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CASE STUDY

Acoustic simulations

Predicting sound system performance

Case study based on Oslo Atrium building in Oslo, Norway.

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Introduction

Oslo Atrium, originally designed by Nielstorp+ architects in 2003, is undergoing a transformation led by Watrium in Bjørvika. The building and it's interiors will undergo a general renovation which includes public-oriented amenities like restaurants, cafes and a conference center. The main aim is to open the space to the public. Practical upgrades such as new meeting rooms, a roof terrace and an extended facade are part of the project. The building's facade will be extended and architectal features will be added to enrich the streetscape. Oslo Atrium's renovation aims to create a vibrant hub for tenants and the public.

CASE STUDY:	Acoustic simulation for the Public Address and Voice Alarm System
THE VENUE:	Oslo Atrium
LOCATION:	Oslo, Norway
SURFACE:	28,300 m2

Acoustic Simulation

Acoustic simulation allows for the prediction of the soundwaves passage and the performance evaluation of a sound system within a virtual room model using computer software. By simulating different situations, such as loud machinery, ventilation noise, occupancy, or use of different materials, we can optimize sound systems to increase speech intelligibility and design rooms to have less noise and reverberation, making them safer and more comfortable for people.

The Venue

The property spans approximately over 28 000 square meters, across 8 floors, featuring a complex and expanded volume. The building's exterior presents itself as a sleek and substantial cube, with a multitude of cutouts and openings that offer glimpses into the interior space. The main acoustical challege is the large central volume of the Atrium, where long Reverberation Time is expected as a direct result of the room volume. Due to the architecture of the building the potential scope for acoustic adaptation is limited. At the same time the architecture of the builing allows for sound to travel between multiple floors unhindered, with late direct sound adding energy to the sound reflections.

Goal

The goal of the works was to evaluate the acoustic parameters provided by the sound system, as well as to determine guidelines for the Reverberation Time of the rooms and their acoustic adaptation.

Scope of Analysis

- Sound Pressure Level (SPL) generated by the system
- Speech intelligibility described by the Speech Transmission Index (STI)
- Reverberation Time (RT)

The calculations were performed using the EASE (Enhanced Acoustic Simulation for Engineers) software package, using the advanced EASE AURA mode.

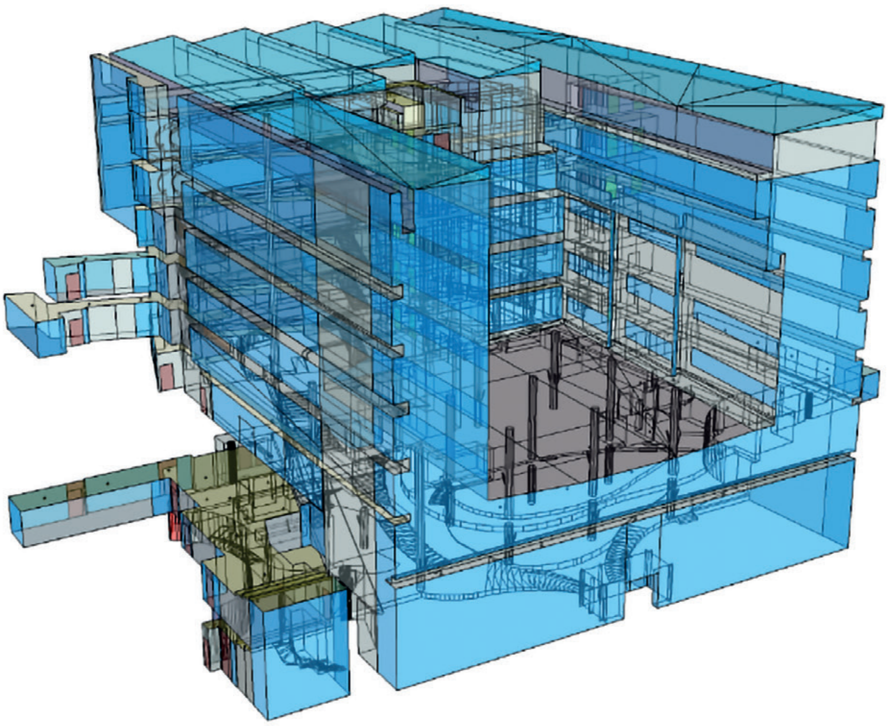
Qualification Criteria Applied

1. In order to provide fair speech intelligibility the system should be able to generate a Sound Pressure Level sufficiently exceeding the background noise generate by people and smoke ventilation systems. In this case the target is for the PAVA system to reproduce male speech signal equivalent at a Sound Level of no less than 86dB SPL(A).

2. Speech intelligibility is described by the Speech Transmission Index (STI) – a parameter showing the likelihood of syllables, words and sentences being comprehended. The parameter is standardized by the IEC 60268-16 and normalized in the 0 – 1 range. The target STIPA (Speech Transmission Index for Public Address) is in this case an average of 0,60.

3. Reverberation Time (RT) is an acoustic parameter describing the rooms susceptibility for creating sound reflections. Long Reverberation Time shall in practice make it not possible to achieve fair speech intelligibility, due to the large energy of reflected sound within the room. Given the surface and room height it is critical for the Reverberation Time not to exceed a maximum of 2s.

Room Model



Loudspeakers

Total of 219 x EN54 certified loudspeakers were used. Each loudspeaker was represented by its mathematical EASE model. The 5 types of loudspeakers used in the project were:

» **ABT-W6** - 6 watt surface mounted cabinet speakers,

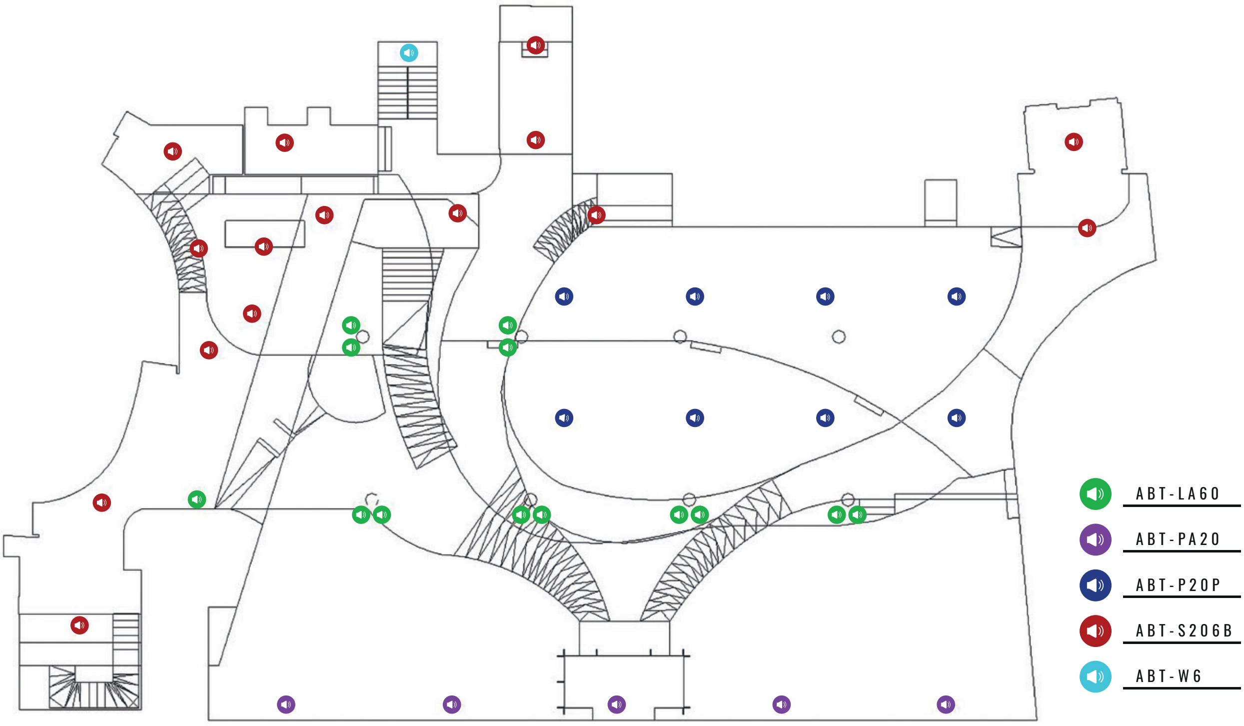
» **ABT-S2010** - 10 watt recessed ceiling speakers,

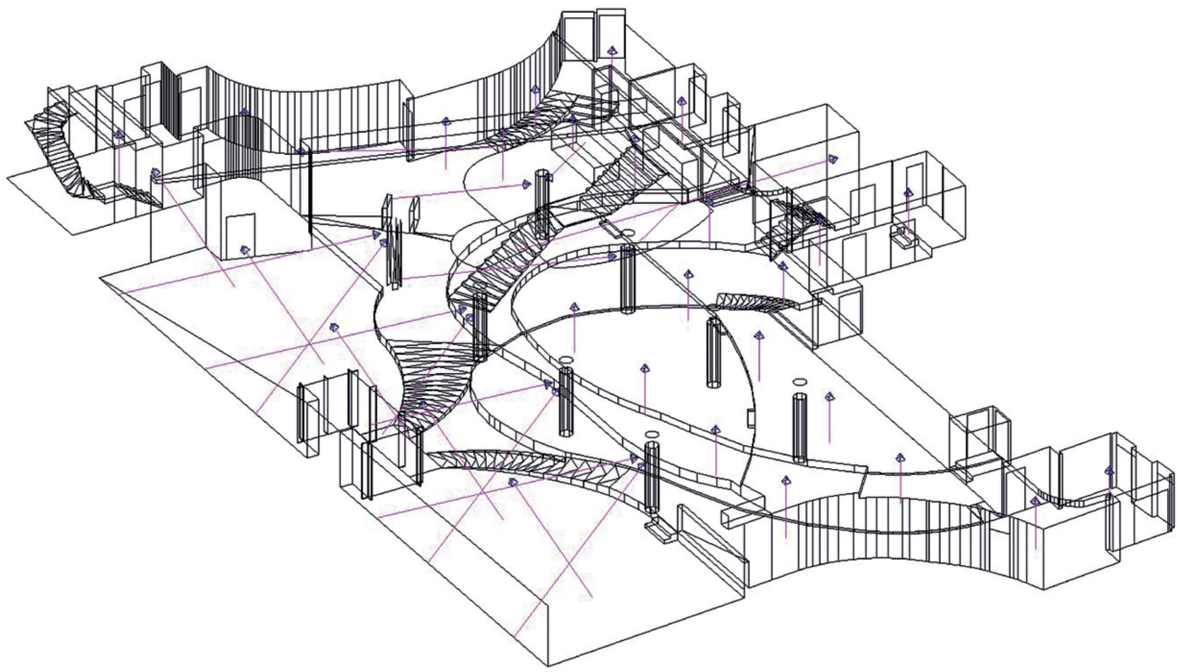
» **ABT-P20** - 20 watt sound projectors,

» **ABT-LA60** - 60 watt line array speakers,

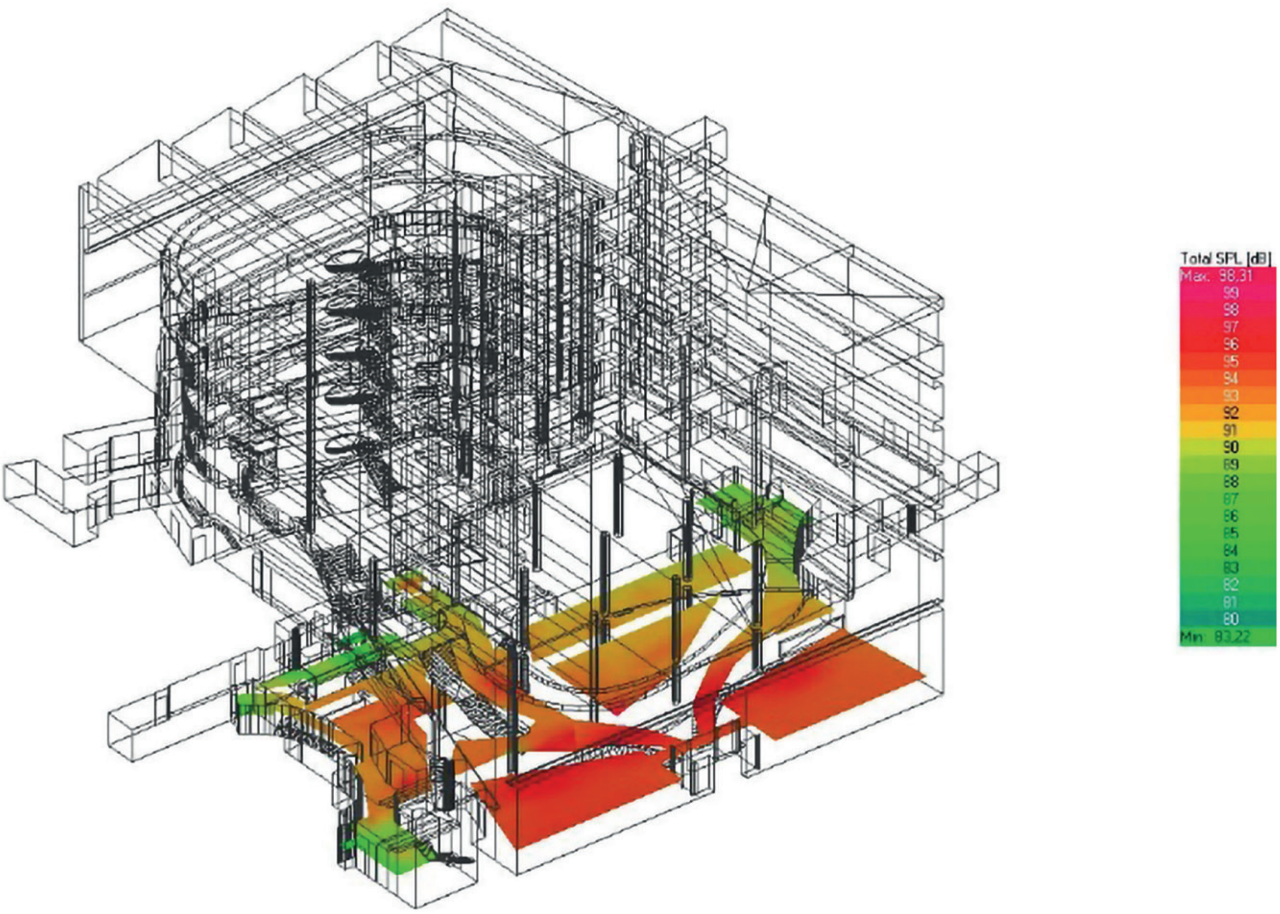
» **ABT-S206B** - 6 watt recessed ceiling speakers.

Loudspeaker Positioning





Results



Improvements in Loudspeaker Setup Through Acoustic Simulation

As a result of the acoustic simulation the proposed loudspeaker setup had significantly changed from the original design. Multiple ABT-LA60 line array loudspeakers were introduced into the atrium central area. On the bottom levels it turned out to be necessary to change the recessed ceiling speakers to a more powerful speaker type (ABT-S2010).

Sound Absorption Guidelines for Building Materials

Also as a result of the study guidelines have been provided to the Civil Works Contractor in regards to specific building material types – which provide the necessary sound absorption. Perforated baffle ceiling, A-class sound absorbing pannels and acoustic plaster was introduced into various parts of the building.

Summary

Acoustic simulation enabled the early prediction and mitigation of potential issues in the PAVA (Public Address and Voice Alarm) system performance. By identifying challenges and modifying the loudspeaker system design and building architecture at an early stage, risks were effectively managed. The acoustic study played a crucial role in uncovering these issues. Without it, they might have gone unnoticed until a later stage of the project, potentially causing delays and additional costs. By conducting acoustic simulations early on, we could anticipate problems and make changes efficiently. This ensured that voice alarm and communication systems ran smoothly, prioritizing people’s safety and comfort in the building.

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Ambient System Sp. z o.o. | ul. Bysewska 27, 80-298 Gdańsk | T: +48 58 345 51 95 | ambient@ambientsystem.pl | www.ambientsystem.eu