POLITECNICO
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Honors thesis

COURSE OF ARCHITECTURE CONSTRUCTION CITY

Abstract

Prevision of optimal speech intelligibility in primary school classrooms

through simulation of optimal acoustic absorption and diffusion conditions

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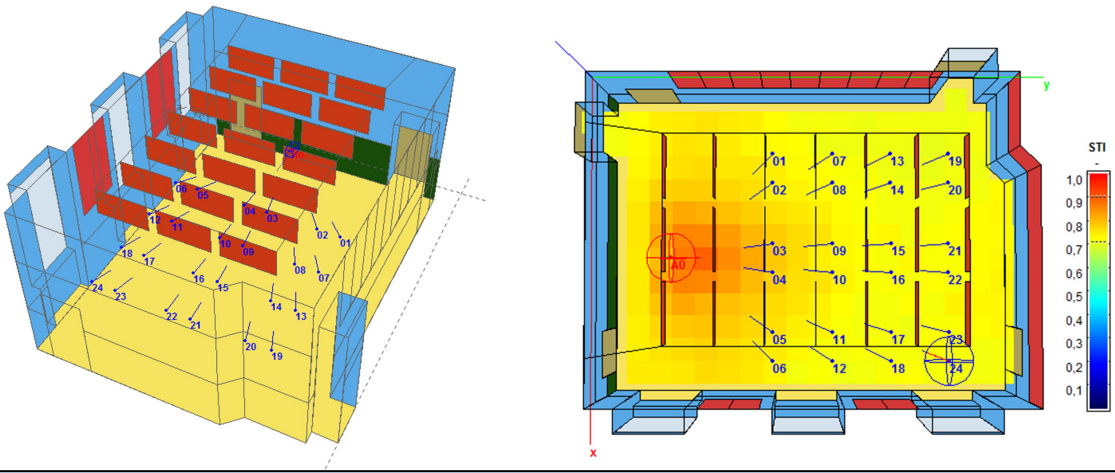
Speech communication is a so natural action that it is easy to underestimate the incredible difficulties our auditory system has to overcome in order to extract meaningful information from the complex auditory signals entering our ears. There are several types of environments in which obstacles to our sound perception may be various, however our auditory system's capacities are particularly stretched to the limit in environments where we try to understand one talker among multiple people speaking at the same time.
Aim of this thesis is to investigate how architecture and room design can help in different aspects of human listening activities and what could be the solutions to optimize the signal comprehension in environments where the clarity of communication has to be the fundamental aspect: school classrooms.

At first, the main aspects of sound have been analysed: both as a physical phenomenon and as hearing sensation after passing our human auditory system; how sound is perceived and what are the main parameters that play a fundamental role in speech intelligibility.
After having studied some general principles of rooms' acoustics and advices to correctly design schools, the experimental route took place: this step can be considered the characterizing one of the thesis and introduced a new way to predict intelligibility through the use of a provisional software which can be used both in case of new interventions and environmental correction.
The experimentation has been carried out in Oldenburg from March to July 2016, at the Carl von Ossietzky Universität. Sound quality has been studied through the virtual simulation of classrooms and the research of the best improvement considering situations where students have to correctly understand the teacher speaking while surrounded by noise sources in other positions of the classroom.
The research for the best configuration was made working on
-surface typology
-surface dimension
-surface position
The best improvement has been obtained for the following configuration:



Chosen configuration and intelligibility distribution evaluated through STI (Speech Transmission Index).

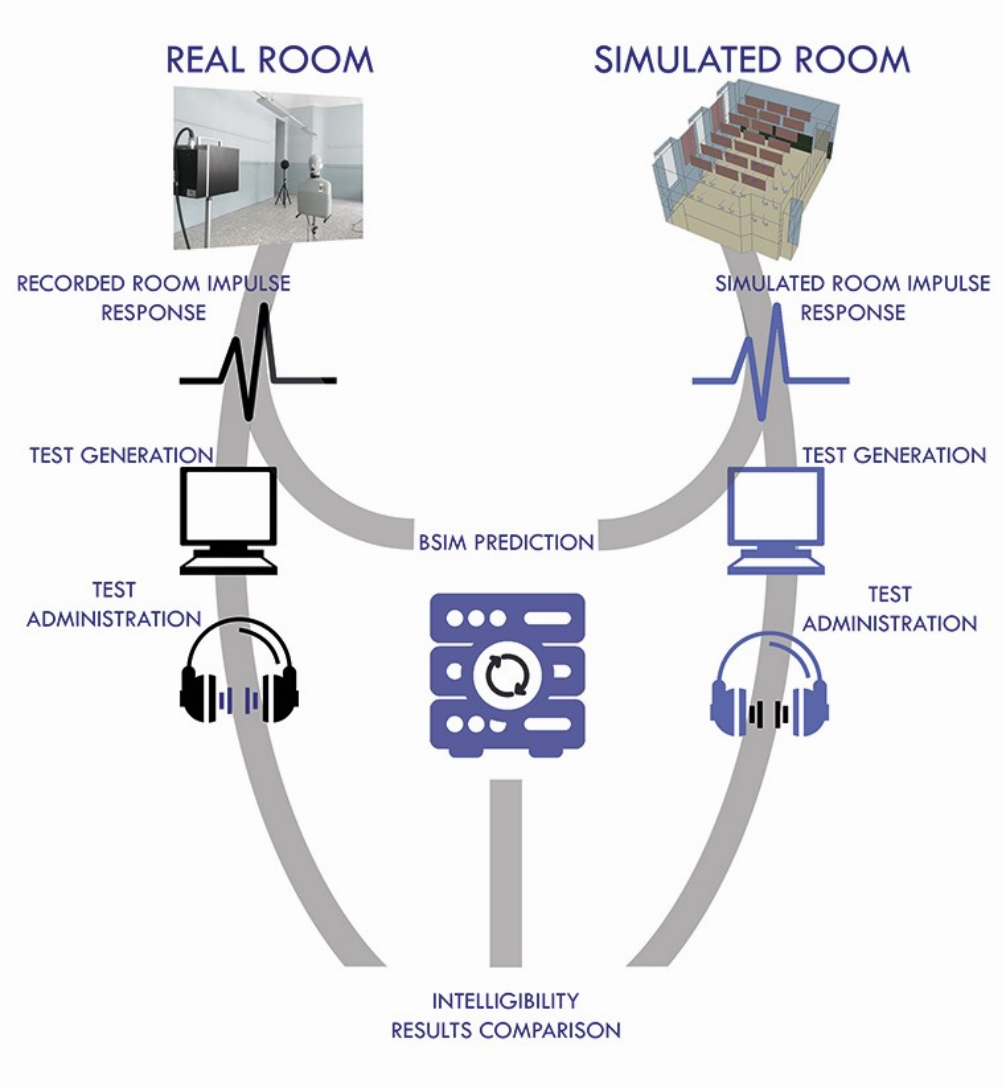
This configuration shows the use of a diffusing panel on the lower front wall (under the blackboard), absorbent panels on the higher side walls and on the higher rear wall; the ceiling has been treated with absorbent baffles applied on a reflective ceiling with an absorbent frame all around.

Three goals have been reached at the end of the work:

-Achievement of optimal classroom acoustics providing a good improvement in speech intelligibility;

-Introduction of an innovative way to acoustically treat classrooms using both absorbing and diffusing surfaces in order to allow early useful reflections to reach the last raws of seats;

-Validation and introduction of a provisional model for intelligibility as a design support tool for architects which is very faithful to the human perception.



Experimental route. Three comparable ways to predict intelligibility. The BSIM prediction allows to skip some steps, save time and avoids to involve a great number of subjects to test.

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