Paper ID: 51089
student

IAF MATERIALS AND STRUCTURES SYMPOSIUM (C2)
Interactive Presentations - IAF MATERIALS AND STRUCTURES SYMPOSIUM (IP)

Author: Mr. Brandon Mackey
Clarkson University, United States, mackeybt@clarkson.edu

OPTIMIZING THE GEOMETRIC PARAMETERS OF A SPACE MODULE'S OUTER SHELL DURING A ROCKET'S FLIGHT SEQUENCE

Abstract

Over the course of the last decade, the Moon to Mars Mission proposed by NASA, as well as missions proposed by private aerospace companies, require the use of space modules in low Earth orbit, Mars orbit and cis-lunar orbit. NASA's philosophy to reach Mars is to create a crew tended spaceport in cis-lunar orbit for spaceship refueling, research, and living quarters for astronauts. With the International Space Station as the only crew tended space station, analysis and design of manned space modules are scarce in the literature. Any payload sent into orbit experiences forces, vibrations, and heat transfer during the rocket's flight sequence. Manned space modules require a structural design that minimizes the material while withstanding the loads and vibrations induced on the module during the rocket's flight sequence to orbit. An engineering procedure is presented using small deflection theory, Donnell-Mushtari 8th order equations, and dynamic lumped mass models to optimize the structural geometry of a manned space module. The analytical solution is supplemented with empirical data and finite element analyses codes. Finite element codes incorporate shell elements in the static structural model to supplement the axial and lateral loading conditions. A modal analysis model in ANSYS is used to supplement the lumped mass model. The two outer shells of concern are a thin monocoque cylindrical shell and a honeycomb sandwich shell. An example problem is solved to demonstrate how the geometric optimization process is used for a particular manned space module.