

Componeering Inc.

Aerospace Electronics

Finland



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ANSYS® Mechanical™

Overview

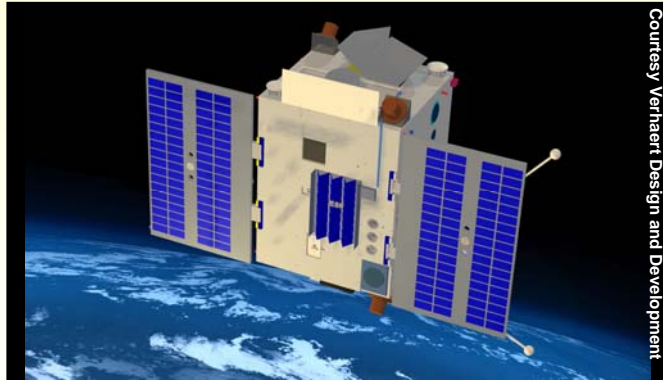
Scientific, observation and reconnaissance missions are often performed by low-orbiting micro satellites. These systems are much smaller and more compact than larger telecommunications satellites, so space is severely limited and heat is more difficult to dissipate from closely packed electronic components. Traditionally, satellite electronics housings are made of aluminum. This material is lightweight, has adequate heat dissipation, and provides good protection against ambient spatial radiation. In one recent study, the European Space Agency (ESA) investigated the feasibility of fabricating these housings of composites to determine if this type of material systems could provide the same heat dissipation as aluminum but with less mass.

A carbon fiber reinforced plastic (CFRP) composite housing designed at the Laboratory of Lightweight Structures at Helsinki University of Technology had a tungsten foil embedded inside the laminate structure for radiation protection. Heat dissipation for the structure was provided by layers of plastic reinforced with high-conductivity K1100 carbon fibers. Analysis for the composite housing was performed by Componeering Inc., which specializes in simulation and design of high-performance composite structures. Their core business focuses on ESAComp software, which they developed for study of composite laminates, sandwich constructions and structural elements made of laminates.

Testimonial

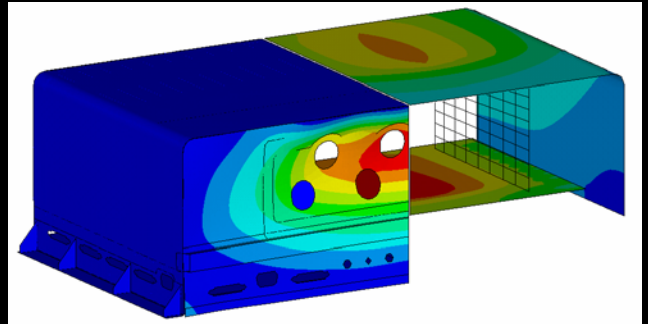
"The ability of ANSYS to work well with ESAComp, to provide a robust parametric model representing all the different components and to reliably perform both structural and thermal analyses was key to the speed and accuracy in successfully completing the ESA study. With the help of this level of advanced analysis, the behavior of the structure could be properly understood, the design of the composite housing was optimized to provide a mass saving of 29 percent over a comparable aluminum housing, and the project was completed in only 18 months from the kick-off meeting to the final presentation of results."

Harri Katajisto
R&D Engineer, Componeering



The Proba 2 micro-satellite has instruments to make solar observations and space weather measurements. The electronics housing from this micro-satellite was used as a reference application in the ESA study.

Courtesy Verhaert Design and Development



The same ANSYS model was used for both structural and thermal analysis in determining characteristics such as the thermal balance of the laminate structures and mode shapes of the system.

Challenge

Designing composite structures with sandwich-type elements or layered solid laminates is very challenging due to the anisotropic behavior of the material. Moreover, the design depends on multiple variables such as material selection, numbers of layers, layer orientations and stacking sequence. In the composite housing under investigation, the K1100 fibers exhibit very low failure strain and break easily when bent on a small radius. Also, mismatches in coefficients of thermal expansion between the composite housing and aluminum wedge locks and support structures cause deformations when the structure is subjected to temperature change. Because of these complexities, determining structural integrity and thermal balance using conventional analysis methods can be an extremely cumbersome task.

Solution

Laminate design of the housing was performed using ESAComp software, with lay-ups and material data exported to ANSYS Mechanical for modeling the structure using beam and shell elements. Results from ANSYS were exported to ESAComp for detailed post-processing. This capability was used, for example, in studying high interlaminar shear (ILS) stresses close to inserts attaching different panels. Creating simulation models was facilitated using ANSYS Parametric Design Language (APDL), which could be linked to ESAComp for optimizing the design. ANSYS also was used to perform modal analysis for natural frequencies up to 800 Hz. ANSYS node-to-surface and surface-to-surface contact elements represented numerous adjoining surfaces of composite housing and aluminum wedge locks and support structures.

Benefits

In this project, ANSYS worked smoothly in exchanging data with ESAComp. Time was saved in generating simulation models by importing required data directly from ESAComp into ANSYS, as well as taking advantage of automated features of ANSYS contact elements and power of ADPL for parameterization. Considerable time was saved through the ability to use the same ANSYS model for both structural and thermal analyses. In the course of the project, details of the composite structure were studied with simulation before going through the time and expense of building physical prototype breadboard models. In this way, the modified structure could be analyzed and feedback provided almost instantly to the design team.