NUMERICAL ACOUSTIC RADIATION MODELS

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INTRODUCTION

A phenomenon difficult to identify and quantify is the complex relation between structural vibrations and the sound caused by those vibrations (structure borne sound). This relation is important since a large percentage of the noise pollution is of structure borne nature. Whenever a mechanical structure producing vibrations is conceived, measures should be taken to reduce the sound inherent to those vibrations. To do this efficiently the sound radiation mechanism must be first identified and quantified in appropriate models. The theoretical base for such a model is known since more than a century, and is given by the solution of the 3d wave equation, with the surface velocity of the vibrating structure as boundary condition. Several theoretical studies have been devoted to this subject in the past and have resulted in analytical formulas which
are only valid for a limited number of relative simple source geometries such as axisymmetric structures (spheres, cylinders) or flat plates. Analytical solutions for the general radiation problem do not exist, numerical solutions are conceivable but rather complex due to numerical instability problems, and hence require considerable computer power.

This paper deals with the implementation and use of a numerical radiation model based on a solution of the Helmholtz integral equation, the model has been integrated into a global sound optimisation philosophy by combining finite element modeling (FEM), modal analysis and the mentioned radiation model. Hereby the vibration patterns generated by the FE model or the experimental modal analysis identification serve as input to the radiation model. Linking FEM results to a radiation model yields an optimal tool for judging a new design with regard to its sound radiation, provided that a dynamic finite element model of the concerned design is available. Linking data from experimental modal analysis identification to a radiation model creates on the other hand the possibility to predict the impact of local structural modifications on the sound radiated by mode shapes at resonance frequencies, which is important for trouble shooting applications or for prototype optimisation. Applying this method, on a real life structure such as a combustion engine the influence of changing locally the stiffness, mass or damping on parameters such as the radiation efficiency or the radiated sound power can be predicted.