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CONFIGURATION AND TYPES OF FOLDABLE JOINTS FOR SPACE EXPLORATION ROVERS IN REGARDS TO G-FORCE EXPOSURE IN LAUNCH AND UNFOLDING MECHANISMS UPON ARRIVAL

Abstract

All rovers that have been deployed to the moon and Mars have used wheels to ensure mobility, and most designs for future rovers also employ circular wheels for on-ground transportation. In order to ensure sufficient ground clearance for the rover chassis, different rovers employ different configurations of wheels - either being attached directly to the main body, or being attached to separate "arms" or "legs."

Space exploration rovers, notably for moon and Mars, often times employ foldable structures for the wheels to both save space within highly confined payload volume, or to mitigate the affects of structural stress that comes from exposure to high-g acceleration during launch. For rovers whose wheels are attached to extended structures, such as "arms" and "legs," the folding mechanism can utilize these existing structures to elevate the wheels to or above the bottom of the rover main body. For smaller rovers whose wheels are directly attached to the main body, however, folding of the wheels require the design of separate joints.

This study investigates the different configuration and different types of such joints. Firstly, the joints can be either sideways, as in perpendicular to the wheels' direction of movement, or aligned, as in parallel to the wheels' direction of movement. The configuration of joints can fold the wheels either to the top of the rover or the bottom, or the mixture of both for different set of wheels.

This study discusses and compares the different configurations of most likely folding mechanisms to be employed in future rover designs, and analyze the benefits and drawbacks of each design to the metrics of: (1) Stress load: how well can the folded structure survive high-g launch environment, (2) Utilization of space: how well does the folding mechanism conserve space both within the payload volume, and for the equipment space within the rover, and (3) Unpacking sequence: the ease of unfolding the wheels, in relation to friction to ground elements, and the level of external support required.