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Benefits and Limitations of Analysis in the Design of Pressure Restraint Structures for Inflatable Space Habitats

Andrew Lennon[1] and Maxim de Jong[2]

[1] ABL Engineering
Clonmel, Co Tipperary, Ireland
e-mail: andrew.lennon@abl.ie web: www.abl.ie

[2] Thin Red Line Aerospace
Chilliwack, British Columbia, Canada
e-mail: maxim@thin-red-line.com

Inflatable structures have many benefits for use as space habitats, such as the high ratio of deployed to stowed volume and the ability to take advantage of directional stress behaviour in the structure. The two projects that set the standard for inflatable space habitat technology are Genesis by Bigelow Aerospace and TransHab by NASA. Genesis I was launched in July 2006 and became the first craft on orbit to successfully incorporate a flexible, high-stress, pressure restraint shell. Genesis II followed in June 2007 and repeated the success of its sister craft.

The Genesis spacecraft uses a pressure restraint structure primarily designed, engineered and manufactured by Thin Red Line Aerospace. This presentation draws on the lessons learned from Genesis to show the benefits and limitations of analysis in the design of pressure restraints for inflatable habitats.

Assumptions and data must be carefully examined to ensure that analysis matches physical reality. Inflatable structures display highly non-linear behaviour and meaningful analysis can be difficult. A particular issue is the large degree of variability in the physical properties of the materials used for the construction of inflatable structures. Simplified models provide critical information for the design of the structural geometry and selection of the pressure-restraining structure. The number of variables in the model must remain small if these models are to provide useful information to the designer. Including of all parameters deemed significant can lead to models that become too complex for meaningful application.