Using Adaptive Architecture to increase the Habitability of Subsurface Mars Habitats

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Abstract

Longer mission durations and distances, like to Mars, will increase the number and severity of problems experienced by astronauts, like isolation, lack of independence, lack of privacy, monotony, sensory deprivation, sensory overload, unsatisfaction with the usability/accessibility of devices, ambient noise, poor lighting, poor air quality and thermal discomfort (Häuplik-Meusburger & Bannova, 2016; Lipińska, et al., 2021; Smith, 2023). These stressors can lead to mental and physical health effects which can endanger individual wellbeing as well as the safety and success of the mission (Imhof, 2003). In order to prevent that, space habitats need a high level of *habitability*, which is an *umbrella term that describes the suitability and value of a built habitat for its inhabitants in a specific environment* (Häuplik-Meusburger & Bishop, 2021, p. 4). To ensure habitability in a confined, multifunctional environment that is housing a crew of astronauts for several months, adaptive architecture could be one solution. Adaptive architecture (sometimes also cyberphysical or responsive architecture) enables adaption to changing inputs given by environments, their inhabitants, and objects by using sensors, actuators, and an underlying ICT-infrastructure (Schnädelbach, 2010; Bier & Mostafavi, 2016). This project investigates 1) ways to improve habitability through adaptive architecture considering several parts of space architecture (the astronaut, physical configuration of the interior, indoor environment, and life support system) and 2) the technical feasibility of integrating a sensor-actuator infrastructure in a 3d-printed subsurface habitat on Mars.

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