MARTIAN HABITAT

1:1 INTERACTIVE ARCHITECTURE PROTOTYPES

GROUP 1

DIYA SHARMA

GRAYSON RYAN

ZIXIONG WAN

ANN AN

YUQUING ZHANG

INTRODUCTION

As aerospace technology advances, the prospect of human habitation on Mars has become increasingly feasible. Nicholas (2017) notes NASA and SpaceX's ambitions to send humans to Mars by 2030 and 2040, respectively. In response to this growing interest, the Martian Habitat project aims to design architectural solutions for sustainable living on the Red Planet. Tailored for 2-3 research scientists, the habitat is envisioned as a space for exploration and study, particularly focused on investigating the presence of water. Emphasizing efficiency, safety, and adaptability, the habitat integrates innovative human-robot interaction methods. This approach not only ensures the successful execution of tasks, from construction to daily operations, but also lays the groundwork for future colonization efforts. Leveraging local resources such as Regolith, the project explores cutting-edge technologies like Design-to-Robotic-Production-Assembly, Computer Vision, and Human-Robot Collaboration, signaling a promising step towards sustainable living beyond Earth.

CONDITIONS ON MARS

Constructing habitats on Mars presents a unique set of challenges due to the planet's harsh environment and distance from Earth. Some construction challenges on Mars include:

Atmospheric conditions: Mars has a thin atmosphere composed mostly of carbon dioxide, with occasional dust storms. These conditions can impact construction materials and techniques, requiring adaptations to ensure structural integrity.

Extreme temperatures: Mars experiences wide temperature fluctuations, with average temperatures around-80 degrees Fahrenheit (-62 degrees Celsius). Materials and equipment must withstand these extreme conditions to maintain functionality and structural stability.

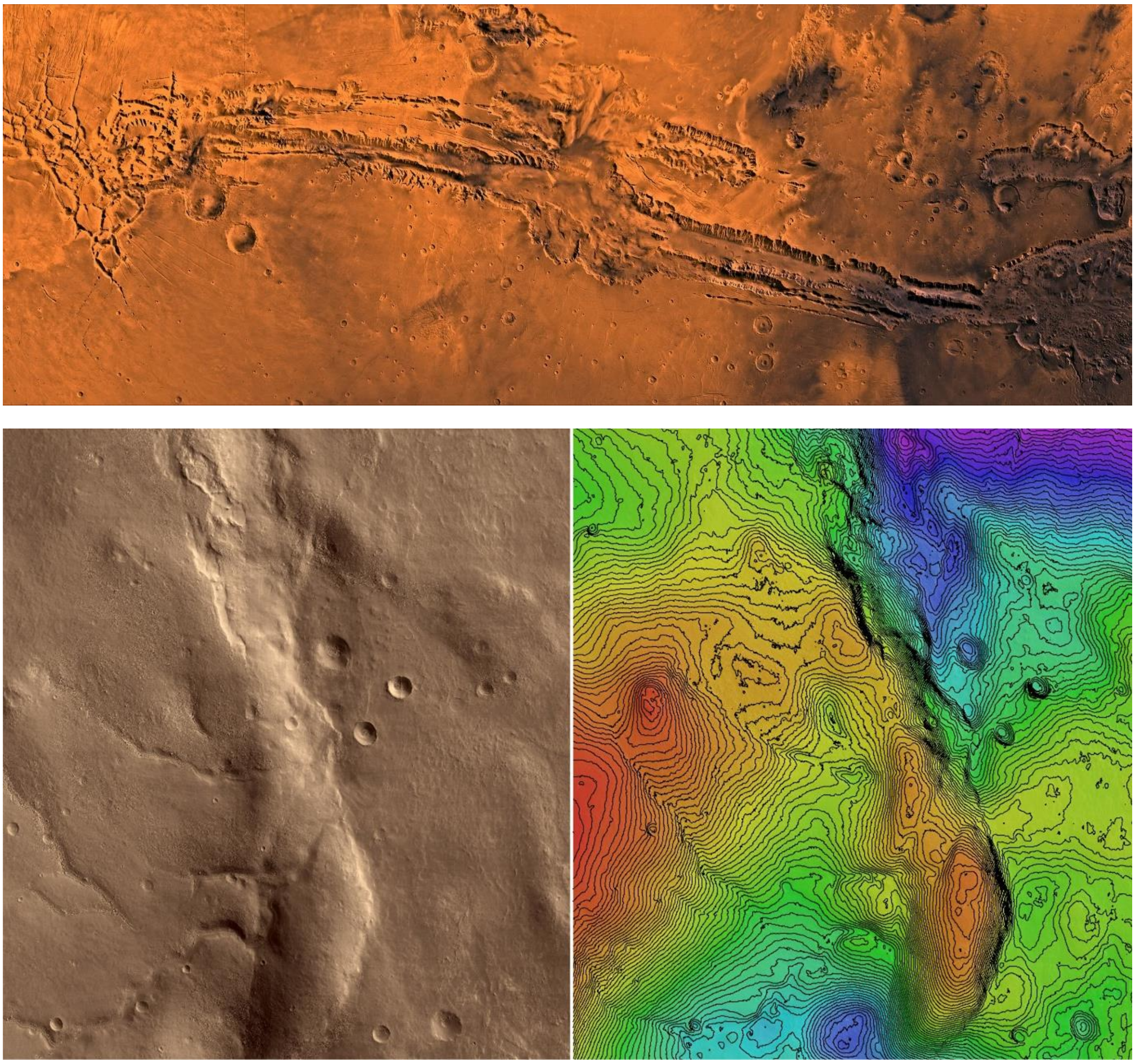
Radiation exposure: Mars lacks a strong magnetic field and thick atmosphere to shield against solar and cosmic radiation. Constructing habitats that provide sufficient radiation protection for long-term human habitation is crucial. Long-term habitats should be equipped with radiation shielding, thick enough to reduce the radiation to a level equal to Earth, that is, almost zero. Best protection may be achieved with houses built in natural caves or set into cliffs or hillsides. Any matter placed between a person (or radiation-sensitive equipment) and a radiation source reduces the amount of radiation they absorb. Mars One's solution is a thick layer of regolith on top of the settlement modules. (Marspedia 2022).

Dust and regolith: Mars is covered in fine dust and regolith, which can pose challenges for construction equipment, machinery, and seals. Minimizing dust infiltration into habitats and preventing equipment degradation are significant concerns. "Dust storms, cosmic rays and solar winds ravage the Red Planet's surface. But belowground, some life might find refuge" says Nikk Ogasa in the article Martian crust could sustain life through radiation (Ogasa).

SITE

Based on research of Mar’s environmental condition and findings by previous groups, we've chosen to build the habitat underground within a crack on Mars to shield it from cosmic waves and radiation. Sealing the cracks is vital to prevent dust infiltration and regulate internal temperatures, requiring specialized materials and techniques. Constructing in this rugged terrain demands resilient systems adaptable to Martian geology, while careful assessment of risks like seismic activity is essential for safety.

The site is located in the large rift system on Mars known as the Valles Marineris . Deep gullies and valley-like formations on the edge of the Ius Chasma indicate possible erosion by flowing water. Other formations and sediments also indicate the former presence of liquid water, therefore the location was more suitable for design. There is also presence of a chaotic terrain consisting of cracks in the Pyrrhae Region the Valley region that could be used for the design development.



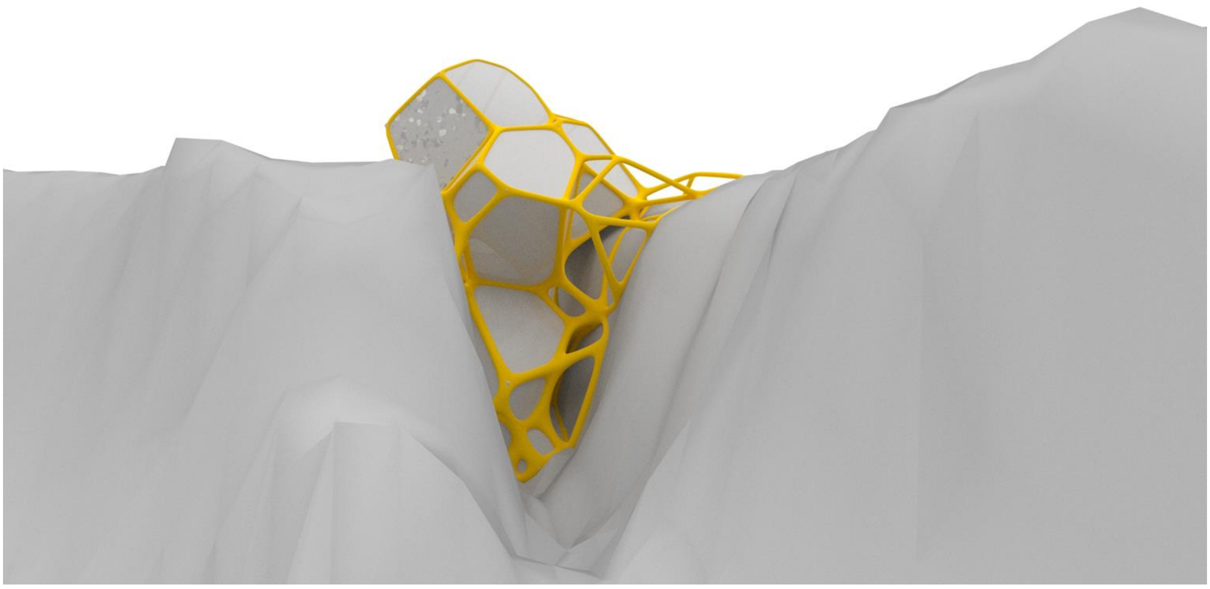
(Source : Wikipedia, Valles Marineris Mars)

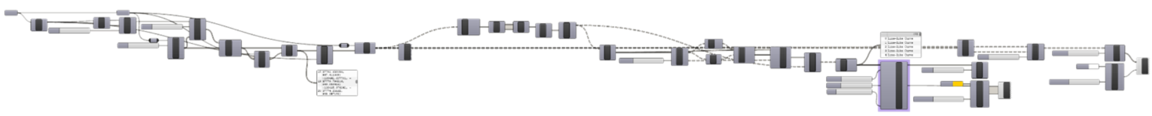
CONCEPT

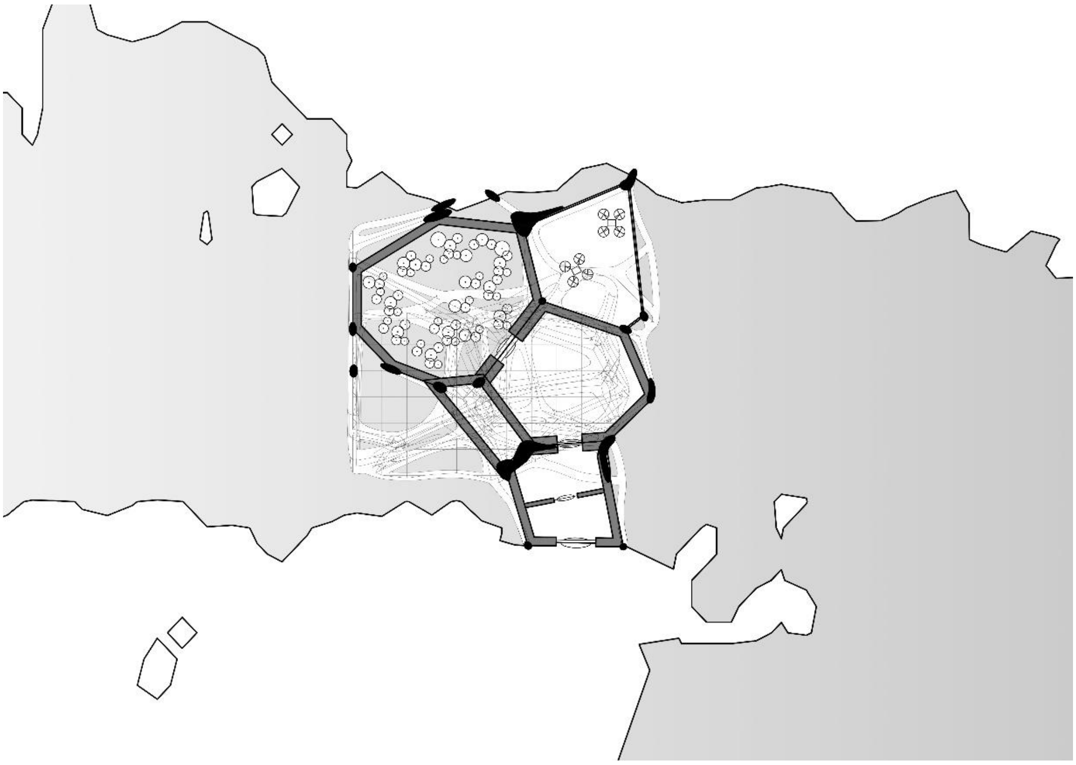
Our site selection is within the cracks on the surface of Mars. These cracks are scattered across the Martian surface, ranging in width from 15 to 35 meters and depths of up to 30 meters. They serve as natural shelters from the frequent Martian dust storms, providing a good shelter for astronauts.

Our structure is generated automatically after robot scans the surroundings. The generation method involves Voronoi cells. By precisely controlling the size of each unit based on the distance between points, we create different space inside the shelter. These structural connectors are 3D-printed and deeply inserted into the cliffs of the cracks by robots, forming a 3D spatial structure. This stable structure can support our shelter, mitigating the effects of potential Mars quake.

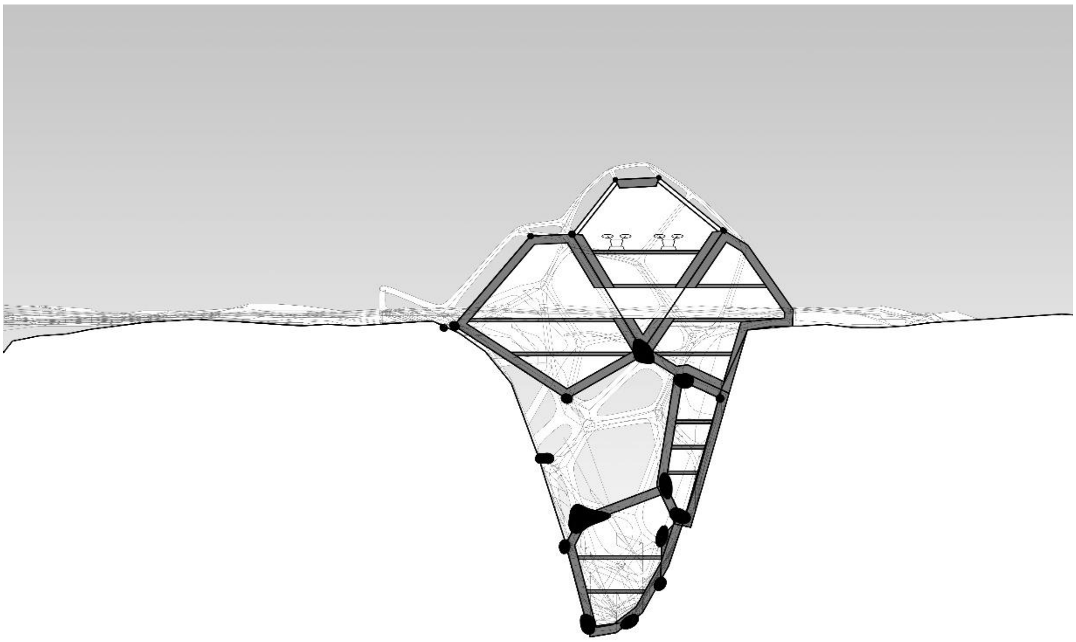
At the core of the shelter there is a greenhouse, providing the necessary oxygen and food. Fertilizers for cultivation come from local rock formations, while water is sourced from deep layers of water ice. Sunlight is artificially provided. This section also serves as a relaxation and open space for the astronauts. Through this core space, connections are made to other residential units, equipment spaces, research labs, etc.







PLAN



SECTION

FRAGMENT

Basic Organic Cell unit

Each unit is stacked vertically and horizontally

Concrete Printed Skeleton Structures support the units

The division of the surface of each cell also uses Voronoi cells