Project Definition Document

Aerospace Senior Projects (ASEN 4018 & 4028)
Fall 2003 and Spring 2004

1.0 Information

1.1 Project Title

MEP – Martian Environmental Pod

1.2 Project Customer

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2.0 Background and Context

Mars is the fourth planet from the sun. The conditions on Mars vary greatly from the conditions on Earth. The average temperature on Mars is -65 degrees Celsius. A day on Mars is 24 hours and 37 minutes, with a year lasting 687 days. The seasons are similar to Earth's but are approximately twice as long. The amount of solar radiation falling on Mars is approximately 0.4 that of Earth per square meter. Due to the dust storms on the surface, much less solar radiation can occur. The atmospheric pressure on Mars is 0.1 kPa, which is insufficient for sustaining life.

The first step to inhabiting Mars is the understanding of the possibilities of life on the planet. The CO_2 content on the planet makes it uninhabitable for humans, but plant life can be sustained with controlled conditions. Plant life on Mars would need a higher temperature, higher pressure, high humidity, high nutrient source, and better growth medium than available on the surface.

A miniature greenhouse could be proposed to fly abroad a Mars Lander in the next 5-10 years. The proposed greenhouse can act as the source of the fundamental requirements for the plant life on Mars. The greenhouse would be able to control temperature, pressure, humidity, nutrients, and a platform for the plants to grow. The greenhouse would house Arabidopsis plants and maintain a suitable environment for their survival and growth.

3.0 Objectives

3.1 Overall Objectives

The overall objective of the proposed project is to conceive, design, fabricate, integrate, test and verify a deployable greenhouse for a robotic Mars Lander.

3.2 Structural Design

3.2.1 Objective

The structure will be compact for transport and will inflate to create a closed system. The greenhouse must be large enough to house an Arabidopsis plant, but within mass and size guidelines of onboard experiments of the Beagle II Mars lander.

3.3.2 Discussion

This implies that the structure will need to be packaged to fit the Mars Lander, deployed, and inflated to create the closed environment. The structure will be inflatable to meet the demands of the customer. The structure will be tinted to filter out UV rays that may be harmful to the plant and will be able to withstand Martian winds.

3.3 Environmental Controls

3.3.1 Objective

The greenhouse will need to maintain habitable conditions for plant life including temperature, pressure, and proper UV lighting.

3.3.2 Discussion

At the request of the customer this greenhouse will be designed to house an Arabidopsis plant. This means the greenhouse must maintain temperature, pressure, and the proper light spectrum for an Arabidopsis plant. The structure will maintain an internal pressure between 10-50 kPa. The temperature inside the structure must be maintained at room temperature.

3.4 Mass

3.4.1 Objective

The total mass needs to not exceed 5 lbs.

3.4.2 Discussion

The mass needs to be minimized due to cost and space constraints of transporting the unit.

3.5 Power System

3.5.1 Objective

The greenhouse will use an outside power source.

3.5.2 Discussion

The power source will inflate the structure and provide power to systems that maintain pressure, thermal, and atmospheric conditions. The power source will also provide power to all testing equipment.

3.6 Interface with Environmental Controls

3.6.1 Objective

The MEP will interface with an outside source that powers and controls the environment.

3.6.2 Discussion

The umbilical cord linking the MEP to an outside source will include gas lines, power source, and electrical feeds for data and testing equipment.

4.0 Required Engineering Expertise

Technical Expertise	How Applied
Mechanical Design	Develop conceptual and detailed solid 3D models of the structure
Electomechanical Actuators	Actuator subsystem
Analog Electronics	Design of the actuation and sensing subsystems
Data Acquistion Software	Real-time measurement subsystem
Thermal Analysis	Computer modeling
Mechanical Fabrication	Part machining
Electronic Fabrication	Analog and digital electronic subsystems
Pressure Test	Verification of the pressure levels within the unit
Temperature Test	Verification of the temperature levels within the unit

5.0 Resources

5.1 Facilities

No additional facilities are necessary to verify the success of the Martian Environmental Pod. Although the unit will be tested at existing

temperatures and different pressure differentials, the unit might be tested in an environment with an ambient temperature of -65 degrees Celsius and an ambient pressure of 0.1 kPa if such facilities are located.

5.2 Funds

The additional funds are made available by the BioServe Space Technologies program at the University of Colorado at Boulder in the amount of approximately $4500.