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HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
Long Term Scenarios for Human Moon/Mars Presence (2)

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AEROSHELL DESIGN CHALLENGES FOR MARS DESCENT CONCEPT

Abstract

Newton considered a fluid flow as a uniform, rectilinear stream of particles, much like a cloud of pellets from a shotgun blast. Newton assumed that upon striking a surface inclined at an angle θ to the stream, the particles would transfer their normal momentum to the surface but their tangential momentum would be preserved. After collision with the surface, the particles would then move along the surface leading. This basic theory would later on be the building blocks for space body entry vehicles aeroshell design. Although, there are a number of factors that go into the selection of aeroshell design, often times the best selection relies on an iteration of the following parameters.

The paper discusses major design challenges:

L/D - For a human Mars Mission, would a mid to high L/D ratio be a reasonable constraint? Most importantly, which L/D (mid/high) ratio system is more volumetrically efficient?

Volume/Volumetric Efficiency - Transporting a large volume of supplies/materials is critical for Mars Missions thus the crew/cargo Lander must be able to accommodate a crew, supplies, environmental/support systems and fit the size constraints of a specific launch vehicle.

Structural Mass - A Mars manned/unmanned vehicle capable of launching a crew to Mars along with the required life/habitability/environmental support systems, supplies, must have an aeroshell with the lowest structural mass possible.

Heating rates - Are aeroshells with a high L/D ratio safer for the crew and vehicle? Is designing a vehicle capable of withstanding high heating loads during descent with a low structural mass and volumetric efficient an ideal selection.

Simplicity and Reliability - The simplicity and reliability of the aeroshell for a Mars manned mission is especially significant because failure of the aeroshell on any level most likely will result in complete mission failure and crew lost. Additionally, future aeroshell concept systems must have the ability to be easily packed internally, with cargo or crew Mars Lander vehicles with available space for a transfer vehicle and externally in order to be launched from the earth surface.

The paper outlines several aeroshell concept designs such as conical lifting brake, raked sphere cone, symmetric conic, biconic configurations etc., and therefore utilized historical data/formulas to generate a series of MATLAB models in order to analysis their advantages and disadvantages and utilized this information as a blueprint for designing new and innovative aeroshell concept designs.