Colorado Space Grant Consortium

DEMOSAT DESIGN DOCUMENT

New Roots

Written by:
Connor Elfering, Brooke Olsson, Melissa Marshall

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1.0 Mission Overview

This experiment aims to determine the effects of the upper atmosphere conditions of pea plant sprouts. Numerous issues can occur when attempting to grow plants from seeds. The seeds can fail to sprout for numerous reasons, and in the worst case scenario, they will never sprout at all. Thus, it would be useful to send plants to space that have already sprouted, to ensure that the seeds are viable and the plant is healthy. While some data exists about the effect of the upper atmosphere on plant seeds, this would be among the first with plant sprouts.

In order to narrow down the variety of causes of issues on the plants, the experiment has 2 test groups and 1 control group. The control group would be grown normally on the ground and would never see the upper atmosphere. The two test groups would be sent to the upper atmosphere; one would be temperature controlled, enabling us to see any changes caused by pressure and radiation in the other group. Our group expects to see somewhat stunted growth in the plants sent to space, as plants tend not to like shocks in their environment.

2.0 Requirements Flow Down

Our mission is to see what effects the upper atmosphere has on pea plants. To accomplish this, we need to produce a container that can successfully maintain heat on one side, carry the plants to the theorized height of 100,000 feet, and hit the ground without causing any lasting damage to the plants themselves. We also need to have consistent growing standards for the plants once they are safe on the ground. The requirements are as follows:

Level 0:

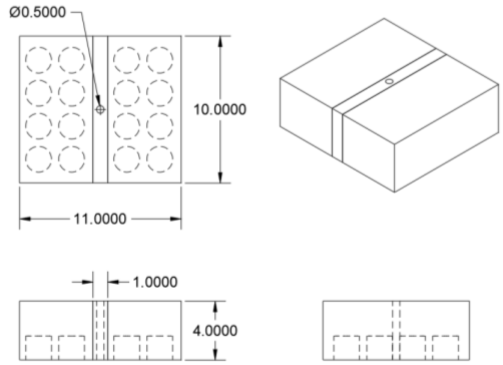
- Solid payload
- Consistent growth conditions
- Must measure Temperature, Humidity, and Pressure every 5 seconds
- Plants Must survive

Level 1:

- Maintain heat for one half of the payload
- Contain Water and soil from plants

3.0 Design

For this mission to be successful, our team was going to build a lightweight payload capable of carrying 16 sprouted pea plants in a structurally sound container fully equipped with temperature and pressure sensors to send into the stratosphere. Recording the changing atmospheric conditions of the temperature and pressure would give us data to prove/disprove our hypothesis after we observe the plants growing patterns once they have landed from their journey. Our design called for a DS18B20 temperature sensor and a BMP180 pressure sensor to collect data with an arduino connected to an SD card for recording data.



4.0 Management

Our team was extremely small this year. As a result, everyone filled several roles on the team, and those listed are generalizations of the tasks assigned. The schedule ended up being cut short, so an original plan and revised plan will be included below.

Organizational Chart

Team Member	Role
Brooke Olsson	Payload Design/Construction
Connor Elfering	Coding/Mechanical Engineer
Melissa Marshall	Project Manager

Original Schedule

Week/Meeting	Goals	Deadlines
January 31	Come up with Experiment	
February 7	Create Review, Order in Supplies	
February 14	Begin Construction on Structure	Preliminary Design Review
February 21	Begin Work on Sensors	

February 28	Create Critical Design Review Presentation	
March 6	Finish Sensor Orientation/wiring	Critical Design Review
March 13	Finish Coding, Run Bench Test	
March 20	Finish Building, Begin Testing	
March 27	Pressure Test, Cold Test	
April 3	Final Detailing, Add Identification	Launch

5.0 Budget

Our original plan for allocating resources put most of the budget towards structure and plants, as shown below:

- Original Budget:
  - Structure: $200
  - Electronics: $100
  - Plants: $200

We expected to be well below budget for this experiment, with plenty of wiggle room for when inevitable plant and electronic failures occurred. The original expected weight was going to be about 800 grams. The structure and electronics would have to be about 300 or 350 grams, and the plants would take up the other 450 grams. The plants were the heaviest part of the payload due to the volume of soil and water they needed to be planted in.

Unfortunately, the payload was not completed and launched due to the pandemic that broke out. Therefore, the following data is from the middle of the project.

- Middle Budget:
  - Structure: $34
  - Electronics: $30
  - Plants: $50

Many of these are low as a result of using resources provided by the college, and because a bit more was planned to be ordered, and was not at the time of the breakout. The final data set here will be the new projected costs for finishing the project.

- Final Budget(maybe):
  - Structure: $40
  - Electronics: $60
  - Plants: $60

The additional costs would be the second required sensor, any extra material required for structure, and more soil for further growth of the plants after launch.

6.0 Test Plan and Results

Our goal was to determine how launching sprouted pea pods into the upper atmosphere would affect their growth once returned. The plan was to launch two different groups of pea plants, one of which would be in a temperature controlled compartment. We planned to have three groups of peas total: one control group on the ground, one group exposed to pressure change, and one group exposed to both temperature and pressure change.

We planted different groups of peas initially in order to determine which type of pea plant would be best for our experiment. Once our peas were chosen, we tracked their growth over a period of a couple of weeks. This gave us an idea of how these plants would normally grow. We next planned a series of experiments to try and determine what results we could expect. We planted eight new seeds and planned a series of experiments to take place once these seeds had sprouted. Two plants were to be left as controls, two plants would be exposed to low pressure for the estimated time of flight, two would be exposed to cold temperature for the estimated time of flight, and two would be exposed to low pressure and cold temperatures for the estimated time of flight. The goal was to replicate the environmental factors that we expect the plants to experience during flight and measure the effects. Due to campus closure and state stay-at-home orders, we were not able to conduct these experiments.

We had planned additional tests to ensure the payload would function as designed. We planned to drop the box off of the third story building to test the durability of the box, the durability of the equipment inside, and our method of restraining the plants. We planned to test our dual temperature and pressure sensors before adding them to the payload. We also planned to test the functionality of the temperature controlled compartment to ensure it would maintain the intended temperature for the duration of the flight.

We were not able to complete the experiments described above, therefore there are no results to share.

7.0 Expected Results

Due to our inability to complete the experiments discussed in the section above, the expected results are vague and based on speculation. We chose a hearty type of pea plant specifically for its resilience to cold temperatures. We expected one group of plants to be exposed to 60° F and 10 mb and the other to only be exposed to the pressure since it would travel in a temperature controlled compartment. We expected the group exposed to the cold temperature to either have the greatest decrease in growth rate or to have the most plant deaths. We were unsure of how the low pressure would affect the plants and expected the group exposed to only low temperature to have few to no differences in growth from the control group.

8.0 Launch and Recovery

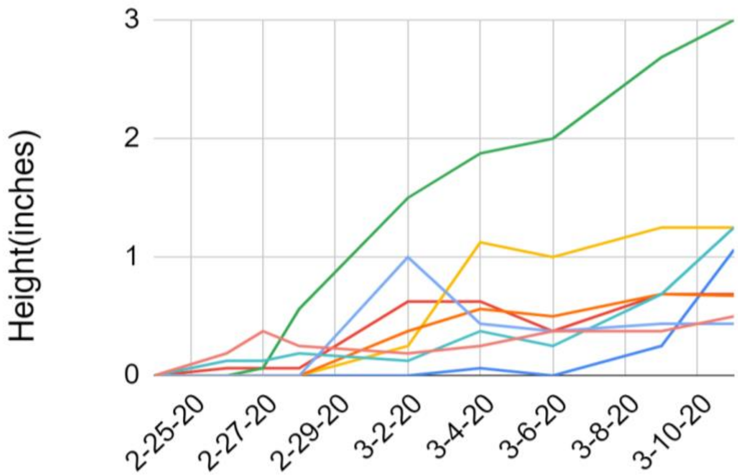
It was never discussed who would launch the payload. However, the general consensus was that the team will retrieve the payload, unless circumstances prevent such actions. There will be pictures, and a SD card will be extracted from the payload along with the plants. All data will be loaded onto a computer to be processed.

Launch never occurred, so this process was never tested.

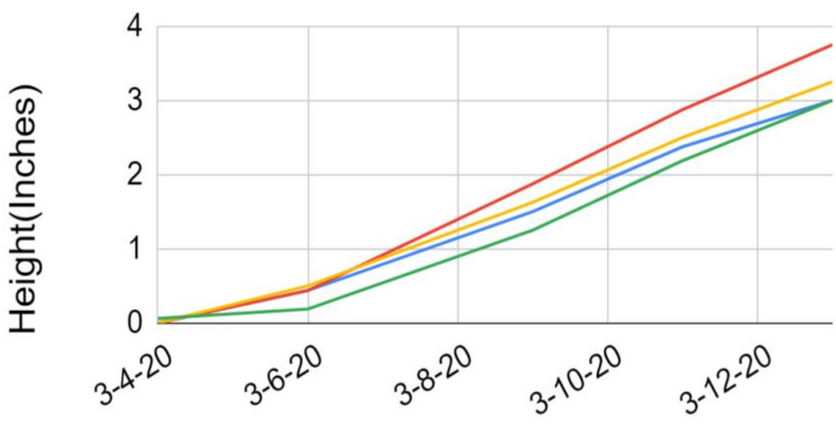
9.0 Results, Analysis, and Conclusions

While we did not get the chance to launch our payload, we did get some valuable data about the plants intended to fly. Most of the data consists of growth patterns of the two different varieties of plants tested for viability before the flight. The charts below will demonstrate the growth of the two test sets of plants.

Super Snappy Growth Chart



Early Perfection Growth Chart



The plants we intended to use for flight were the Early Perfection variety of pea plants, as they had more consistent growth patterns as compared to the Super Snappy variety. The average time it took for the plants to sprout was very similar; Early Perfection seeds took 7.5 days on average to sprout, while Super Snappy seeds took an average of 7.8 days to sprout.

Overall, not much was determined when it came to stressing the plants. Much was learned about how to care for them and what to expect, which may aid future DemoSat teams.

10.0 Ready for Flight

As the payload never flew, nothing has been done to prepare for another flight. No matter what happens, the plants would need to be regrown each time the payload flew if the same or a similar experiment were conducted. The battery for the heating and sensors would have to be recharged, and the heating devices would have to be tested again to ensure sound functioning.

11.0 Conclusions and Lessons Learned

We have learned quite a bit about the raising of plants. We also have been learning, along with the rest of the world, how to be more flexible with the project.

We started off raising the plants in a plastic greenhouse, which worked well until they outgrew it. As soon as the lid came off the greenhouse though, the plants dried out extremely quickly. We experimented with a couple different ways of watering the plants. The first, just adding water every two days, did not work, the plants dried out too quickly. The second idea was to make a water reservoir underneath the plants to try to get them growing. This was more effective, but that was more likely because it meant we performed deeper watering of the plants when we filled the reservoir. A third idea that was never tested was a drip irrigation system. If the opportunity presents itself, it would be a good idea to try this and avoid the extremes that we encountered watering the plants.

We never got to test the design for the payload. In the future, we would do that.

12.0 Message to Next Year

This semester was very unique. Between the excitement of school, the primary elections, and the global pandemic, the amount of turmoil is unlikely to be topped any time soon. So first off, may your semester be more peaceful.

There is some good to be had. Even if the world might end, don’t forget to maintain the experiment. Always maintain communication with the team, and do not assume everyone knows what is going on. Try to spell everything out, as it prevents headaches further into the project.

Start with a plan, and break it out among the team. Having everyone crowd around one computer is unnecessary, especially when time is limited. Start with the simplest, most finicky parts of the project first, and have fun with the project as you go. Even if it unexpectedly ends, it can still be a great time.