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A COST EFFECTIVE METHOD FOR CUBESAT STRUCTURES USING 3D PRINTING

Abstract

The ESO organisation (ESTACA Space Odyssey) is designing and manufacturing composite-based structures for 1U Cubesat, as part of the ESTACA engineering School in Paris, France. The main goal is to design and test new processes for composite structure based on 3D printing allowing complex 3D-shaped designs.

The structure of the satellite is made of composite formed out of a pattern using fused deposition modeling. The Cubesat is designed to accommodate 5 electronic cards for experiments and a motherboard placed on racks in an external composite shell.

The material used for the printing of the pattern is Polyvinyl-Alcohol a water-soluble material (PVA), several tests have been made to study the compatibility of the PVA with the epoxy resin used for the composite. The PVA has been chosen for its good solubility in water, a non-toxic liquid. Furthermore its low melting temperature makes it easily printable with a large range of 3D printers.

The internal rack structure is composed of commercial off-the-shelf components and aluminium U-shaped profiles inserted in the plastic pattern before covering the pattern with the composite material by draping. Once the external composite shell is fully dried up and correctly attached to the internal rack structure, the internal PVA shape is dissolved.

Another solution is currently under study. The concept is to print the rack structure with a non soluble material directly inside the PVA and have it stuck to the external composite shell. The two methods will go under acoustic and vacuum testing to verify the compatibility of the system with space and launcher environments. Several plastic for the rack structure are already being tested in a vacuum.

Several covering methods have been tested for the outer shell composite material to ensure a maximal compatibility with specific 3D-shapes. The shape of each of the Cubesat's sides has been optimized and simulated using finite-element calculus method on the ABAQUS software.

The U-shaped architecture of the rack allowed for a full access of each card making them easily and quickly replaceable. Generaly, CubeSat structures are made by threading the cards one in an other so

that they cannot be accessed without pulling out the cards situated above. The system works mainly like a server bay.

This method under development is low cost, ready to use and highly flexible and can be applied to a large range of 3D structures allowing for further innovations in the field of complex shape design.