Loudspeaker Simulations in a Car Cabin

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Introduction: For automotive applications, simulation methods are used to optimize the position and orientation of speakers to get the best acoustic performance[1][2]. The goal of this study is to improve the audio simulation accuracy. For a woofer mounted on a rigid enclosure, a simulated and measured sound pressures were compared.

Figure 1. Loudspeaker in the vehicle interior

Computational Methods: A 3D scan of the vehicle interior was done. This point cloud was post-processed to deliver the cabin mesh.

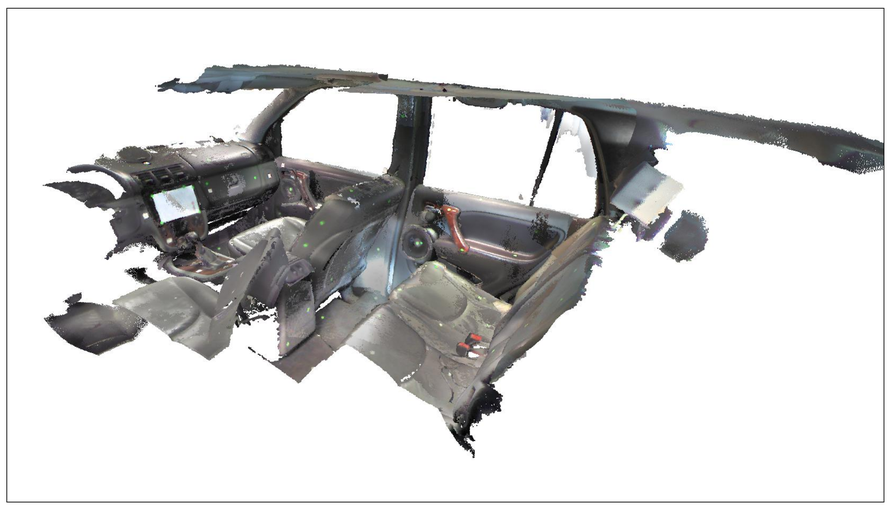

Figure 2. 3D scan of the car cabin

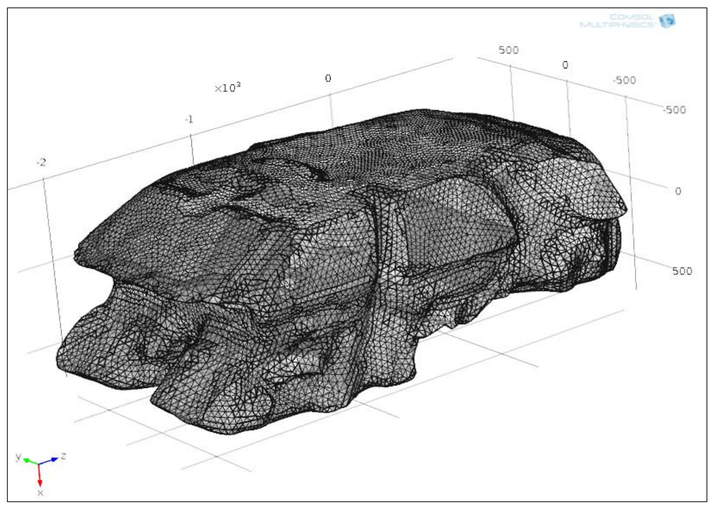

Figure 3. Mesh of the car cabin

Frequency dependent absorption coefficients, described in the literature[3], were optimized to get the best correlation between the simulated and measured sound pressures at the 4 seat positions. The speaker is modeled as a rigid flat piston (valid below 1kHz since the speaker membrane is rigid).

Results:

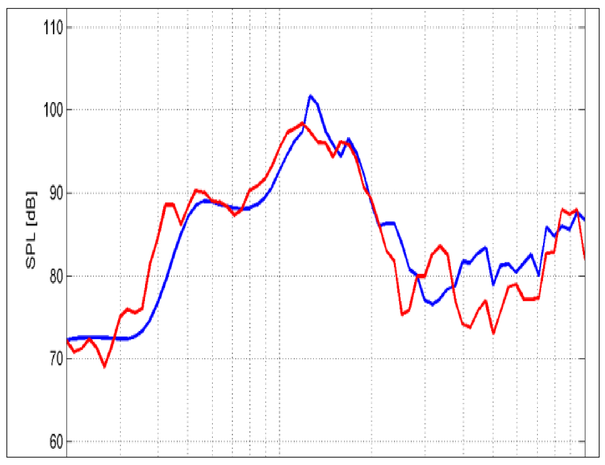

Figure 4. Pressure on Array A

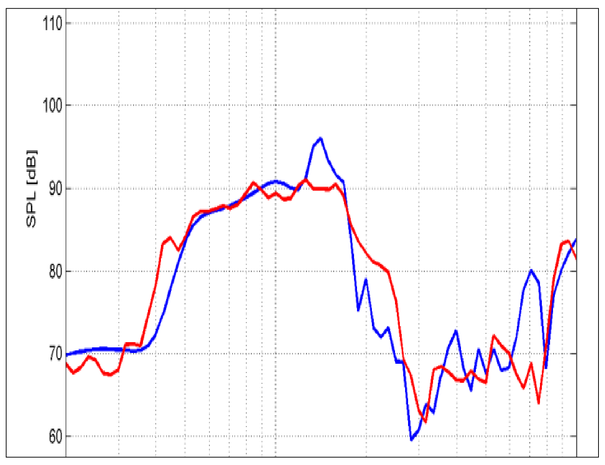

Figure 5 Pressure on Array B

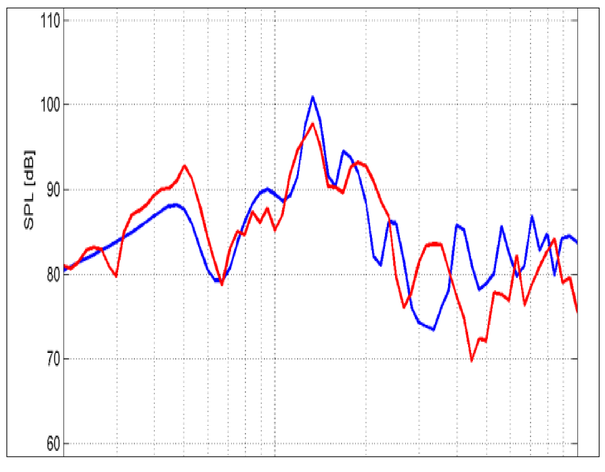

Figure 6. Pressure on Array C

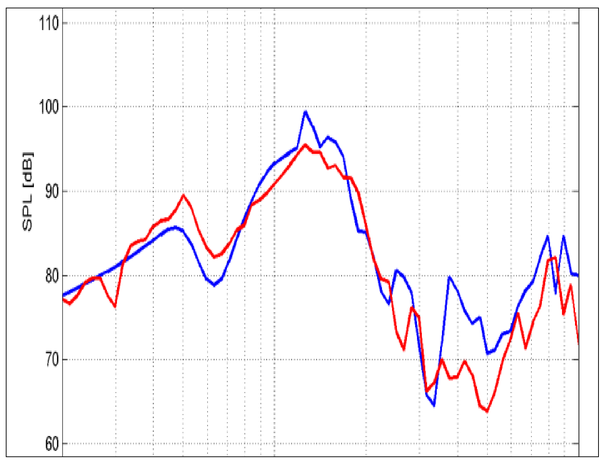

Figure 6. Pressure on Array D

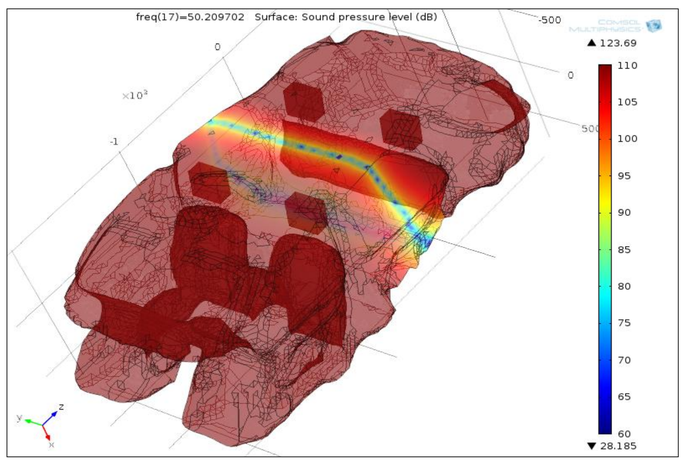

Figure 7. Simulated sound pressure

Conclusions: The pressure comparison shows a very good correlation between the simulated and measured data. A relative difference shows that 62% of the predicted frequency bins have a difference less than +/- 3 dB

References:

1. J. Cox and Peter d'Antonio, Acoustic absorbers and diffusers, Theory design and applications, Trevor, Second Edition, Spon Press, 2009
2. R. Shively, J. Halley, F. Malbos, G. Ruiz, "Optimal Location and Orientation for Midrange and High Frequency Loudspeakers in the Instrument Panel of an Automotive Interior", Presented at the 129th AES Convention, San Francisco, USA, CA, 2010, Preprint 8249
3. Trevor J. Cox and Peter d'Antonio, "Theory, design and applications", Second Edition, p 441-444 (2009)

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