Modelling the Sound Radiation by Loudspeaker Cabinets

M. Cobianchi[1], Dr. M. Rousseau[1]

[1]B&W Group Ltd, Dale Road , Worthing, BN11 2BH West Sussex, England

Introduction: loudspeaker cabinets should not contribute at all to the total sound radiation, but aim instead to be a perfectly rigid box. Two phenomena contribute to the total SPL radiated from the cabinet: the acoustic field exciting the wall vibration and leaking by transmission through the wall, and the direct mechanical excitation of the cabinet by the reaction force related to the drive units operation, the subject of this research.

Figure 1. loudspeaker system B&W 800 Diamond

Computational Methods: a 3D model of the cabinet was simulated in three steps:

•A Stationary study to solve the curvilinear coordinate system used for the orthotropic properties of the wrap (diffusion method)

•A solid mechanics - Eigenfrequency study and Frequency Modal Domain study

•A solid mechanics - Frequency Domain study

Due to the left-right symmetry of the system, only half of the structure is used. Thin Elastic Layers are used to simplify the joints modelling. The model is constrained with a “Fixed Constrain” boundary condition at the spikes tips.

The materials used in the assembly are:

•curved plywood external wrap
•internal MDF stiffening panels (Matrix™),
•Aluminium plinth and drive unit chassis
•Steel and Neodymium loudspeaker motor
•Water based glue joint

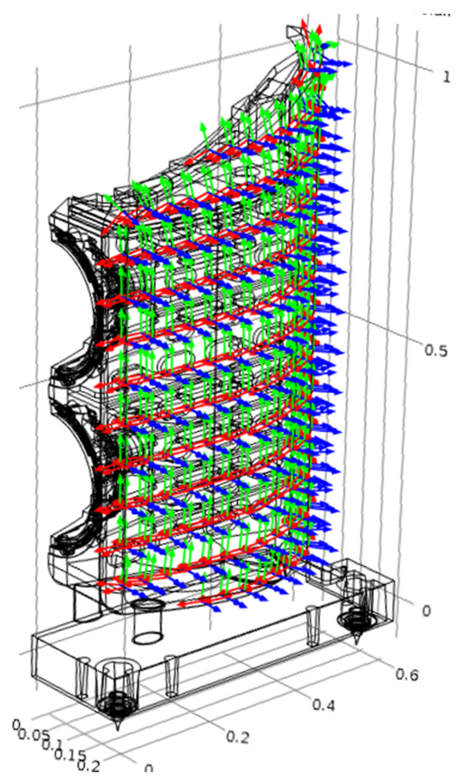

Figure 2. wrap curvilinear coordinate system

Our forced response simulation assumes a unitary force input applied to the magnetic motor. A linear lumped parameter electromechanical model which describes the transducer cone (assume infinitely rigid) and the electrical impedance of the coil was used to describe the electromechanical transfer function between the input electrical voltage applied across the transducer terminal and the motor output force. This approach allows us to simply post-process the model output quantities.

Results: The purpose built drive units were driven while the velocity of each point on a user defined grid over the wrap and front baffle (the two largest radiating surfaces thus the most important) were measured with a Polytec laser Doppler scanning system. The measured modal shape and frequency, on the left, are compared below to the predicted data, on the right, for the front baffle, for the first relevant modes.

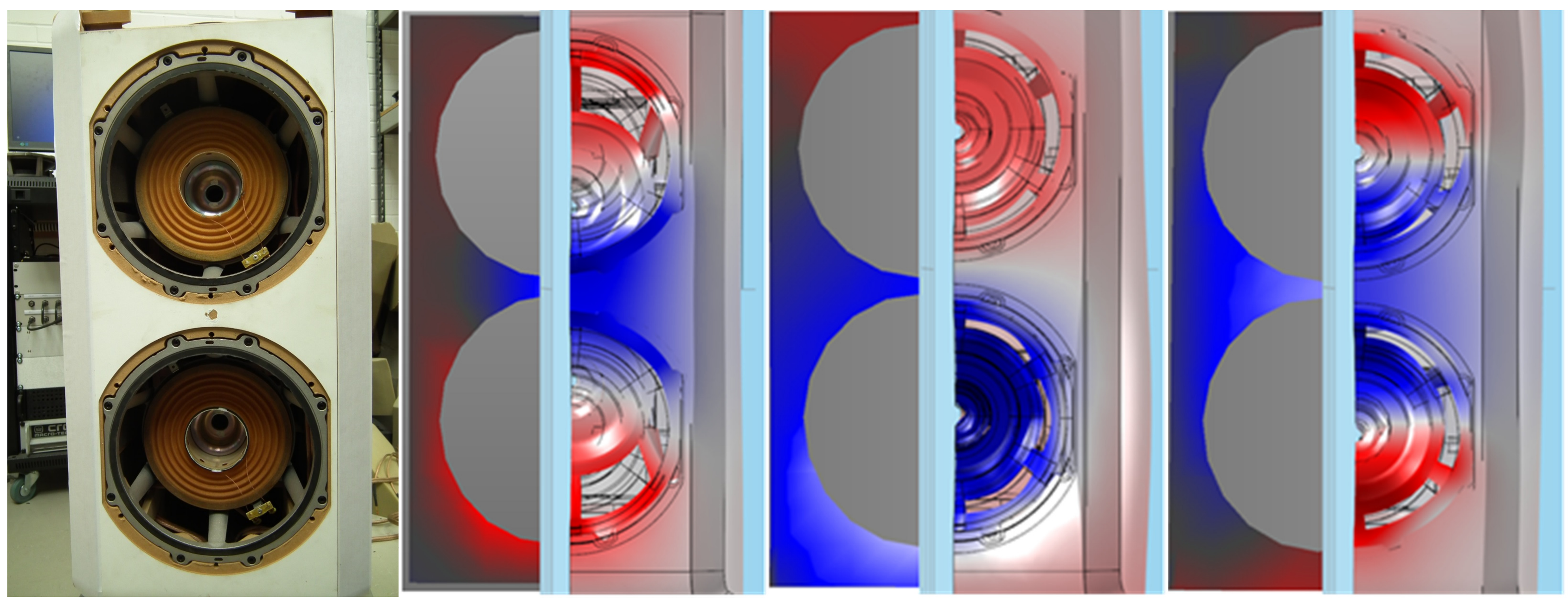

Figure 3. Purpose built drive units on the left, and the first three vibration modes of the baffle at 222/281Hz, 313/466Hz, 603/690Hz

As comparing animated simulated forced responses to measured responses can be visually misleading, the measured and predicted acceleration magnitude spectra were also overlaid for two critical locations (cabinet front baffle and middle of side baffle)

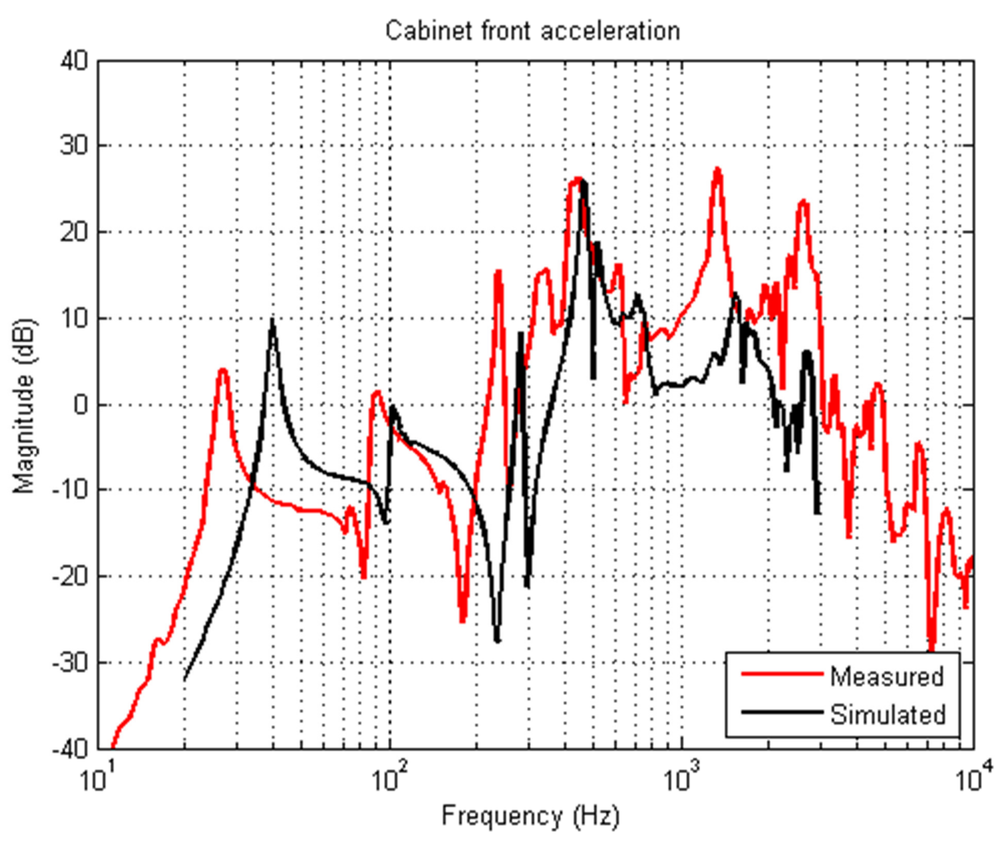

Figure 4. cabinet front acceleration

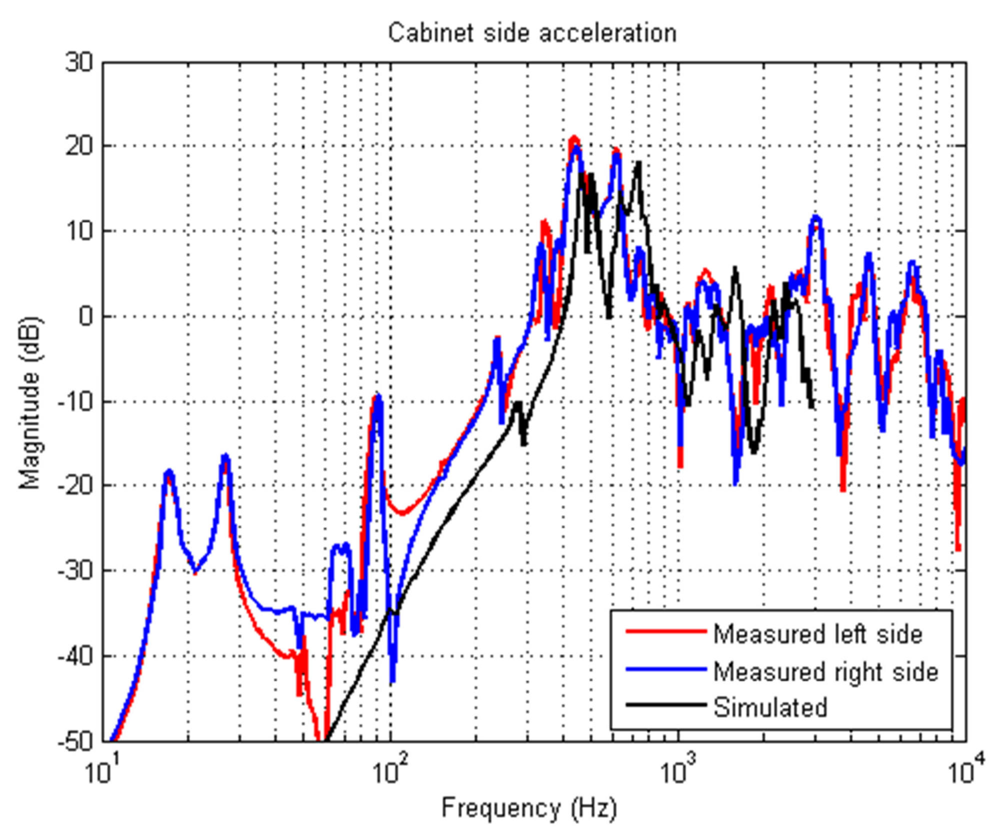

Figure 5. cabinet side acceleration

Conclusions: Simulated accelerations show good agreement with measured results; the model is able to accurately predict trends even if overestimating the resonances frequency values. Further work should be aimed at improving the accuracy of modes frequency values prediction and evaluating through simplified BEM formulations the total acoustic power radiated by the cabinet.

Excerpt from the Proceedings of the 2014 COMSOL Conference in Cambridge