ABSTRACT

Traditionally, noise performance analyses in military aero structures have been pushed into the background, behind other considerations such as structural performance or weight optimization. In recent years, this scenario has changed and the design of acoustically optimized structures is nowadays seen as a competitive advantage of paramount importance.

Here, emphasis is set in designing an effective analysis procedure for comparing the noise performance (radiated interior noise) of different cockpit structure configurations. This procedure should be implemented at early design stages and it can be applied to other parts of the aircraft where radiated interior noise must be considered.

This project developed by AIRBUS Defense & Space and ALTRAN is included in the European Clean Sky GRA Research Programme, whose aim is to define advanced aircraft configurations that will permit weight reductions and high level of operative performances regarding polluting emissions and noise generation levels.

Vibroacoustic performance of a fuselage section of a medium weight aircraft was evaluated by means of a FEM/FEM structural/acoustic model using the software packages MSC NASTRAN and ESI VA ONE. Different fuselage design configurations combining metallic and composite materials were evaluated. The analysis considered the effect of integrated damping treatments in form of viscoelastic materials with different properties and various degrees of surface coverage.

The vibroacoustic models were developed with the aim of reproducing structural dynamic and cabin interior acoustic response up to 400 Hz, which required a relatively detailed finite element mesh. The areas incorporating viscoelastic materials were modeled using equivalent shell elements, whose properties were derived using an adapted implementation of Ross-Kerwin-Ungar equations for damping materials. This approach allowed considering in the
analysis frequency-dependent viscoelastic material properties in terms of elastic modulus and damping, while maintaining acceptable total model size and computation time.

The analysis was done in two steps. In a first step, a frequency response analysis was performed by means of a finite element model of just the fuselage structure using MSC NASTRAN. Different excitations, defined in form of point forces as well as distributed pressure loads, were applied on different structural locations.

In a second step, the fuselage structure FEM was coupled with an acoustic finite element model of the cabin using ESI VA ONE. The exterior acoustic domain was not considered in the analysis. Cabin acoustic modes were calculated and the structural frequency response results derived in the first step were fed into the coupled vibroacoustic model in VA One. This vibroacoustic model allowed determining the impact on interior acoustic levels resulting from structural modifications.