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MORPHOLOGY OF POLYHEDRAL SPACE HABITAT MODULES - IDENTIFYING THE IDEAL FORM USING MULTI-CRITERIA ANALYSIS

Abstract

Over the past fifty years, the form and function of space habitat modules have remained largely unchanged. While cylindrical modules are simple to transport and deploy, their limited size poses a challenge to their efficiency and usability. In contrast, large space habitat construction projects are costly and present logistical difficulties. The development of polyhedral modules could bridge the gap between these two approaches, allowing for modular, polyhedral units to be assembled and linked together to create larger habitats more efficiently and with less risk. However, identifying the most suitable polyhedral form remains a critical question.

Previous research has explored the construction of polyhedral modules, but little attention has been given to identifying the ideal form. This is a crucial issue because the first module deployed will likely set the standard for subsequent modules and any inefficiencies will be perpetuated. Therefore, it is essential to identify the optimal form prior to constructing any prototypes.

This research paper employs weighted analysis to compare the common Platonic solids and common plesiohedrons using multiple variables, including comparative face tension, comparative joint stress, volume to surface area ratio, and face size to volume ratio, among other quantitative and qualitative analyses. The results demonstrate that the rhombic dodecahedron is a particularly suitable candidate compared to other forms analyzed. Thus, the rhombic dodecahedron should be considered the standard polyhedral form for future research involving the development of polyhedral modules.