Spaced Out

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1.0 Mission Overview

Team Spaced Out has designed a Balloon Sat mission that will capture and record the amount of energy generated by two independent systems through the process of electromagnetic induction to determine which system is most efficient in producing electrical energy over the launch period. Additionally, the class requirements for this Balloon Sat included a temperature, humidity, and pressure sensor that will be used to see if the conditions of a high atmospheric test will affect energy produced by our systems and then be able to be reused for future missions.
Background/Purpose

- We learned that the primary energy source for satellites were batteries.
- Solar panels used to charge batteries become completely ineffective 778,600,627.2km away.
- Pluto used Radioactive Thermoelectric Generator for long distance space voyages.
  Cons:
  - Small energy yield.
  - Scarce resource.
- Came up with two different systems: KERS (Kinetic Energy Recovery System) and wind turbines to see if they could yield a more efficient return.
- KERS could be used in large satellites if results are effective and wind turbine could be used in missions which take advantage of atmosphere like other Balloon Sats or World View.
- Compare results side by side to see which system is most efficient.
Expected to Be Discovered

- Electromagnetic Induction works by a change in the magnetic flux through a surface attached to a conducting wire which induces an electromotive force that will produce a current according to Faraday’s law.
- Balloon Sat will produce most energy in jet streams occurring in the troposphere due to high kinetic gyration and also during free fall where Balloon Sat will whip violently around.
- Second system uses a wind turbine which will have constant periods of high and low energy gain.
- Expect to discover overall energy output will be higher with the turbine due to predictability and efficiency.
- Other sensors will gather information to see if there is any correlation between temperature, humidity, or pressure with energy production.
- Expect these variables won't have much effect on energy gain other than low possibility of fan freezing from moisture.
- Expect to discover if both electromagnetic generators could be used to produce a significant amount of energy.
- Both experiments are expected to perform well.
## 2.0 Requirements Flow Down

### Level 0 requirements

<table>
<thead>
<tr>
<th>Number</th>
<th>Requirement</th>
<th>Origin</th>
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<tbody>
<tr>
<td>0.0</td>
<td>Spaced Out will track humidity, temperature, acceleration and pressure using sensors to test correlations and data with energy produced.</td>
<td>Mission Statement</td>
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<tr>
<td>0.1</td>
<td>Spaced Out will harness, measure and compare kinetic energy using a Kinetic Energy Recovery System (KERS)</td>
<td>Mission Statement</td>
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<tr>
<td>0.2</td>
<td>Spaced out will measure the amount of energy produced using a wind turbine</td>
<td>Mission Statement</td>
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<tr>
<td>0.3</td>
<td>Spaced Out will be reusable.</td>
<td>Mission Statement</td>
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</table>
3.0 Design

- 18cm x 15.5cm x 10.25 cm Foam Core Design
- KERS: 1” tubing donut, 3” inner diameter, ¾” Neodymium Magnet (14.74lbs), 1 coil
- Wind Generator: 3D printed anemometer design, Neodymium Magnet (12.12 lb)
- Circuitry: 22 gauge copper wire, resistor, arduino (analog→ digital conversion)
- Canon Camera, Pressure sensor, Temp sensor (internal/external), humidity, accelerometer
CONOPS

FLIGHT
- All launch the turbine will start spinning and begin to create energy
- As the Balloon Sat travels through the tropopause, jet streams will help the satellite around and produce highest results for KERS
- When the weather balloon bursts, the wind turbine will produce low measurements of energy due to lack of atmosphere
- Free fall after burst will cause the the Balloon Sat to whip violently through the air taking full spin of KERS
- Accelerometer will track increases and decreases in acceleration through flight
- Throughout flight period, humidity, temperature, and pressure

LAUNCH
- Dye is sealed up with all parts inside secure
- Batteries that power everything will be flipped on
- Camera will be turned on and start its automatic program to take video and picture

LANDING
- Once landed, we will use the GPS system to track and retrieve the Balloon Sat
- Once retrieved, we will flip the switches off which will automatically save the data gathered throughout the flight
- We will try and keep pieces as intact as possible if damaged for reusability

DATA AND ANALYSIS
- We will take the SD card from the SD Shield and connect it to the computer with the adapters to see the results gathered
- We will copy data side by side of each system
- See which electromagnetic induction system produced the most energy
- See what information the sensors picked up
- See if there is any correlation between any of the results
4.0 Management

**Important Dates:**

- 10/10/2015: DD Rev AB
- 10/14/2015: Assembly of the satellite and its components
- 10/26/2015: Testing will happen
- 11/03/2015: Launch Readiness Presentation
- 11/07/2015: Launch Day
- 11/12/2015: Quick Look Post Launch Presentation
- 12/08/2015: Team Spaced Out Final Presentation
## 5.0 Budget

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<thead>
<tr>
<th>Item</th>
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<tr>
<td>Neodymium Sphere Magnet</td>
<td>27.2</td>
<td>7.79</td>
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<tr>
<td>Neodymium Cylinder Magnet</td>
<td>13.85</td>
<td>3.53</td>
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<td>Batteries</td>
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<td>Camera</td>
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<tr>
<td>1-Inch Black Copper Tubing</td>
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<td>Foam Core</td>
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<td>Skateboard Bearings</td>
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<td>Aluminum Pen Rods</td>
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<td>Aluminum Tape</td>
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<td>Stickers, Velcro, Resistors, Glue</td>
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<tr>
<td>Insulation</td>
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<td>3D Printed Turbine</td>
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<td>Copper Wire</td>
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6.0 Test Plan and Results

The satellite will undergo a series of tests to ensure it is capable of operating and surviving the extreme forces of flight. The satellite will undergo a series of tests to specifically assess each individual sensor’s performance. The electric generators will be tested multiple times during and after construction, as well as multiple times after the generators have been mounted to the satellite. Finally, the completed satellite will undergo a series of tests designed to assess the structural durability of the BalloonSAT. After each test, every part will be assessed for satisfactory performance and adjusted accordingly.
6.0 Test Plan and Results Cont.

- **Sensor Tests:** Pressure test, accelerometer test, humidity test, internal and external temperature tests.

- **Structural Tests:** Whip test, cold test, drop test, stair test, pressure test.

- **Electric Generator test:** Wind test, shake test.

Tests will be used to test individual parts before and after installation in the BalloonSAT structure for functionality and satisfactory performance. Each test will be performed at least twice.
7.0 Expected Results

- Results for KERS system will be recorded via electromagnetic conduction.

- The team expects for the kinetic motion of the balloon sat to increase with altitude until it got to the tropopause where the jetstream is and wind speeds are greatest. After the jetstream is reached power generation should decrease until burst where the most power should be collected waning off over time.

- The wind turbine will follow the same method of induction as the KERS.

- We expect similar results as far as when the most energy collected will be up until burst where there atmospheric density will still be too low for sufficient wind energy to be produced.
References

Requirements flow down: A New Hope, Red October
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