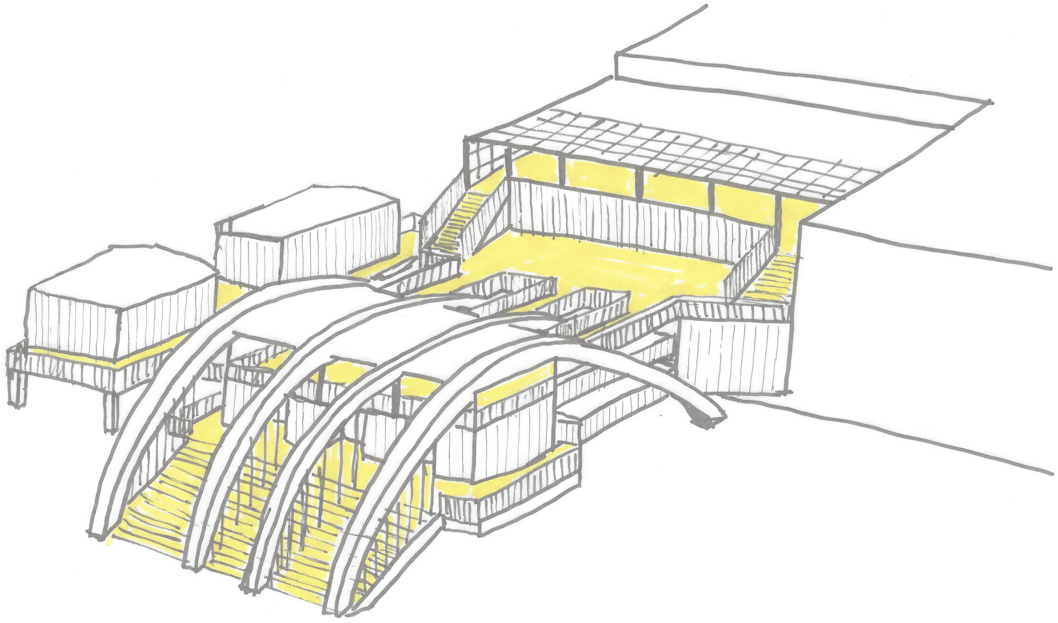
Crescendo - En bro mellan arkitektur och akustik

Programmet för detta projekt var att gestalta en operahall för ett campusområde som har stark koppling till musik. Operahallen har i största syfte att användas för operaföreställningar och musik men andra event för tal ska kunna ske i samma lokal.

Projektet var också ett bidrag för tävlingen för design och ingenjörsvetenskap som hålls av “Acoustical society of america”. Tillsammans med akustikstudenter projekterade jag detta operahus där både akustik och arkitektur var främsta randvilkoren genom projektets gång.

Projektet skulle presenteras på 3 planscher där 1 plansch motsvarar ca en A1:a i storlek.



Programmets innehåll bestod av beskrivningar kring användningen för hallen, mängden och storlek på vissa ytor samt den akustiska utmaningen på tomten. Platsen var beskriven som en tomt på ca 1 hektar som har trafik på alla håll. Utmaningen var att isolera operans husdelar från buller och vibrationer samt skapa en trevlig akustiskmiljö i rummen beroende på funktion och koncept.

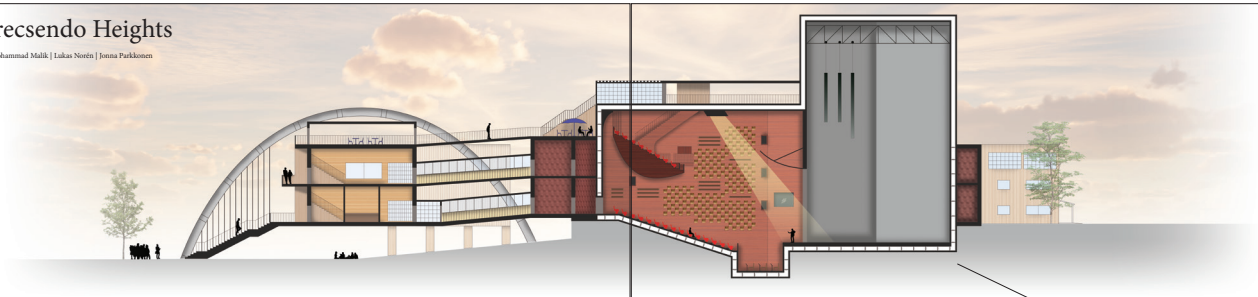
För att göra denna uppgift tydligare för mig började jag kolla tidigare referensprojekt och läsa om hur en opera fungerar logistiskt. Uppgiften för mig var att tillgodose både bra arkitektur och akustik utan att kompromissa för att slippa en halvbra lösning. Då jag hade mer flit i att skapa arkitektur än att hantera akustik i rum började jag sätta vilkoren för akustiken först där jag sedan bygger kring iden med ett arkitektoniskt koncept.

Förutom att skapa bra arkitektur satte jag ett mål att försöka koppla in hållbarhetstänk i material och modeller för operan.

Mitt tävlingsbidrag med 3 planscher

Crecsendo Heights

Ali Mohammad Malik | Lukas Norén | Jonna Parkkonen



A bridge between architecture and acoustics

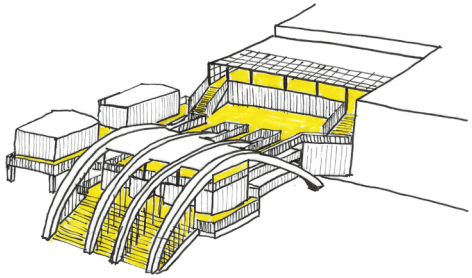
Acoustics and architecture. Two similar art forms that depend on a well calculated technical execution in order to express the ambience and the inteded exprience in a space. Due to the fact that they are entwined with each other, a balance between ambitions and boundaries must be established in a seamless way, to diminish any compromises in order give the concept the freedom to apply itself in, and around the establishment.

The concept for this operahouse is to levitate the experience and present the journey in an ascending order in to the middle of the buildings, where the opera lies with its weight to tranquil the movement and captivate the focus and towards the main event.

The opera, which can contain 1200 visitors, sends the audiance through a journey of sensory engagements between visual and acoustical mediums. Traveling through the buildings prepares people to attend a performance in a unige enviorment.

The site embodies floating volumes connected by rooms with an outdoor setting. The disconnected volumes marks key places that contain the operas different functioning areas such as back of house, lobby, front of house, rehearsal and the scene shop. To attain optimal connectivity between the areas the volumes that enclose them have been sought out to maintain a logical distribution among the functions and enable a chance for an acoustical benefit. The benefit of having such separation creates spaces, blocked from roadside noise by other volumes, the same principle applies for the opera since it is surrounded and protected from outdoor noise rumble.

The way the spatial acoustics are tuned in the different sections of the building, the visitor aproaches the opera hall through a staircase that escalades the anticipation for what comes next. As the visitor walks through the lobby and on to the floating bridges, a room that enclosses a quiter environment makes the visitor pay attention and prepare for the operas unique ambience through architecture and acoustics.



Acoustical properties

Regarding the opera hall and the rehearsal hall, a box-in-box system is implemented. This method involves constructing a floating structure for the entire hall, including the walls, ceiling, and floor. The purpose of this system is to achieve the desired low noise levels inside the rooms, and meet the noise criteria (Nc 15) requirement for the rooms. For that, walls will be constructed as double walls made of solid timber with a spring system in between. To minimize the coincidence effect different timber dimensions are used through the wall section. MEPFIT room will also cause cumbersome vibrations that will spread throughout the building. That problem is combated through a floating floor construction, effectively dampening the vibrations and ensuring that it doesn't cause problems.

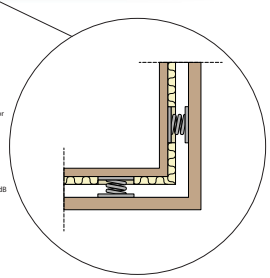
The teracces between the buildings exhibits an outside characterstic, to attain reasonable sound ambiance on these places, the terraces are placed strategically behind walls to block from any road rumble. Lobby and offices also have a goal of keeping sound levels on a comfortable level by using proper insulation materials in the walls.

Weighted reduction index for walls between rooms (R_w):

- MEPFIT to operahall and rehearsal hall: 54.7 dB

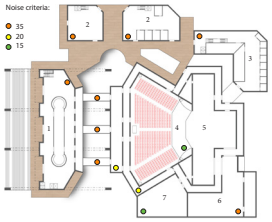
- Traffic to lobby: 29.5 dB

- Traffic to rehearsal hall: 49 dB



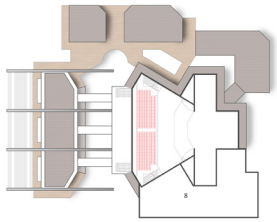
Plan through opera parquet level

Noise criteria:
- 35
- 20
- 15

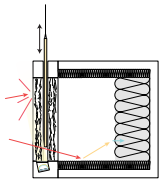


1. Lobby
2. Front of house
3. Back of house
4. Opera hall
5. Stage house
6. Scene shop
7. Rehearsal hall
8. MEPFIT

Plan through opera balcony level



Scale 1:500
10 m



Variable room acoustics

The opera hall will serve as a venue for both opera, orchestra, and speaking events. A goal is to have a distance from front of the stage to the furthest row of maximum of 25 meters. To accommodate the demands of all types of performances, we aim to create different sound environments in the room with varying reverberation times.

To achieve this goal, a module that could be installed on surfaces was developed to serve as a scatterer, absorber and an aesthetical wall panel. The module contains layers of crushed glass that create an uneven surface to scatter propagating soundwaves. The reason crushed glass is utilized is to support the reuse of materials and minimize the carbon effect for the building. The layers of glass are not airtight which makes soundwaves seep in to the module and be absorbed in to soft materials. Depending on how airtight the module is the absorption coefficient will vary with the help of a closing wood panel in between the glass layers. Additionally the module has an aesthetic look that enriches the room with warm scattering lights.

To control lower frequencies in the room, Helmholtz resonators set at 125 and 250 Hz will be installed in the wall. To create a musical warmth when playing music, the reverberation time is slightly longer at lower frequencies than at higher frequencies, all frequencies below 250 Hz are affected by this modification. Aside from the module there is porus absorbers which help absorb a wider range of frequencies.

The orchestra pit, which accommodates an ensemble of 80 musicians, is positioned in a pit in front of the stage to minimize the volume of the orchestra in relation to the singers. The goal for the orchestra pit is to achieve high absorption levels for both high and low frequencies. This is important because different instruments have unique sound characteristics that need to be properly balanced. The main aim of this is to provide a comfortable sound environment for the orchestra staff and to keep the noise level at least 1 dB lower than that of the opera singer on stage. This is necessary to ensure that the orchestra and the singer can be heard clearly without any disturbance.

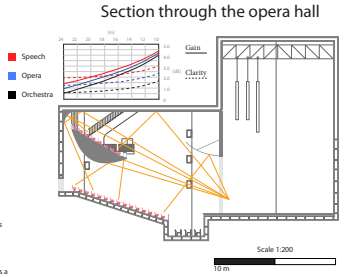
A consideration was sougth for early reflections from both walls and the roof. The opera hall itself is designed to ensure that sound travels simultaneously to all audience locations to prevent annoyance among the audience. The balcony is elevated and moved away from the back of the hall to reduce the risk of echoing and annoyance among balcony listeners. This allows the sound to flow around the upper balcony and reach the seats at the back of the lower section.

Furthermore, the overhang is limited to maximize reverberant energy and minimize the early decay time for the seats below. Also a convex surface under the balcony is incorporated to scatter and offset any lack of reverberant sound. Average ITDG values for the opera hall is less than 20 ms.

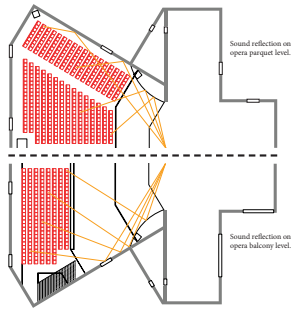
Loudspeakers are placed above the stage and to the sides at an optimal position for amplified speech and performance to ensure that the sound is spread equally to the audiance.

Clarity and gain values have been calculated and presented on the section for the opera hall. The values for reheasal hall will have a G-mid less than 8 dB. The rehearsal hall reverberation time is slightly lower than the opera halls to ensure that the sound level won't be too long and the musicians can practice in a suitable environment.

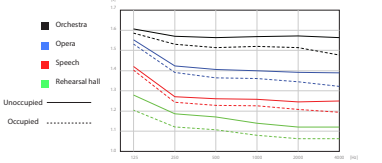
Section through the opera hall



Scale 1:200
10 m



Reverberation time



Texten som var med på plansch 1

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Texten som var med på plansch 2

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Texten som var med på plansch 3

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Skisskedet

De tidiga skisserna i arbetet ledde snabbt till former som skapade separerade volymer, förhöjda platser och en rörelse genom rum som hade kontrast mellan ute och inne.

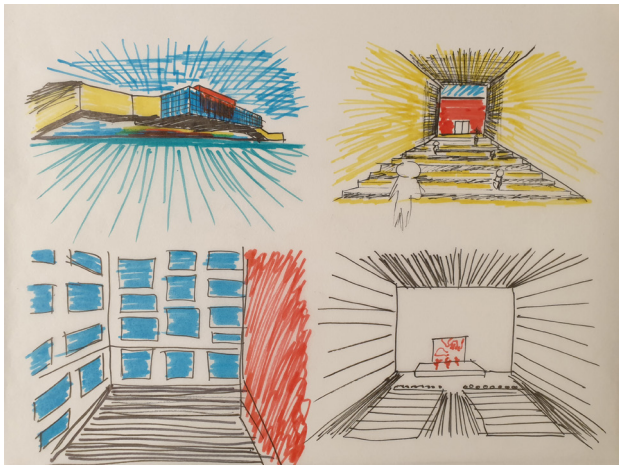
För att skapa en tydlighet i byggnaden var målet att arbeta med kontrast där man kan se och höra skillnader mellan rummen man rör sig i. Därför kunde saker som buller, tysta sidor av byggnader, ljusinsläpp och täthet i rummen hjälpa att skapa denna kontrast. Målet var att finna dessa metoder för att ha skapa en verktygslåda som jag sedan bygger rummen med.

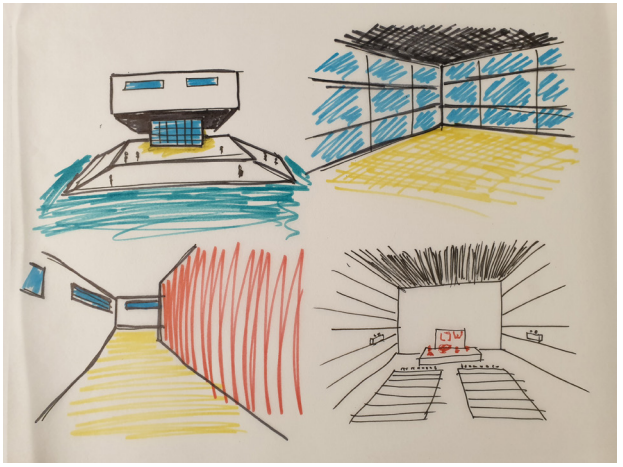
Arbetet började från operasalen som då hade högst krav för rumslighet och akustik. Operasalen behövde dimensioneras för att passa in 1200 besökare där ca 720 av de behövde vara på parkettplan och resterande i balkong. Detta var första variabeln som skulle bestämma hur akustiken i rummet behövde hanteras då den utgick från en rumsvolym som räknar bland annat efterklang.

Tidigt ville jag implementera ett sätt att variera akustiken i operasalen för att tillåta olika evenemang använda platsen. Beroende på om det var opera, tal eller en orkester så behövde en viss efterklang ske i rummet. Enklast att hantera detta var genom att variera mängden absorbtion som finns i rummet.

Andra krav på operasalen var att tillföra paneler som har ojämn yta för att diffusera ljudet samt ha medvetna vinklar på väggar och tak då relektioner har en stor betydelse i hur tidigt och var de kommer landa. Allt detta försökte jag ha i åtanke när jag formgav operan.

Tidiga skisser för olika koncept



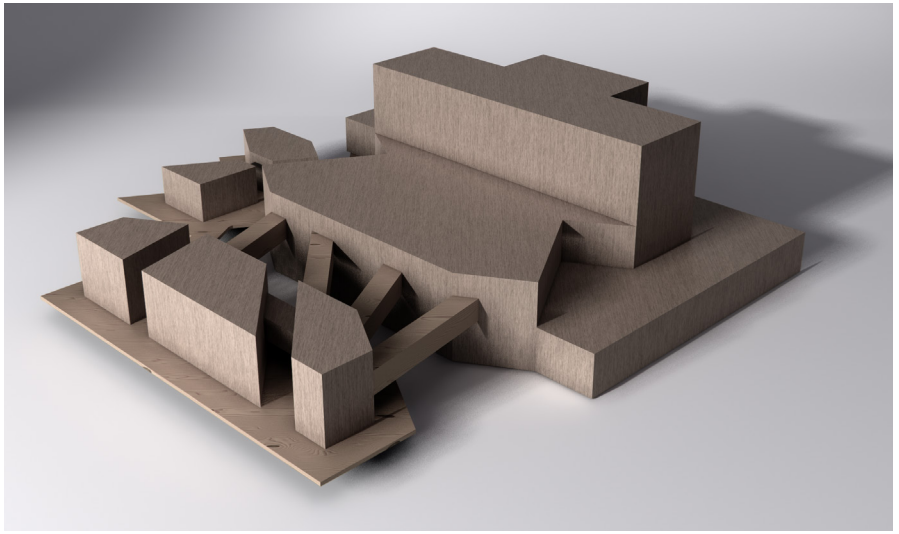


Metod och volymstudie

Koncepten hade svår tillförlitlighet utan någon volymstudie och platsanalys, och jag försökte arbeta utifrån att bygga utan kontext för att få en byggnad som ska vara flexibel och mångsidig. I verkligheten är detta en utmaning som slutar i att byggnaden inte får ta sin plats där det är meningen att den ska vara. Förutom problemet av att jobba utan tydlig plats försökte jag använda andra metoder till att arbeta än vad jag redan hade i min erfarenhet. Vanligtvis arbetade jag på projekt genom att tydligt markera platsen och bygga utifrån livet och vilkoren på denna plats. När detta ändrades blev min metod av att hantera hela byggnaden genom att bygga inifrån ut och flödet blev ett nytt sätt att arbeta. Kontrasten mellan ute och inne samt olika ljudmiljöer lyckades men vidare vill jag arbeta på logistiken och bekvämlighet i hur en byggnad används samt kopplingar mellan olika delar av huset.

Efter ett par tester på volymer och platsfördelning blev det tydligare vad för gränser tomten hade men det saknade fortfarande koppling till området.

Konceptmodell

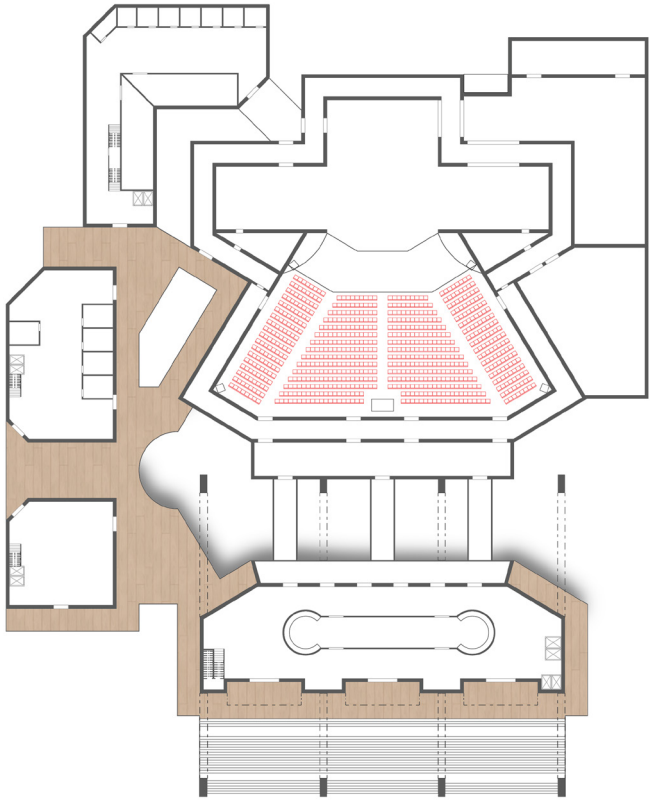


Resultat

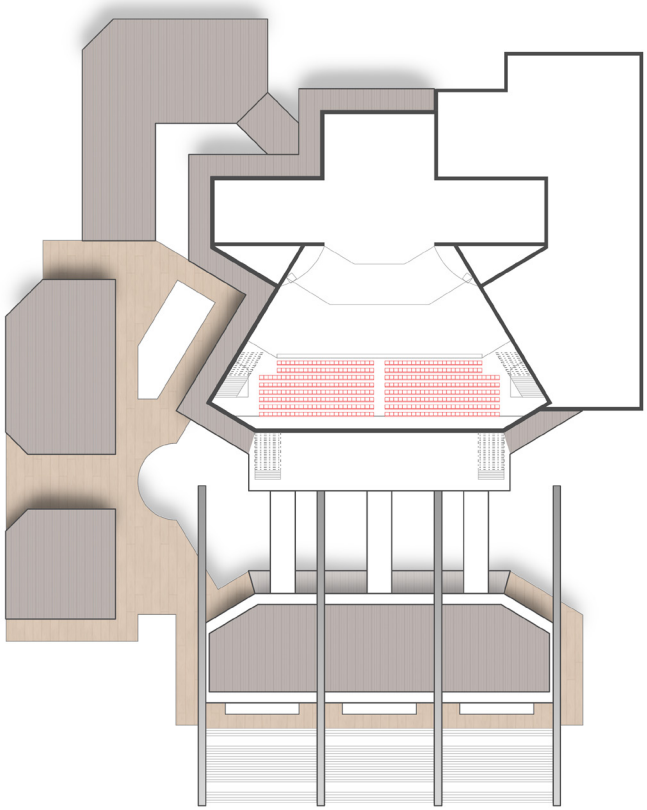
Resultatet av att arbeta på sättet jag beskrev blev en opera som berättar om koncepten jag hade från skisskedet på ett tydligt sätt. Rörelserna jag ville ha blev tydliga och kontrasten blev tydlig, det jag skulle vilja arbeta vidare med är kontexten och hur byggnaden tar plats i sin miljö.

Några ändringar jag tror skulle förbättrat projektet är att lita på mitt arbetssätt som alltid fungerat innan detta projekt samt att våga tillföra en logisk upplevelse i huset med alla i åtanke. Personal, gäster, servicepersonal, och uppträdningsteam ska alla kunna få en upplevelse som är bekväm för deras ändamål.

Plan 1



Plan 2



Ett bra intryck

Det som blev bäst med projektet tycker jag är kommunikationen mellan mina ideér och ritningsmaterialet och presenationen av dem. Jag fick ett intryck att läsare förstår tydligt vad för plats det är och hur allt hör ihop samt känslan man får av att vara där. Det har varit viktigt för mig att utveckla förmågan av att kommunicera i bild och presentation, vilket jag lyckades med. Samtidigt har jag lyckats hitta ett arbetssätt till att skapa dessa bilder på ett smidigt sätt vilket stärker min produktionseffektivitet.

För att hantera akustikten utvecklade jag en modul som bestod av krossat glas som ska diffusera ljud, skapa ett ljusspel samt absorbera olika frekvenser beroende på lufttätheten i modulen. Denna modul fick beröm av kritiker och i efterhand håller jag med om att den borde ha tagit mer plats i presentationsmaterialet då den återkopplar mycket bra till ideén jag hade om att inte ha kompromisser, samt att den blev en gemensam nämnare för alla mål jag hade, hållbarhet, estetik och hantering av akustik.