

Composite Design and Manufacturing Development for Human Spacecrafts

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Abstract

The Structural Engineering Division at the NASA Johnson Space Center (JSC) has begun work on lightweight, multi-functional pressurized composite structures. The first candidate vehicle for technology development is the Multi-Mission Space Exploration Vehicle (MMSEV) cabin, known as the Gen 2B cabin, which has been built at JSC by the Robotics Division. Of the habitable MMSEV vehicle prototypes designed to date, this is the first one specifically analyzed and tested to hold internal pressure and the only one made out of composite materials. This design uses a laminate base with zoned reinforcement and external stringers, intended to demonstrate certain capabilities, and to prepare for the next cabin design, which will be a composite sandwich panel construction with multi-functional capabilities.

As part of this advanced development process, a number of new technologies were used to assist in the design and manufacturing process. One of the methods, new to JSC, was to build the Gen 2B cabin with Out of Autoclave technology to permit the creation of larger parts with fewer joints. An 8-ply pre-preg layup was constructed to form the cabin body. Prior to lay-up, a design optimization software called FiberSIM was used to create each ply pattern. This software is integrated with Pro/Engineer to allow for customized draping of each fabric ply over the complex tool surface. Slits and darts are made in the software model to create an optimal design that maintains proper fiber placement and orientation. The flat pattern of each ply is then exported and sent to an automated cutting table where the patterns are cut out of graphite material. Additionally, to assist in lay-up, a laser projection system (LPT) is used to project outlines of each ply directly onto the tool face for accurate fiber placement and ply build-up. Finally, as part of the OoA process, a large oven was procured to post-cure each part.

After manufacturing complete, the cabin underwent modal and pressure testing (currently in progress at date of writing) and will go on to be outfitted and used for further ops usage.

Author Background

Doug has been worked as a designer in the Structural Engineering Division at JSC for just under two years. His focus is on non-metallic structures with his main projects including the MMSEV Composite Cabin and Inflatable Structures. He has become the lead composite ply pattern designer using FiberSIM at JSC and is the engineering expert in a number of manufacturing tools including an automated cutting table and laser projection system, both used for composite lay-up. He graduated from the University of Illinois at Urbana-Champaign in May 2011 after completing three co-op tours at JSC in the Structural Engineering Division and Mission Operations Directorate. He is currently pursuing a Masters Degree in Mechanical Engineering through an online program, also from the University of Illinois.