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Moon, Mars and Beyond: Analogues, Habitation and Spin-Offs (2)

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INTELLIGENT SPACECRAFT MODULES: EMPLOYING USER-CENTERED ARCHITECTURE WITH ADAPTABLE TECHNOLOGY FOR THE DESIGN OF HABITABLE INTERIORS IN LONG-TERM MISSIONS.

Abstract

The paper presents a working scaled model of the living quarters in a spacecraft targeted for long duration/range missions. Guided by the principles of *sensponsive architecture* the proposed model presents a user-centered, functional interior equipped with intelligent systems applied upon the existing mechanical and chemical support ones. The module hosts the living quarters of six crew-members, along with their hygiene, leisure and eating areas, as in the Mars500 project, however all with adjustable sizes and dynamically connected with each other. Transformable design techniques introduce spatial economy, adjustable zoning and increased efficiency within the interior, securing at the same time precise spatial orientation and character at any given time. Specific care is given to the design of the personal quarters in order to create a safe haven for each crew-member, both physiologically and psychologically, to make them feel better and consequently perform better on their mission tasks.

The sensponsive configuration is programmed to exhibit *behavior* in direct relation to human activity. It is based upon two active systems, the Activity Evaluation System (AES) and the Response System (RS), with combined action that is always controlled by the user. The AES includes various types of sensors that measure and quantify human and environmental related information, for example, temperature, humidity and spatial presence. It also includes precision motion tracking devices that record movement patterns as well as cameras connected with facial expression analysis software able to identify emotional states of an individual. The AES monitors the daily activity of the astronauts in order to find patterns of activity, understand the context of actions and moreover to assess the psychological condition of the crew

members. If it finds cause for intervention AES will give way to the RS which employs smart materials, controllers and actuators in order to perform subtle changes in the environmental factors, both spatial (volume, surface) and ambient (audio, visual, olfactory, haptic), and induce a desirable spatial and/or psychological condition that is beneficial for the astronauts' comfort and well being. Prior to a mission, both systems will go through a training process to form a database with the crew-members' physiological data, phycological profile, as well as personal preferences and wishes.

The proposed habitable module is an effective example of sound architectural design for manned expeditions beyond Earth orbit, employing human factors and robotics to provide a solution for habitable environments in the future missions to explore the cosmos.