SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Strategies & Architectures as the Framework for Future Building Blocks in Space Exploration and Development (1)

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PANORAMA OF IDEAS ON STRUCTURES AND MATERIALS FOR THE DESIGN OF A MULTI-MODULAR MANNED SPACE STATION LOCATED AT EML2.

Abstract

Released in September 2011 by the ISECG, the Global Exploration Roadmap brings under light a way of exploring a large array of destinations situated beyond low-Earth orbit by following a "Moon"-"near-Earth asteroids" and "Mars" pathway. Strong emphasis is put on the need to come up with new and modern space station that would conform to the concept of "Deep Space Habitat". In order to widen the human presence in the Solar System, this paper shows some pioneering design ideas on materials and structures to build a seven-module manned space station located at Earth-Moon Lagrange point n2 (EML2). In order to meet all the challenges posed by space environment, many material and structural concepts have been proposed, all of which will be thoroughly analyzed in the present study. The space station structure examined here is based around seven cylindrical habitable modules, each one fulfilling a specific function - leisure and daily life, experiments, Extra Vehicular Activity module, Space Medical Center - and two extra spherical sections, used both for daily life activities and docking tasks. Making use of Finite Element Analysis, various structural modeling have been analyzed in a first part: rectangular panels, circular and annular panels, cylindrical thin-walled shells, stiffeners, ring-shaped frames, sandwich and composite structures, fuel tanks, trusses and truss frames and photovoltaic solar generators. Taking the challenges and constraints of deep-space environment into account and adding up the effects of solar winds in deep space environment, each component has been put through a series of tests and checks to then be optimized in light of strength, thermo-elastic, modal and dynamic analysis. A thorough investigation of the dock configuration has also been performed. It consisted in testing and optimizing the anchor points between the spherical modules and the cylindrical ones. To make the study at hand as thorough as possible, a second part will therefore focus on and examine a wide array of materials used to build spacecraft and stations: metal alloys, composite materials, sandwich honeycomb core, inflatable anti-solar-radiation and (at the option of water storage inside), and see-through glass-like materials. Eventually, a conclusive part will then confront both module and material analysis. The goal here will be to come up with an optimized solution that can answer the question of how to build a space station fit for Deep Space Habitat.