# Boeing 727 Test Equipment Data Package

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# Experiment Title: Plant Viability for a Legume Food Growth Chamber

## Introduction

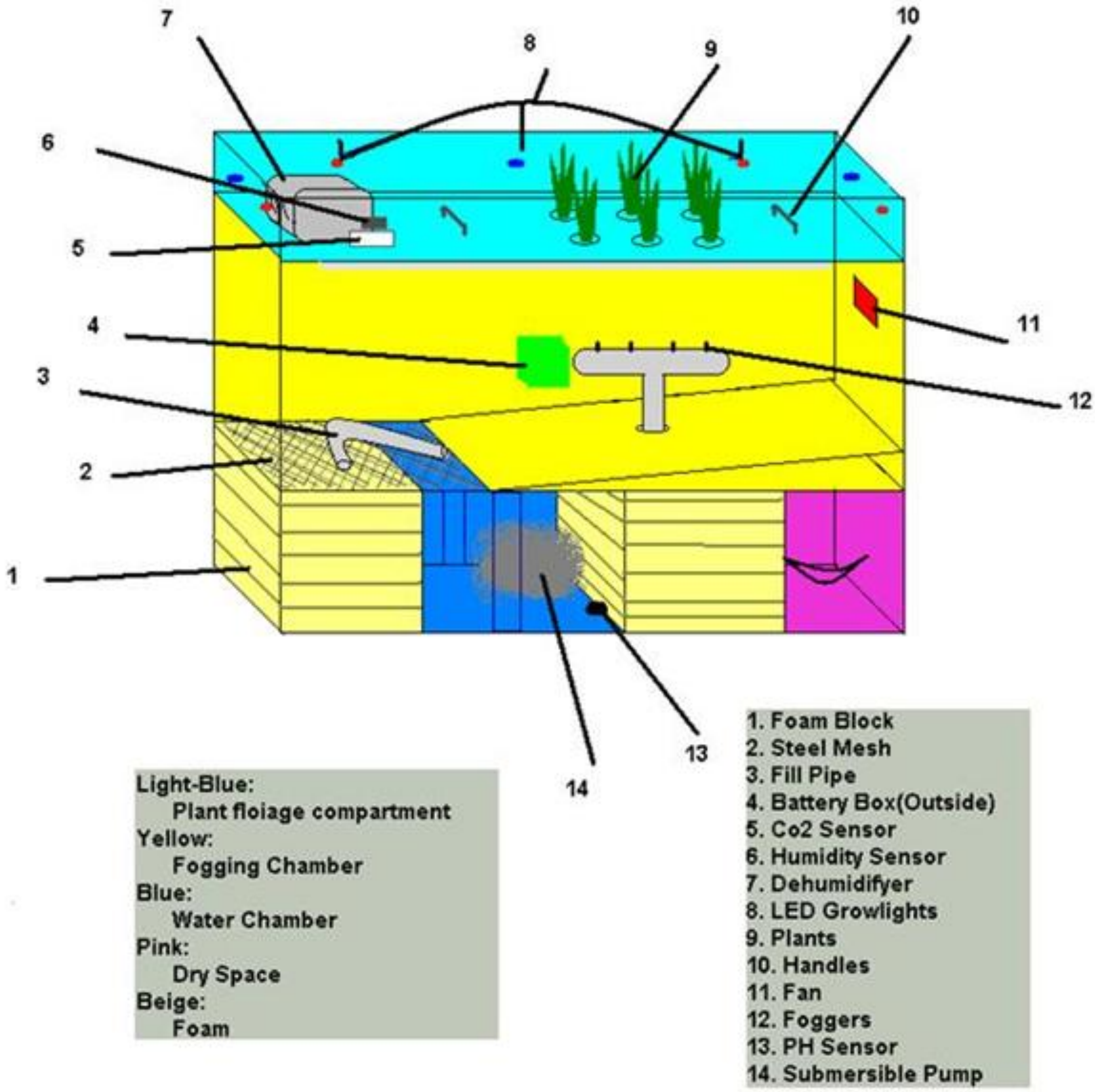
The experiment was flown as a part of the H.U.N.C.H. Program (High School Student United with NASA to Create Hardware). The students yielding the experiment attend Clear Springs High School in League City, Texas. More specifically, the experiment was developed in the Engineering Design and Development class of the Project Lead The Way (PLTW) program.

## Abstract

A food growth chamber was developed for the purpose of growing legumes in an artificial biome independent of the presence of gravity. The chamber will potentially reduce the need for food re-supply in space, especially for long duration missions. The experiment tests the plant viability of the *Medicago truncatula* and *Phaseolus lunatus (*lima beans*);* these plants were chosen because they are easy to manage and fast-growing which are ideal characteristics for multiple trials. The experimentation will include sensors that measure the plants overall condition and environment. The testing will include the LED lights, misters, filters, fan, and pump as well as sensors that will measure: $CO_2$, hydration, temperature, pH, and oxygen.

## Background

The Aeroponics design uses a water misting/fogger system. The design used this year is an improved continuation of the previous year's design, which entailed unequal water distribution and excess humidity inside the chamber when it flew on the Zero – G plane in August, 2010. This year we redesigned the system and monitored these factors with sensors. Observed aspects include the characteristics of the water flow through the system and how it attaches to the legume roots using a misting/fogger method. The lighting system consists of blue and red lights to give the proper wavelengths of light to simulate a night and day experience for the plants.




**Method**

We began our studies by recognizing five main points of importance for the experiment; thus dividing the class into five project groups: Integration, Lighting, Electrical, Water, and Plant Viability. Each group was responsible for carrying out the designs and building/ troubleshooting until their subsystem was fit for compilation. The integration group was responsible for bringing all of these subsystems together.

## Results

| Chamber Name | Function of System | Appearance | Efficiency | Errors | Needed Changes |
|---|---|---|---|---|---|
| Plants | Plants are lit and dehumidier keeps a desirable environment | Extremely Visible and no leaking | Efficient data gathering Dehumidifier Produced recycled water | Sensors lost During second flight Due to power surge | More plants |
| Fogging | Roots are sprayed with foggers and dried with fan | Semi-Visible Roots dripping water | Foggers worked well Fan was too weak | No seal on slant peice | Stronger Fan or repositioning |
| Water | Water is sent through pvc pipes with submersible pump | Water leaking around foam and into dead space | Recycling worked well | Poor sealing For chambers inside box | Double containtment within chamber for better seal |

## Discussion

**Challenges-** In the flight we experienced a multiple amount of challenges with our fogging system. The first challenge that occurred was the issue of the foggers bubbling up. We noticed that our first mister and our last misters were the ones that happened to bubble up the most. On the second flight we found out that the first and second foggers bubbled as well, making it look like soap. In a collective assessment of the entire fogging system, we conclude that the third to left fogger did the best out of all of them. We also had challenges with the platypus bag first of all when we put it in through the pipe we noticed water was coming back out through the mesh because of a insufficient seal around the mesh. Another problem we had was actually being able to see into the box. We noticed that the foggers made the Lexan pieces fog up making it difficult to see into the box. Another challenge we had was keeping water moving in a circular pattern to be recycled and the fan did not push the water hard enough to be recycled.

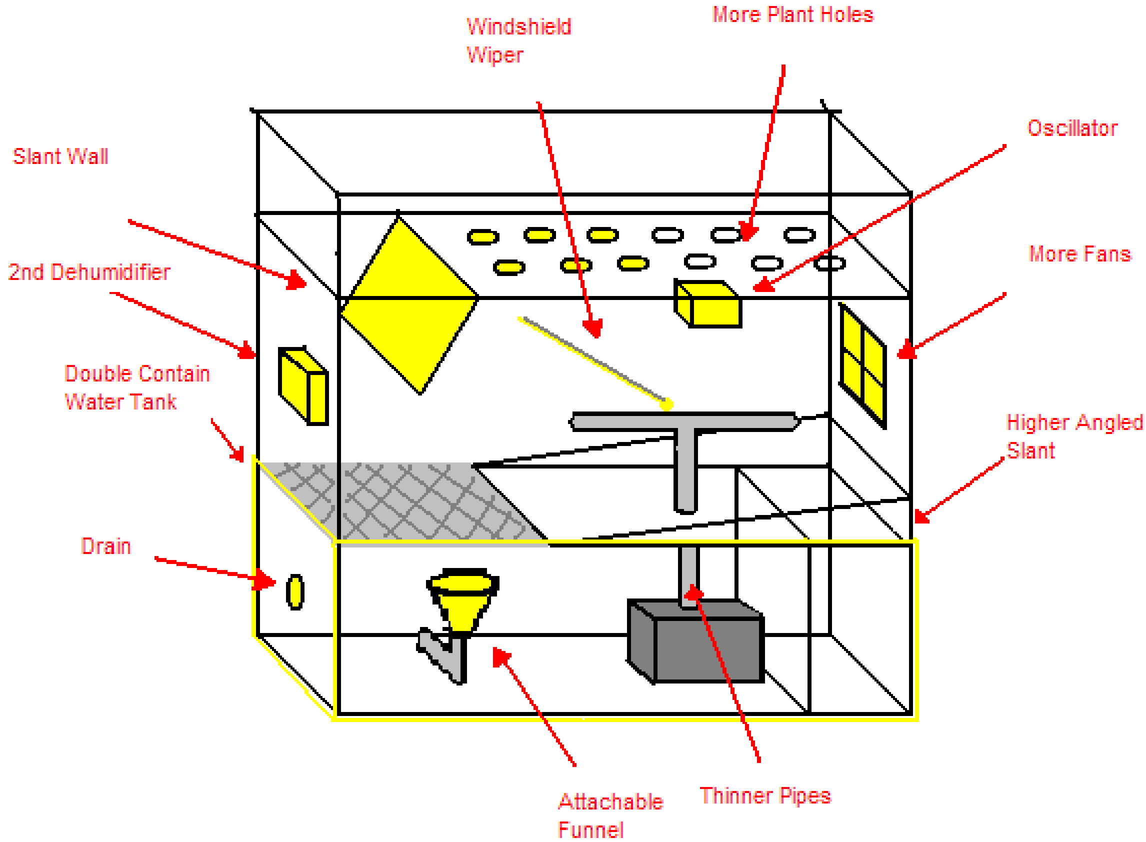
**Successes-** In the flight we experienced a multitude of successes with the system. One of our first successes was the plant foliage chamber. In the plant chamber we demonstrated a system that would hopefully be able to sustain life of plants in space. The first part of our system in the plant chamber that we had was the dehumidifier which actually rapidly decreased the humidity of the chamber making the humidity levels able to sustain plant life. Another piece of our system that worked well was the lighting system when we tested it the lights seemed to be very productive being able to sustain life without giving off any heat. Lastly in our plant chamber our sensors worked very well monitoring the temperature humidity and carbon dioxide. Along with the plant chamber there was the actual process of putting in the plants we found out our system worked very well by sealing the plants with Rockwool and Silicon, the Rockwool and Silicon prevented any water leaking going through to the plant chamber. In the water chamber we had great success with the pump being able to sustain a good water level and not blowing out because there was not enough water. Along with the water chamber we used the platypus bag which refilled the water system. This seemed to work very well by being able to use the valves very easily with the gloves that we were given to put water back into the box. When we were putting the water back into the box we found out kneading the water works the best to refill the tank.

**Conclusion**

The majority of the changes we have considered involve the structural innovations rather than conceptual. We concluded that the water chamber should be double contained-a Lexan glass box within a Lexan glass container. To prevent the extremely foggy root chamber, a dehumidifier and glass-wiping device may be added. Potentially, an oscillator could be used to help direct the water back to the water chamber through sending out a constant vibrating force. One major change in our design is condensing our box such that it could fit on the Soyuz. (see Diagram 1)

Our outreach items included an hourglass, metal coiled spring (slinky), gyroscope (spinning top), and bouncing ball. We chose these items because they incorporate the fundamental forces of the earth within their function. In testing these items in reduced gravity, one could easily show their reliability on 9.81 Newtons of gravity per kilogram of mass at all times in order to work correctly.

Diagram 1


Windshield
Wiper
More Plant Holes
Slant Wall
Oscillator
2nd Dehumidifier
More Fans
Double Contain
Water Tank
Higher Angled
Slant
Drain
Attachable
Funnel
Thinner Pipes

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