

LISTAHÁSKÓLI ÍSLANDS

Tónlistardeild

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Resonating spaces and room acoustics

Report of study projects

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Introduction to room acoustics

What is „room sound“? One way to define it would be as physical characteristics of room that determine how the sound is transferred. One could imagine a room as a filter or modulator for the sound that's led into it with parameters that depend on the properties of the room. For example, talking in a room sounds different than talking outside, because when sound hits surfaces or boundaries, they react and add to the sound. As there are less of these boundaries outside, what you hear more is the sound source itself, though the sound tends to get lost more easily as there is less to make it travel to the listener.

Sound waves are physical movements of air particles. When they hit an object, they move it physically and because of that the object responds. Depending on the object, the response can be different – objects can either mute the movement and absorb the sound, they can reflect it by bouncing it back or they can start vibrating and create new waves. The latter happens on certain frequencies which depend on the object, these are called resonant frequencies. Usually object react in all these ways – some frequencies are absorbed, some are bounced back and some create resonances. Also some lower frequencies just go through the object without being affected by it. The way an object responds depends on the size and shape of the object as well as the material, structure and mass of it.

Artworks based on room acoustics

Many sound art works have been created around room acoustics. Two of the newer ones that were created by a German artist Lukas Kühne are rather similar to each other. The earlier one, located in Tallinn, Estonia, is called Cromatico and was opened in 2011 when Tallinn held the title of culture capital of Europe. The other one is just outside Seyðisfjörður in East Iceland and is called Tvisöngur. They both utilize the same principle – they consist of resonating chambers made of concrete that are tuned in a certain way, reacting to certain pitches of sound. Cromatico is tuned in 12-tone chromatic scale, while Tvisöngur uses traditional Icelandic five-tone harmony. In either case visitors can walk through these chambers, make sounds or sing and see how the construction reacts.

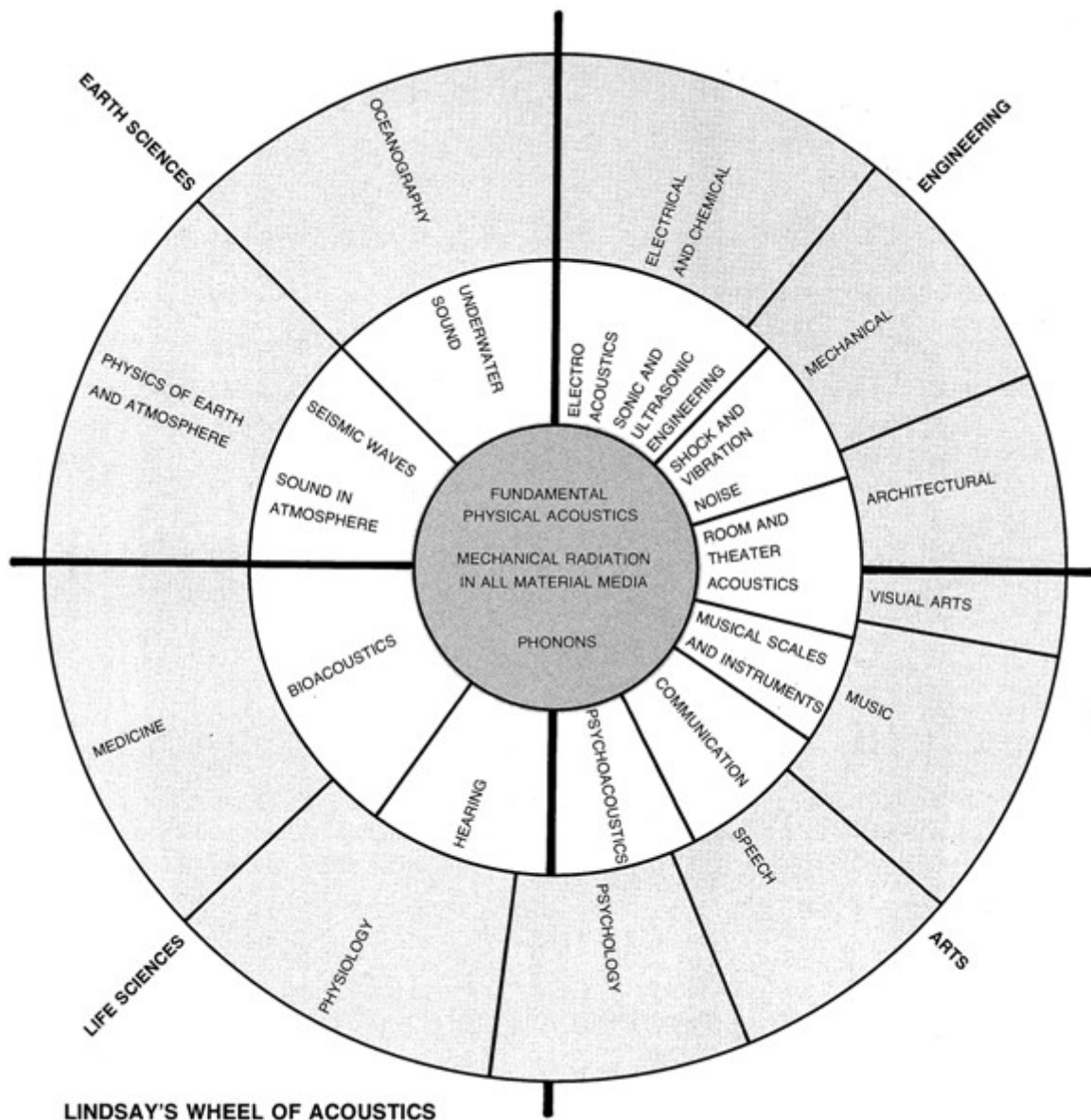


Another, much older and very different well-known piece, or experiment, was Alvin Lucier's „I am sitting in a room“. Originally created in 1969, the idea of the piece was to demonstrate the effect of room acoustics on sound source. Lucier recorded a text that he read and then played the recording back via a loudspeaker in the same room and re-recorded the playback. Then he played the re-recording and recorded it once again and continued the loop many times, until his speech became muffled and unclear and the room resonances took over. This allowed one to perceive the sound of the room instead of the speech or text.

This artistic experiment is very nice in that sense that can be easily recreated and it gives you some information of the sound of the room, which could be of practical use. As a demonstration of how this experiment works, we carried it out in a lecture hall in the schoolhouse on Sölvhólsgata and we confirmed that it gives the results that one would expect.

Practical applications of room acoustics

Besides artworks, room acoustics are even more important to consider in many other fields. Lindsay's „Wheel of acoustics“ proposes fields that deal with acoustics – this, of course, applies for acoustics in general, which is far more than only the transferring of sound in rooms, but it gives a rough idea about the latter too.



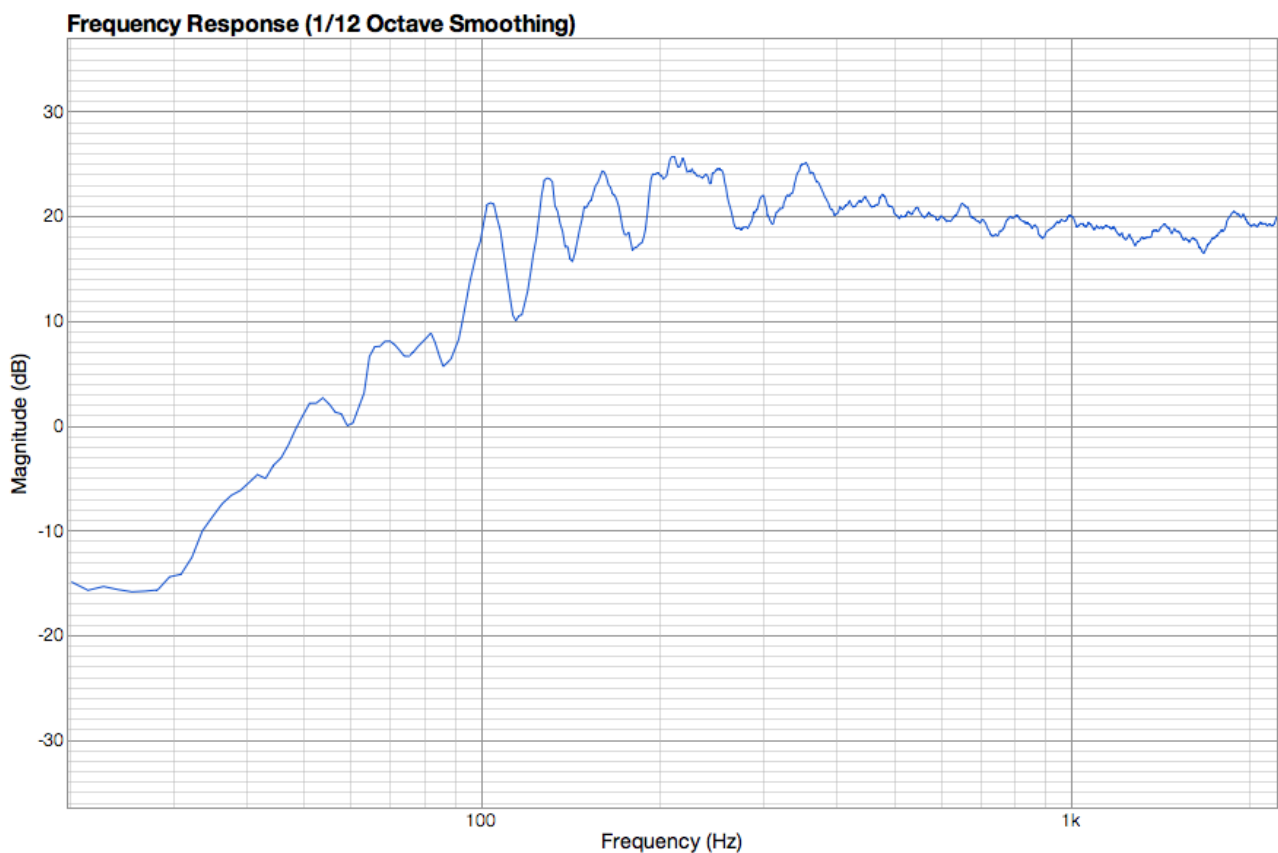
In many cases we want the sound to be transferred in the room in a certain way, may it be for aesthetic or practical reasons. For example, the essence of a church hall is different from that of a concert hall and we expect different musical experience from those places. Apart from that we also want to hear the details and even more so in the case of lecture halls, where the clarity of speech is important, or in sound studios, where neutral and detailed acoustics is essential for the work process.

To get the room sound under control, acoustic engineering and treatment is often used. This can be considered while engineering the room by using suitable dimensions and shape, but in rooms already existing, acoustic panels are often used to improve acoustics. For example, reflecting panels in the ceiling can be used in lecture halls to transfer the clarity of speech to the rear seats, while diffusers and absorbers in the walls can reduce the overall reverb of the room. In sound studios, absorbers called „bass traps“ are used in corners to cut down bass frequency boosts and tuned resonator panels are used to control a certain frequency band.

Our experiments

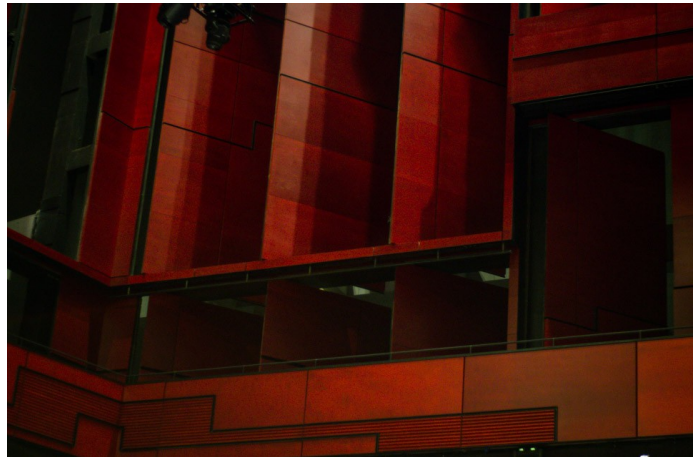
During the course „Sonology 1B“, we carried out several sound experiments with the idea of manipulating with sound in an artistic manner. The goal was to work together with students of Háskóli Íslands and let them do necessary engineering and calculations to achieve the effects that we wanted to get. This goal was not reached in the context of ideas that we had about altering room acoustics, because the tasks turned out to be too much for the length of the course. We did brainstorming and several measurements that are worth documenting anyway.

The main idea that we decided to work on together with HÍ students was to mess up acoustics of a rehearsal room using Helmholtz resonators for boosting certain frequencies and perhaps creating an unexpected overtone series or something alike. For this, we measured a small room in the schoolhouse on Sölvhólgata both spatially and acoustically. To get the acoustic response graph, a sine sweep was run through a monitor speaker into the room and the response was captured with a measurement microphone. A program called Fuzzmeasure was used for that. In spatial measuring, placement and dimensions of the door and the window were taken into account.



To familiarize ourselves with room acoustics issues, we also did measurements in Eldborg concert hall in Harpa. The biggest and most prominent concert hall in Harpa has acoustics that can be adjusted to liking by opening and closing doors to resonance chambers on both sides of the hall and lowering or rising a floating ceiling plate above the stage. The frequency response measurements we carried out showed that opening or closing the doors to the resonance chambers did not change the response of the room remarkably as we thought might be the case, but it only changed the reverb length of the concert hall.

We also took a look at another room in Harpa that is not finished and therefore not in use. We called the room the „pizza slice“ because of its shape that looked like one. What we noticed in the room was how the reverberation time changed from the wider end to the narrower. The sound of the narrow end was really dry while the wide end had lots of room sound. We found that this space could be nice for doing some experimental performances.



Because of my personal interest, me and the teacher Halldór also measured the studio control room behind the schoolhouse in Sölvólsgata, looking into possibilities of making some acoustic treatment for the room. Though we didn't get to doing any treatment, the measurement graph shows that the room most of all has an issue with bass boost around 100-150 Hz. This could be fixed by using some absorbers and „bass traps“, but because we didn't do any calculations, it's hard to say exactly what and how instead of just rough proposing.

