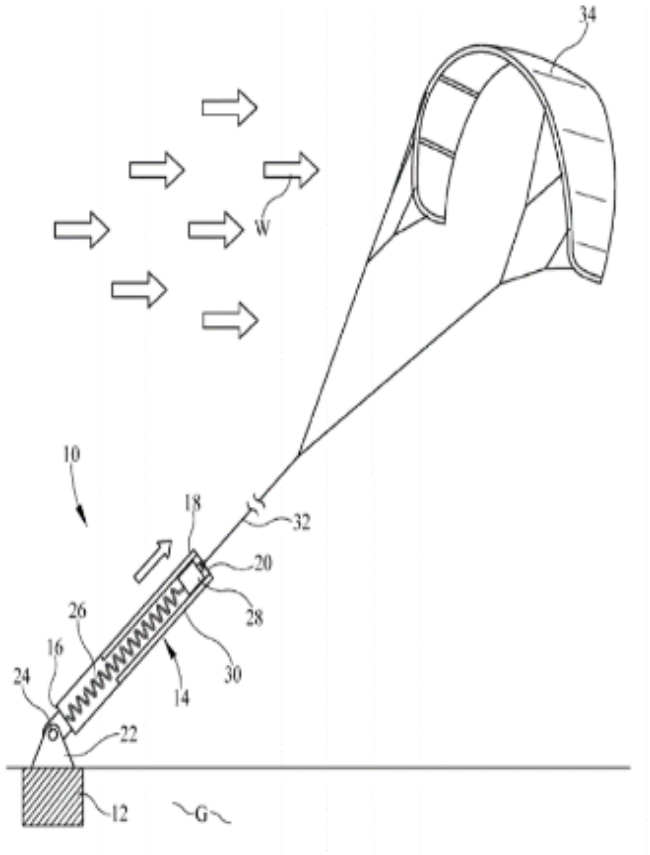
Andrew Barba

Project Background

Project Recap

- Project Definition
  - Provide power to off-grid locations
  - Harness wind energy with portable system
  - 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



Presenter: Andrew Barba

Concept Selection

Solenoid Generator vs. Transmission Generator

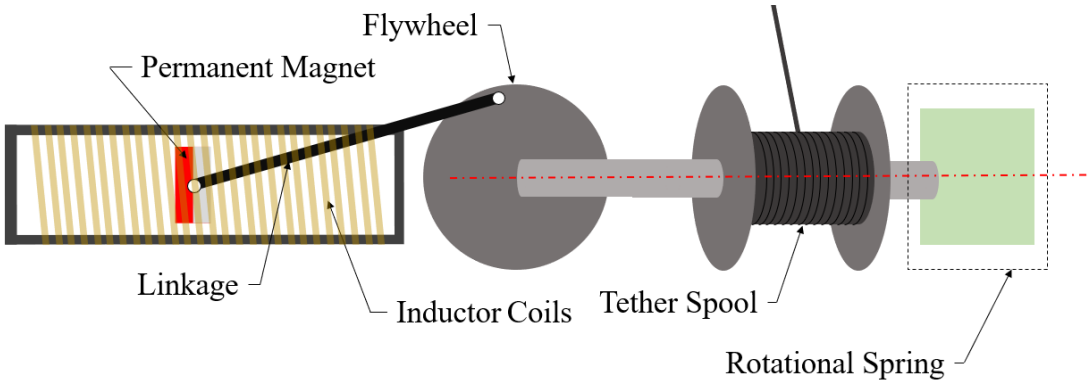
Solenoid Power Generator

Pros

- Continue last team's work
- We currently hold the patent

Cons

- Large amount of copper
- Uncommon system for power generation
- Complex behavior of inducing emf



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Concept Selection

Solenoid Generator vs. Transmission Generator

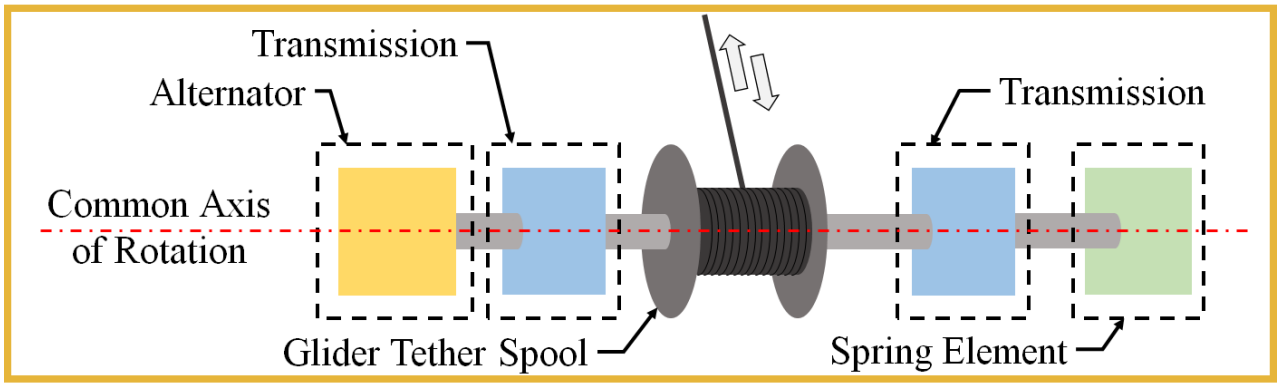
Transmission Power Generator

Pros

- Greater efficiency
- Proven concept

Cons

- Design a gearbox
- More mechanical components



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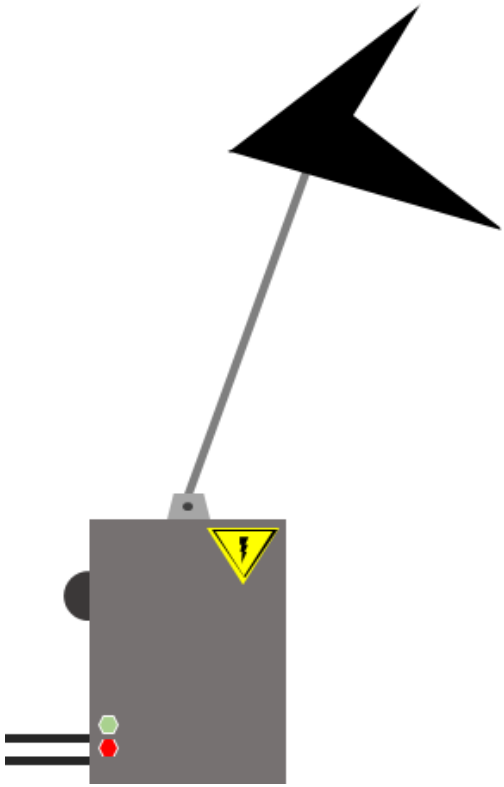
Concept Selection

- Concept Selection with Sponsor Jeff Phipps
  - Solenoid vs Transmission
    - Transmission models readily available
    - Kite design not necessary
    - Explore potential of solenoid power generator



- Redefined Project Scope:
  - Build and test a model to verify solenoid application
  - Research and analyze solenoid for varying power levels
    - Gas Generators
    - Makani

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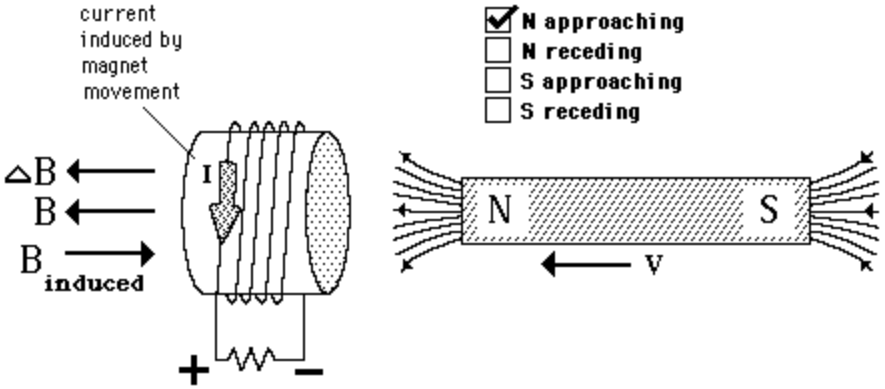
Jared Gremley

Power Generation

Power Generation

- Solenoids are complex in nature
  - Induced emf
    - Emf induced magnetic field opposes motion
    - Sinusoidal voltage and current with varying magnitudes

- Important variables of the solenoid
  - Number of wrappings and layers
  - Wire diameter
  - Length of solenoid
  - Magnet strength
  - Magnet velocity



- Model solenoid power generation with MATLAB
  - Measure voltage, current, & resistance through system
  - Maximize power output for varying diameters

Presenter: Jared Gremley

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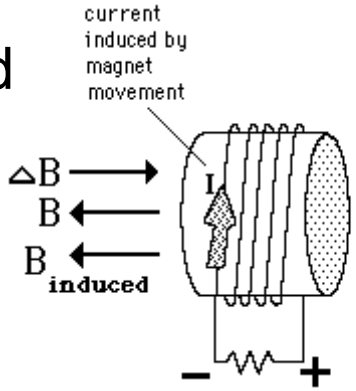

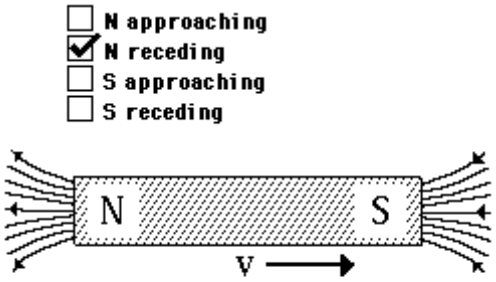

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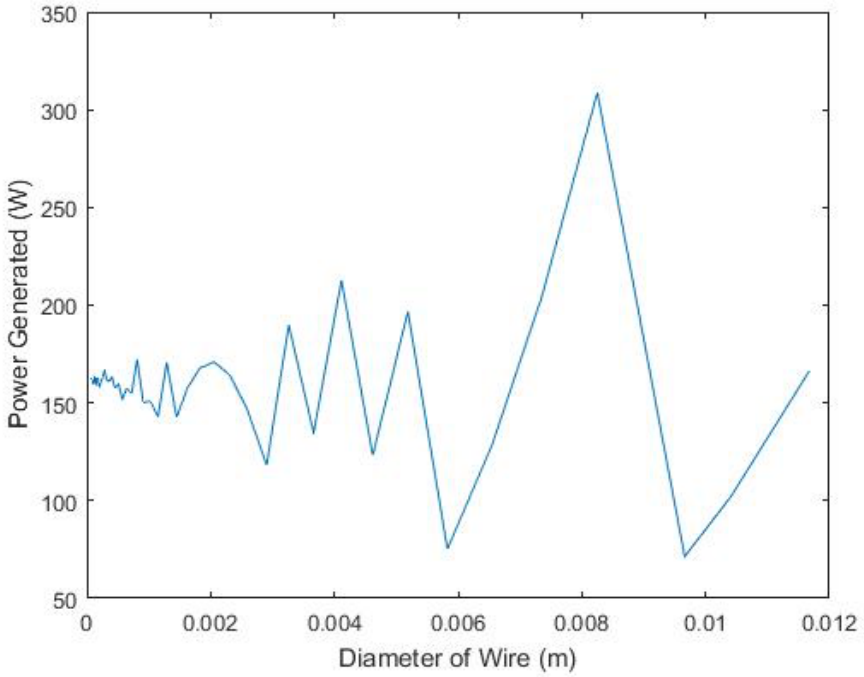
  - Maximize power output for varying diameters

Presenter: Jared Gremley

Power Generation

- Rated for 50 lbs of copper wire

Length of Solenoid	0.75 m
Wrappings per layer	90.9
Layers	2.88
Maximum Power Output	300 Watts
Optimal Wire Diameter	8 mm - Copper Wire Gauge 0 (1/0)



- MATLAB Model
  - Model does not account for minor losses
- Improve model
  - Minor Kite Analysis

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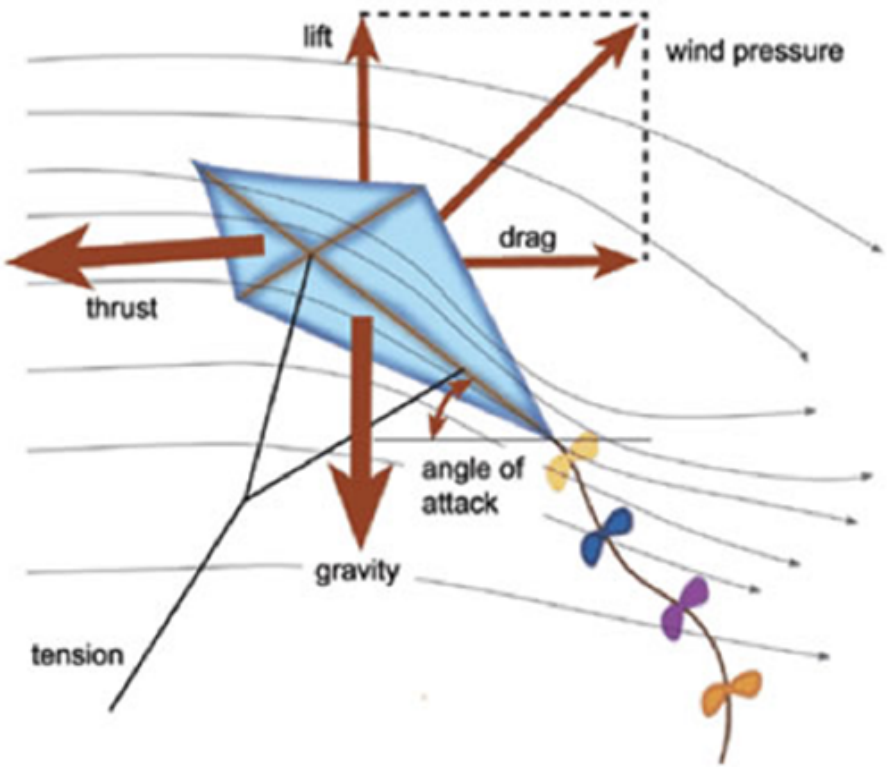
Aerodynamic Analysis

Boundary Conditions

- To fly a kite:
  - Lift must be greater than weight
  - Thrust must be greater than drag
  - Yields minimum velocity for flight

- Kite Movement
  - Kite will oscillate from varying winds
  - Magnet will translate similar to kite
  - Short tethers do not factor
  - Lift and Drag determine magnet velocity by work-energy theorem



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Scalability

- The MATLAB code can be scaled to a desired power output
  - Gas Generator - 10 kW output
    - Disaster relief emergency generator
    - Campers or boaters
    - Military combined generator and surveillance
  - Makani - 600 kW output
    - Baseload power on the grid
    - Cheaper alternative
    - Portable unit
- Depending on the scale, various ‘kite’ subsystems may be required
  - Aerostat
  - Fixed wing airfoil

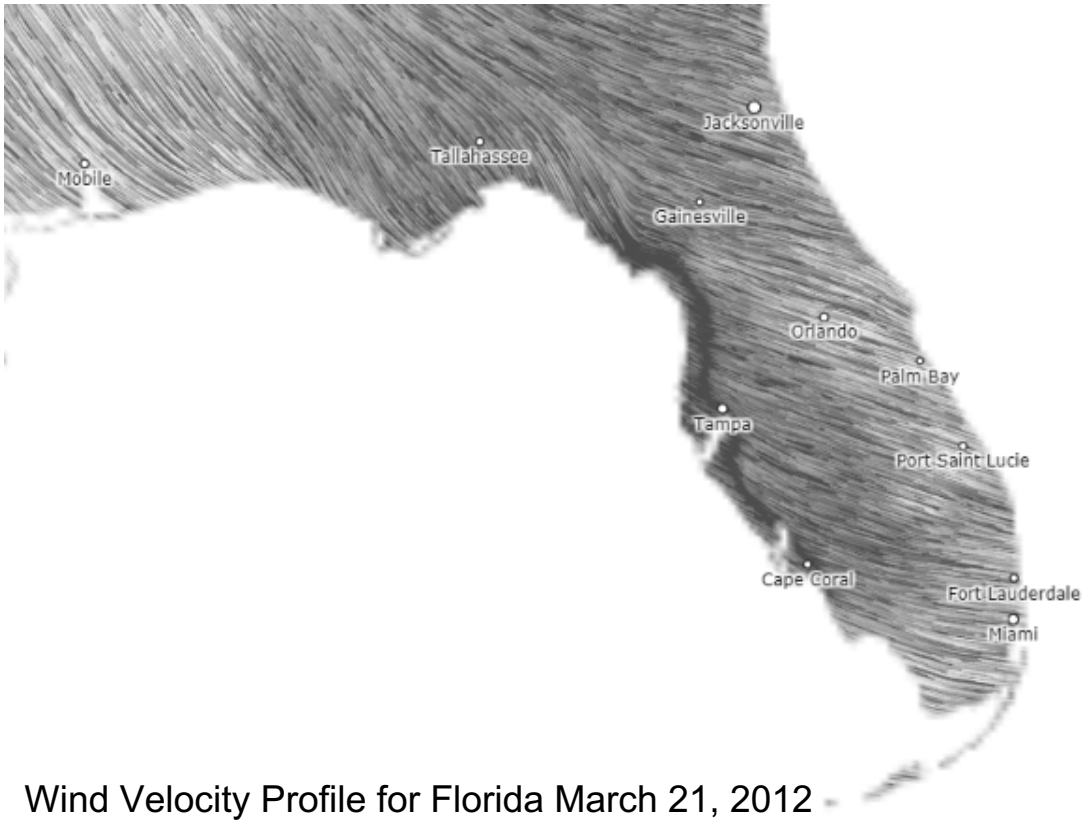
Presenter: Jared Gremley

Brian Lyn

Future Work

Future Work

- Obtain instantaneous wind velocity dataset
  - National Weather Service
  - Data.Gov
  - German Climate Computing Center
  - Handheld anemometers
- Match aerodynamic and power generation analysis in Matlab
- Size solenoid accordingly
- Purchase remaining parts



Wind Velocity Profile for Florida March 21, 2012

Presenter: Brian Lyn

Financial Considerations

- Solenoids are not on the market at the scale needed
  - Necessary to custom-build one
  - Scale must fit within budget
  - Size for previously purchased kites

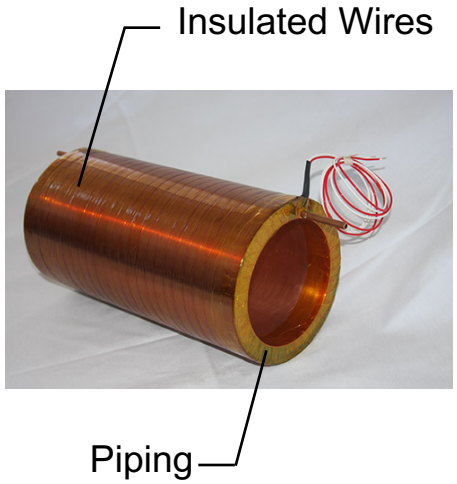
- Obtained from previous year:
  - Dual tether kite
  - Magnet

- Remaining components are being sized and purchased:
  - Spool
  - Spring
  - Motor
  - Shafts
  - Bearings
  - Copper Wire

Presenter: Brian Lyn

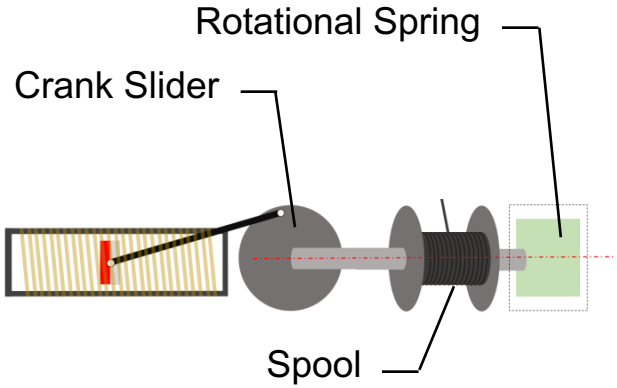
Purchasing

Highest Priority
Solenoid Production



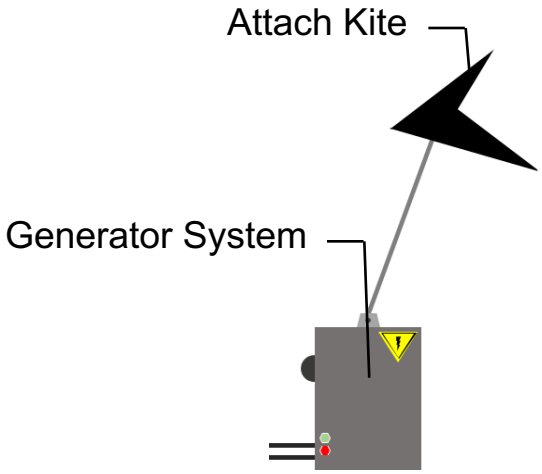
Already own most items required to construct and experiment with solenoid power generation sanity check.

Medium Priority
Generator Prototype



The team is highly interested in developing a small scale model of the key systems a full blown product would entail, including a method for retracting the spool.

Lowest Priority
Mount Kite



Although the project has been called the kite generator project. The sponsor is currently only focused on the proof that a solenoid can produce power.

Presenter: Brian Lyn

Building and Testing

Experimental Analysis

- Motor to vary oscillations of magnet
  - Prove relationship of magnet speed and power
  - Measure voltage, current, and resistance
  - Determine efficiency of solenoid

- Compare experiment and computer model data
  - Remove any errors in code and experiment

- Repeat oscillating magnet experiment
  - Validate previous experiment results
  - Analyze tendencies in experiment and variables

- Apply results from experiment and model to analyze other power output levels

Presenter: Brian Lyn

References

- Phipps, Jeffrey Sterling. Kite System for Generating Electricity. Phipps, assignee. Patent 9,013,055. 21 Apr. 2015. Print.
- Wind Map. (n.d.). Retrieved February 27, 2018, from http://hint.fm/wind/index.html
- DKRZ long term archive. (n.d.). Retrieved February 27, 2018, from https://cera-www.dkrz.de/WDCC/ui/cerasearch
- Data.gov. (n.d.). Retrieved February 27, 2018, from https://www.data.gov/

Presenter: Brian Lyn

Questions?
Comments?

Additional Slides

Copper Wire comes in a set range of diameters

Modeling our solenoid to fit within our initial metrics and targets of 50 lbs we produced this relationship

Mass = Volume * Density

Volume = Length*Area

Area = 3.14*r^(2)

Additional Slides

Work - Energy Theorem

Total Work = change in kinetic energy

Fdx = 0.5*m*dv^(2)

From an instaneous velocity data set we can find:

the Force experienced on through the tether

The change in position through kinematic equations

And solve for the velocity of the magnet

Additional Slides

Cost Breakdown Without Electrical Components

- Gauge 0 Copper Wire 341’ - $750
- Neodymium 6”x1” in cylindrical magnet - $225
- Sch 40 0.25” x 10’ PVC Pipe - $3

- Approximate Cost - $1,000

- Remaining Budget - $1,000
  - Electrical Components and Housing
  - Grounding
  - Battery
  - Spring