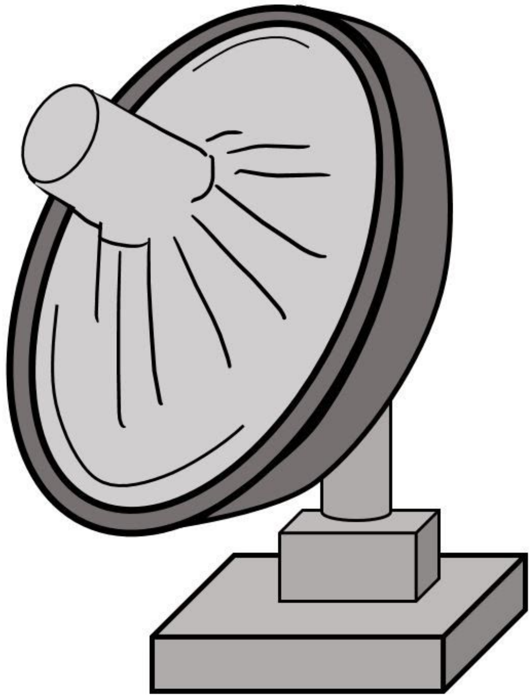
Microgravity Mushrooms



BSE 4125 - Comprehensive Senior Design Project

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Cover Letter

- “We have neither given nor received unauthorized assistance on this assignment.”
- "Our advisor(s) have had an opportunity to review this document."

List of Acronyms

1.0 Introduction

2.0 Potential Solutions

Analyzing our problem, our team decided the best solution was to break our model into three sub groups to deal with the multiple aspects of growing mushrooms in a low gravity environment. These three subgroups covered the pore size and tube geometry, stand and pressure system, and the housing/containment.

2.1 Pore Size and Tube Geometry for Predicting Moisture Level

The goal of the porous tube group is to provide an optimal yield of mushrooms for consumption on the ISS. To accomplish this general goal, we broke down our possible solutions into 5 criteria we would like to focus on. As seen in Table 1, we chose cost and availability of the tubing to be the most important parts of our potential solutions, while tube diameter, length, and pore size would be of variable importance. Solution 1, would represent a model with a preferred diameter already available on a suppliers website. Solution 2 would deal with a preferred pore size also already available on the same suppliers website. Solution 3 would be a custom order to test not only the availability, but also a different pore size or diameter.

Table 1: Decision matrix identifying porous tube criteria

Criteria	Weight	Solution 1	Solution 2	Solution 3

Tube diameter*	15	5	3	5
Tube length*	12.5	3	3	3
Availability	25	5	5	3
Cost	35	4	4	3
Pore size*	12.5	3	5	5
Total	---	4.15	4.1	3.55

*values importance subject to change

Another goal of the porous tube subgroup is to come up with an equation that allows for the general use for other future crops to be grown on the ISS. This equation would allow researchers to quickly put in the known (by literature review/seed packet/or observation) water requirement of the crop, and have an output of recommended tube length, pore size, tube diameter. Our solution to approaching this came in the form of what format we would give the researchers the information. As seen in Table 2, we chose usability for how easy it would be to to use the given software, cost for how much they would have to pay if they did not have the software, adaptability for how applicable the results are to another crop, the adjustability for how easy the equation is to adjust, and the preference for what the researcher would like to use.

Table 2: Decision matrix for experimental equation

Criteria	Weight	Excel	Matlab	Standard Equation
1. Usability	20	5	5	3
2. Cost*	20	5	5	5
3. Adaptability	20	2	3	2
4. Adjustable	20	4	4	5
5. Preference*	20	4	3	1
Total	---	20	20	16

*assumed values subject for change

2.2 Stand and Pressure System for Mimicking Microgravity

The stand and pressure system will be used individually or in tandem to aid in the delivery of water. Due to the presence of gravity on Earth, the PPTNDS functions differently in the KSC Lab than in microgravity. The stand is required to be 3D printed and will hold the porous tube above the reservoir so that capillary action can take place. While KSC currently has stands, they are hindering the capillary action (due to height) and are not adjustable for the different moisture demands of a variety of crops and mushrooms. Our goal is to redesign the stand so that it is adjustable.

We have created a decision matrix (**Figure #**) that analyses four different solutions. The "Hole-U's" design features a printed U clamp that holds the porous tube. The U has pegs on the top outer edge of both sides that can be snapped into vertically placed holes in 3D printed columns. This design received a final score of 165, putting it in 3rd place. The Velcro design features a design similar to the U, but utilizes velcro instead of pegs and holes to allow for a "continuous" adjustment. In other words, adjustment is not limited to the hole placements, but is instead adjustable at any point within the bounds of the velcro. This design received a final score of 194, putting it in 2nd place. The Snap Pegs ….. This design received a final score of 152, putting it in last place. The Microcontroller design features a 'continuous' system that can be adjusted either passively (without the microcontroller) or actively (when hooked up to a power supply). This design works in tandem with the pressure system to determine and adjust the required stand height based on measurements taken from the pressure system. This design received a score of 315, giving it the highest score of our four designs.

Decision Matrix 1. Stand Adjustment

Design Idea	Precision	Use of materials/ Cost	Ease of Movement	Sturdiness	Amount of loose pieces	Difficulty to prototype/ tolerance	Connection to pressure adjustment	**Final Score**
Weight Factor (10)	8	1	7	6	4	2	9	--
Hole-U's	3	8	8	7	3	7	1	**165**
Velcro	6	10	6	4	8	10	2	**194**
Snap Pegs	6	9	5	4	2	5	2	**152**
Microcont roller	8	3	10	9?	8	1	10	**315**

The point of this matrix, and what you can say for the writing, is that it would be ideal to have the method of adjustment CONNECTED to the water reservoir pressure adjustment system (whatever you want to call it). We could do manual adjustment, but it's about ⅔ as ideal.

The purpose of the pressure system is to

Decision Matrix 2. Pressure system

Design Idea	Cost/materials involved	Predicted Precision	Ease for manual adjustment	Predicted ease of implementation	**Final Score**
Weight Factor (10)	2	10	6	8	--
Microcontroller	2	9	7	7	**192**
Spring-Pressure System	7	5	8	6	**160**
Weighted Pressure-System	6	6	8	5	**160**

This one explains that a microcontroller would be ideal to alternatives with more pieces and no technology (could add more pieces as a category actually?).

2.3 Housing Apparatus for Maintaining Environmental Conditions

3.0 Analysis of Potential Solutions (Discussion and Matrix)

3.1 Pore Size and Tube Geometry for Predicting Moisture Level

Discussing the potential solutions for the porous tube solutions, the three main differences between the solutions deal with the three variable criteria. Without testing we would not be able to determine the importance of diameter, length, and pore size.

However, we have placeholder importance for what we think would be the more influential variables over mushroom growth. Seeing this and analyzing the given results from Table 1, we can see that solution 1 would have the best theoretical yield due to the highest score. This, however, will be subject to change once we test and get values to go along with our predicted solutions. As for the general equation, there is a tie between an excel file and a Matlab file for the best theoretical solution.

3.2 Stand for Mimicking Microgravity

3.3 Housing Apparatus for Maintaining Environmental Control

4.0 Results

5.0 References

6.0 Appendix