Needs Assessment Report

Team 9

Kite Power Generator

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ABSTRACT

The purpose of this project is to design a kite based water collector for remote islands that generates power. To generate power, the kite will be tethered to a permanent magnet within a housing that contains an electric coil. As the kite is subjected to a wind load, the kite will pull the magnet through the coil. When the load decreases, a spring or hydraulic will force the magnet back through the coil housing. Electricity is generated each time the magnet slides through the magnetic housing. The kite will also collect water from the moisture in the atmosphere. The kite will condense the moisture which will then travel along the tether of the kite to an aquifer.

ACKNOWLEDGMENTS

Thank you to Jeff Phipps for making himself available through email to answer our questions in regards to this paper and for coming up with the original idea for this project. We would also like to thank Dr. Shih and Dr. Gupta for presenting us with this project and giving the opportunity to execute the desired tasks.

1. Introduction

The idea is to achieve power generation from a water collecting kite in remote island areas. The purpose for this project is to provide affordable power for areas that do not have a major reliable source for power. The idea is to harness the energy of the wind without constructing a permanent wind turbine. Conventional wind turbines need a permanent setup and require a high amount of maintenance. Kite power allows for more maneuverability and less maintenance due to less mechanical parts.

The kite will be of relatively simple design and construction, as to make the product inexpensive and economically appealing. The water collector will be constructed along the tether of the kite, but not as to cause an obstruction to the housing of the power generating magnet. The simplicity of the design will warrant very little service and costs resulting in maximum in-service time. This design will also allow the kite to be retracted at times when necessary, thus making it less intrusive to the surrounding environment.

Helium will be used to initially lift the kite from the ground until the force of the wind is capable of keeping the kite aloft. Once the kite is able to remain in the air on its own, the helium discharge will retract. When aloft the helium will only unfold if insufficient wind forces fail to keep the kite up.

The power generator consists of a housing that has a top and bottom and a hollow interior. The coil will be situated within the housing, where the magnet will consistently pass through. A spring will be fixed on one end to the housing with the other end of the spring connected to the magnet (Figure 1). As the kite is subjected to a wind load, the magnet, connected to the tether of the kite, will be pulled through the coil housing. As the wind load decreases, the spring acts to restore its natural state by forcing the magnet back through the coil housing. The housing is attached to a swivel port, allowing the housing to spin on its axis depending on the direction of the wind and the flight path of the kite.

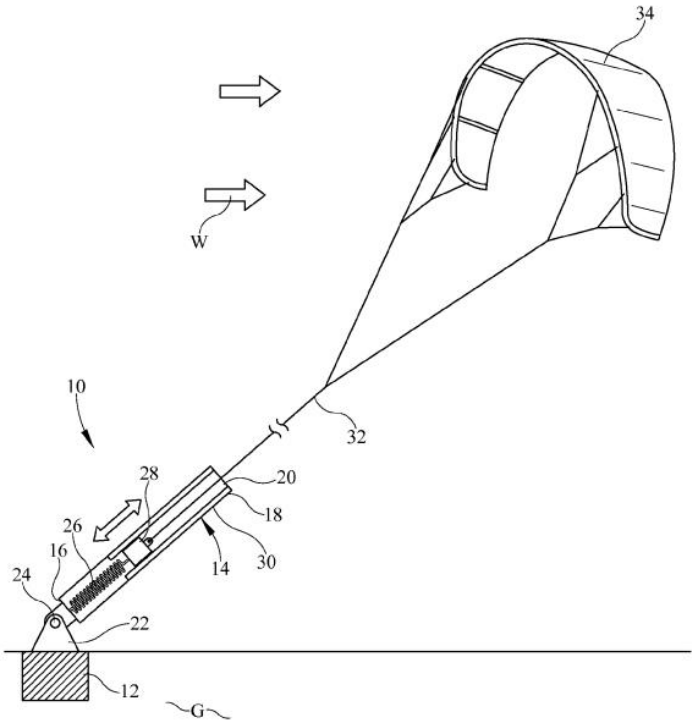


Figure 1. Jeff Phipps Pogo Solenoid Patent [1]

2.0 Project Definition

In this section background research will be presented about various companies and what they have done that is similar to the design goals that are being pursued. It will be important in future endeavors to have reliable reference material to fall back on to check what will work. In addition to the background research, a need statement will be defined, the constraints will be clearly listed, and the methodology of how the project will be approached will be laid out.

2.1 Need Statement

The need statement for this project is as follows:

To design a power generating kite that will also deliver clean water to rural mountainous areas.

2.2 Background Research

2.2.1 Kiteship

In regards to harnessing power from the wind via the motion of a kite, it is important to take note of other companies who have successfully built such mechanisms. One in particular is Kiteship[2], a company that utilizes sail-kites on freight commercial ships as an aid to pull the ships in their journey across the ocean. The company also holds the world record for the largest kite to pull a land vehicle and largest vessel pulled by a kite. To put things into perspective, a13,000-square-foot kite allows for fuel costs to be decreased by 10-20% on a normal-sized commercial vessel. This directly translates to $400,000 in savings per year. Thus, kite-sails are a more cost-efficient and energy-saving green alternative to transporting traded goods across the world. It can be taken note that the bigger the kite, the more wind energy will be generated and the higher the kite, the stronger the winds. Utilizing this information in further projects will be deemed useful in generating more wind power through the motion of a kite.

2.2.2 Skysails

Skysails[3] is another company that serves as a more efficient and green alternative to utilizing wind power than the conventional sails propulsion systems. The flying towing kites generate 25 times more power than the sails previously used. It works through the control pod which is used to steer the kite in front of the vessel to help pull it in the right direction (Figure 2). The kite and

control pod are connected via a towing cable covered by a coat of synthetic fiber that serves as communication for steering between the pod and kite. It is interesting to take note that there is no need for a launching aid such as a balloon filled with helium since the kites are intended to be used in the ocean where there are strong winds. The winds are monitored in direction and velocity in order to achieve optimal propulsion from the kites.

Figure 2. Skysails

2.2.3 Strandbeests

Strandbeests[4,5] are giant artistic structures made from PVC piping, wood, and fabric that are self-propelled. Theo Jansen created the first Strandbeest in 1990 and he continues to create them today. Over the years they have evolved into more complex and lifelike creatures. They are self-propelled, using wind power to move around, and have specialized adaptations to help them "survive" on the beach. The Strandbeests have a "spine" that runs down the middle of the structure and acts as a crankshaft for the legs. The legs are designed so that there are always multiple legs supporting the structure at any one time. The more complex Strandbeests (Figure 3) move using wind power and stored up wind energy when necessary. They use sails to initially capture the energy of the wind and use it for movement. Wings are used to power pumps that can pump air into plastic bottles. When these bottles are filled, the air inside can be released and used to move

the Strandbeests when there is no wind. The complex Strandbeests also include reflexes to react to certain scenarios. For example, if a Strandbeest detects water, it will turn and go towards high ground or, if it detects high winds indicating an approaching storm, it will stop and anchor itself. Jansen refers to the Strandbeests as animals due to their ability to move on their own and he tours the world showcasing his creations.

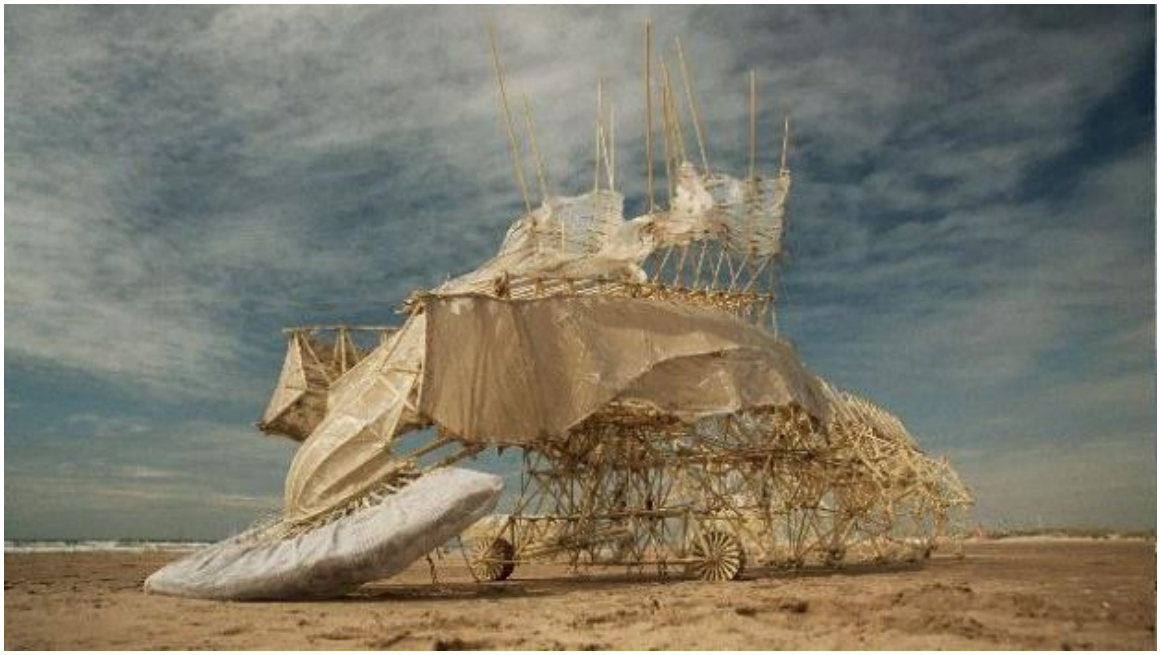


Figure 3. Strandbeest

2.2.4 Kitano

Kitano[6] is a concept yacht that uses a kite as the primary means of propulsion with dual water jets used as secondary propulsion during calm winds. Using a kite as propulsion instead of a sail has advantages that include being able to capture more constant wind speeds at higher altitudes and generating more forward force using less surface area. This means that even a light breeze will provide enough force to propel the yacht to planning speed. The position of the kite can be changed which can be used to counter the force of heeling and the yacht is able to sail without tilting. This makes for a smoother ride and lessens the chance of the passengers experiencing seasickness. Electric winches are used to control the position of the kite. The autopilot controls the winches to compensate for unexpected changes in wind speed and direction. The kite can also be steered

manually by changing the tension in the lines connected to the kite. The position of the hauling point of the kite on the yacht can be changed in the longitudinal and transverse directions depending on the direction of the course. The kite will have helium filled bladders in order to help support the kite during launch and to keep the profile. As of now, it is just a concept however that will most likely change in the future as sustainable energy becomes more prominent.

2.3 Goal Statement/Objectives

There are two end goals to this project. The first goal is to demonstrate that the scaled power generating device will be able to turn on a light bulb. In an ideal world, a kite would be used as the mechanical input, however if that is not possible a hand pulling on the kite string can be used. The main challenge in doing this is to get the kite to oscillate to generate power via a pogo solenoid coil. The second goal of this project is to harness the moisture in the air at altitude and deliver it to an aquifer on the ground. For this aspect of the project, a proof of concept with detailed drawings is all that is needed. There is also a desire to come up with a mechanism that will launch the kite when the winds are strong enough and gracefully lower the kite when the winds die down.

2.4 Constraints

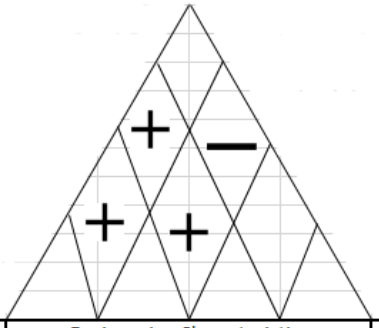
Below is a list of the constraints of this project:

- Budget of $2,000
- Deliver AC power
- Meet grid standards for timing and voltage of electricity delivered
- Use off-the-shelf products only (Nothing custom made)

3. Methodology

The team is still in a background research and brainstorming phase. Initial design ideas are expected to be completed within the next two weeks. In an effort to narrow the scope of the design goals and prioritize the designs functions, a house of quality was created (Figure 4). The most important customer requirement was determined to be the ability to generate power, because this is the main goal of the project. The least important customer requirement was the ability to collect water. This was because this is a separate function that is only planned to have concept drawings completed by the end of the year.

The most important engineering characteristic was found to be the timing and voltage of the generated electricity that will eventually be delivered to the grid. This was not surprising. If usable power is not generated, then there would be no point in generating the power to begin with. The least important engineering characteristic was determined to be the amount of water that is collected. This is again related to a separate function of the device that will only require concept drawings by the end of the year.



		Engineering Characteristics				ComA		
Customer Requirement	CI	Voltage and Timing for Power Grid	Spring/ Hydraulic Force	Wind Speed Recognition	X Liters of Water Collected	KITEnrg	KiteGen	Planned
Water Collector	1	0	1	1	3	0	0	3
Launching Mechanism	2	2	0	3	1	1	1	3
Budget of $2,000	3	2	2	2	1	2	1	3
Power Generation	5	3	3	2	0	3	3	3
Convert DC to AC Power	4	3	1	0	0	3	3	3
Score		37	26	23	8			
Relative Weight		0.39	0.28	0.24	0.09			
Rank		1	2	3	4			

Figure 4. HOQ

4. Conclusion

Designing a power generating kite that will also double as a water collector will come with its own set of challenges. The method of power generation, as of now, is based on the Pogo Solenoid Patent from Jeff Phipps[1]. Getting the kite to oscillate up and down while still sustaining flight will require a perpetual motion aspect, which may be derived from the Strandbeests[5]. A method of launching the kite to a desired altitude and lowering the kite when the winds will not support its weight is still being determined. As of now a helium balloon with a retractable feature is being considered. Collecting moisture from the air is not a necessity of this project, but concept drawings of the mechanism that will collect and deliver the water are expected.

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