Vibro-acoustic analysis of aeronautical composite structures

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Abstract.

In the preliminary design phase, predictions of aircraft interior noise levels are made using simple approaches: the Finite Element Method (FEM) is used when the near field noise excitation is due to the propeller and the acoustic energy is concentrated in the low frequency range (0-300 Hz); the Statistical Energy Analysis (SEA) is employed when the noise excitation is due to Turbulent Boundary Layer and higher frequencies are involved.
Nevertheless, there is a lack of reliable and efficient numerical models, valid for innovative aircraft configurations, able to predict accurately the radiated acoustic power of structures made of advanced materials, such as composite and metamaterial. The availability of a numerical tool is a fundamental need for a realistic interpretation of the results produced.
First of all, we will present the results obtained by the vibroacoustic simulations performed with both Actran (FEM) and VA one (SEA) in the cabin of a regional aircraft, in which the fuselage walls were made of sandwich material with composite skins and metamaterial core. Finally, this work aims to develop advanced finite element models based on the Carrera Unified Formulation (CUF) for the vibroacoustic analysis of the same structures. Indeed, the powerful notation of the unified approach in CUF permits to obtain a wide class of refined 2D theories with a unique formulation, providing an optimal tool to arbitrarily describe the complicated effects that can arise in complex composite layouts at both low and high frequency ranges.