

POLITECNICO DI TORINO
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Honors theses

Comparison of different scattering algorithms in the example of reverberation room and virtual concert hall

by Louena Shtrepi

Tutor: Arianna Astolfi

Co-tutors: Livio Mazzarella, Monika Rychtáriková, Renzo Vitale

A scattering coefficient belongs to one of the most important input parameters in room acoustics simulations. Its effect is mostly pronounced in simplified 3D models where the shape of the room doesn't contribute to general sound diffusion. This contribution deals with comparison of three prediction algorithms, validation of a simulation model and objective and subjective assessment of scattered sound in the example of a virtual concert hall.

First, three different simulating algorithms (used in software ODEON, RAVEN and CATT acoustic) are compared and the implementation of the scattering coefficient is studied.

Later, experiments related to validation of the simulation methods are performed in a case study with boundary controlled acoustical environment (a reverberation room at the Institute of Technical Acoustics (ITA), Aachen). Four different alternatives are investigated: (1) an empty reverberation room, (2) a room with one absorptive wall, (3) a room with one absorptive wall and one scattering wall constructed by vertical wooden beams and (4) a room with one absorptive wall, and a scattering wall consisting out of crossed wooden beams. Simulations results of reverberation times and impulse responses as such are discussed and compared. In all simulations a very good correspondence has been found between the simulation and measurement for the model of the empty reverberation room, but remarkable differences were found for the other models.

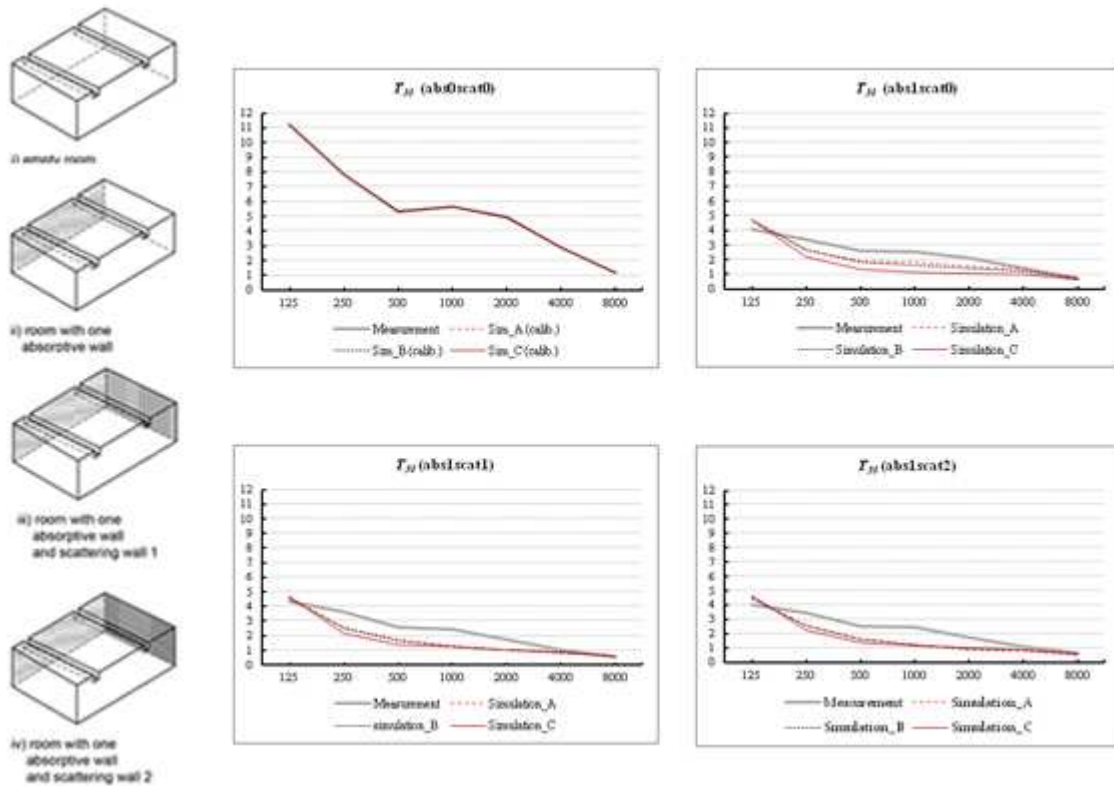


Fig.1 Reverberation chamber models and T_{30} results comparison for the three software

The last part of the research relates to the objective and subjective assessment of the scattered sound in a virtual concert hall. Six different alternatives in the room model were simulated. In each model 6 different scattering coefficients were applied to the interior surfaces of the ceiling, side and rear walls. Analysis has been performed by comparing the results of objective room acoustical parameters on one hand and by investigation on subjective perception of scattered sound (in listening tests) on the other hand.

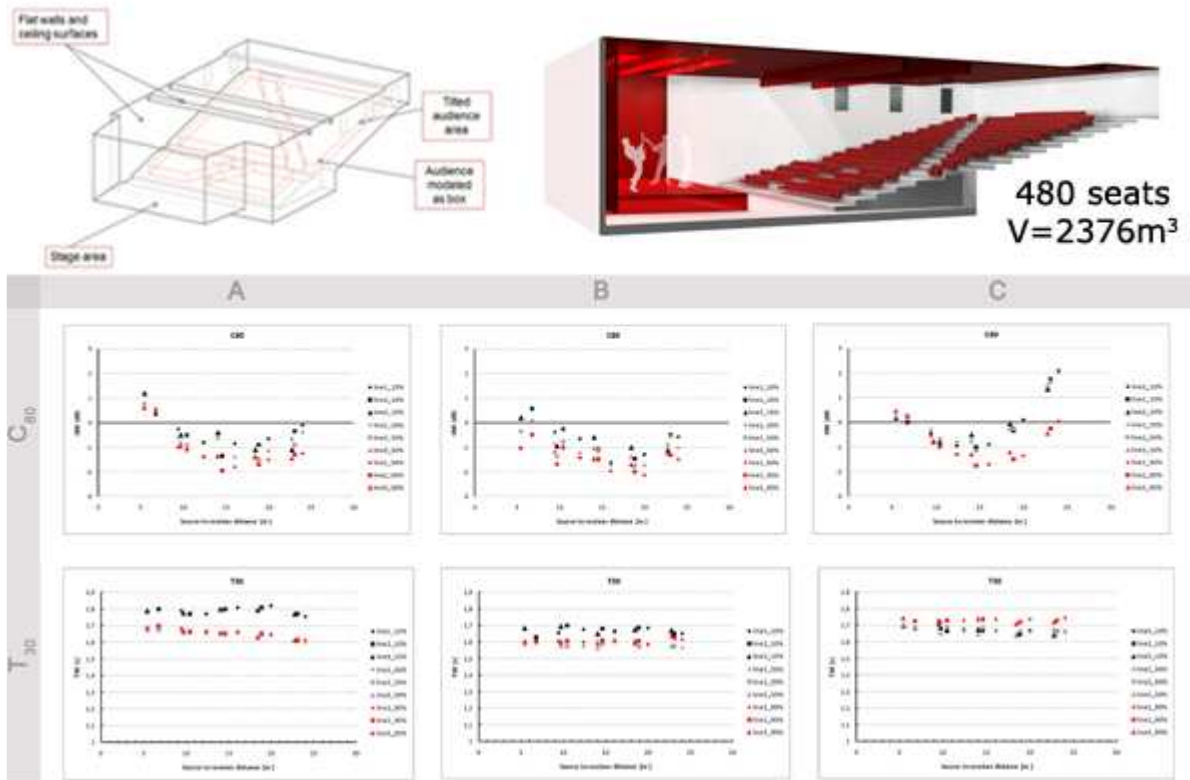


Fig.2 Concert hall model, and C_{80} and T_{30} values for the three software (ABC) estimations

Listening tests applying the 3AFC method were performed with stimuli presented to subjects via headphones by using signals auralized in one of the software (Odeon). Results have shown different JND-s for the different motifs played, which were coherent with the degree of difficulty expressed by listeners for each sample. The tests showed differences of JND for the two listener positions as well.

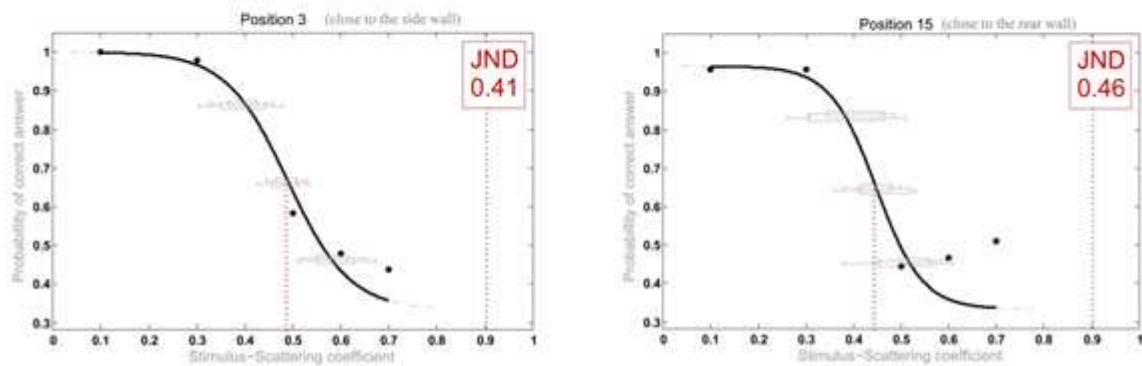
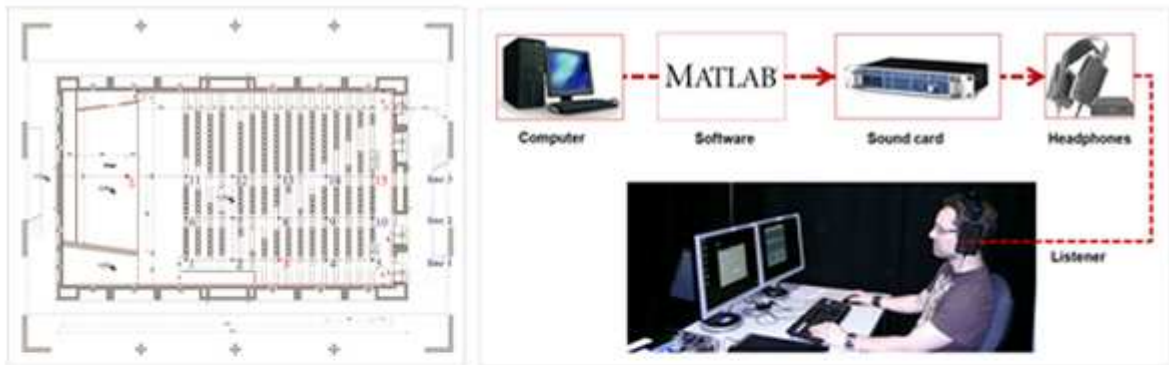


Fig.3 Listening test scheme and Psychometric curves for two listener positions

In conclusion, as scattering is strongly related to geometrical characteristics of surfaces and objects within the room, it seems to be the parameter that affects the interior design of spaces. This makes it interesting for architects and designers to collaborate in multidisciplinary research related to optimal solutions concerning both acoustics and visual aspects of design.

For further information, e-mail:
 Louena Shtrepi: louena.shtrepi@gmail.com