**PROJECT NAME: CAFÉ LUNA**

**SPACEAPP CHALLENGE: DEPLOYABLE GREENHOUSE**

**ENVIRONMENT: THE MOON**

**By Nick Providakis**

**Objective:**

The purpose of this project is to create a conceptual design of greenhouse that can be deployed to the moon ahead of an astronaut mission in order to grow food for human consumption.

**Abstract (See Figures 1 and 2):**

Cylindrical module, flat on the top, conical on the bottom, delivered as a payload stage of a rocket launch device, consisting of:

1. Inner and Outer shell
2. Concentric lens with UV shield at the top, concave focusing toward the bottom
3. Glass shield on the bottom
4. Multiple aeroponic arrays along the inner walls for growing crops
5. Multiple florescent lighting panels along the inner sides, alternating with the above aeroponic arrays
6. Water reservoir under glass shield comprised of a parabolic mirror and vapor channels connecting to the bottom of aeroponic arrays
7. Oxygen tank connecting to above vapor channels
8. Plant nutrient/fertilizer tank connecting to above vapor channels
9. Carbon (graphite) repository with ignition apparatus connecting to main growing chamber
10. Mining apparatus at the tip of the cone to extract and process oxygen, potassium, magnesium, and carbon from the lunar soil
11. Airlock with door for human access to the man growing chamber
12. Air interlock to connect to human habitat module
13. Solid waste interlock to connect to human habitat module
14. Water interlock to connect to human habitat module

**Functional Description of Concept:**

Prior to launch from Earth, mature plants are pre-planted into the aeroponic arrays. The greenhouse is loaded with sufficient water, fertilizer, carbon, and oxygen to last at least until the astronauts are expected to arrive on the moon.

While in transit to the Moon, the plants receive light from the florescent panels in between the aeroponic arrays. All surfaces in the growing chamber are reflective to maximize light used for photosynthesis. Diaphragm pumps are used to vaporize the water and nutrient solution and deliver them to the aeroponic arrays.

When the launch vehicle arrives in orbit around the moon it ejects the greenhouse with the necessary momentum to land it on the lunar surface by embedding the conical section into the lunar soil without damaging the module. After landing, a shield covering the lens at the top is ejected and solar panels are deployed from the sides. The solar panels provide power to pumps and control systems. Surplus energy is stored in batteries.

During the sunny half of the month, sunlight passing through the lens at the top is filtered of ultra-violet rays and focused onto the bottom of the water reservoir. The parabolic mirror reflects the remaining sunlight onto the plants. The water absorbs a portion of the radiant energy from the sunlight in both directions. The absorption of radiant energy by the water has the triple effect of lowering the intensity of the sunlight reflected onto the plants to a non-lethal level, vaporizing some of the water so it can be channeled to the aeroponic arrays without spending energy on the diaphragm pumps, and maintaining the temperature of the aeroponic arrays and main chamber at desirable levels.

Oxygen and nutrients are mixed with the water vapor and delivered to the roots of the plants in the aeroponic arrays. Carbon dioxide is generated by burning graphite and exhausted into the main chamber for the plants to breathe.

A mining / refining apparatus at the bottom of the conical section could possibly be used to extract and process oxygen, potassium, magnesium, carbon, and/or water ice from the lunar soil to replenish water, oxygen, carbon dioxide, and nutrient supplies.

When the astronauts arrive and set-up a human habitat module, an interlock is established to exchange air between the greenhouse and the habitat module. Oxygen produced by the plants is breathed by humans, and carbon dioxide exhaled by humans is breathed by the plants.

Humans enter the greenhouse via an airlock hatch and harvest the crops manually. Humans consume and digest the crops. Waste water produced by human digestion and other human activities is filtered on the habitat module and a portion is transferred to replenish the greenhouse water reservoir via a water interlock. Solid waste produced by human digestion is transferred to the greenhouse to replenish the carbon repository and/or the nutrient / fertilizer tank via a solid waste interlock.

During the dark half of the month, surplus energy captured by solar panels and stored in batteries during the sunny half of the month is used to power the florescent lighting panels in the main chamber to provide light to the plants for photosynthesis. Ideally, insulation in the greenhouse is sufficient to maintain the temperature within the desired range during the dark days. However, if temperatures begin to fall rapidly, additional carbon could be burned to maintain the temperature. This would necessitate closing the air interlock between the human habitat module and the greenhouse until carbon dioxide levels return to normal due to photosynthesis.