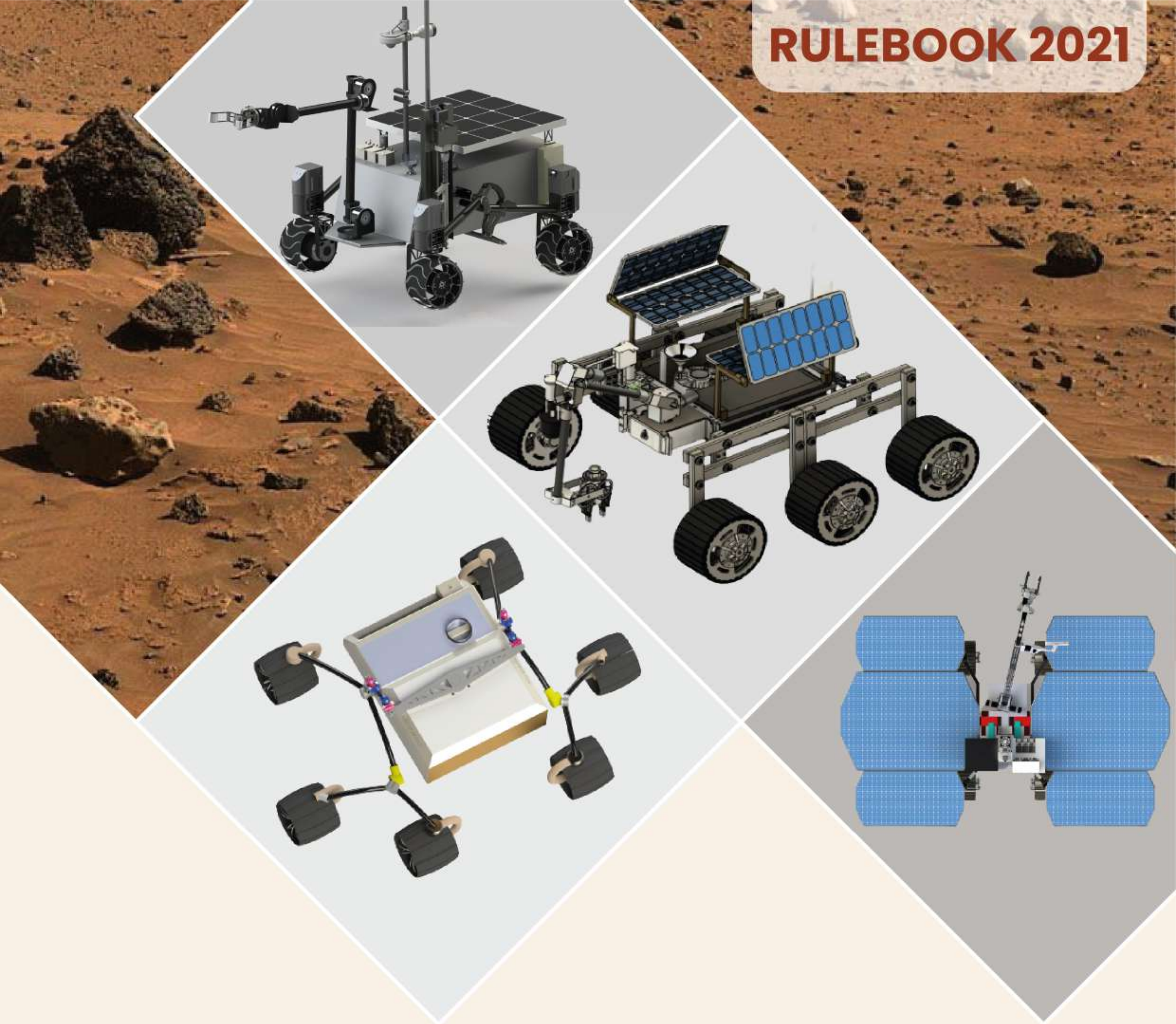

MARS SOCIETY SOUTH ASIA

INTERNATIONAL ROVER DESIGN CHALLENGE

INTERNATIONAL ROVER DESIGN CHALLENGE

—— Changing the way you Innovate ——

June 25 - August 15, 2021
Online

www.roverchallenge.org

marssociety.southasia InternationalRoverChallenge mars-society-south-asia

1.0 COMPETITION OVERVIEW

1.1 COMPETITION OBJECTIVE

Mars Society South Asia's International Rover Design Challenge (IRDC) - 2021 is an online space engineering design competition. It challenges university students to conceptualise and design Next-Gen Mars Rovers, which shall be fully equipped and mission ready for future astronaut-assistive exploration operations on Mars. Teams are supposed to carefully plan each sub-system of the Rover considering various extra-terrestrial parameters in design (Exceptions, if any shall be mentioned). This online research-oriented competition is designed for students to explore their mind and spark the innovative design thinking of individuals, free from constraints on available physical resources. Students are encouraged to be as Imaginative, Creative and Insightful as possible within practical implementable limits for the human race.

The stated guidelines in this Rulebook are intended to give the teams a direction and outline for their designs.

The scenarios and specifics not mentioned in the Rulebook regarding rover capabilities and rover subsystems can be treated as "Open to Interpretation". Teams are allowed to make certain assumptions in such scenarios while providing proper justification for them. This step is taken to promote imagination and creativity in teams, rather than being bound by a higher number of constraints. It should also be stated that there is no "Right Answer" in this competition. We are expecting to see a gamut of approaches and strategies from teams. Teams will be judged primarily on the merit of their System Concept Review (SCR) Package, which includes a written report and a 10 second rendered video submission of the designs.

2.0 GENERAL GUIDELINES

2.1 Competition Format

The IRDC is a completely off-site (online) competition, and no physical inception of designs is mandated to the teams. Graduate and undergraduate students are allowed to participate. IRDC 2021 edition will be a 2-stage competition. Stage 1 will be the submission of the System Concept Review (SCR) Package. In stage 2, the top 10 teams from Stage 1 will be asked to present their ideas to the judges during one-on-one online presentations.

MSSA reserves the right to use and reproduce the information submitted by teams in the competition for educational and promotional purposes through any of its media channels while duly citing the contribution made by respective teams.

2.2 Registration

The registration window for the IRDC 2021 will be open from June 25 to July 10, 2021, and the System Concept Review (SCR) Package submission deadline is August 15, 2021. The top 10 teams will be further asked to present their designs to the judges. The submission procedure shall be intimated to the registered teams in the coming weeks.

The registration details and form is available at https://roverchallenge.org.

2.3 General Official Authority

The officials reserve the right to revise the schedule of the competition and/or interpret or modify the competition rules at any time and in any manner that is, in their sole judgment, required for safe, fair and efficient operation. All team members are required to cooperate with and follow all instructions from the officials.

2.4 Queries Regarding the Rules

Any issues not covered by these published rule sets will be addressed on a case-by-case basis by the IRDC Judging Panel on contact@roverchallenge.org, and all such matters raised by teams shall be posted on the IRDC FAQ section of the competition website (https://roverchallenge.org). Teams are suggested to view the FAQ section regularly for updates.

3.0 SYSTEM CONCEPT REVIEW (SCR)

The teams are required to formulate a System Concept Review (SCR) Package of their Rovers pertaining to the given mandatory parameters in this document. SCR consists of two components: a written report and 10 seconds rendered video.

3.1 SCR Report

Page 1 of the SCR Report should bear the Team Logo, Institution Logo, Mars Society South Asia (MSSA) Logo, Team Name, Team Lead Name and Contact Information. Document Margins should be 2.54cm from each side. Font Sizes should range between (11pt-16pt) in the document, used appropriately for Headings, Sub-Headings, Text and Annotations.

Font should be uniform across the entire Report. All Images should be annotated. Teams are encouraged to adopt a mission-based approach in the Report. Starting with rover composition and base system information, then explaining each of their additional systems by showing their application in their mission approach. The team's approach to each mission needs to be individually elaborated.

The Teams are required to include one Orthographic/Isometric Image of the entire Rover on Page 2, labelling the primary systems of the Rover (Sample: https://tinyurl.com/y8tbyotq), with system descriptions not exceeding 15 words per system. A higher number of illustrations, images, CAD models, flowcharts, simulations and representative figures are encouraged.

Teams are required to compulsorily cite any published material that they may use for developing their design at the end of the SDR in an Appendix section. The System Design Review Report shall not exceed a total of 26 Pages (Excluding appendix).

3.2 SCR Video

Teams have to make a rendered video of their Rover performing any of the given mission objectives. The video should not be of more than 10 seconds and should be in MP4 format.
The SCR will be judged on the basis of:

1. Compliance of Rovers to the given parameters and effectiveness on mentioned tasks.

2. Depth of extra-terrestrial conditions and parameters considered in systems.
3. The depth of justification and reasoning provided in the SDR on each design decision.
4. The novelty, innovation and imaginativeness of the design.
5. System Sophistication and effectiveness of the presentation.

4.0 COMPETITION MISSIONS

Several hazards on the Martian surface, such as radiation, micrometeorites and dust storms, make surface habitation a dangerous solution. Caves on Mars were found to provide excellent natural shelter against these environmental threats. It is expected that the radiation doses within caves can be three orders of magnitude lower than on the Martian surface. Furthermore, several engineering reasons warrant the use of caves as habitation solutions. Lightweight and rapidly deployable structures, such as inflatable structures, can be used within the cave instead of the heavy structure surface counterparts.

Several natural caves may exist on Mars ranging from glacial caves, ice volcanism caves, dissolution caves, and lava tubes. However, the only type of cave observed on Mars and Earth is a lava tube. Terrestrial lava tubes have a diameter typically less than 15m, but lava tubes are believed to exist more than several hundred meters in diameter on Mars. The primary explanation suggested for this discrepancy is the lower gravity.

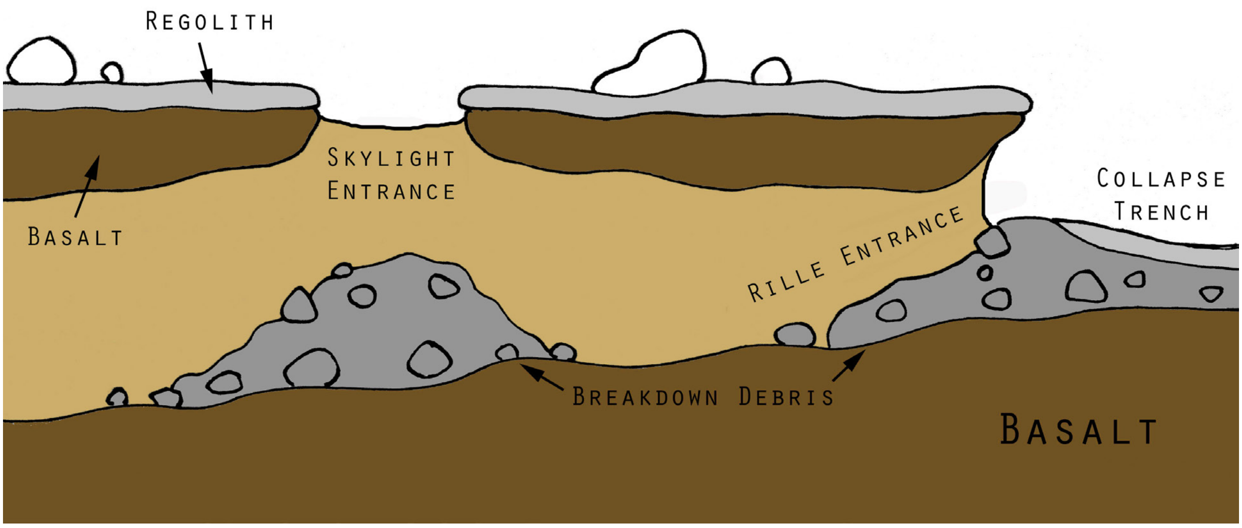

Figure 4.0: Mars Lava Tubes Structure

A lava tube can have several types of entrances, such as cave skylights, horizontal slopes, or diagonal slopes. Skylights, formed from the collapse of the roof or formation processes, have been found on Mars and were estimated to be from 130-270m wide and 10-22m in depth. Under these skylights, there are typically piles of rock debris. Horizontal or diagonal entrances are formed from the original draining exits or entries of the lava, but these are presently more difficult to locate.
A precursor robotic mission to further explore and investigate these lava tubes would be an excellent option to reveal the characteristics of these structures.

4.1 Theme

A robotic mission to explore and investigate potential Mars lava tubes.

4.2 Mission

Conceptualise and design a Mars Rover(s) to carry a subsurface mission inside Mars Lava Tubes to explore and characterise lava cave properties.
During the mission, the primary objectives of the Rover would be to:

- Map the entire tunnel and locate all its possible entry/exit points.
- Capture photographs/videos of the cave in the dark.
- Navigate and traverse successfully through the different types of terrain inside the tunnel.
- Communicate with the base station during the entire length of the mission.
- Carry out atmospheric analyses inside the cave.
- Conduct various scientific experiments (biological, geological etc.) and analysis, including in-situ analysis with the Rover for signs of microbial life, habitability and characteristics
- Collect and analyse regolith samples from the ground and the walls/ceilings of the tunnel.

Note: The above-mentioned list of objectives is not exhaustive. They have been provided just to give the teams a direction about the Rover's capabilities. Exploration of Mars is a complex task, and there are a lot of other objectives and aspects which the teams might find more suitable for their Rover exploration mission of characterising the properties of the lava caves.

For this mission, teams have to make the following assumptions:

- The Rover has already been transported inside the tube through a Skylight entrance.
- The mission length is 10 hours.
- The minimum diameter of the lava tube is 50 metres.

- The depth of the lava tube is 15 metres below the surface.

- An astronauts base station with all the necessary resources is situated at a distance of 5km from the tunnel entrance.

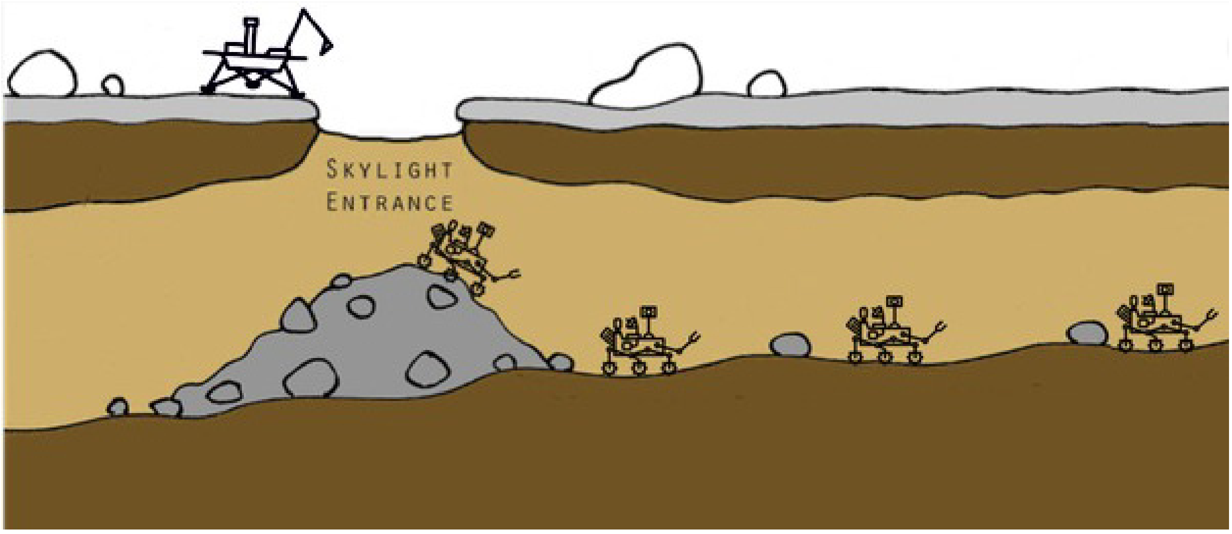

Figure 4.2: Rover Exploration of Lava Tubes

4.3 Rover Sub-System Guidelines

Teams are encouraged to design the maximum proportion of the Rover indigenously. Teams are, however, allowed to use readily available products/parts in the market. In such cases, the reasoning of the component selection will be judged rather than the actual design of such market-ready components.

1. Mechanical Design- All the mechanical systems, including but not limited to wheels, motors, drive/actuation mechanisms, robotic arm and science module, should be readily operable on Mars.

2. Electronics Design- The focus is to Design and Conceptualise a reliable Electronics System. The Judges understand that the onboard electronics are mainly Silicon Based on Earth which may not be able to function properly on Mars. Teams may treat this as an exception and are not required to look at Material (Semiconductor Level) aspects of electronic components. All other parameters are to be considered for Martian operation.

3. Scientific Experiments and Analysis (Science) Package - All Martian parameters must be considered while developing instruments and equipment for scientific analysis.

4. Power and Communication System Design - Teams should consider the challenges presented by subsurface environments to lava tubes, the rover must overcome various difficulties, including: Extended periods without access to solar power, limited accessibility to communication, operating exclusively in a dark environment.