Group 18 - Lunar Buggy

Upon identifying an opportunity for medium-ranged, highly adaptable vehicles in the lunar transportation market, Lunar Industries' CEO, Prem Sundaramoorthy, tasked his engineering department with the design of a Lunar Transportation System. Further, the design shall incorporate the company's strive for sustainability, innovation and inspiration. To make use of then already existing infrastructure, and to potentially secure a first customer, the project will be aligned with the timeline and needs of NASA's Artemis Program. However, the design will be highly adaptable and modular, as Lunar Industries' aim is to produce a design that will eventually become the preferred general transportation method for future lunar inhabitants.

Mission Objective

The Engineering Department of Lunar Industries will demonstrate an autonomous and adaptable system for ferrying passengers and cargo by 2040, thereby enabling safe and sustainable exploration and transportation of future lunar inhabitants on the Moon's surface.

System Design

Five design concepts were identified to be further analyzed: a large, inflatable ball that can traverse rocky terrains, a snake that propels itself forward with a screw-like outer body, a sledge that pushes a ship-like bottom hull, a cylinder that has two big wheels and a small motorized one, and a buggy, a pressurized cabin on top of wheels. The buggy quite clearly outscored the other concepts in sustainability, simplicity and practicality while scoring second best in mobility in a trade-off. Hence the design of a buggy was started, considering NASA's desired functions of exploration and of ferrying cargo, sustainability and harsh lunar conditions in the Artemis Exploration Zone. An undercarriage, a pressurized cabin and an airlock have been identified as the main structural components. So far, topology optimization has been employed to explore different undercarriage designs, an airlock system was designed and an initial cabin lay-out was selected. The focus for the next weeks will be to finalize the cabin design with an iso-grid layer, which will run iteratively while integrating all the subsystem, and to optimize the undercarriage design. In terms of powertrain and mobility, it was decided to equip the LTS with six wheels. Michelin's Moon Wheels were identified as the best existing option. A drive motor, which will also function as a regenerative braking system, was selected to be integrated into every wheel, while a steering motor was chosen to be integrated into the front and back two wheels. Further, a trade-off yielded an active electromagnetic suspension system as the best viable option, considering the rough lunar terrain, cryogenic temperatures and reduced gravity. To shelter the crew, the LTS was designed to keep the thermal balance of the pressurized cabin to around 21 °C through passive insulation layers, active radiators and heat pumps. The placement and final size of the components still need to be constrained. Additionally, sensors and filters have been selected for proper air management inside the cabin. The radiation shielding is still being designed for; most likely the LTS will employ an outer layer of regolith. The LTS has been set up to communicate with different external agents through LunaNet Service Providers, enabling a robust and reliable communication channel. This provides the LTS with global positioning, navigation and timing capabilities. Moreover, the local guidance and path planning were chosen to be facilitated by a Level 5 autopilot using a fusion of different sensors. The LTS is also designed to enable the direct stopping of the vehicle by its crew through a redundant user interface. Additionally, the LTS was chosen to allow autonomous cargo handling capabilities using a robotic arm. To enable all these functions, it was decided to use hydrogen-oxygen fuel cells. The water produced will then be re-electrolyzed at Basecamp, allowing for refuelling and continuous use of the LTS. The fuel cells are sized for nominal power needs, while during peak power usage batteries will provide the required extra energy.