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Strategies & Architectures as the Framework for Future Building Blocks in Space Exploration and  
Development (1)

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BARCHAN: DESIGN OF A BASELINE ARCHITECTURE FOR HABITATION, A NEW ITERATION  
ON THE “NEST” NASA MARS 3D PRINTING CHALLENGE PROJECT ENTRY.

**Abstract**

Mars presents a rather harsh environment for human habitation, and establishing a self-sufficient settlement will require life support systems that maintain stable temperature and atmospheric pressure, breathable air, water, and food supply while shielding the crew from space radiation and other environmental hazards. Habitability conditions often come as an afterthought; nonetheless, the design of quality and comfortable living conditions is critical for the success of a long-term mission and eventually a permanent colony. This paper presents an integrated approach to designing a sustainable and habitable base, a new iteration of the “NEST” NASA Mars 3D Printing Challenge project entry, previously shown in a published paper. Inspired by the formation of barchans—natural crescent-shaped dunes formed by wind erosion that move across desert landscapes—this design focuses on creating a functional and comfortable living space that can support the physical and psychological well-being of its inhabitants while being self-sufficient and adaptable to environmental factors such as sand and dust mitigation. This paper discusses the key elements of the proposed architecture: the incorporation of 3D printing technologies with regolith, the implementation of a tent and light structure as scaffold, and the assembly of inflatable modules. Our findings suggest that the barchan-inspired design can provide a promising solution for achieving long-term and incremental Martian habitability, and that further research and development in this area can help pave the way for sustainable human exploration and implementation in extreme environments on Earth.