Operation Geronimo

Team 8: Seal Team Six
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I. Overview and Mission Statement

The mission of Team Seal Team Six is to successfully launch and recover a functional Balloon Sat that measures and records the concentrations of carbon dioxide in the ozone layer at different locations along its flight path. This data will be used to find a correlation, if any, between concentrations of carbon dioxide in the ozone layer and the population size of the area.

With “going green” being a main focus of the University of Colorado, the city of Boulder, and the worldwide population as a whole, this experiment will help to contribute to the research of carbon dioxide emissions. Carbon dioxide captures heat in the ozone layer and create a “greenhouse,” heating effect that warms the planet and is thought to cause many problems for humans and animals\(^1\). Because of this, many cities and countries are making an effort to cut down on the emissions of greenhouse gases in order to reduce global warming. This experiment will be able to measure the different concentrations of carbon dioxide over different areas to find a correlation between the population and the concentration of greenhouse gases. It could also reveal other causes for the carbon dioxide emissions. For instance, if there is a spike in carbon dioxide over a town with a low population, it may be caused by factories or something industrial. This experiment could possibly help draw attention to the emissions of industrial centers and be a call-to-action to implement a plan to reduce emissions.

While large natural events and solar flares can also contribute to changes in the atmosphere, the EPA says that man-made changes to the ozone layer are concerning. The amount of carbon dioxide fluctuates normally, but since 1950, the carbon dioxide concentration in the atmosphere has been sharply increasing. Human activity is thought to be the main contributor to this sharp spike\(^2\). This experiment could be beneficial to show which cities and towns in Eastern Colorado are emitting the most carbon dioxide and can help draw attention to what these towns can do to reduce those emissions. For cities that are already implementing emission-reducing measures, this can be a good test to see if those are effective.

The ozone layer is found at an altitude anywhere from 15 km to 50 km above the Earth’s surface, making Operation Geronimo the perfect experiment to test the levels of carbon dioxide in the ozone layer\(^3\). This Balloon Sat will fly to an altitude of up to 30 km. A spectrometer will be attached to the payload and will be programmed to record and collect data over specific areas. Assuming the payload will be spinning a lot during the flight, the spectrometer will be programmed to record the data only when the spectrometer is facing a certain direction using a compass that is connected to the spectrometer. If there was no programming of this kind, it would be impossible to tell what the levels of carbon dioxide are over specific location. The gas may not be measured exactly overhead of each location that it was produced from so we will account for wind speeds and direction from the ground during the balloon satellites flight and look for trends in the data to match it to where the gas was originally produced. The spectrometer will be in the air for about ninety minutes and could fly as far as 350 miles. We expect a good range of data to be collected from the experiment. The concentration

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data can then be overlaid on a map of where we think they were produced to see each town’s production of carbon dioxide emissions.

II. Technical Overview

II.I. The satellite will have a standard 20x20x10 cm main frame with an extra external 5x5x5 cm block on the underside of the satellite that is designed to hold the spectrometer. The extra case will house the spectrometer which will be used to get the CO2 reading. The spectrometer will be programed to only be recording when the spectrometer is oriented so that is facing north, due to the continuous rotation of the satellite while it is lifted up into the air. The additional 5x5x5 cm block will need to be also well shielded as it will likely take the brunt of the impact. In addition the block will have to be well insulated as it is carrying a vital component of the project. The block will be open on the bottom in order for it to allow the exchange of heat to ensure that is remains functioning throughout the mission.

II.II. Drawings

II.III. Hardware

The majority of this hardware will come from the project sponsor, the COSGC. The one anticipated piece of hardware that will come from elsewhere is the spectrometer. This is the main piece of hardware that the experiment acts around, and this piece will be acquired via Carolina Biological.

II.IV. Testing

• **Structural**: The Balloon Sat will be subject to several structural tests: drop test, stair test, and whip test, to determine its overall structural, strength, and stability. These test will be
carried out in locations meeting the set safety standards, including not being performed near windows.

- **Drop Test:** The drop test consists of dropping the structure, as well as the mass of its payload, from a height of approximately six meters (two stories). This test will help simulate the force exerted upon the structure on landing.

- **Stair Test:** This test will replicate the effects of the Balloon Sat being bounced across the ground upon impact: a situation which may arise on a windy day. For the test, the structure, with the appropriate weight of the payload, will be thrown down a cleared stairwell.

- **Whip Test:** The whip test is performed by having an individual swing the Balloon Sat, with an attached flight string, in an open area, away from windows. As the tester swings the Balloon Sat in a circular motion above their head, the Balloon Sat will experience high velocities and a jerking motion similar to those upon its ascent and descent. The test will be performed for at least two minutes.

- **Temperature:** To account for the freezing temperature in near space, which can exceed -40°C, the Balloon Sat and its thermal components will undergo temperature testing. The Balloon Sat will be placed in a cooler containing dry ice for four hours to simulate conditions during flight. During this test, all hardware will be operational and recording data.

- **Spectrometer:** The spectrometer will need to be calibrated prior to testing to respond to carbon dioxide. Additionally, a compass to track where readings are taken will be integrated with the spectrometer.

- **Arduino Unos:** Both Arduino Unos being utilized in the experiment will be put through testing to ensure functionality of components and data recording. The Arduinos will be involved in the temperature test.

- **Camera:** The digital camera will be included in the temperature test to verify its ability to function in freezing temperatures. Pictures will be taken every fifteen minutes during the test.

- **Other Sensors:** The other sensors involved in the experiment (pressure, temperature, accelerometer, compass) will also be subject to functionality testing in situations that simulate the extreme conditions of the mission. Several LEDs will be installed to be visible from the exterior of the Balloon Sat; these will indicate each component is operational.

II.V. Safety:

Assurance of safety is very important in this project. In order to maintain a safe environment during testing and assembly, several precautions must be followed. Testing should be performed with at least two team members to prevent accidents. All tests must be done in suitable areas (not near windows, away from people, etc.). When working with machinery, it is necessary that the individual is qualified to operate said machinery, or under supervision. Additionally, all team members will wear attire appropriate for the task they are performing (i.e. goggles while soldering). In addition to proper communication among team members, these precautions will prevent injury.
II.VII. Data Retrieval

Operation Geronimo will collect data from the spectrometer as point values of concentrations of Carbon Dioxide during the flight. These values will be stored on memory chips aboard the balloon satellite. Once the balloon satellite returns to the ground and is retrieved, Seal Team Six will process the data by examining the points alongside calculations of wind speed and direction. This will allow the team members to then effectively analyze the data.

II.VIII. Functional Block Diagram

II.IX. Project Requirements

While designing our current design we are also meeting the general requirements. Our team has incorporated an additional experiment within our design. Our additional experiment is described above in mission overview. Our mission will collect science data which we will analyze when we recover our payload attached to the balloon satellite. In order to successfully collect data and meet our second requirement, we will use a spectrometer as our additional sensor to collect engineering data about the flight.

After flight our Balloon Sat will be turned in working and ready to fly for a second time if needed. In order to make sure our payload will be returnable we shall also ensure that our payload reach the requirements of a flight interface tube that is not metal that runs through our Balloon Sat. This string will be secured so it will not pull through the Balloon Sat and interfere with the flight string.

To ensure the internal temperature of our balloon satellite remains above -10° C, our Balloon Sat will be insulated and tested with dry ice to ensure insulation is working correctly before launch.
Throughout our design process we will ensure that our payload will weigh no more than 1,100 grams. We will continuously weigh our balloon satellite to ensure we do not exceed our maximum weight. We will be sure to acquire accent and decent rates of flight string. When designing our payload we will ensure to an Arduino UNO will fit inside our balloon satellite in order to control our sensors. We will include a microSD card shield to collect data. Our team will also include a temperature sensor that extends outward of our Balloon Sat by one inch to measure the temperatures outside during the flight. When designing our balloon satellite we will also allow space for a Canon a3400 IS Digital Camera that weight 145 grams. Our design will also include an active heater system that will weigh 100 grams that will allow our temperature at or above -10°C. Our Balloon Sat will be fabricated of foam core. When listing and budgeting all of the parts needed for our balloon satellite we shall include spare parts. Our team will also ensure our Balloon Sat will provide contact information as well as a United States of America flag. Throughout our proposals, designs and other documentation we will use units in the metric system.

On November 15, 2014, at 6:50 am in Windsor, Colorado all of our team members will attend the launch and at least one member of our team will be on the recovery team.

Throughout our entire process of creating our Balloon Sat we will ensure that all members of our team will be unharmed as well as those around us. When we have completed the semester our team understands that all hardware is the property of the Gateway to Space program and will be returned in working order. To ensure there is a minimal amount of reimbursement paperwork, all parts will be paid by ad ordered by Chris Koehler’s CU Visa by appointment. Our team will also keep a detailed budget of every purchase throughout this semester. Receipts of these purchases will also be turned in within 48 hours of purchase with our team name written on the receipt along with a copy of the Gateway order form. Although highly discouraged, when our team needs to purchase an item we will be sure to approve the purchase beforehand. An item purchased which was not approved will not be reimbursed. If a receipt is not submitted within 60 days of purchase, reimbursement will be through income taxes. Only one person will be in charge of asking for permission of a purchase and being reimbursed.

Throughout this project our team will be sure to have fun while being creative and avoiding any complaints of the workload. Nothing alive is allowed inside of our payload, nor needed. At the end of our project we will be sure to complete a final report and video of the semester’s work. Finally, we will ensure that our Balloon Sat will have a visual indicator to confirm the payload is active and running on the outside of the flight structure. This state of activity also ensures excellent internal wire management. This is to avoid any case of failure.

III. Management and Cost Overview

III.I. Schedule

Seal Team 6 will plan to stick to a strict schedule in order to adhere to all the requirements and deadlines of the Balloon Sat project. The dates are subject to change in case of an emergency or due to conflicting issues with members of the group. Meetings will change location throughout the week due to the resources the team will need to succeed. At every meeting Seal Team 6 will plan ahead to discuss the progress on the project, assign individual tasks for each member to complete, and prepare for the upcoming week to meet deadlines. Each member will work coherently together, as well as independently, to ensure nothing but success in the mission.
The team will meet every Monday from 7-9pm, every Wednesday from 3:30-6pm, and every Friday from 3-5pm at Andrews Halls, Aden Hall, or at the ITLL.

Thursday 9/18: CoDr Slides Due
Monday 9/22: Final Proposal due
Friday 9/26: Award Announcement
Friday 10/03: Acquire all hardware
Tuesday 10/14: Design Document Rev A/B Due
Wednesday 10/15: Structure Complete/Prototyping Design Complete
Thursday 10/23: Mid Semester Team Evaluations Due
Friday 10/24: Cold Testing Complete
Thursday 11/06: Service Approvals Due
Friday 11/07: Design Reviews & Revisions
Tuesday 11/11: LRR Presentation Slides Due
Thursday 11/13: Design Document Rev C Due
Friday 11/14: RFF Cards Due
Saturday 11/15: **LAUNCH DAY @ Windsor, CO**
Thursday 11/20: Quick Look Presentations Due
Saturday 12/06: 1st Draft of DD Rev D & Final Team Videos Due @ Judging
Tuesday 12/09: All data due/Final Presentations
Monday 12/15: Final DD Rev D Due

III.IV. Budgeting

Melody and Abby will work together to maintain the budget for Seal Team 6. In order to keep track and accurately estimate the costs, they will record all purchases in a spreadsheet and calculate our expenses. All of the purchases will be approved by Professor Chris Koehler to ensure the team will be getting the technology needed at the lowest price possible.

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