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Space Architecture: Habitats, Habitability, and Bases (1)

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ADAPTABILITY IN SPACE USING THE RHYTHMIC BUILDINGS FRAMEWORK

Abstract

Space habitats, facing the extreme environments of space and other planetary bodies, need to be redundant and versatile. Although the main challenges in the field have been identified as changes in gravity, radiation protection, extreme temperatures (fluctuations), changes in daylight patterns, and lack of (or less) atmosphere, more (unknown) challenges will undeniably emerge. Therefore, space habitats should not only be redundant but also have the ability to adapt to their environment. There are many adaptability strategies for building on Earth but none of these strategies were developed to work for more extreme environments.

Research presented in this paper applies the Rhythmic Buildings adaptability strategy – a strategy that helps building adapt to the rhythms of their context (frequency, speed, and intensity of changes occurring on the case study location). The strategy is applied to the case study of a Martian habitat, at Jezero Crater. The developed Rhythmic Buildings strategy includes the rhythmic framework and its 33 parameters as well as analytical, technical, and design tools. First, the analytical tool was used to map the changes in the context following the environmental, economy, and society aspects. The rhythms of the context include local temperature, pressure, solar radiation, strong weather events (i.e. storms), but also comfort needs of the crew. These rhythms were then translated into a habitat design using an adapted version of the bubble diagram method. Lastly, novel technologies and materials were selected to address the rhythms using a point-based system which includes adaptive properties of materials.

Results of the study show that the context's most important challenges are the daily temperature fluctuations and weekly crew schedule, while the most promising opportunity lies in the daily daylight rhythm. The design developed based on the Rhythmic Buildings strategy directly addresses nine out of the 33 parameters and indirectly addresses a further five parameters. The proposed compact habitat, utilises the rhythms of daily temperature cycles and the 24h daylight rhythm to reinforce the materials structure of the habitat. The habitat is adaptive and responding to its surroundings and the crew's needs. In the discussion, the paper explores speculations on how space architecture can develop itself by intrinsically adapting to the rhythms of the environment and evolve into their own typologies, distinctly different than Earth architecture.