Team 9: Development of Power Converting Sub-System of Kite Power Generator

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Presentation Overview

- Project Scope
- Project Objectives
- Progress Made
- Future Plans
- Challenges
- Planned Methodology
- Summary

The Problem at Hand

- Worlds energy consumption expected to increase by 48% by the year 2040[1]
  - Wind turbine
  - Solar energy
  - Nuclear energy
- Water shortage in Greek Islands[2]
  - Wind speeds of around 20mph

Design and build the power generating system of a kite power generator, and scale for a 100kW concept kite.

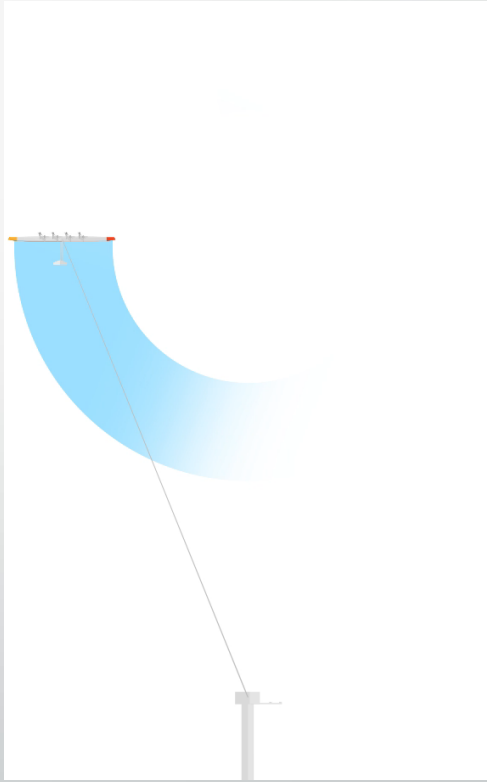
Constraints

- Altitude between 500 and 1500 feet
- Must deliver AC power to grid
- Limited to off the shelf products
- Optimized for Greek Islands

Figure 1. Picture showing mountainous Greek islands

Project Goals

- Demonstrate that magnet in electrical coil will generate usable electricity
  - Power a lightbulb
  - Varying tension in line/spring
  - Use a kite to oscillate magnet
- Concept for a method for optimization of energy output based on wind speeds
  - Scale for a 100kW kite
- Show commercial potential
  - Compare to Makani
  - Water Collection



Makani energy "kite"

General Schematic

Kite flies in unsteady wind conditions

↓

String and spring are tensioned → Magnet moves through coil

Hooke's Law $F = -k\Delta x$

↓

Spring pulls back on magnet → Magnet moves back through coil

↓

Faraday's Law

$$V = -N * \frac{\Delta(BA)}{\Delta t}$$

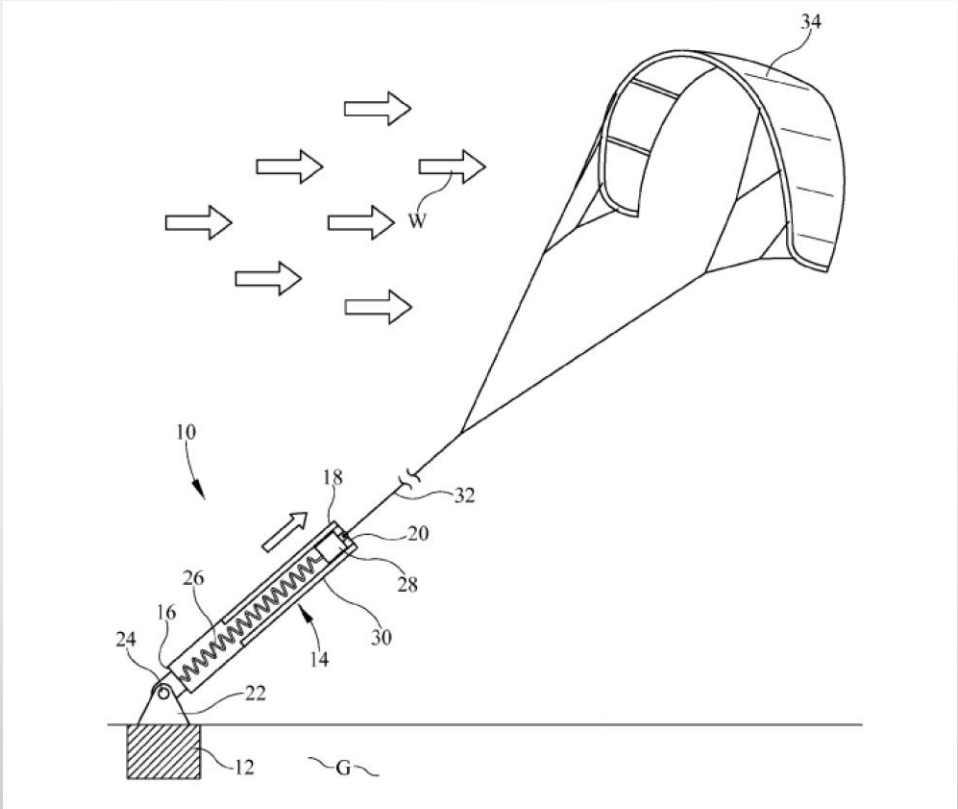


Figure 2. Jeff Phipps patent of power generating kite (diagram not to scale)[3]

Figure 3. Figure-8 kite path

Progress Made

- Demonstration Model Design
- Came up with method to stabilize/control the kite
- Method of varying the spring stiffness
  - Concentric springs
- Determined optimal conditions for necessary power generation
  - Magnet speed/strength
  - Number of coils
    - Magnet speed of 50 wraps/sec with magnet of 1.32T strength to power 40W light bulb

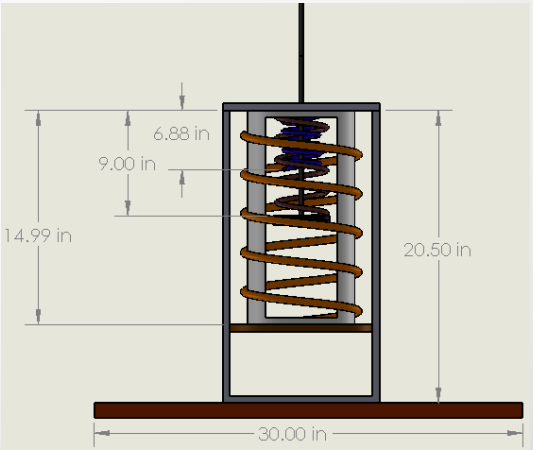


Figure 4. Demonstration model

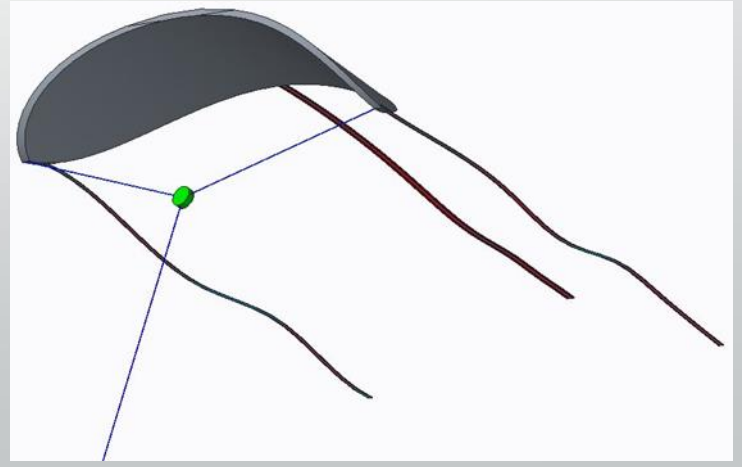


Figure 5. Concept for kite stabilization/control

Zachary Ezzo

Kite Testing

- Tested kites for maneuverability
  - 1 traction and 1 stunt kite
  - Chose the traction kite due to more lift
  - Force output via spring scale:
    3-5 lbs on straight path, 10-15 lbs on curves

Tethering the Kite

- 3 String Kite
  - Attach an additional string to the kite to tether to the oscillator
  - Use remaining two to maneuver kite
- 1 String Kite
  - Tie the two string kite to create one string
  - Attach a kite tail for kite stabilization
  - Wing flap on kite string for oscillation
  - Only for steady winds

Mimicking Kite Motion

- Designed concepts for kite oscillation if kite cannot be correctly maneuvered
  - Stationary bike
  - Motor

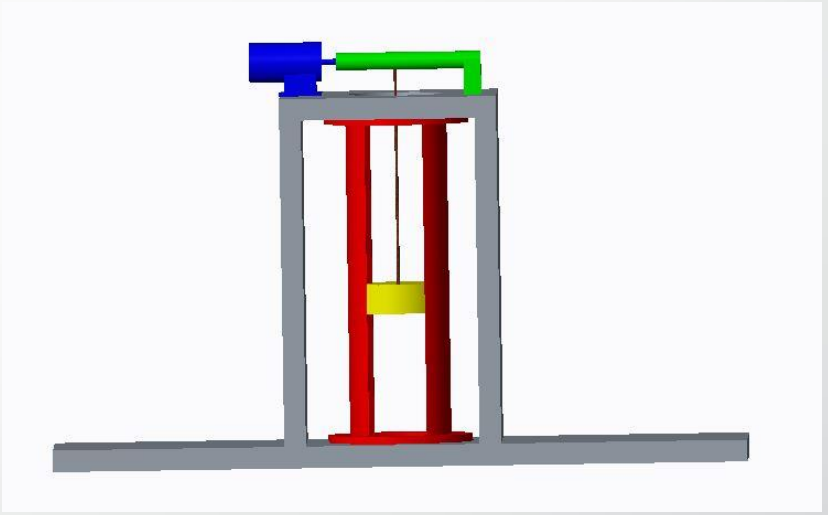


Figure 6. Motor

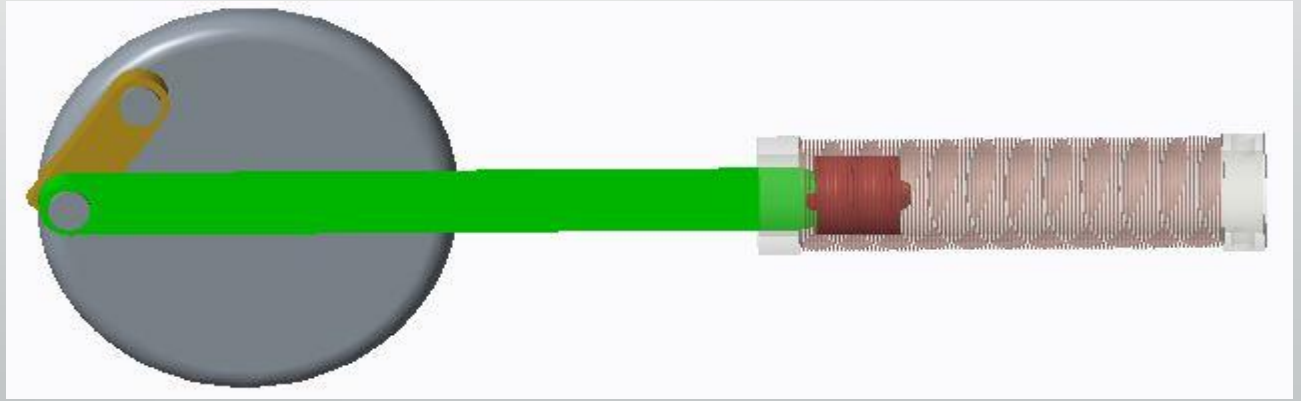


Figure 7. Stationary Bike

Lift Calculations

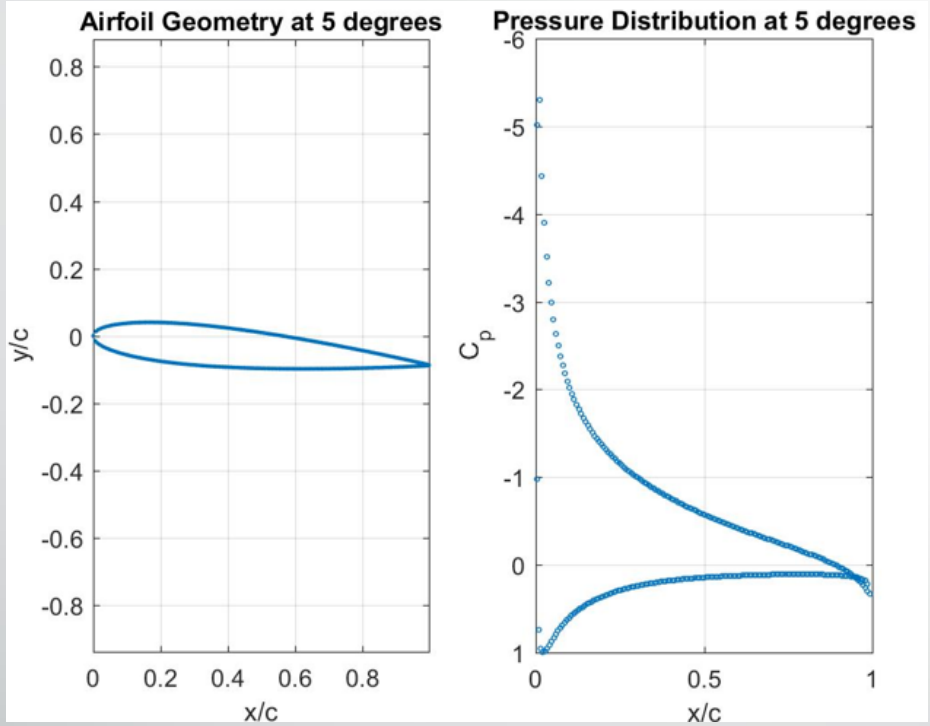


Figure 8. 5 degrees

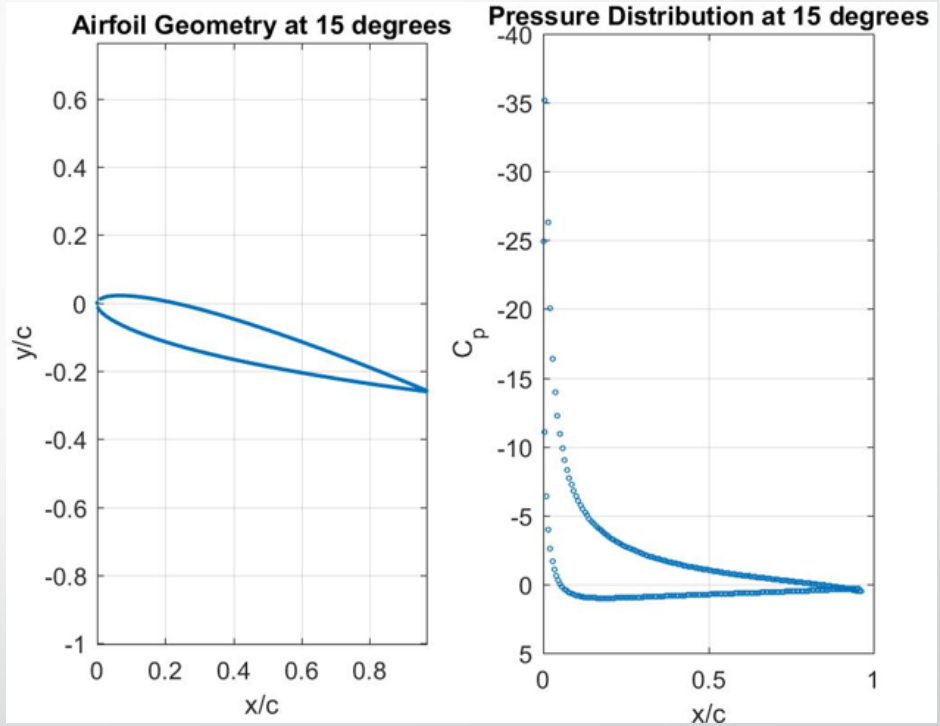


Figure 9. 15 degrees

- 15 m/s headwind—Lift force at 5 degrees angle of attack is 70 N.
  Lift force at 15 degrees angle of attack is 201 N.

Water Collection Concept

- Air foil acts as a funnel
- Grooves on air foil direct moisture to a tube
- Tube transports water to the ground

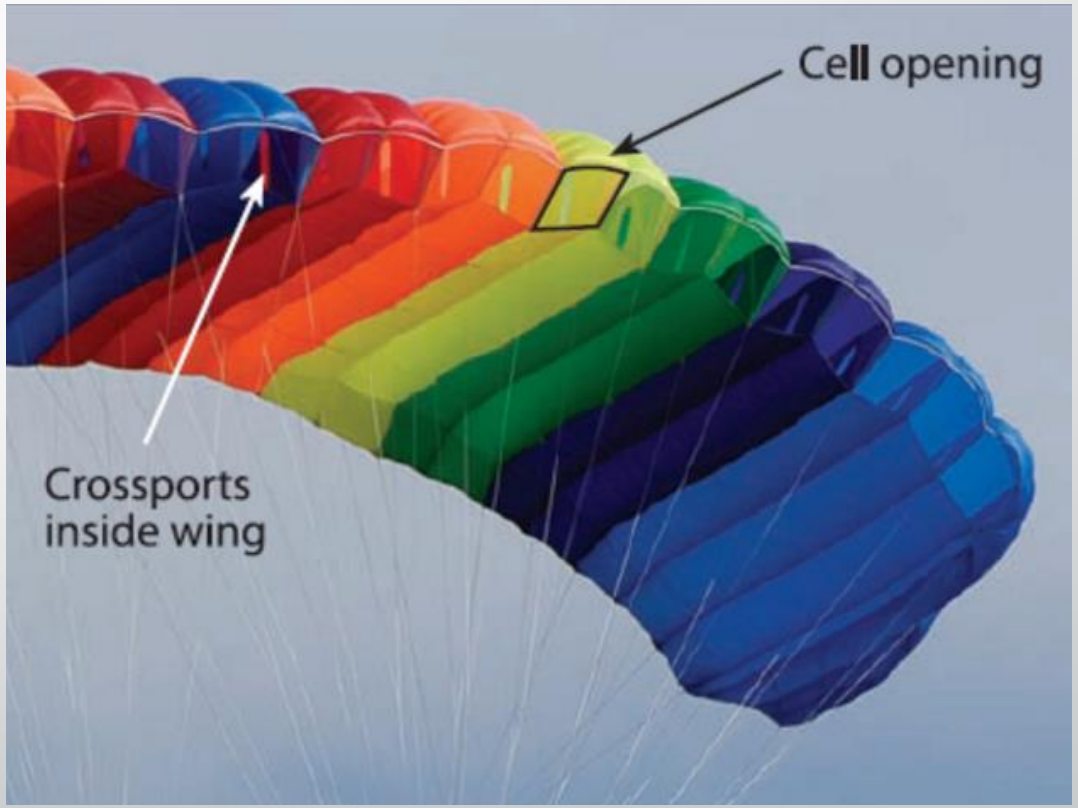


Figure 10. Traction kite

Challenges

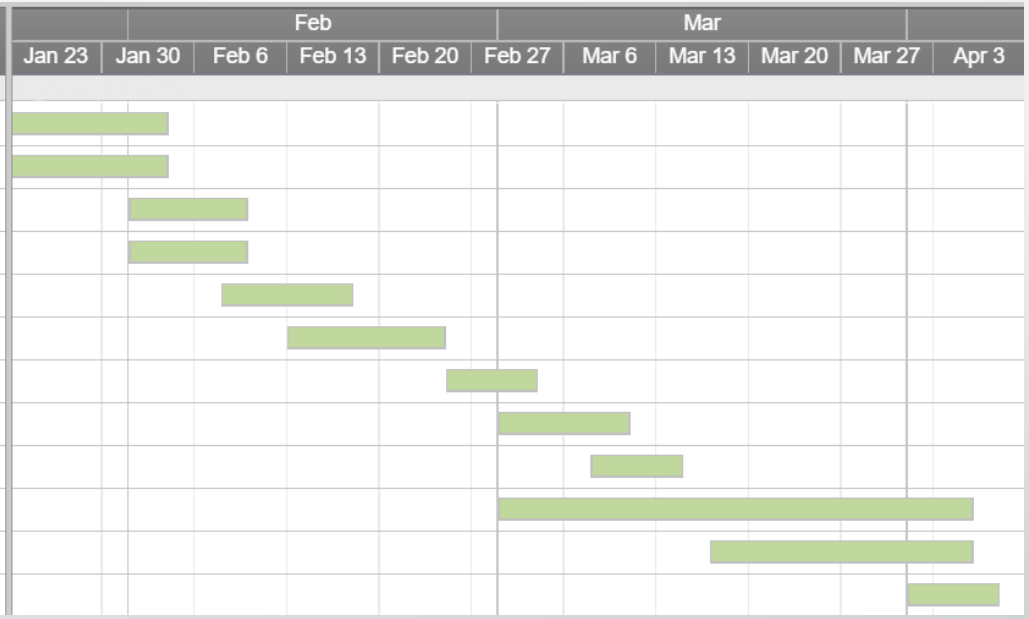
- Controlling demonstration model kite
- Feasibility for scaled model
  - What needs to happen for 100kW of power
  - Will we actually compete with other forms of alternative energy?
- Portability
- Determine the significance of losses in the elasticity of the string
- Water collection
  - Added weight
  - Freezing

Figure 11. Icing on an airfoil

Planned Methodology

Table 1. Gantt Chart for Spring semester

Task Name	Duration	Start	Finish
Order kites	10d	01/23/17	02/03/17
Finalize ground plate and housing designs	10d	01/23/17	02/03/17
Machine grounding plate	7d	02/01/17	02/09/17
3D print springs housing	7d	02/01/17	02/09/17
Test kites	8d	02/08/17	02/17/17
Kite control concept generation	10d	02/13/17	02/24/17
Kite control concept selection	6d	02/25/17	03/03/17
Kite performance optimization	8d	03/01/17	03/10/17
Concept kite material selection	5d	03/08/17	03/14/17
Demonstration model testing	26d	03/01/17	04/05/17
Refine demonstration model	14d	03/17/17	04/05/17
Finalize 100kw scale model concept	6d	04/01/17	04/07/17



- Weekly meetings with sponsor/faculty advisor
- Bi-weekly meetings with team to tackle problems and catch up on individual tasks

Future Plans

- Assemble demonstration model and test with kite
- Refining test model
- Finalize concept for 100 kW scale model
  - Failure Modes Effects and Analysis

Summary

Design and build the power generating system of a kite power generator, and scale for a 100kW concept kite.

- Demonstration Model parts have been selected, ordered and received
- Challenges ahead
  - Control demonstration kite
  - Water collection feature
- Ready to machine parts and assembly demonstration model

References

[1] http://www.eia.gov/todayinenergy/detail.php?id=26212

[2] http://www.climatechangepost.com/greece/fresh-water-resources/

[3] https://www.uspto.gov/patents-application-process/search-patents

[4] http://www.conserve-energy-future.com/Disadvantages_SolarEnergy.php

[5] https://www.windfinder.com/weather-maps/forecast/greece#6/38.367/23.810

[6] http://www.kitenergy.net/technology-2/key-points/

[7] https://adrienjousset.wordpress.com/2009/09/15/kitano/

[8] https://www.ted.com/talks/saul_griffith_on_kites_as_the_future_of_renewable_energy?language=en

Questions?