

SCALES

AN ACOUSTIC EXPERIENCE

Kurs Kandidatarbete Arkitektur och teknik

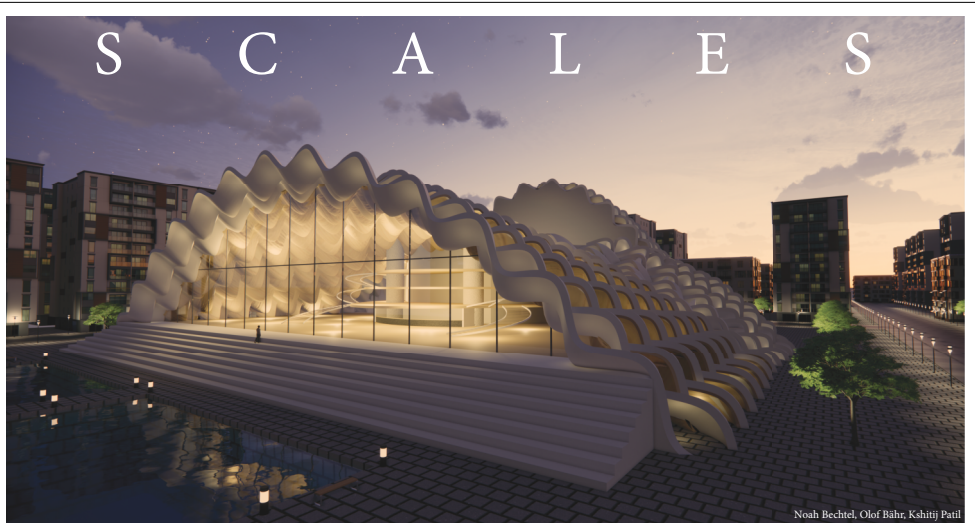
Storlek 15 hp

År Årskurs 3, VT 24

Lärare Morten Lund, Wolfgang Kropp & Peter Christensson

UPPGIFT

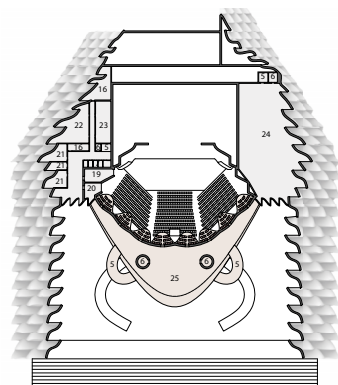
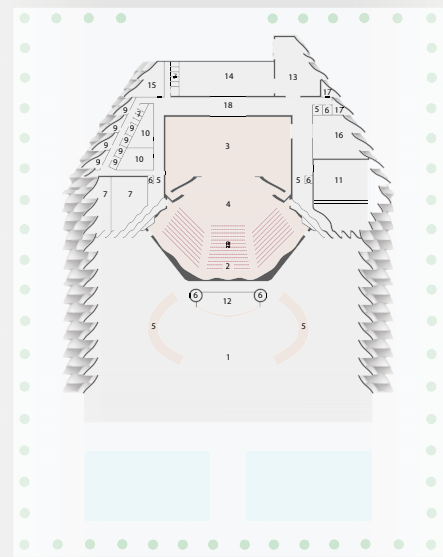
Uppgiften utgick från att kombinera våra kunskaper inom arkitektur och akustik för att i grupp designa ett tävlingsbidrag till Newman Student Award Fund's 2024 Student Design Competition. Mer specifikt skulle vi designa ett operahus med 1200 platser som samtidigt skulle bli en attraktiv studiemiljö för studenter från närliggande college.



Noah Bechtel, Olof Bähr, Kshiraj Patil

A MULTIFUNCTIONAL CONCEPT

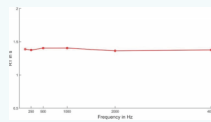
The key to this project is the scale grid. Taking inspiration from the scales of a fish, its double curved surfaces create openings which have been used for acoustic panels and skylights to name a few. This pattern also makes for a secure cover while still creating a connection between the outside and inside wherever you are in the building.



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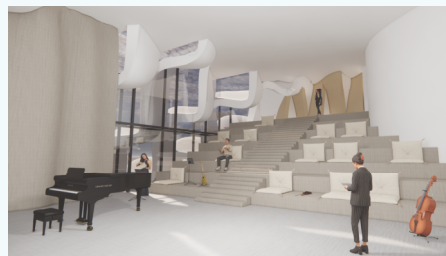
ACOUSTICS OF THE REHEARSAL HALL

To create good opportunities for rehearsing, acoustics mimicking the opera hall were sought. The achieved reverberation time was a bit lower than in the opera hall, which is preferable to avoid too much sound gain. As for clarity and strength, they ended up at around 2 dB and -0.8 dB, similar to the opera hall. This will ensure the performers get a good environment to rehearse their performances while still being able to leave the opera hall unoccupied. The perfect chance for practicing.



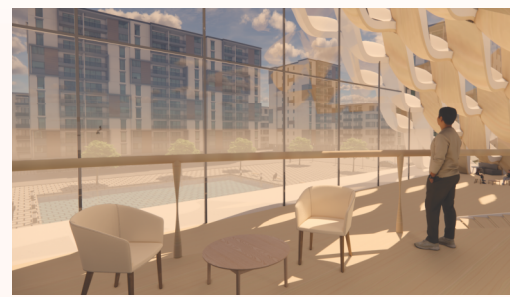
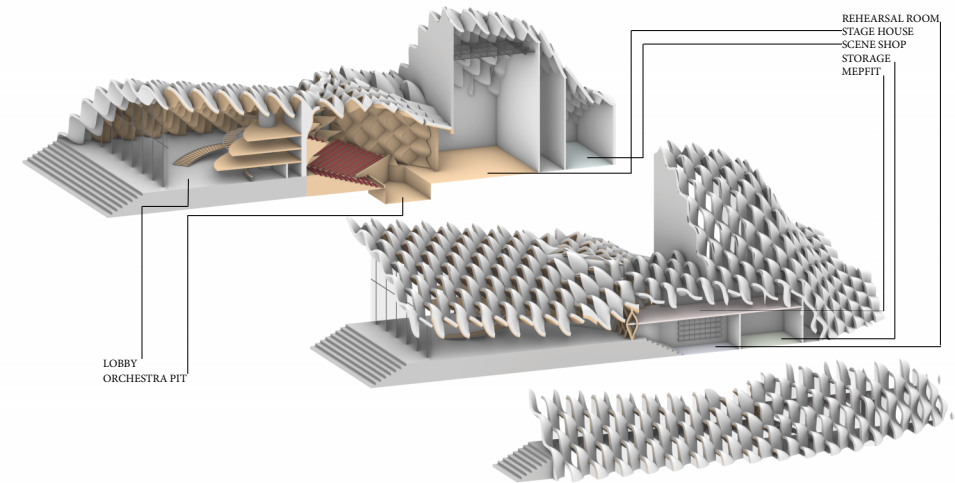
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FLEXIBLE REHEARSAL ROOM

A rehearsal space designed to fit an orchestra of up to 80 people has been incorporated into the building. The room also houses a seating area which allows the space to be flexible and fulfil various functions, meaning the room can double as a lecture room or hang out place if necessary. This also creates a difference in elevation, creating the opportunity for the conductor to be clearly visible for the entire orchestra or for a choir to be arranged appropriately.



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Considering the MEPFIT-rooms sensitive location, placed directly above the rehearsal space and sharing a wall with the opera hall, precautions around its construction had to be taken. To solve the issue, the box-in-box concept was applied for the MEPFIT-rooms, meaning the rooms were put on springs to absorb the vibrations from the machines. This also creates an airgap to add another layer of isolation between the MEPFIT-rooms and the other spaces.



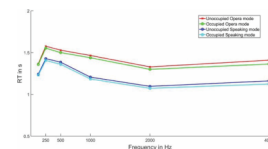
A LOBBY WITH A VIEW

The large, open lobby welcomes all visitors without feeling cramped. It creates a busy atmosphere on nights when there is an event, but becomes an appealing study area during the days. Students can sit inside the semi-private niches created by the scales or enjoy the view from one of the lobby's three balconies. These areas also double as cozy lounges where the visitors of the opera can relax between acts.



A UNIQUE OPERA HALL

The soft, overlapping curves of the scale grid creates a stunning experience inside the opera hall. With skylights integrated in the overlappings in the ceiling, natural light is able to fill the hall during the day, while also creating an impressive shadow play. During the night the warm light from inside the hall elevates the contours of the scales, making them stand out. It creates a majestic framing for the opera hall, while not taking focus from the performance.



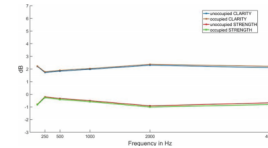
REVERBERATION TIME

With help from the variable acoustic panels, different modes for different performance types have been created. The main focus has been on the opera mode, however, it is possible to adjust the hall to a speaking mode as well, making the hall flexible and multi-functional.



VARIABLE ACOUSTIC PANELS

To be able to adapt the acoustics of the opera hall, adjustable acoustic panels were created. These consist of reflective panels which can be folded open to expose the inside of the scales. The inside is covered in porous, absorbent material to help bring the reverberation time down if necessary. With all of these panels open, the reverberation time can be as low as 1.1 seconds, appropriate for speeches.

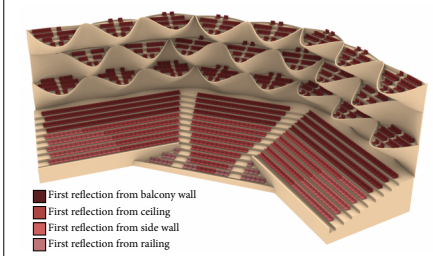


CLARITY AND STRENGTH

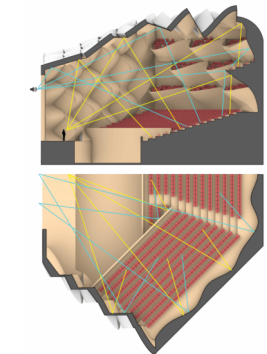
The opera hall showcases exceptional acoustics, that is characterized by a mean clarity (C80) value of 2.02 dB. This signifies a reverberant environment where sound reflects distinctly, enriching the auditory perception with crispness and resonance.

ITDG AND EARLY REFLECTIONS

With the many different surfaces, the reflections were integral for the design of the opera hall. To create a good and similar experience for everyone, especially those sitting in the center, the angles of the reflecting wall panels and skylights were adjusted to steer the sound to all parts of the opera hall. Combined with a sloped ceiling, good values for all visitors were achieved.



The final values for the initial time delay-gap range between 20 and 25 msec throughout the opera hall, with the shortest value measured along the side walls and the longest value measured in the center of the opera hall. These values ensure a good and even performance throughout the entire opera hall, with a natural sound reaching all seats.



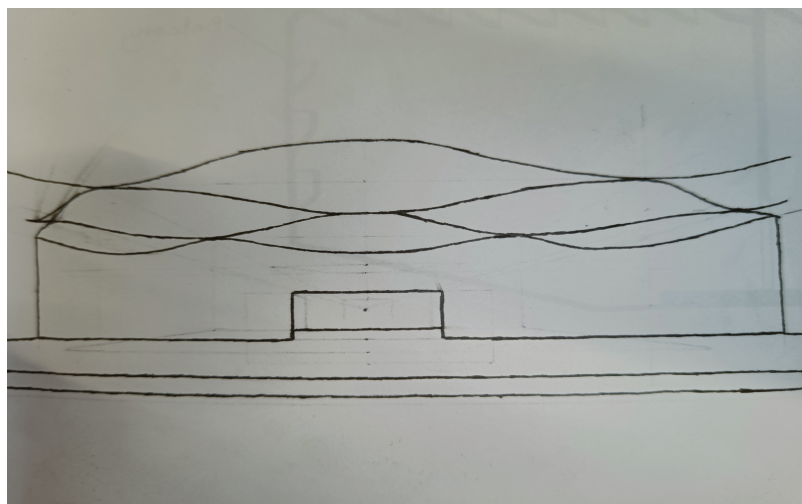
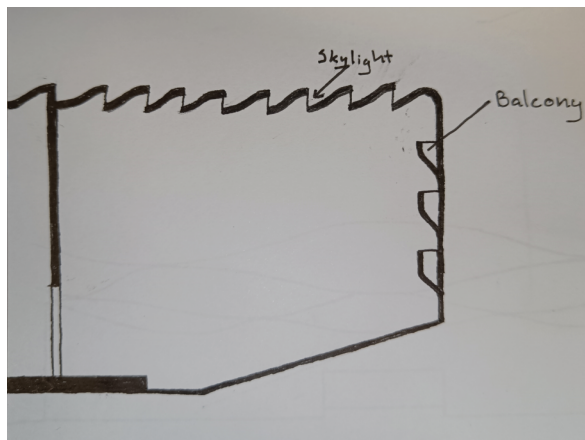
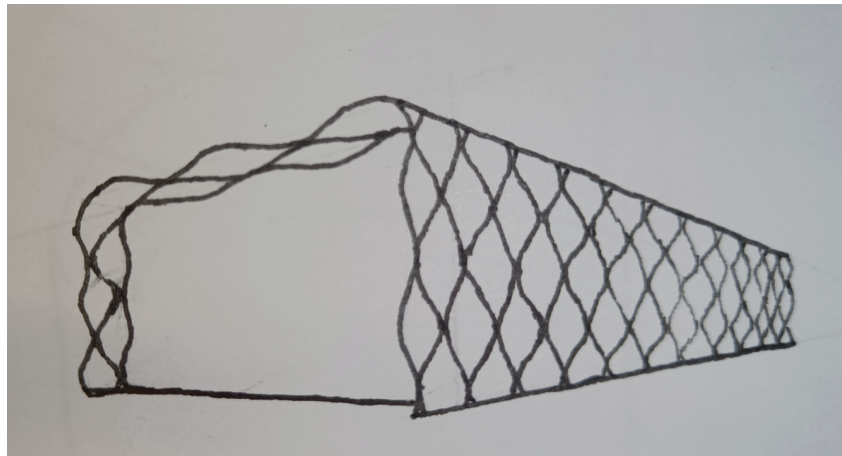
TÄVLINGSBIDRAG

Vi valde att kommunicera vårt koncept med ett starkt exteriörperspektiv samt ett starkt interiörperspektiv. För att binda samman hela presentationen fungerar vår sprängmodell som ett hjälpmedel att orientera var de olika ritningarna och bilderna hör hemma. Akustiken kommunicerar vi med grafer, text samt ritningar över detaljmodeller och den variabla akustikmodellen.

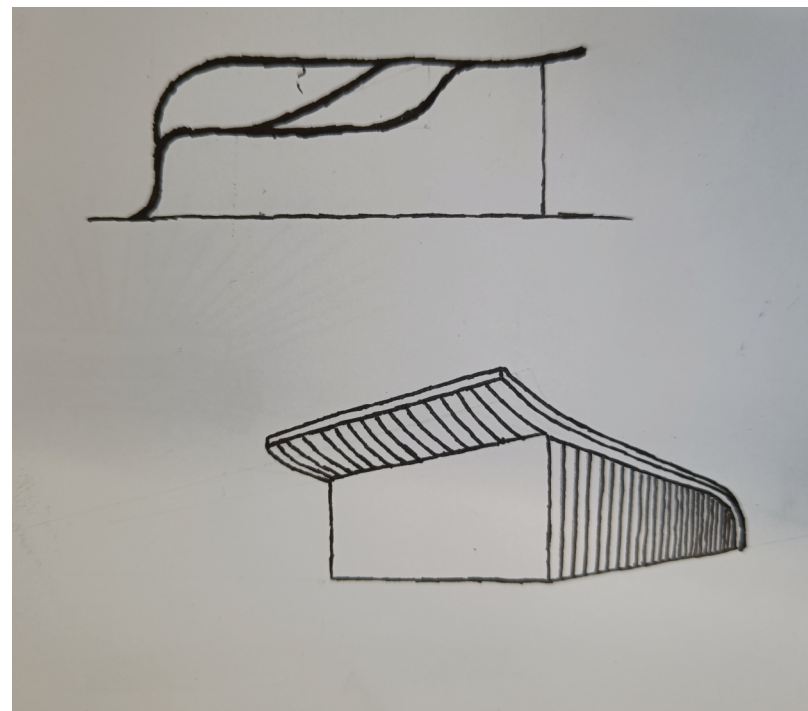
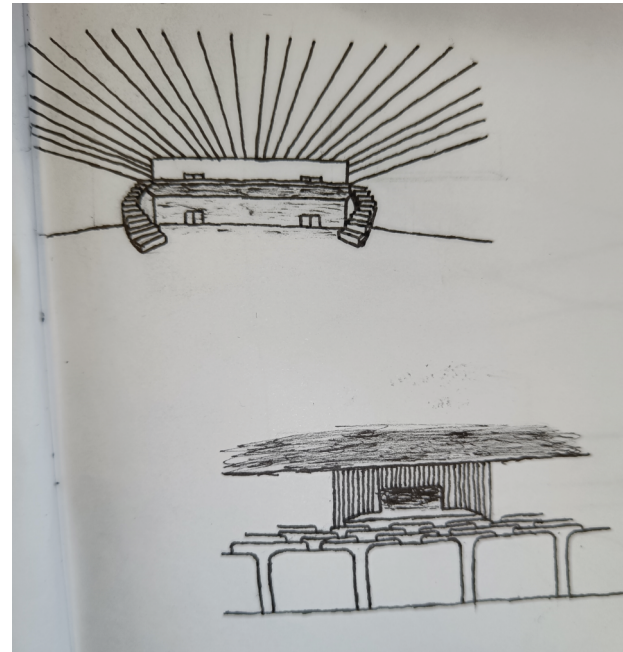
PROCESS

Tidigt i designprocessen tog vi fram flera olika koncept som vi trodde på. Vi kom överens om att vi ville ha en organisk opera med mycket trä där besökare möter en storslagen entré och detta testade vi att presentera på olika sätt. I koncept ett och två provade vi olika sätt att skapa en organisk opera genom att använda oss av organiska, vågliknande former. Koncept tre tog istället det organiska mer bokstavligt där operan får liv i form av en skog. I slutändan vidareutvecklade vi det första konceptet. Detta främst på grund av fjällmönstret, som vi tyckte var väldigt intressant och gav oss många idéer på hur vi kunde skapa rum i fjällen, släppa in dagsljus samt reflektera och stänga ute ljud. Vi valde därför att jobba vidare med dessa idéer.

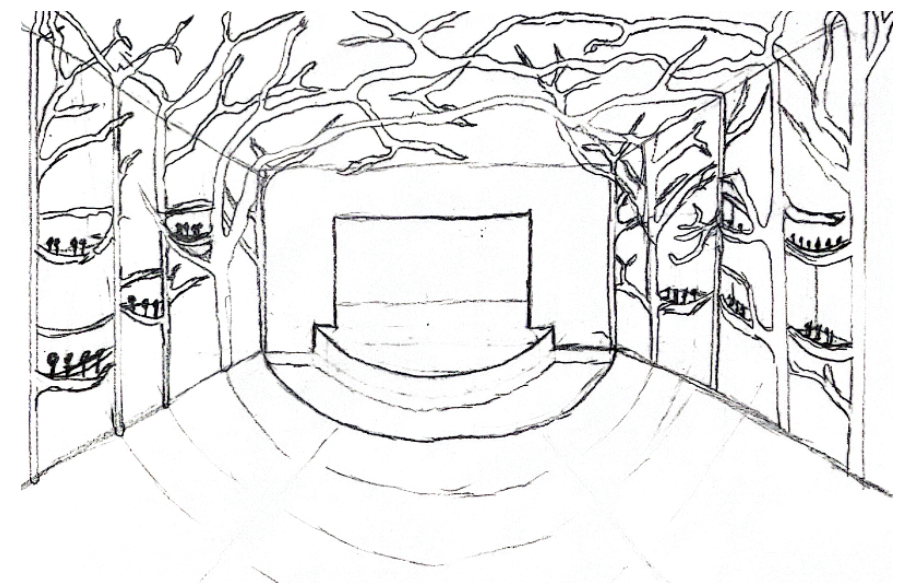
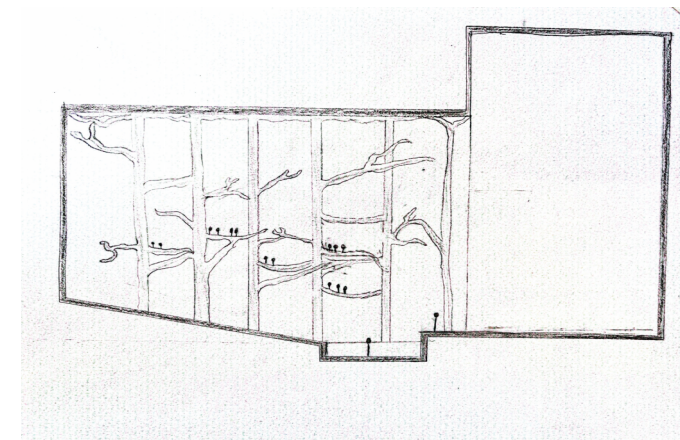
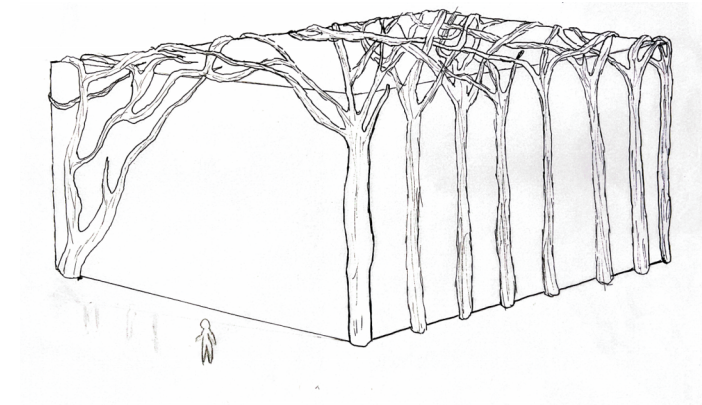
KONCEPT 1



KONCEPT 2

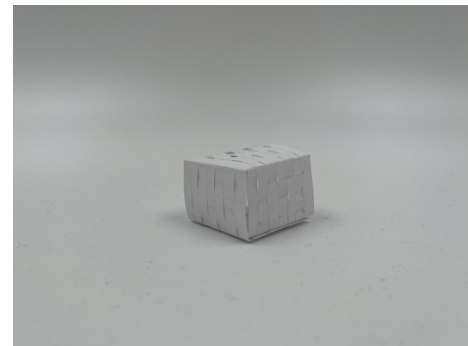


KONCEPT 3



AKUSTISKA MODELLER

Vi skapade fysiska modeller för att visa hur vi kunde använda fjällen för att skapa olika akustiska reflektorpaneler, diffusionspaneler samt balkonger. Eftersom projektet skulle innehålla mycket trä ville vi även arbeta med det under denna process.



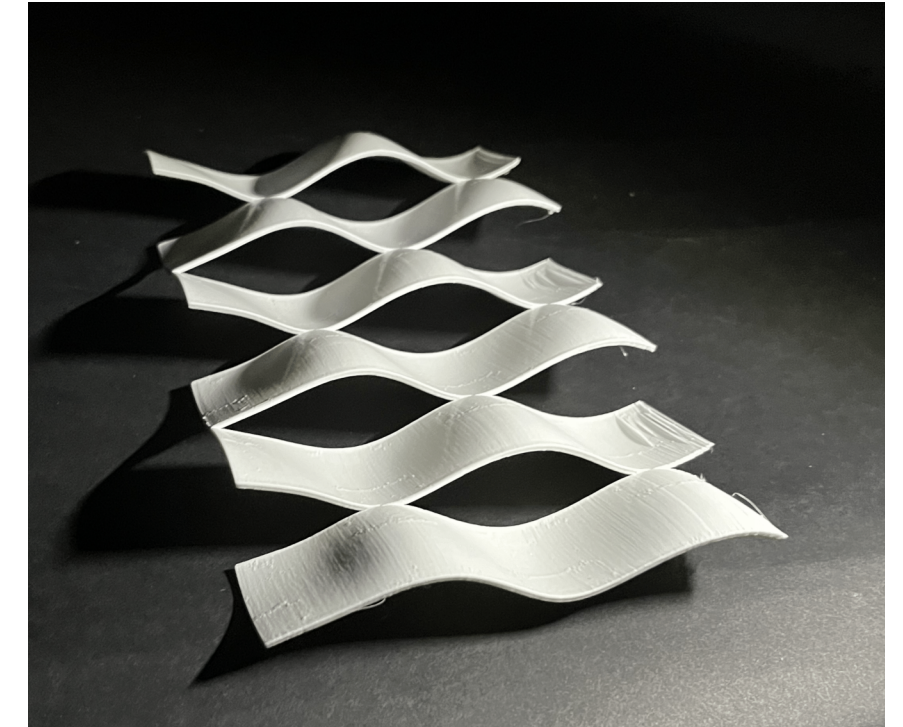
REFLEKTION

Efter att projektet avslutats och jag fått mer perspektiv på det känner jag mig mycket stolt och nöjd. Vi hade ett bra samarbete och inspirerade varandra till att arbeta hårt. Processen att tidigt ta fram många skisser fungerade bra och gjorde att vi sedan kunde välja det bästa konceptet bland flera bra. Genom att tidigt ha mindre presentationer av våra tidiga iterationer kunde vi snabbare komma nära vårt projekt och tidigt ta ägandeskap över vår idé, vilket gav självförtroende och driv att hålla nivån under flera månaders tid. Det jag var mest nöjd med var den överblickbara presentationen och kvaliteten på vårt material. Mer specifikt blev våra modeller och renderingar bra presentationsmaterial då de var tydliga och omsorgsfullt producerade.

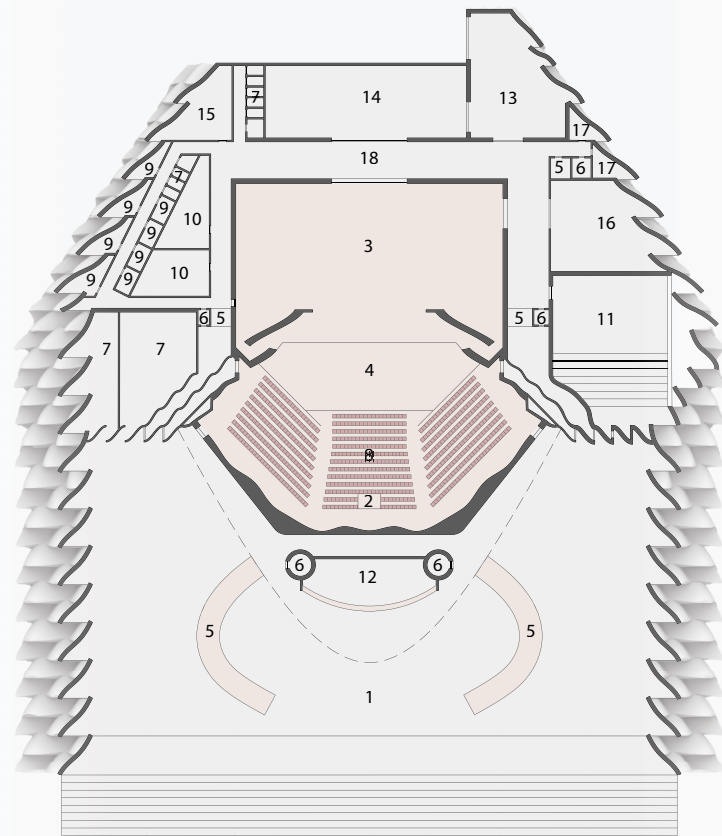
Jag gillar upplägget på kursen där vi under de tidiga iterationerna skulle ta mycket inspiration av naturen. Även om jag gärna hade besökt en operasal tidigare i designprocessen håller jag med om att det gjorde våra idéer mer originella och intressantare eftersom vi inte utgick lika mycket från befintlig arkitektur inom operavärlden. Som med alla projekt finns det en bestämd mängd tid man har att arbeta på det. Hade mer tid funnits hade jag gärna arbetat vidare med projektet och hur man löser mer praktiska problem som kan uppstå med den originella formen som vårt fjäll skapar. Till exempel vattenavrinning och sanering. Vi hade även kunnat välja en specifik plats för projektet då vi nu endast valt en godtycklig stad.

3D PRINTAD MODELL

Vi skapade ett mönster av dubbelkrökta ytor, som vi parametriserade. Då kunde vi leka med olika former på fjällen och hur stora ljusinsläppen skulle bli. Vi använde oss av den parametriska modellen för att vidare skapa balkonger i fjällen samt att justera vinklar för att få bra akustik i operasalen.



Projektet har inspirerat mig att fortsätta utmana mig själv och alltid söka problem som kan lösas på kreativa sätt. Tankesättet att hela tiden leta efter nya problem är något som lärarna i kursen lyft många gånger och det kommer jag ta med mig. Jag tar även med mig hur bra samarbetet fungerade och det tror jag kan vara användbart i framtiden. Under året har vi tränats i att skapa ett eget program i kursen ARK297 Arkitektur och optimerade strukturer, för att sedan nu under kandidatarbetet följa ett strikt tävlingsprogram. Från det tar jag med mig viktiga lärdomar om vikten av att äga sitt projekt från början till slut, samt erfarenhet av att arbeta med ett relativt stort projekt mot en deadline.



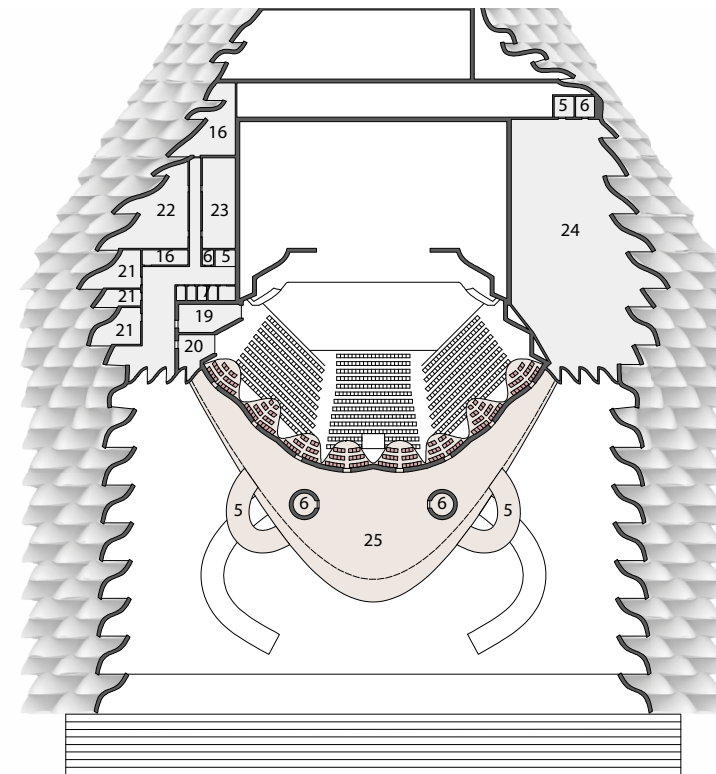
A FLEXIBLE BUILDING FIT FOR A COLLEGE CAMPUS

A large water mirror in front of the opera house creates a welcoming feeling to the building. With plenty of room for socializing and studying around the water, as well as on the steps in front of the building, the entrance situation has been moulded to fit a college campus. A large, open lobby is what is welcoming you after you have entered the door to the opera house, creating an uplifting atmosphere upon arrival.

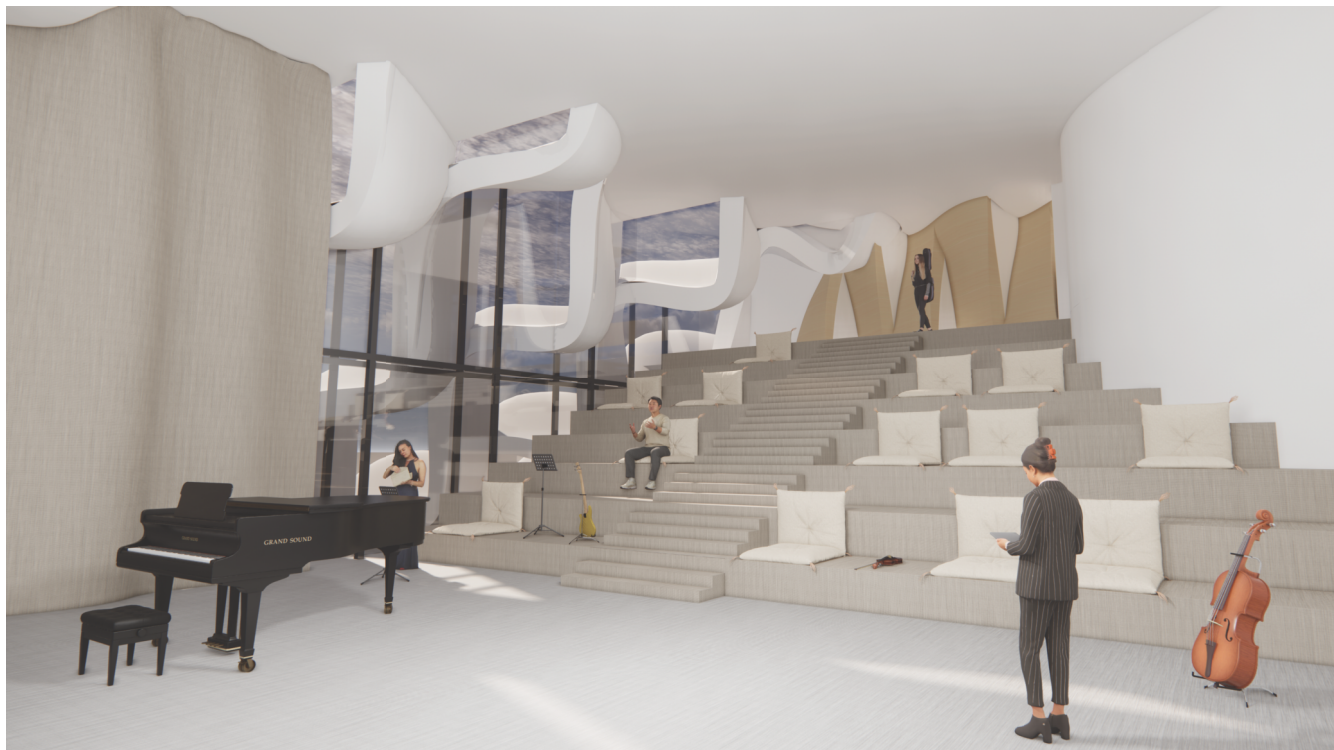
The opera hall has been placed in the center of the building which allows for easy access from all parts of the opera house at the same time as it acts as a natural blockade between the public lobby and the restricted parts at the back of the house. This separation creates a clear structure for the building, and the design also allows the surrounding rooms to act as a sound barrier, shielding the opera hall from the traffic noise outside.

A MULTIFUNCTIONAL CONCEPT

The key to this project is the scale grid. Taking inspiration from the scales of a fish, its double curved surfaces create openings which have been used for acoustic panels and skylights to name a few. This pattern also makes for a secure cover while still creating a connection between the outside and inside wherever you are in the building.



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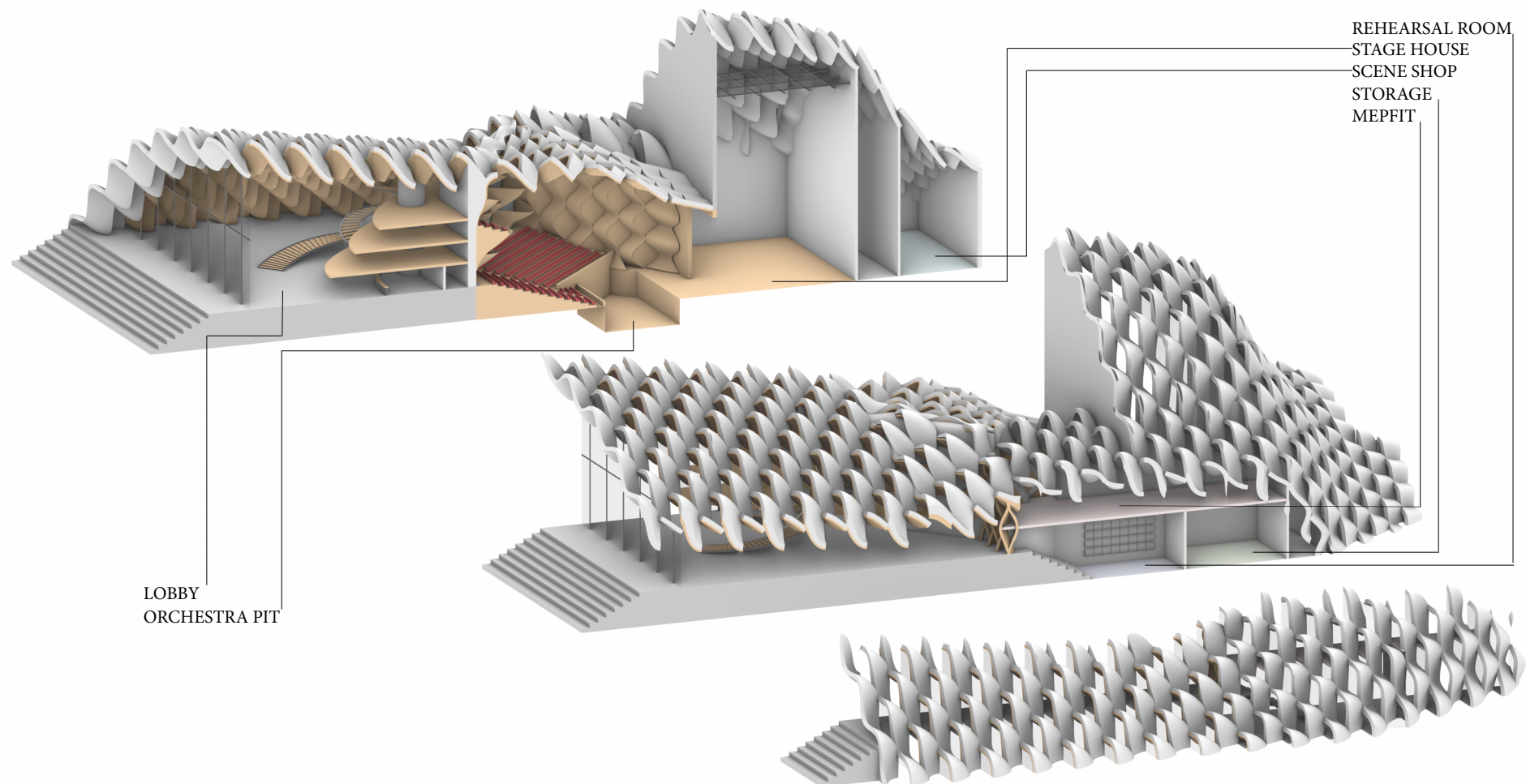


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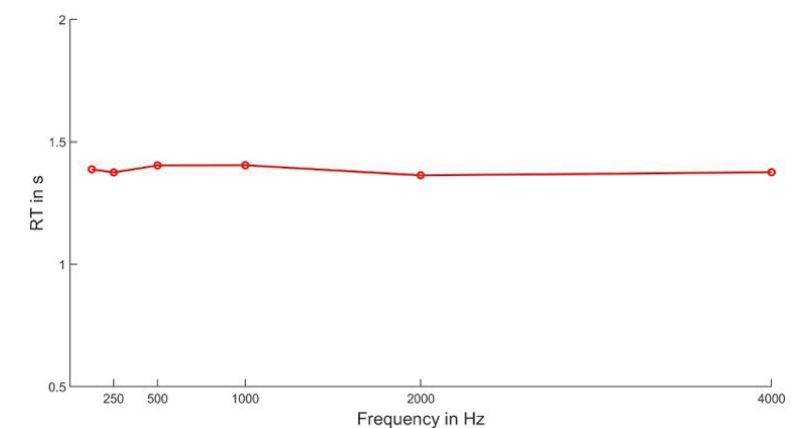
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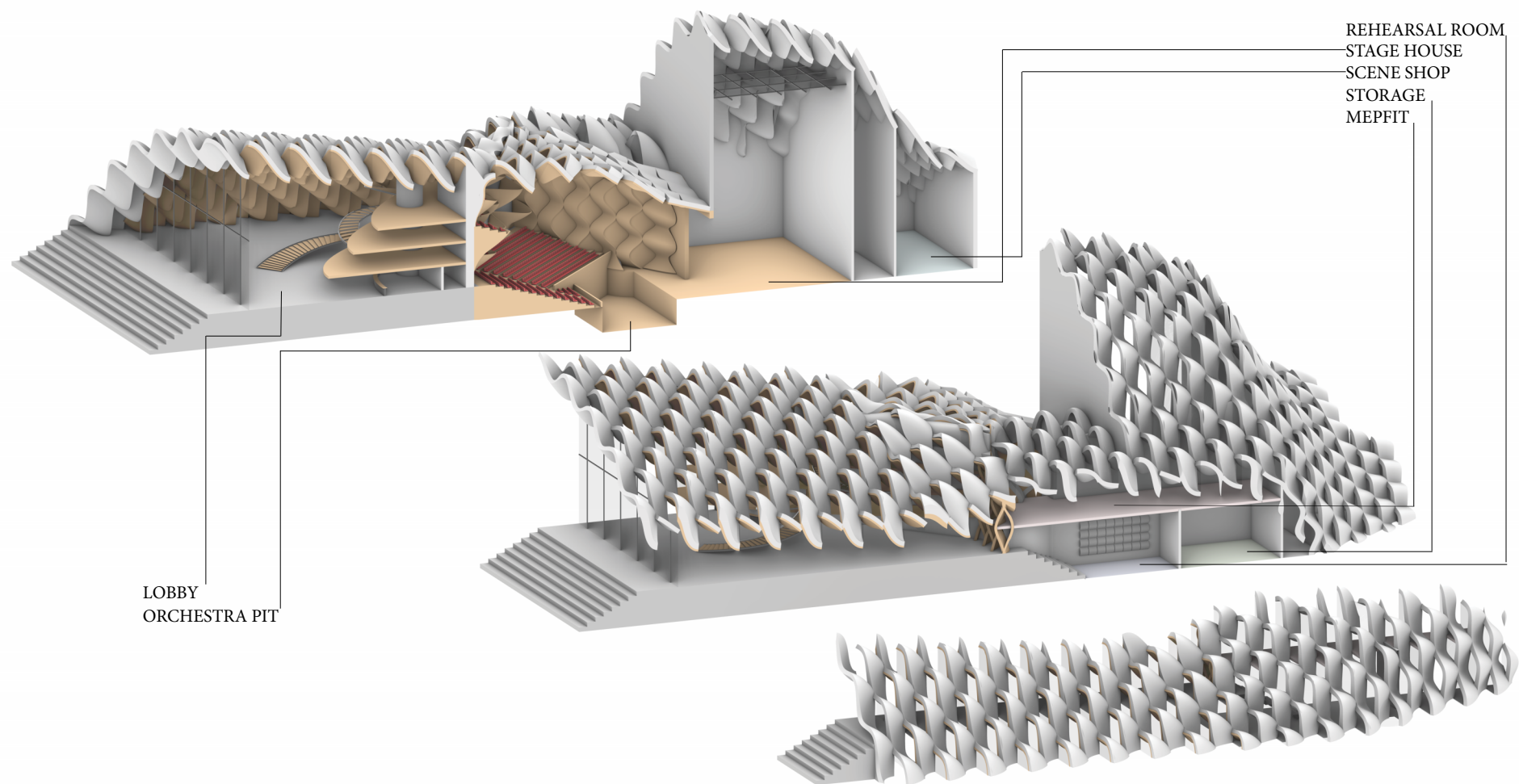
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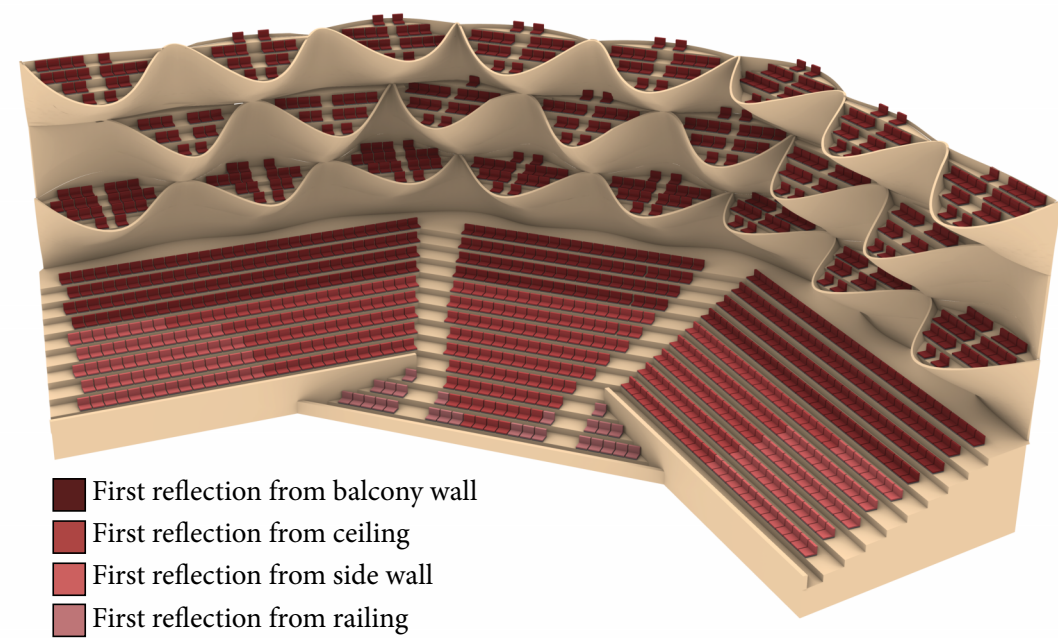
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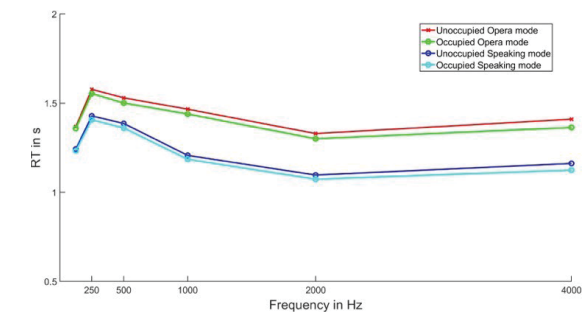
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- First reflection from balcony wall
- First reflection from ceiling
- First reflection from side wall
- First reflection from railing

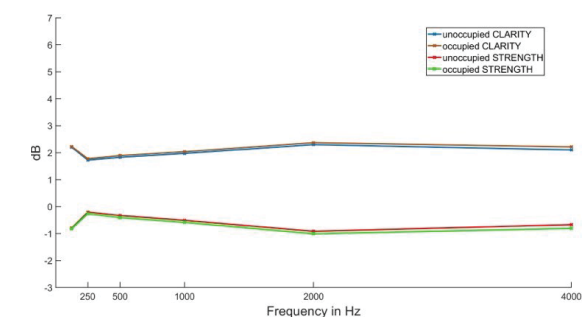
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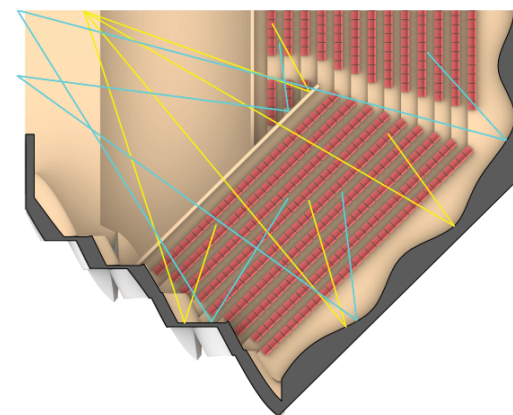
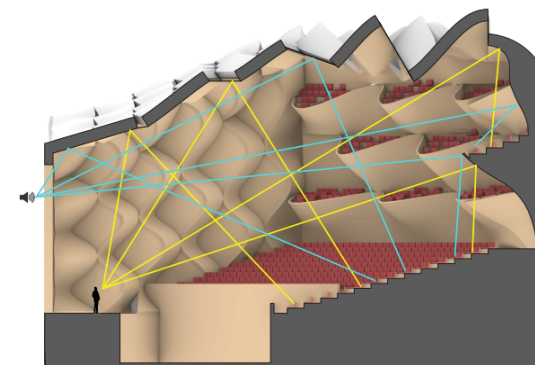


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