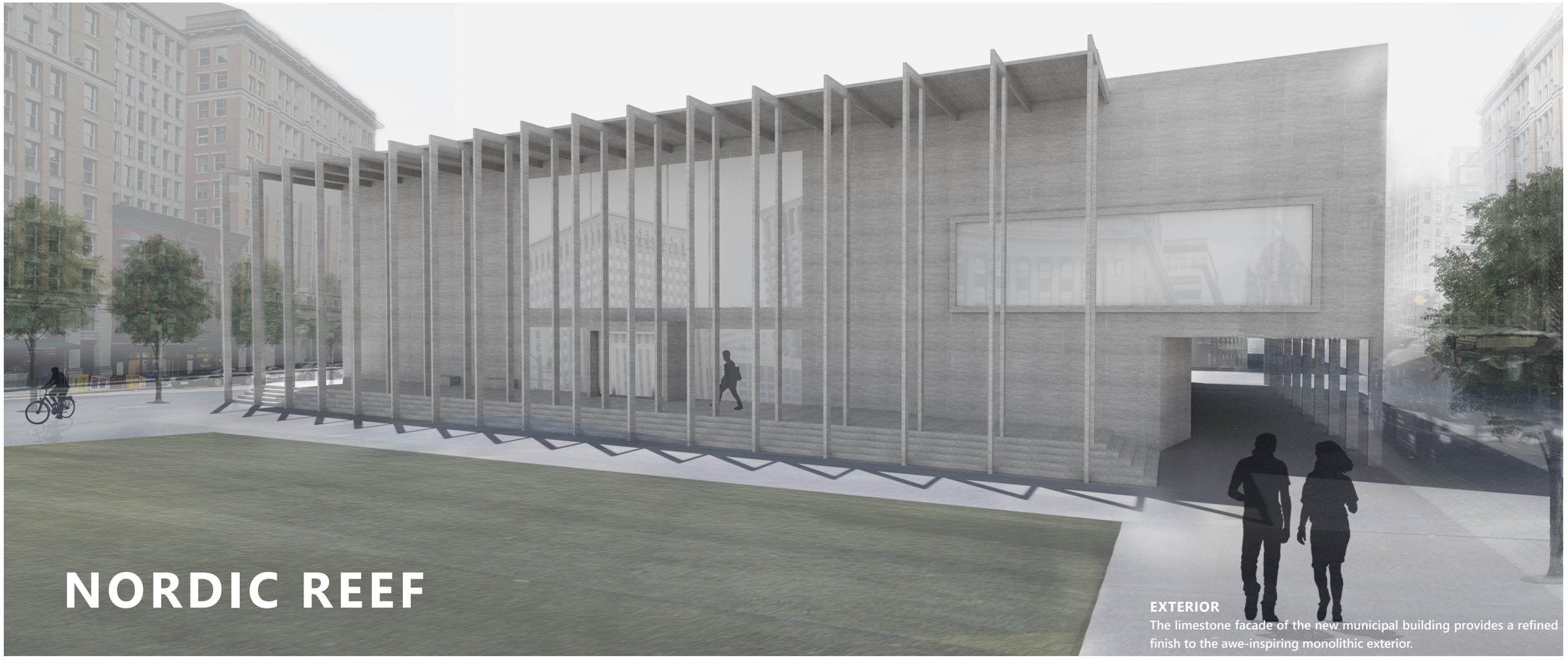


NORDIC REEF

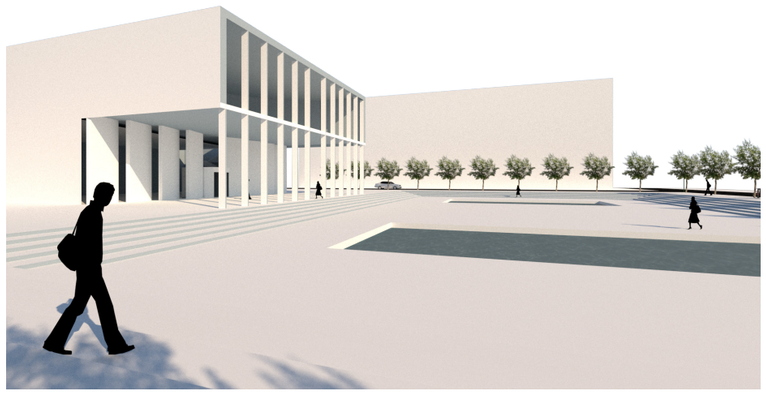
EXTERIOR
The limestone facade of the new municipal building provides a refined finish to the awe-inspiring monolithic exterior.

KANDIDATPORTFOLIO

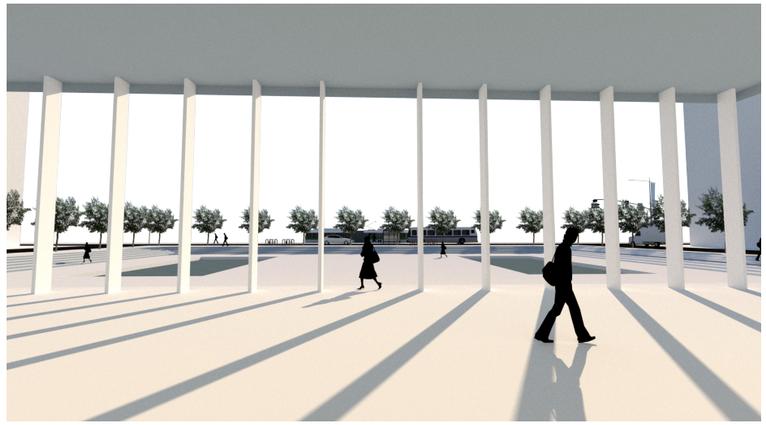
JONAS BERGSTRÖM

PROJEKTET

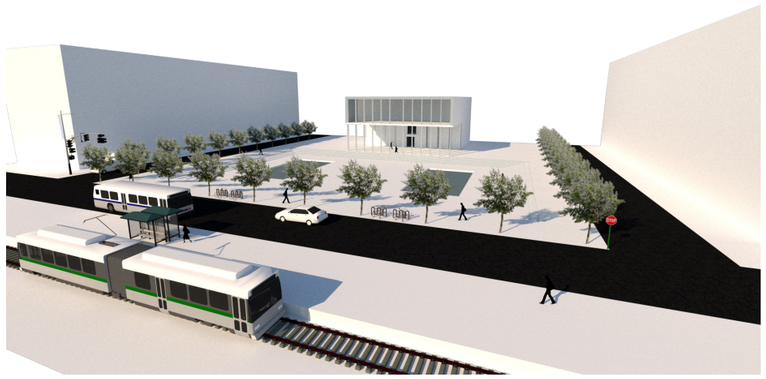
Kandidatarbetet på Arkitektur och teknik integrerar arkitektonisk design med akustik och klimatsystem. Nordic Reef är ett designförslag som var riktat till en tävling i USA utfärdad av Acoustical Society of America. Uppgiften bestod i att skapa ett nytt kommunhus i den centrala delen av en mindre stad. Huvudfokus låg på att utforma Court Room och Community Hall. En stor problematik man var tvungen att ta hänsyn till var de höga bullernivåerna intill den nya byggnaden. Det var även viktigt att få en behaglig inomhusmiljö, både med tillräckligt dagsljus och en god akustisk miljö.



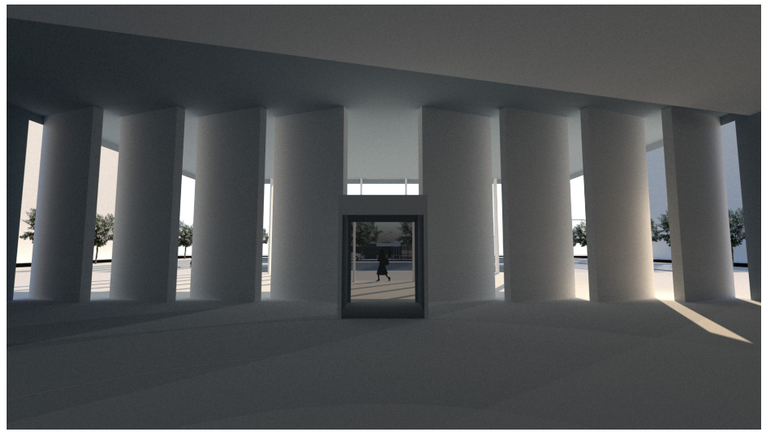
DEMOCRACY, MEETING PLACE, ICON



MONUMENTALITY



ACCESSIBILITY



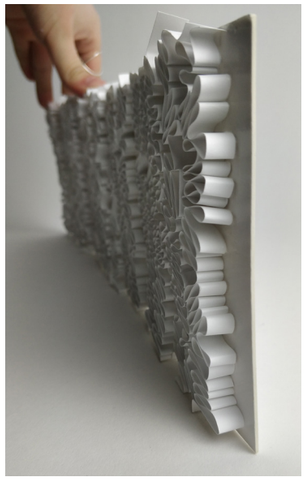
TRANSPARENCY, SECURITY

PROCESS

I detta projekt har vi jobbat i grupper om tre personer, varav en person var masterstudent med specialkunskap inom akustik. De första veckorna låg mycket fokus på att utforska entréförhållanden och fasadutformning utifrån säkerhetsperspektiv, ljusförhållanden och tillgänglighet. Därefter skiftade fokus till att skapa funktionella planlösningar och goda akustiska lösningar i byggnaden. Vi har arbetat både för hand i modellbyggande och skissande, samt 3d-modellerat i Sketchup och ritningar i Autocad.

Tidigt förslag på volymbehandling och mötet med staden.

Ljusstudier med fasadmodell



Modell av korallkoncept för akustik

CONCEPT

The Nordic Reef is a combination of the nordic simplicity and the organic growth of a reef. Upon encountering the building one takes note to the strict colonnade used by ancient Greece, the first democratic society. The heavy limestone facade gives the municipal building a feeling of importance and dignity.

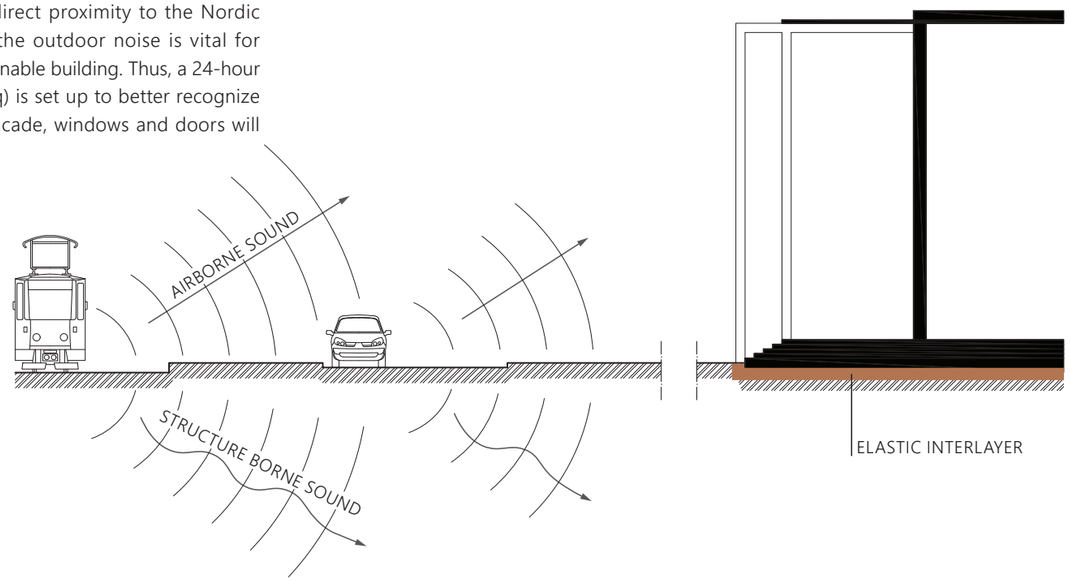
When entering the lobby of the building you find yourself in a sea of light. Between the organic panels in the ceiling the nordic light gently finds its way into the room providing diffuse streams of light, just like under water.

Natural light is provided in all of the major spaces of the building. In the courtroom raking light passes through the slightly rotated stone wall, illuminating the room with a nordic ambience. The walls surrounding the audience on the balcony are overgrown with corals that are both decorative and of acoustical importance.

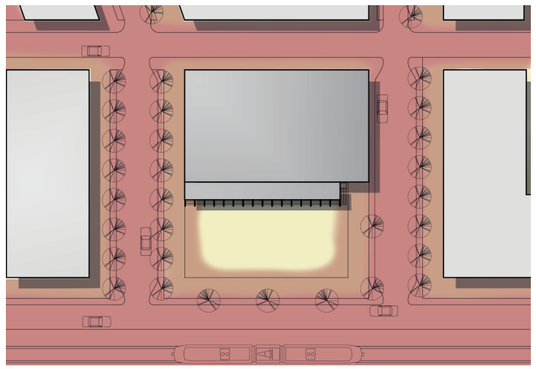
The Nordic Reef is found in the community hall aswell. Here the vinyl corals are flexible and can be erected by magnetic levitation. Thus, providing variable acoustics to serve different activities in the hall.

SITE

The project is located in a heavily trafficked downtown area among buildings with a high noise generating potential, such as a Fire station and Police station. Along with a new light rail-track planned in direct proximity to the Nordic Reef, the need to address the outdoor noise is vital for creating an acoustically sustainable building. Thus, a 24-hour equivalent sound level (LAeq) is set up to better recognize the requirements that the facade, windows and doors will have to endure.



SITUATION NOISE MAP



NOISE LEVEL GRADIENT (LAeq)

- < 50 dB
- 50-55 dB
- 55-60 dB
- 60-65 dB
- > 65 dB

NOISE CONTROL

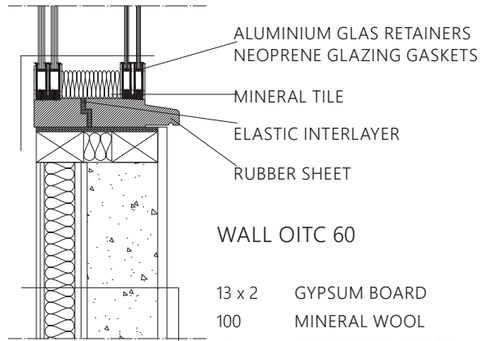
The heavy traffic and potential rail-road in close proximity to the building required a solution that would address the low-frequent structure borne vibrations. A full decoupling by elastic interlayers is the implemented solution with a 100mm thick elastomer layer applied between the impedance plate and the foundation of the building. The resonance frequency of these elastic interlayers under load falls in at a frequency of 15 Hz.

Per the site plan, an expected equivalent sound level in direct adjacency to the building oscillates above 65 dB LAeq, with high peaks expected when the fire brigade or police launch their sirens. This constitutes a strong need for walls, windows and doors with a high transmission loss value. As heavy traffic and noise of low frequent character is expected the OITC (Outdoor-Indoor Transmission Class) has been implemented in this project to describe the reduction ability of the outdoor to indoor partitions. Much emphasis was put on the windows and the reduction index, as the community hall has a major surface facing the street. The window used in the community hall is of the double-glazing type with heavy laminated glass and a large airgap. The connections of the joints as well as the gap between the two sheets has been insulated with silicone interlayers and 6 mm thick rubber sheet. This ensures a high reduction index of OITC 54.

The exterior walls are constructed as a double wall with a massive outer core made of concrete, followed by a lighter structure. With a total thickness of 412 mm it supplies a reduction with a value of OITC 60.

WINDOW OITC 54

10 x 2	LAMINATED GLASS
20	HELIUM-FILLED AIR GAP
10 x 2	LAMINATED GLASS
220	AIR GAP
6 x 2	LAMINATED GLASS
25	HELIUM-FILLED AIR GAP
6 x 2	LAMINATED GLASS



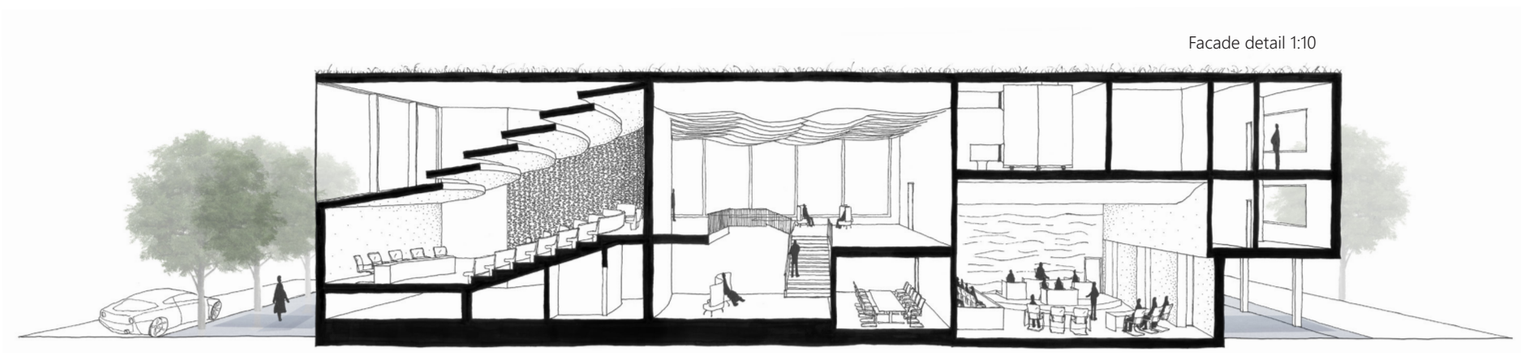
Facade detail 1:20

WALL OITC 60

13 x 2	GYPSUM BOARD
100	MINERAL WOOL
10	INSULATION BOARD
20	AIR GAP
230	CONCRETE
30	LIMESTONE

SECTION 1:300

Facade detail 1:10

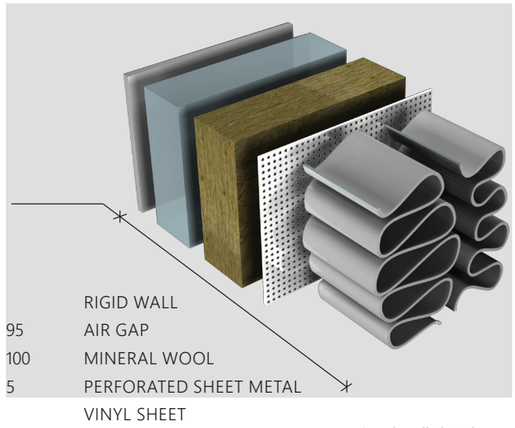


LOBBY

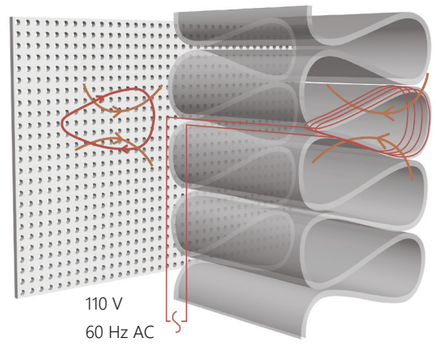
The lobby is a light and open space, where the visitor can sit down in a calm environment before a trial in the court or a happening in the community hall. The ceiling is decorated with wave-like, noise aborbing panels, which keep noise at an adequate level. These panels are slightly seperated from each other, creating gaps for windows through which pleasant diffuse light can flow into the room.

MAGNETIC LEVITATION

The acoustical concept for the community hall is based on the principle of magnetic levitation. Flexible vinyl sheets, shaped as corals, are fixed to a perforated conducting metal plate. Copper threads are then installed in the vinyl as coils, creating closed circuits. As the alternating current from the power supply is switched on, the fixed coil and the metal plate repel from each other, due to opposing magnetic fields. Thereby the vinyl corals are forced to erect from the wall exposing the resonant absorbent behind.



Coral wall detail

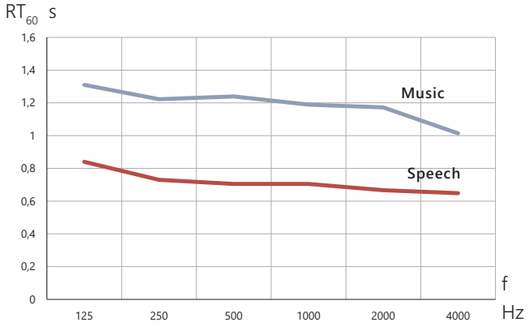


Magnetic levitation principle

VARIABLE ACOUSTICS

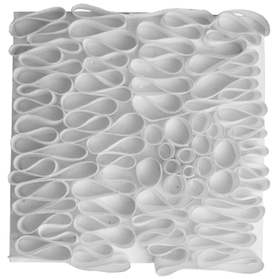
The acoustics in the community hall can be optimized for two different setups – music or speech. The acoustical characteristics are controlled by two main varying elements: the suspended ceiling reflectors and the corals covering the entire rear wall of the hall. The absorptive performance of the coral wall is created using a microperforated resonant absorber with an air gap against a rigid backing. The second absorption measure of the coral wall is an irregular deployment of Helmholtz resonators throughout the entire surface. These Helmholtz resonators are tuned for 125-250 Hz and are not variable in their absorptive manner.

REVERBERATION TIME



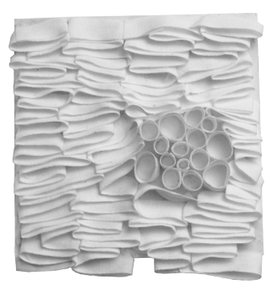
SPEECH MODE

The speech setup indicates the composition where the corals are erected exposing the room to the highly absorptive void behind them. The speech setup is complemented by adjusting the angle of the ceiling reflectors in order to reflect more of the sound energy towards the highly absorptive back surface than towards the audience.



MUSIC MODE

The music setup is characterized by the coral wall being closed and covering the absorptive microperforated panel, however the Helmholtz resonators remain open. Due to the irregular pattern of the corals the result is an asymmetrical surface with high scattering and reflecting properties in the mid and high frequency region. The ceiling reflectors are in their original position reflecting the sound towards the audience.

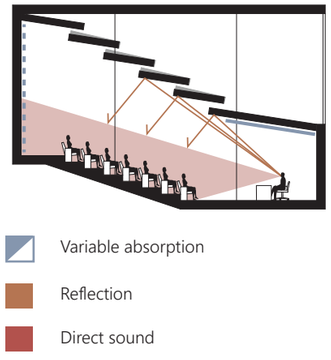


ACOUSTICAL DESIGN

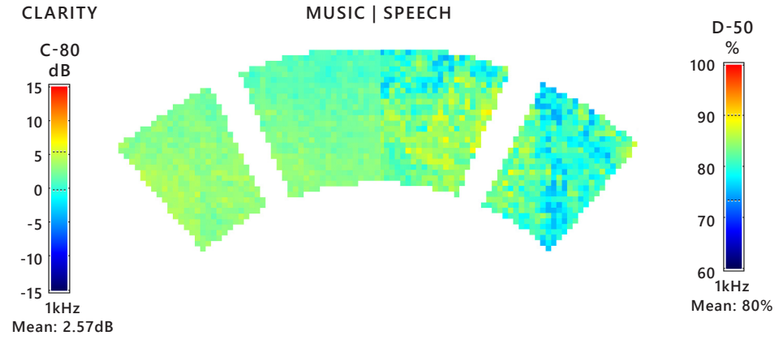
The shape of the community hall along with its low suspended ceiling reflectors produce the necessary short-initial-time-delay reflections, yet the upper volume of the hall is available to allow a longer reverberation time. In its acoustical attributes the community hall can be compared to the Salzburg Wiennersaal in Mozarteum, with a similar volume, capacity and RT. In the speech setup the rear wall is highly absorptive ensuring that no echo is present. A suitably low RT is obtained, providing a good speech transmissibility over the entire audience area, but it is high enough to provide a background noise level that masks unwanted disturbing sounds.

SEATING

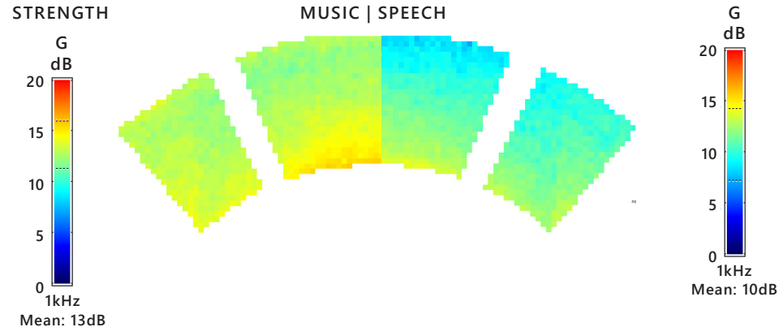
The seating in the community hall provides a pleasant experience regardless of where one is seated. The bent shape brings the audience close to the stage resulting in good visual contact and an excellent acoustical performance. There is no individual seating to efficiently make use of the space and to create an intimacy between the spactator and performer.



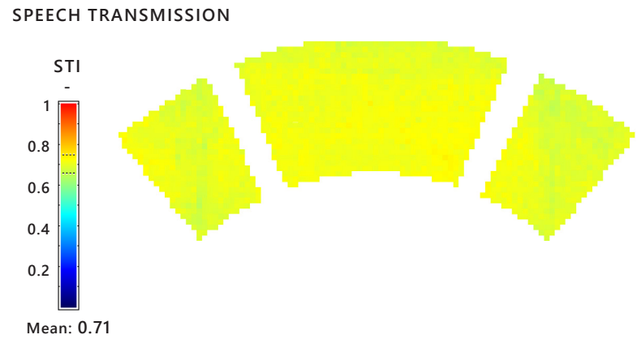
CLARITY



STRENGTH



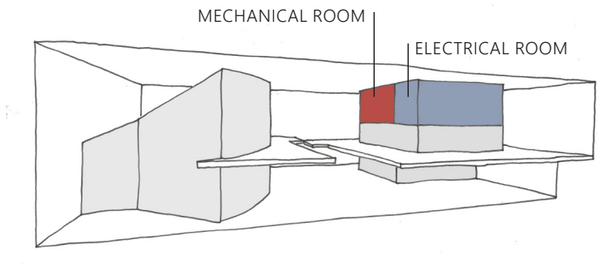
SPEECH TRANSMISSION



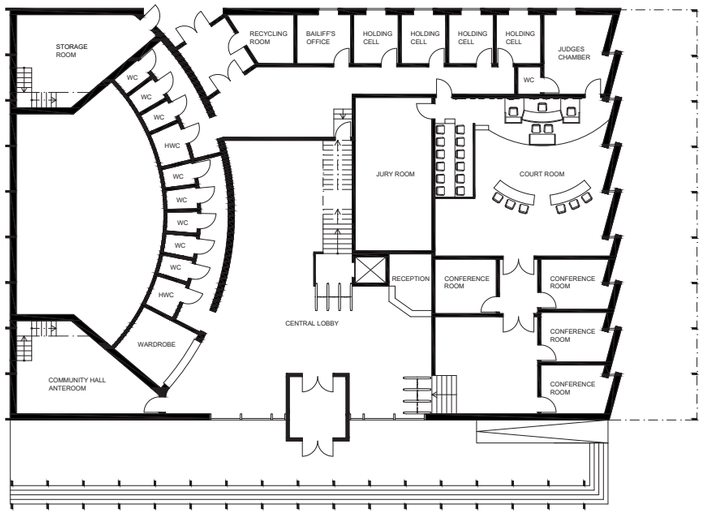
COMMUNITY HALL
The nordic light flows into the room from between the rigid plates in the roof, enlightening the floating corals at the curved rear wall.

MECHANICAL EQUIPMENT ROOM

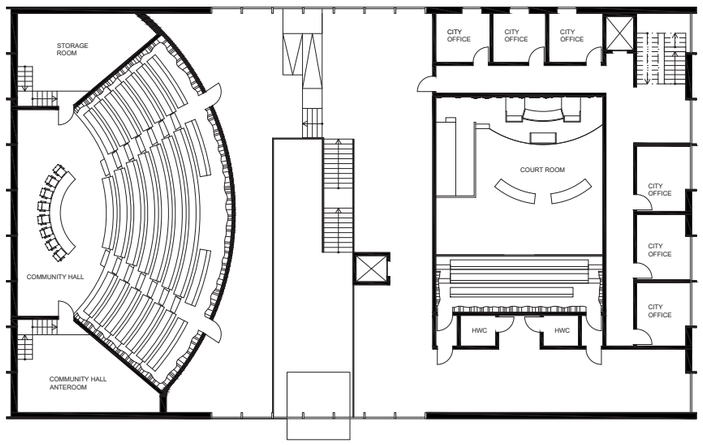
The placement of the mechanical room above the courtroom makes for a challenge. A loud air-conditioning system could impair the room acoustics as well as low frequency vibrations produced by the machinery could excite the structure, radiating sound into crucial rooms. Thus, the entire machinery is acoustically decoupled from the floor using steel springs along with added neoprene pads, for a better isolation at higher frequencies. All ducts leading from the machinery are equipped with elastic interlayers to ensure no structure-borne sound propagation. Finally, silencers are installed to damp the air borne sound.



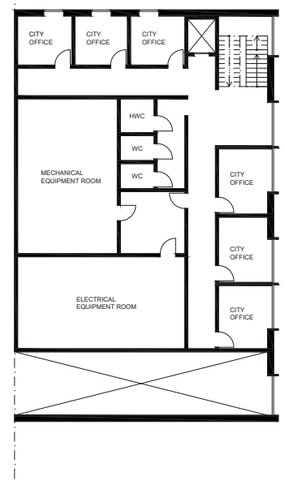
PLANS 1:400



ENTRANCE LEVEL



FIRST LEVEL

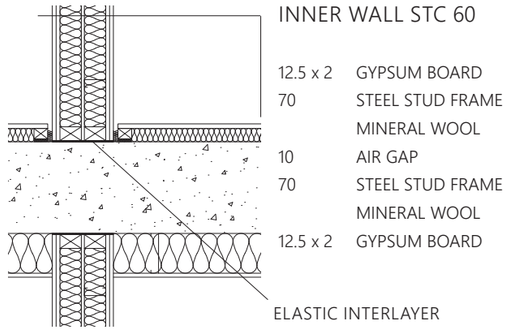


SECOND LEVEL

PRIVACY

To ensure the privacy of the courtroom a double wall with studs at different vertical positions has been implemented along with carefully constructed joints to avoid flanking transmission. Together with a thick concrete slab and a stud double floor setup it provides an overall reduction of STC 60 in either direction. With the implementation of soundproof doors, this setup will ensure no leakage of privileged information from the court. The same composition has been used for the jury room and judges chamber, as well as the conference rooms that could be used by council.

The courtroom glazing towards the street is of similar type to the one used in the community hall. Along with the massive exterior wall it ensures OITC 60 at its weakest point.

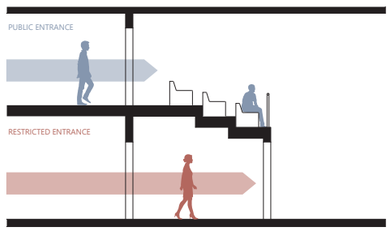


Detail 1:20
Inner wall and Joist floor

SECURITY

The public entrance and the entrance to the litigation area are seperated to ensure everyones safety. The public goes through a security check before being allowed up the stairs where the spectator entrances are located, both for the community hall and court room. In the court room the public is restricted to the balcony and have no interaction with the ongoing trail except visual and audiable contact.

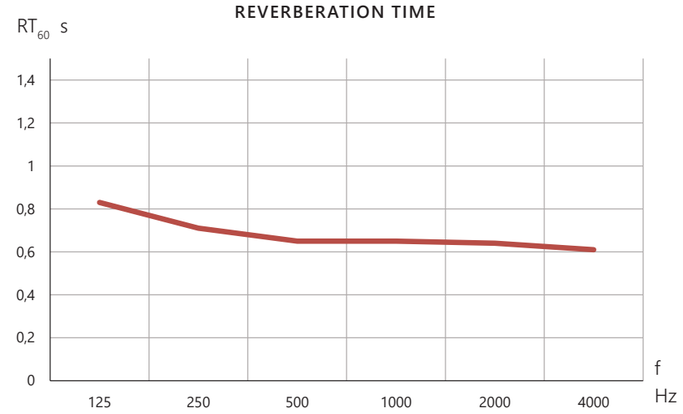
There is a seperate entrance at the rear of the building leading to a highly restricted area. This is used by the bailiff and the detainees.

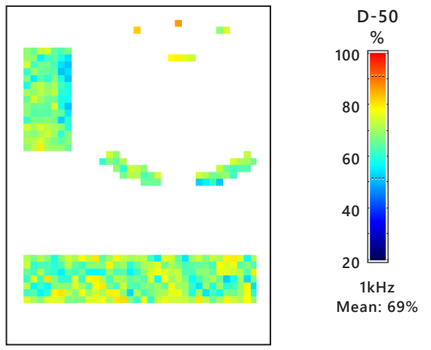


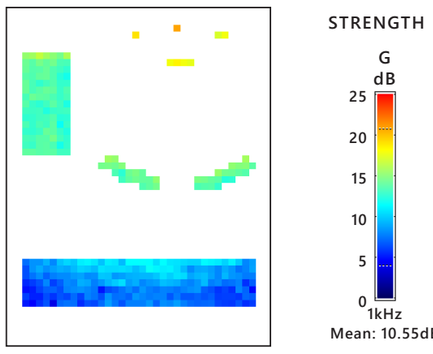
COURT ACOUSTICS

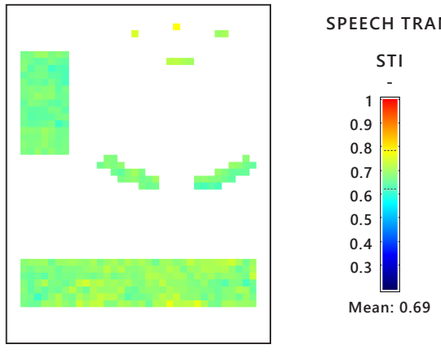
The courtroom has been equipped with a wave-shaped ceiling adjusted to steer the early reflections towards the jury, lawyers and the judge. The front wall is clad with a reflective and scattering surface ensuring a diffused and balanced soundscape within the litigation area. As sound comes from different positions the use of a highly reflective front wall is essential to ensure the audience will hear e.g. a lawyer addressing the judge with his back towards the audience.

The audience of the courtroom has been moved up on a balcony establishing a good view and direct sound from the judge- and witness stand. The coral wall surrounding the audience area is of the same type as in the community hall. The characteristics of this wall is however not varying, it is always in the open configuration providing a high absorption. This is dictated by two reasons - the spectator area should eliminate a high reverberation and reduce the noise level generated by its occupants. Further, the backwall should not be reflective to avoid disturbing echoes. A mean RT of 0,66 s has been obtained in the court. A lower RT could be disadvantageous as every turned page, heavy breath, yawn or other generated noise would disrupt and cause annoyance, hence a low background noise is justified.









COURT ROOM
The terraced seating in the court room allows the audience to get a clear sightline as well as an excellent overview of the trial.

REFLEKTION

Ett mycket lärorikt och utvecklande projekt på många sätt! Särskilt kul att få jobba i ett samarbete med masterstudent från akustikavdelningen.

Beslutet att välja en akustiklösning som baserades på magnetism var vågat och något som aldrig använts förut i dessa sammanhang. Dock tycker jag att vi lyckats väl med att presentera lösningen på ett förståeligt sätt.

När det kommer till förbättringsområden tänker jag främst på placering av maskin- och ventilationsrum. Placeringen ovanför Court Room är inte optimalt och kräver speciallösning för att fungera i praktiken. Vore även bra att jobba vidare med materialitet och klimatlösningar, både invändigt och utvändigt.