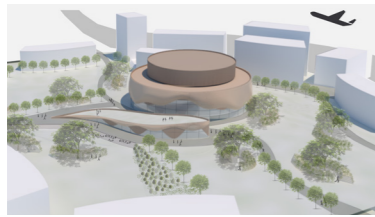


THE SEASHELL

- Nature's amplifier of sound

The seashell, a beautiful product of nature whose only task is to protect against the outside world. It's very calm and quiet at first glance, but when you're getting closer to it and putting it next to your ear, the acoustical qualities of the inside offer you a remarkable musical experience. Just like the new opera house The Seashell - Nature's amplifier of sound.



Concept

The embracing quality of the seashell appears in the multiple layers of timber panels that protect the core of the building, the concert hall. This embracing quality is also shown in the soft and organic shapes of the exterior, that invite you in while the building gradually proceeds to become a part of the landscape. The enclosing shells are raised in some parts to enable daylight openings in the facade. A smaller building, with a restaurant/café in combination with a library/study-area attracts students to this part of campus. The park-like area around the opera house helps to create pleasant acoustical environments around the building where students can meet up and hang out. Smaller pavilions with lots of greenery serve as social places somewhat protected from the noise.

Noise control - On the site

The noise from the highway and the passing airplanes is reduced before reaching the opera house by positioning the campus facilities close to the highway. The sound pressure levels decrease due to distance and due to the buildings acting as noise barriers. The huge and astonishing glass entrance is facing away from the highway, to ensure that the vulnerable part of the building isn't directly exposed to the source of the noise. By avoiding parallel surfaces and working with convex shapes in the whole campus area we avoid unpleasant acoustical environments caused by flutter echo.



The soft and organic shapes of the building control your movement and lead you to the entrance, which is well integrated in the exterior design. When you enter the lobby you're mesmerized by the light and open space, with its high ceilings and beautiful light fixtures. The modern wooden interior in combination with the huge glass facade and elements of greenery, brings your thoughts to Scandinavian interior design. Visitors are moving and enjoying each other's company on the many balconies above you, waiting for the next performance to start.

Lobby

The lobby is designed to be a welcoming and open space with many integrated spatialities to make it possible to host dinners, meetings and smaller gatherings in the different parts of the room. When visitors arrive, they buy their ticket, enter the space underneath the concert hall and then begin their journey towards their seat.

Noise control - Construction

In order to achieve the levels defined by the Noise Criterion inside the Opera House, the construction of the outer walls and ceiling consist of several layers of concrete and absorbing material as well as three-layer glass. To achieve the more restrictive levels given by the NCB-15 curve inside the performance hall, this is designed as a box in a box, decoupled from the outer construction, providing a better sound insulation.

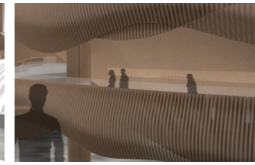
Sound environment - Lobby

Three-layered timber panels in combination with acoustic chandeliers create a good sound environment in the lobby by reducing the general sound pressure level and the reverberation time.



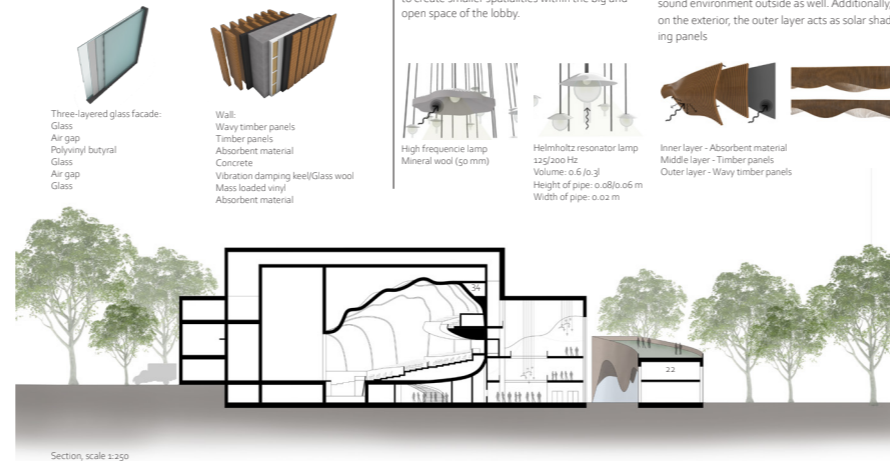
Acoustic chandelier

The acoustic chandelier consists of two different kinds of lamps. The bigger lamps in the chandelier are covered with one layer of mineral wool, providing high absorption at high frequencies. The smaller lamps work as Helmholtz resonators, designed to reduce undesirable low frequency sound, typically from people talking (125-200 Hz). Additionally, the chandeliers relate to the theme of seashells by their organic shapes and they help to create smaller spatialities within the big and open space of the lobby.



Timber panels

3-layered timber panels relate to the concept of protecting shells. The inner layer consists of an absorbent material and the middle and outer layer consist of timber panels that act diffusive. The outer layer also prevents echoes due to the curved shapes of the panels. These same panels are used on the exterior of the building as well to enhance the recurring theme of protecting shells and to some extent create a good sound environment outside as well. Additionally, on the exterior, the outer layer acts as solar shading panels.



After buying your ticket you walk up the stairs to get to the right floor. Even the view from above the lobby is astonishing with a beautiful outlook on the university campus. You enter the concert hall, the protected core, and the first thing that you notice is the beautiful shell, with the many stripes that are embracing the hall. The sheen in between the stripes gives the hall a particular glow, to amplify the experience even more. You know it's just going to be a magical night!

General design

The audience is divided into multiple sections, on different levels, with walls in between them in order to achieve a uniform clarity (C80). The ITDG has been calculated in representative positions of the different areas in order to ensure low values in all cases.

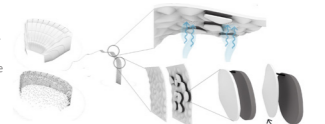
The ceiling of the performance hall is designed to work as multiple reflectors/diffusers. The different inclinations make the reflected waves reach the rear parts of the audience and the convex shapes diffuse the reflected energy and they also help to avoid echoes in the hall.

Furthermore, the width of the aisles is adjusted based on the flow of people, enabling smaller groups of people to gather closer to the entrances when waiting for their company.

| Technical Details Performance Hall | Opera | Orchestra |
|------------------------------------|-------|-----------|
| V (m³) | 7965 | 7990 |
| N seats | 1047 | 1302 |
| S absorbers (m²) | 308 | 55 |
| AS (m²) | 819.5 | 615.2 |
| RT ₆₀ (s) | 1.55 | 1.98 |
| BR (s) | 1.39 | 1.03 |
| G _{wall} (dB) | 1.37 | 2.01 |
| ITDG (ms) | <17 | |

Seashell panels

The back of the hall is completely covered in seashell panels, that gradually decrease in amount closer to the stage. The seashell panels can be adjusted to change the acoustics of the hall by sliding the reflective seashell panel to the side, to expose the absorbent material behind it.

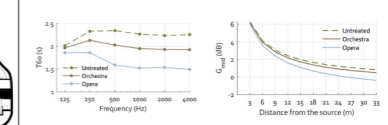


Opera and Orchestra

For the two most common performances, such as opera and symphony orchestra, the acoustics need to be able to change. The quantity of open panels is increased when changing from orchestra to opera in order to reduce the reverberation time and this results in the values showed in the figure.

The pit is lifted to stage level for performances such as symphony orchestra or chamber music, allowing 155 more people to be accommodated. In addition, an orchestra shell is stored in the upper part of the stage tower for opera, and this is lowered for concerts to create a diffuse environment for the musicians and reflect sound to the audience.

The strength decays especially in the 10 first meters from the stage and also varies when adding absorbent material, being lower for the opera use.



Orchestra pit

The pit is located three meters down when the performance hall is being used for opera, making space for 70 members. The front wall and the overhang above the musicians are diffusive, allowing the musicians to listen to themselves and each other. The back wall is tilted upwards in order to reflect the sound back to the stage, so that the singer can hear the musicians as well. Both side walls of the pit are covered with seashell panels to provide acoustic variability.

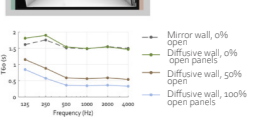
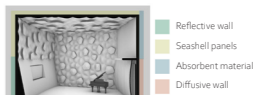


Variable acoustics - Concert hall

As the auditorium will be used for different types of performances, it's important to be able to vary the acoustics. This is done by adjusting the seashell panels, by changing the pit and by adding/removing the orchestra shell.

Variable acoustics - Rehearsal room

The rehearsal room is designed with a similar shape and with the same materials as the pit in order to recreate the conditions in the performance hall as much as possible. The room consists of a tilted reflective wall at the back, a diffusive wall in the front, absorbent material that resembles the stage opening and seashell panels on the side walls and in the ceiling for variable acoustics. There is a mirror behind the diffusive wall, which can be exposed when the room is used for other practices than orchestra, such as theatre or dance. Seashell panels are allowing a great acoustic variability with a RTmid range between 0.35 and 1.5 seconds, depending on the



THE SEASHELL

Kurs: Kandidatarbete, ACEX15

Termin: Vår 2021

Lärare: Morten Lund, Peter Christensson och Wolfgang Kropp

Producerat av: Felicia Bergenram, Wilma Elm Dahlman och Lucia Gonzalez

Kandidatarbetet visar hur arkitektonisk design och ingenjörsmässiga lösningar kan samverka för att skapa resultat betydligt utöver det vanliga. Kursen erbjuder också möjligheter till projektarbete för att träna oss i dessa samverkansformer. Projektarbetet utförs i samarbete med master-programmet "Sound and Vibration" och syftar till att kombinera kunskaper inom arkitektur och akustik för att genom en iterativ design-process, ta fram en slutgiltig konceptuell design för ett operahus.

Kandidatarbetet baseras på en tävling, 'ASA Student Design Competition 2021', utlyst av 'Acoustical Society of America'. Tävlingen går ut på att designa ett konserthus, främst för opera men också för andra musikevenemang och framträdanden såsom kör, dans och symfoniorkestrar. Konserthuset ska vara en del av ett godtyckligt campus med ett framstående musikprogram.

EXTERIÖR

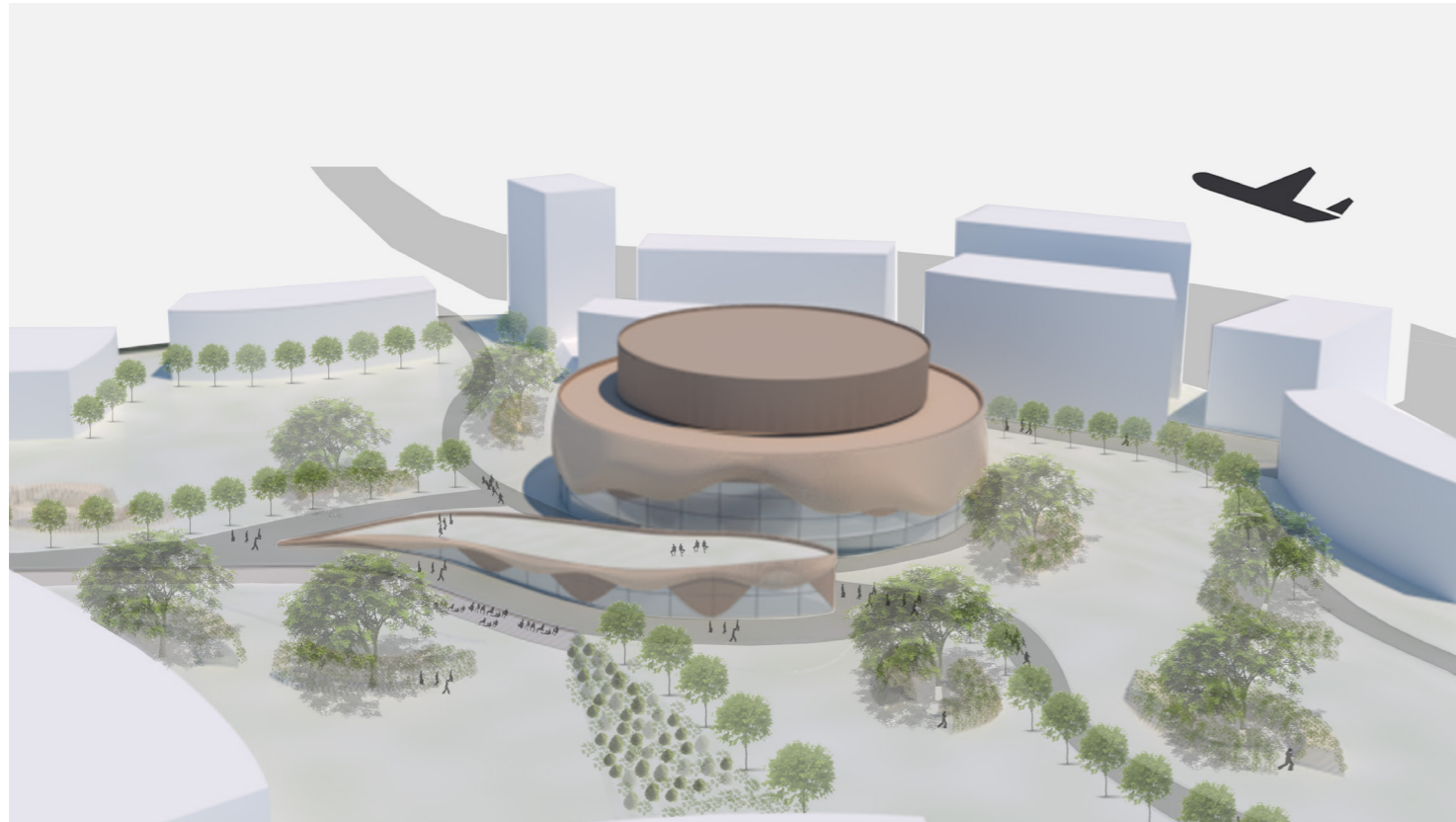


The seashell, a beautiful product of nature whose only task is to protect against the outside world. It's very calm and quiet at first glance, but when you're getting closer to it and putting it next to your ear, the acoustical qualities of the inside offer you a remarkable musical experience. Just like the new opera house The Seashell - Nature's amplifier of sound.

CONCEPT

The embracing quality of the seashell appears in the multiple layers of timber panels that protect the core of the building, the concert hall. This embracing quality is also shown in the soft and organic shapes of the exterior, that invite you in while the building gradually proceeds to become a part of the landscape. The enclosing shells are raised in some parts to enable daylight openings in the facade.

A smaller building, with a restaurant/café in combination with a library/study-area attracts students to this part of campus. The park-like area around the opera house helps to create pleasant acoustical environments around the building where students can meet up and hang out. Smaller pavilions with lots of greenery serve as social places somewhat protected from the noise.

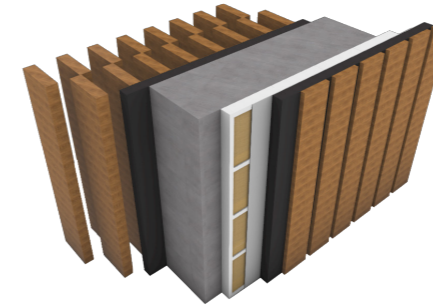


NOISE CONTROL - ON THE SITE

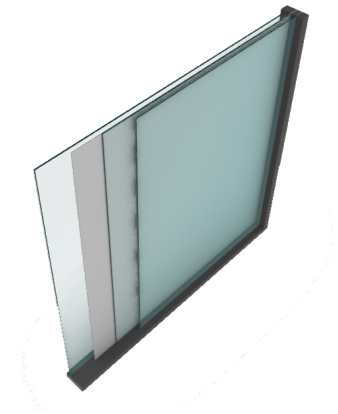
The noise from the highway and the passing airplanes is reduced before reaching the opera house by positioning the campus facilities close to the highway. The sound pressure levels decrease due to distance and due to the buildings acting as noise barriers. The huge and astonishing glass entrance is facing away from the highway, to ensure that the vulnerable part of the building isn't directly exposed to the source of the noise. By avoiding parallel surfaces and working with convex shapes in the whole campus area we avoid unpleasant acoustical environments caused by flutter echo.

NOISE CONTROL - CONSTRUCTION

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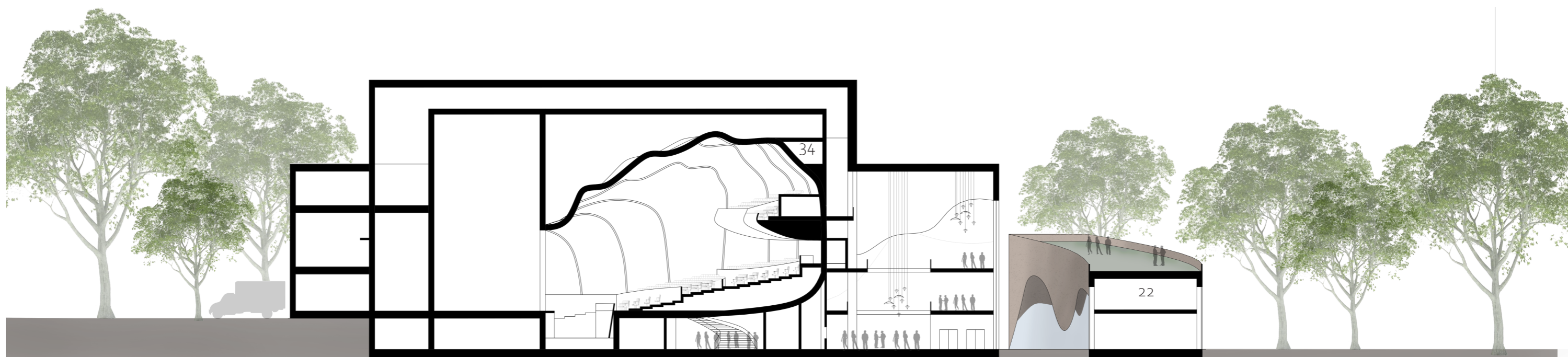


Wall:
 Wavy timber panels
 Timber panels
 Absorbent material
 Concrete
 Vibration damping keel/Glass wool
 Mass loaded vinyl
 Absorbent material



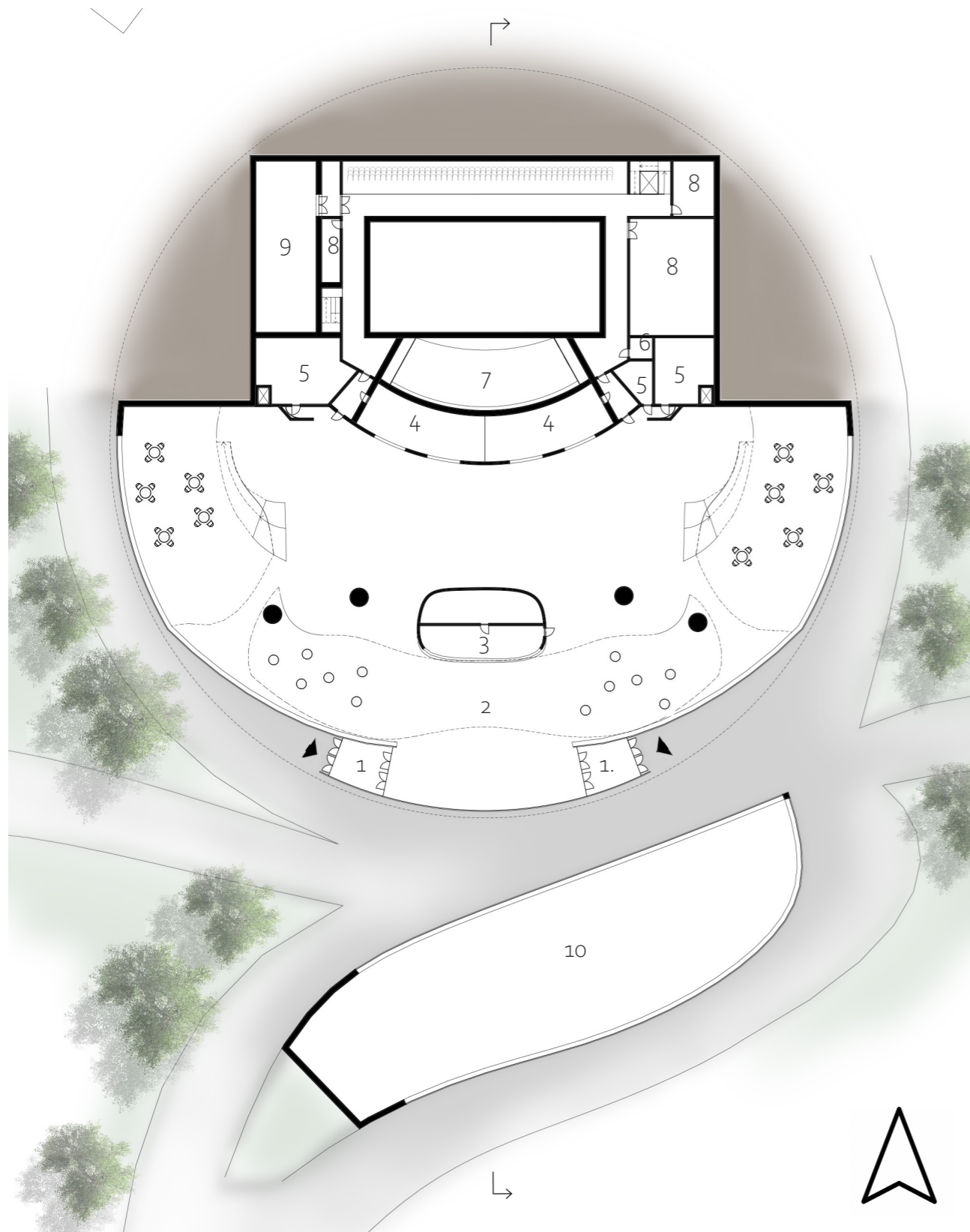
Three-layered glass facade:
 Glass
 Air gap
 Polyvinyl butyral
 Glass
 Air gap
 Glass

SEKTION

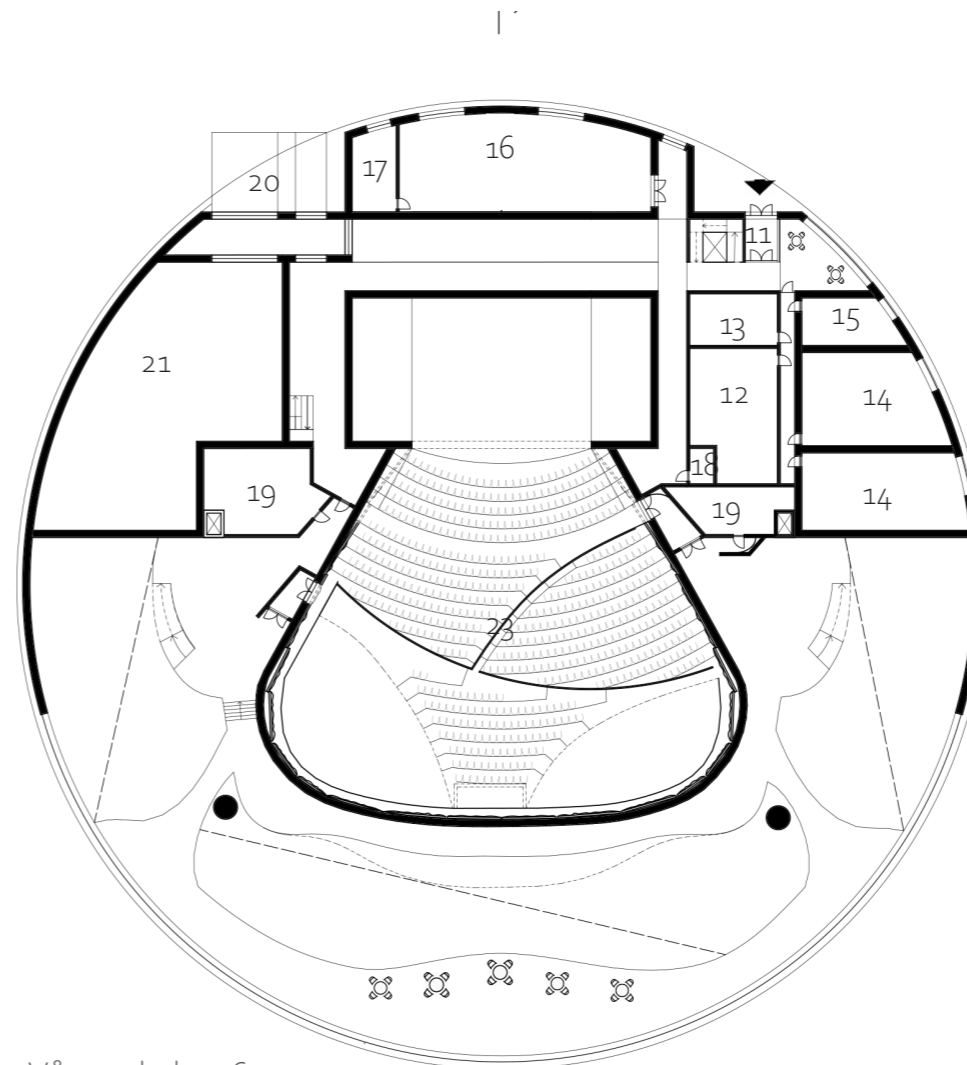


Skala 1:400

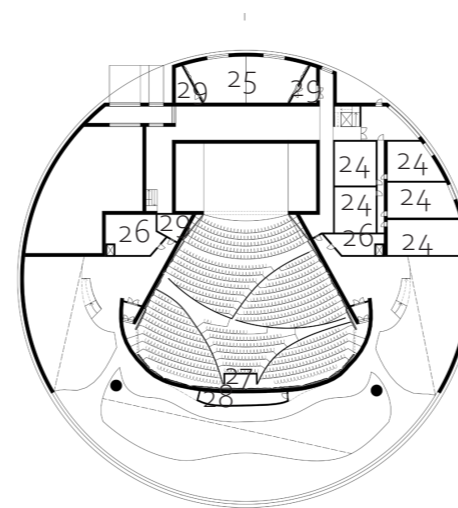
PLANER



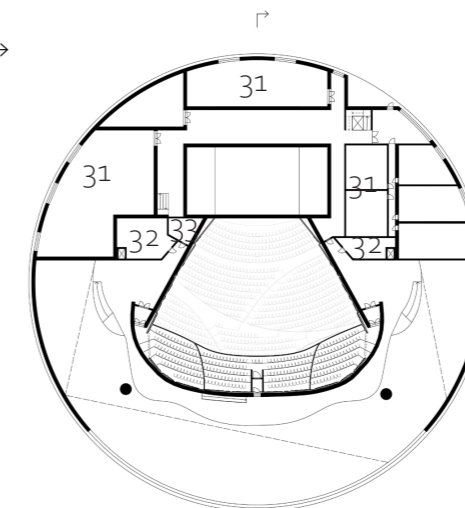
Entréplan, skala 1:600



Vån 1, skala 1:600



Vån 2, skala 1:1200



Vån 2, skala 1:1200

Entrance floor:

- 1. Visitor entrance
- 2. Lobby NC-35
- 3. Ticket manager's office
- 4. Wardrobe
- 5. Public restrooms
- 6. Off-stage quick toilet
- 7. Orchestra pit
- 8. Storage NC-40
- 9. Mechanical equipment room NC-40
- 10. Restaurant/Café

First floor:

- 11. Staff entrance
- 12. Costume shop NC-30
- 13. Wig and make up NC-30
- 14. Chorus dressing rooms NC-30
- 15. Conductors dressing room NC-30
- 16. Green room NC-25
- 17. Prop pentry
- 18. Off-stage quick toilet
- 19. Restrooms
- 20. Truck loading dock
- 21. Scene shop NC-30
- 22. Library/Study-area
- 23. Performance hall NCB-15

Second floor:

- 24. Solo dressing rooms NC-30
- 25. Rehearsal room NC-25
- 26. Restrooms
- 27. In-house audio mix position NCB-15
- 28. Lighting and stage manager control room NC-25
- 29. Storage NC-40
- 30. Library/Study-area

Third floor:

- 31. Office and administration
- 32. Restrooms
- 33. Storage NC-40
- 34. Projection/Title booth and follow spot booth

LOBBY



The soft and organic shapes of the building control your movement and lead you to the entrance, which is well integrated in the exterior design. When you enter the lobby you're mesmerized by the light and open space, with its high ceilings and beautiful light fixtures. The modern wooden interior in combination with the huge glass façade and elements of greenery, brings your thoughts to Scandinavian interior design. Visitors are moving and enjoying each other's company on the many balconies above you, waiting for the next performance to start.

GENERAL DESIGN

The lobby is designed to be a welcoming and open space with many integrated spatialities to make it possible to host diners, meetings and smaller gatherings in the different parts of the room. When visitors arrive, they buy their ticket, enter the space underneath the concert hall and then begin their journey towards their seat.

NOISE CONTROL - LOBBY

3-layered timber panels in combination with acoustic chandeliers create a good sound environment in the lobby by reducing the general sound pressure level and the reverberation time.



ACOUSTIC CANDELIER

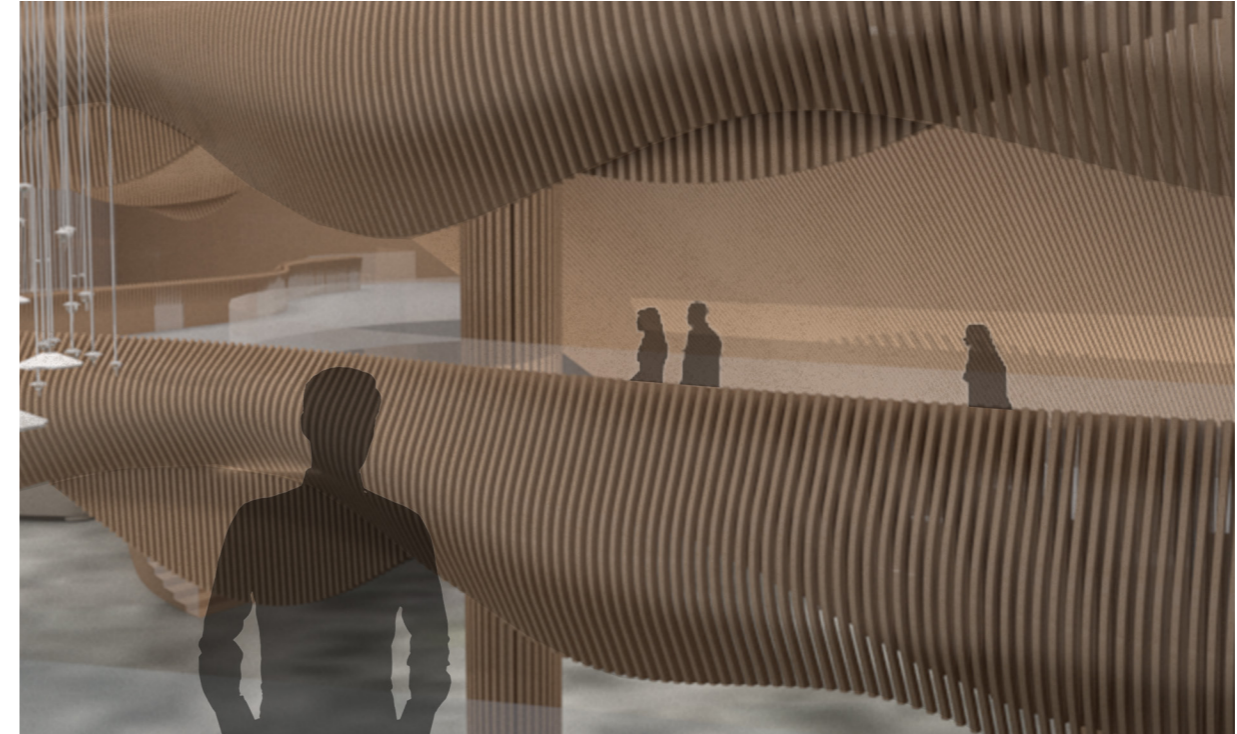
The acoustic chandelier consists of two different kinds of lamps. The bigger lamps are covered with one layer of mineral wool (50 mm), providing high absorption at high frequencies. The smaller lamps work as Helmholtz resonators, designed to reduce undesirable low frequency sound, typically from people talking (125-200 Hz).

Additionally, the chandeliers relate to the theme of seashells by their organic shapes and they will also help to create smaller spatialities within the big and open space of the lobby.



Helmholtz resonator lamp 125/200 Hz
Volume: $0.6 / 0.3$
Height of pipe: $0.08 / 0.06$ m
Width of pipe: 0.02 m

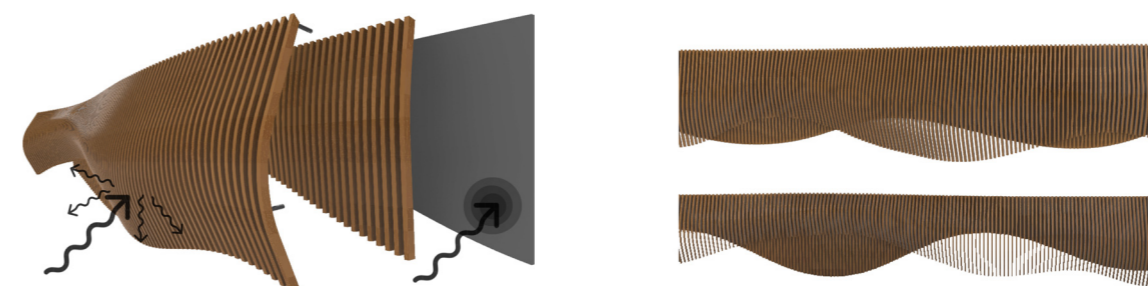
High frequency lamp
Mineral wool (50 mm)



TIMBER PANELS

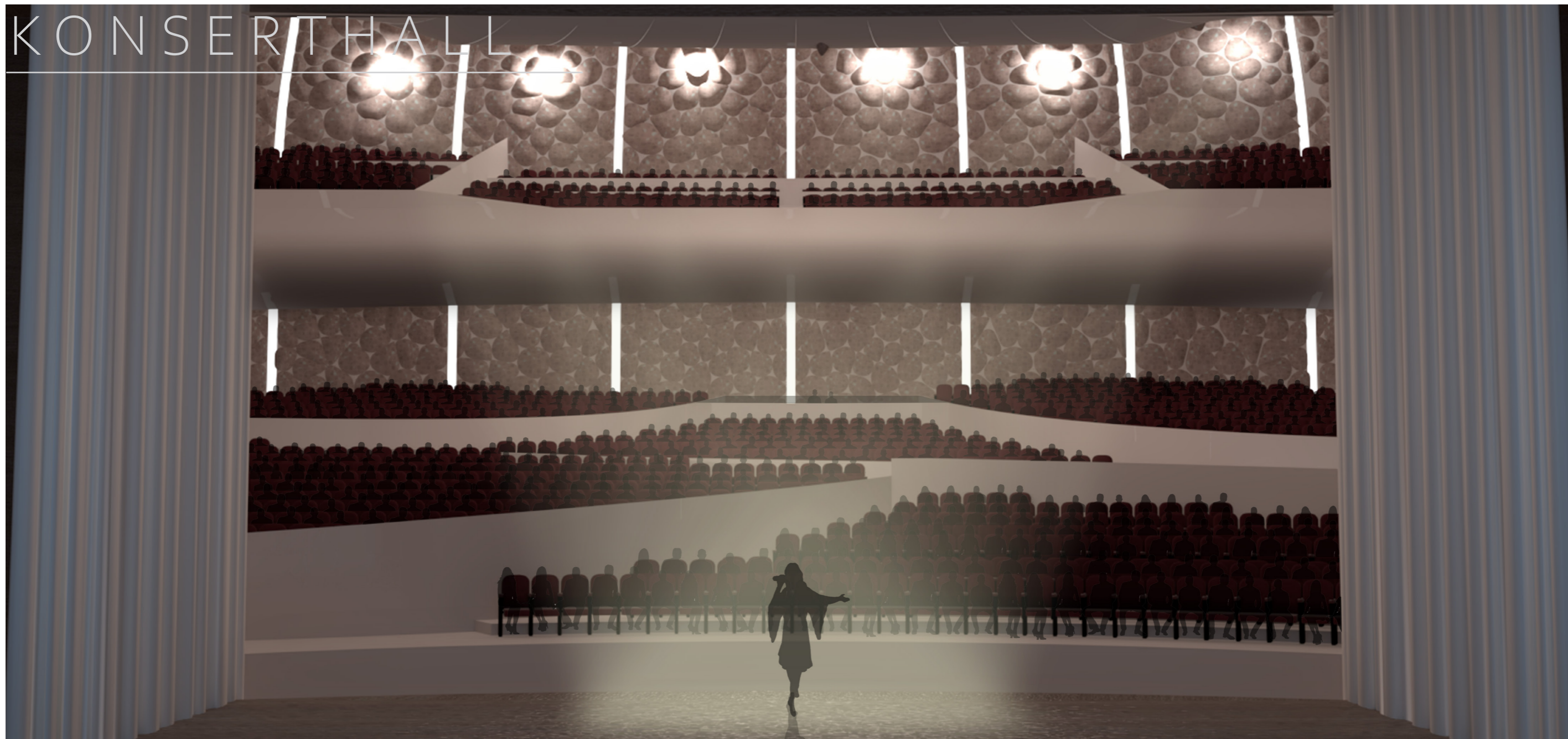
3-layered timber panels relate to the concept of protecting shells. The inner layer consists of an absorbent material and the middle and outer layer consist of timber panels that act diffusive. The outer layer also prevents echoes due to the curved shapes of the panels.

These same panels are used on the exterior of the building as well to enhance the recurring theme of protecting shells and to some extent create a good sound environment outside as well. Additionally, on the exterior, the outer layer acts as solar shading panels.



Inner layer - Absorbent material
Middle layer - Timber panels
Outer layer - Wavy timber panels

KONSERTHALL



After buying your ticket you walk up the stairs to get to the right floor. Even the view from above the lobby is astonishing with a beautiful outlook on the university campus. You enter the concert hall, the protected core, and the first thing that you notice is the beautiful shell, with the many stripes that are embracing the hall. The sheen in between the stripes gives the hall a particular glow, to amplify the experience even more. You know it's just going to be a magical night!

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The audience is divided into multiple sections, on different levels, with walls in between them in order to achieve a uniform clarity (C80). The ITDG has been calculated in representative positions of the different areas in order to ensure low values in all cases.

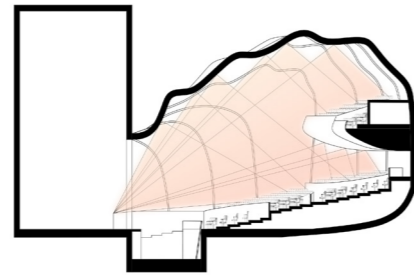
The ceiling of the performance hall is designed to work as multiple reflectors/diffusers.

The different inclinations make the reflected waves reach the rear parts of the audience and the convex shapes diffuse the reflected energy and they also help to avoid echoes in the hall.

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Technical Details Performance Hall

| | Opera | Orchestra |
|-------------------------------|-------|-----------|
| V (m ³) | 7365 | 7050 |
| N seats | 1047 | 1202 |
| S absorbers (m ²) | 308 | 55 |
| AS (m ²) | 819.5 | 615.2 |
| RT _{mid} (s) | 1.55 | 1.98 |
| BR (s) | 1.19 | 1.03 |
| G _{mid} (dB) | 1.37 | 2.01 |
| ITDG (ms) | < 17 | |



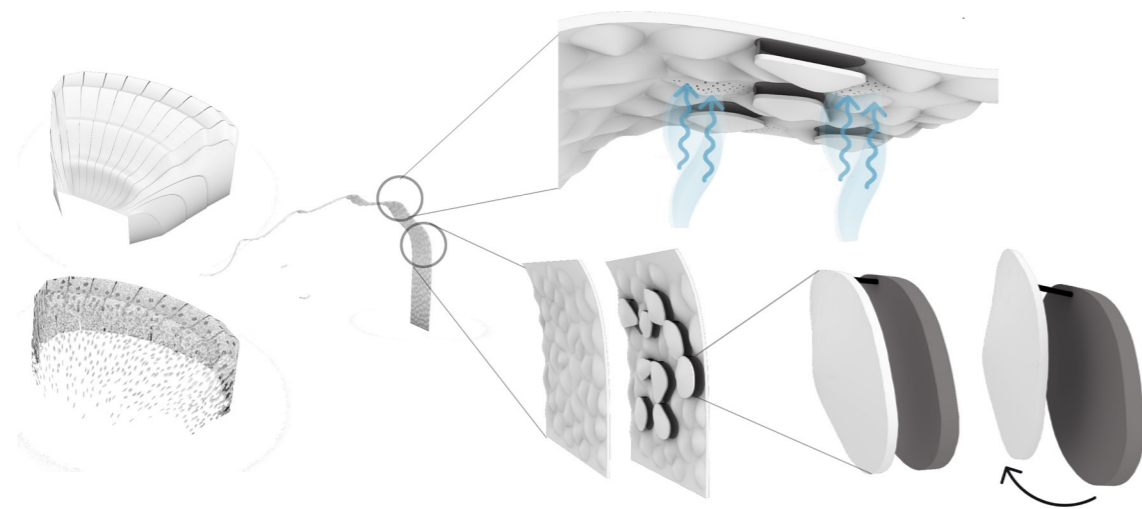
Reflectors/diffusers of the ceiling

VARIABLE ACOUSTICS - CONCERT HALL

As the auditorium will be used for different types of performances, it's important to be able to vary the acoustics. This is done by adjusting the seashell panels, by changing the pit and by adding/removing the orchestra shell.

SEASHELL PANELS

The back of the hall is completely covered in seashell panels, that gradually decrease in amount closer to the stage. The seashell panels can be adjusted to change the acoustics of the hall by sliding the reflective seashell panel to the side, to expose the absorbent material behind it.



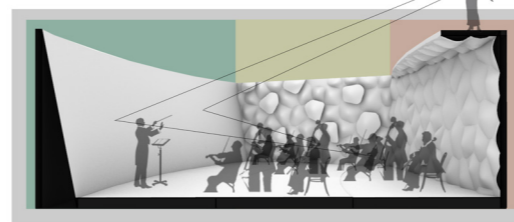
OPERA AND ORCHESTRA

For the two most common performances, such as opera and symphony orchestra, the acoustics need to be able to change. The quantity of open panels is increased when changing from orchestra to opera in order to reduce the reverberation time and this results in the values showed in the figure. The pit is lifted to stage level for performances such as symphony orchestra or chamber music, allowing 155 more people to be accommodated. In addition, an orchestra shell is stored in the upper part of the stage tower for opera, and this is lowered for concerts to create a diffuse environment for the musicians and reflect sound to the audience.

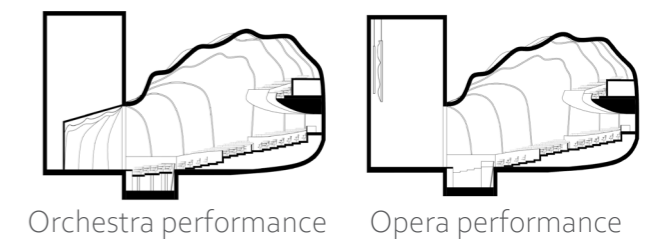
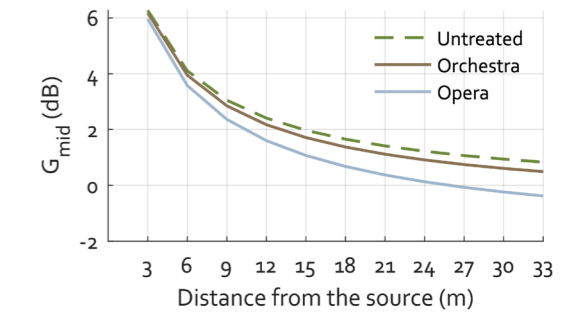
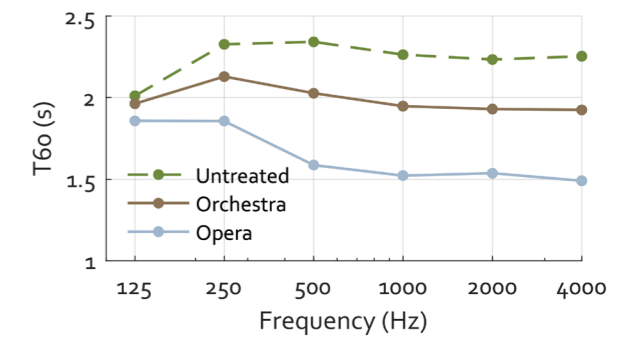
The strength decays especially in the 10 first meters from the stage and varies also when adding absorbent material, being lower for the opera use.

ORCHESTRA PIT

The pit is located three meters down when the performance hall is being used for opera, making space for 70 members. The front wall and the overhang above the musicians are diffusive, allowing the musicians to listen to themselves and each other. The back wall is tilted upwards in order to reflect the sound back to the stage, so that the singer can hear the musicians as well. Both side walls of the pit are covered with seashell panels to provide acoustic variability.

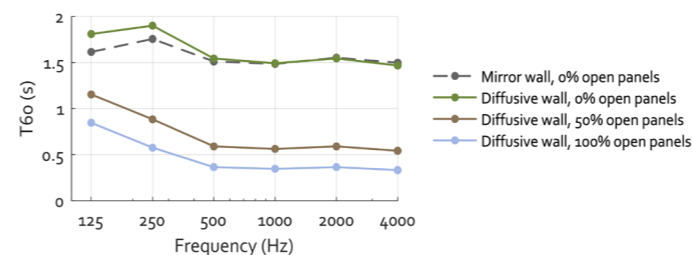


- Reflective wall
- Seashell wall
- Diffusive wall



REHEARSAL ROOM

The rehearsal room is designed with similar shape and materials than the pit in order to recreate as much as possible the actual conditions in the performance hall. Behind the diffusive wall at the front there is a mirror, which can be uncovered when needed for other uses than orchestra, such as theatre or dance. Seashell panels are located also in this room through most of the surface of the room, allowing a great acoustic variability with a RT_{mid} range between 0.35 and 1.5 seconds, depending on the quantity of uncovered panels.



- Reflective wall
- Seashell wall
- Absorbent material
- Diffusive wall



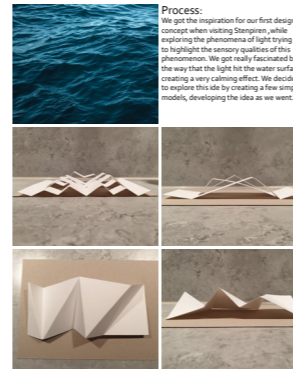
DESIGNPROCESS

Designprocessen har bestått av en iterativ process i några olika steg. Ett av de första stegen var att utveckla tre konceptuella idéer för att sedan gå vidare med ett av dem. Vidare började vi utveckla konceptet med akustiken i konsertsalen och arbeta fram olika multifunktionella akustiska prototyper.

I början av projektet arbetade vi mycket för hand med såväl fysiska modeller som skissade. Med de enkla konceptuella modellerna utforskade vi hur vi kunde förmedla vår konceptuella idé på ett tydligt arkitektoniskt vis. När vi beslutat vad vi ville förmedla och hur, började vi arbeta mer digitalt för att utveckla våra idéer ännu mer. Detta gjorde vi med hjälp av autocad och Rhino tillsammans med Grasshopper.

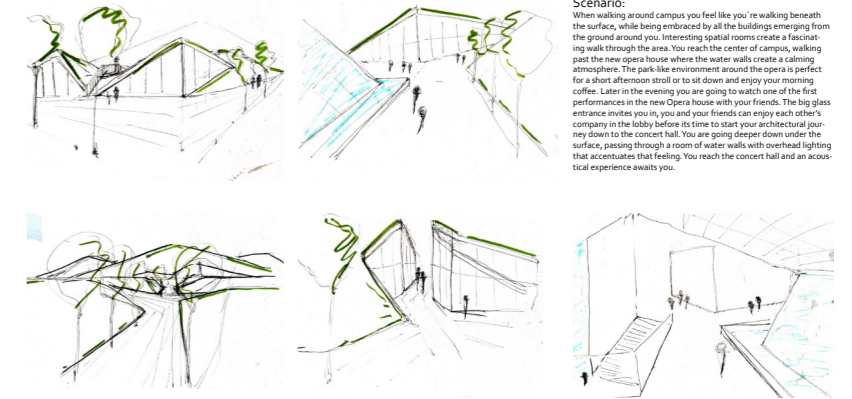
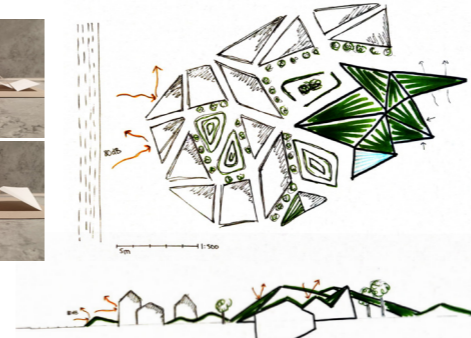
DE TRE KONCEPTEN

Beneath the surface



Process: We got the inspiration for our first design concept when visiting Steingraben, while exploring the phenomena of light trying to highlight the sensory qualities of this phenomenon. We got really fascinated by the way that the light hit the water surface, creating a very calming effect. We decided to explore this idea by creating a few simple models, developing the idea as we went.

Acoustical design concept: Our first acoustical design concept is called "Beneath the surface". We decided to interpret the pattern of waves as different buildings, situated in and away of landscaping on campus. In the middle of campus, the Opera house emerges from the ground, while letting the ground gradually become the roof of the building. The idea is to bury the concert hall beneath ground, "beneath the surface", to be able to take care of the noise problems at the site due to the close lying highway and the passing airplanes. The different triangular shapes reflect the soundwaves in different directions and by avoiding parallel surfaces we reduce the risk of flutter echo all around campus.



Scenario: When walking around campus you feel like you're walking beneath the surface, while being embraced by all the buildings emerging from the ground around you. Interesting spatial rooms create a fascinating walk through the area. You reach the center of campus, walking past the new opera house where the water walls create a calming atmosphere. The park-like environment around the opera is perfect for a short afternoon stroll or to sit down and enjoy your morning coffee. Later in the evening you are going to watch one of the first performances in the new Opera house with your friends. The big glass entrance invites you in, you and your friends can enjoy each other's company in the lobby before its time to start your architectural journey down to the concert hall. You are going deeper down under the surface, passing through a room of water walls with overhead lighting that accentuates that feeling. You reach the concert hall and an acoustical experience awaits you.

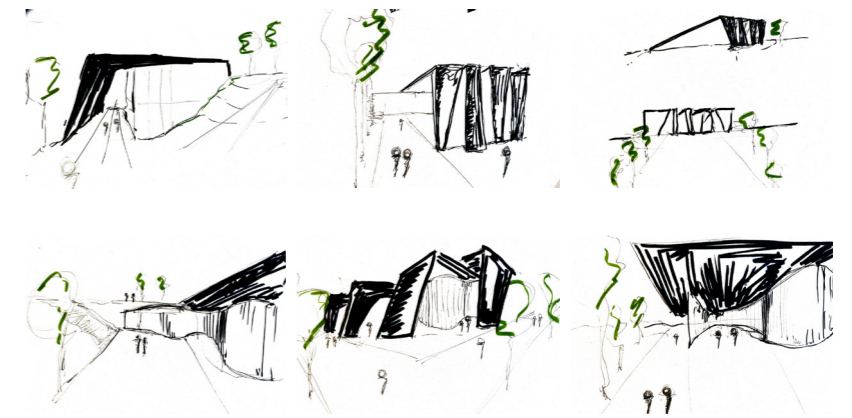
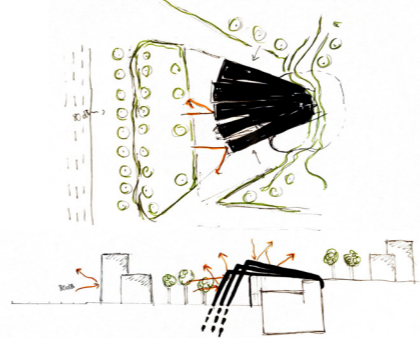
"Ljuset från ovan
Upplevelser under mark
Sen verkligheten"

Stone vs Wood



Process: While exploring the phenomena of sound it was really fascinating to see how much of an impact the surroundings have on how we experience noise. We realized that the traffic noise was way more noticeable and concerning while standing between a tall building and a mountain face than while standing in a more open landscape. The parallel surfaces accentuated the sound due to the flutter echo. We started discussing the impact that different materials have on the acoustic qualities of a space, more specifically the differences between heavy stone or lighter wood. We got the idea of creating a heavyweight barrier out of concrete that can suppress sound vibrations in the material before they reach the lightweight wood building. We explored this by creating a few simple models of possible barriers.

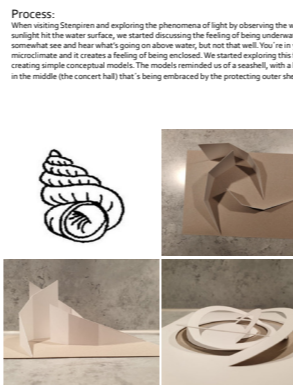
Acoustical concept: Our second acoustical concept is "Stone vs Wood". By taking advantage of the properties of different materials the idea is to create a sound barrier in a heavyweight material around the opera house, possibly continuing underground. The idea is to place the concert hall partly underground, to make use of the sound isolating properties of the ground material too. By tilting the elements of the sound barrier upwards we want to reflect the sound away from campus and by varying the angle of the elements they somewhat create a diffusion of sound. The building, with its sound barrier, could make a fine statement as an entrance for the whole campus area.



Scenario: After a long day at work, you're going to bring your family to attend one of the first performances in the new opera house at the university-campus of your hometown. When driving at the highway next to the campus you can get a glimpse of the huge noise-cancelling stone wall protecting the opera house. After having parked your car, you walk towards the campus entrance framed by the huge stone barrier. While the building is very rough and neat at first glance the actual opera house hidden underneath the outer shell shows the opposite qualities. A warm timber structure in softer shapes that invites you in. The contrast amazes you. It's not really what you expected, wow!

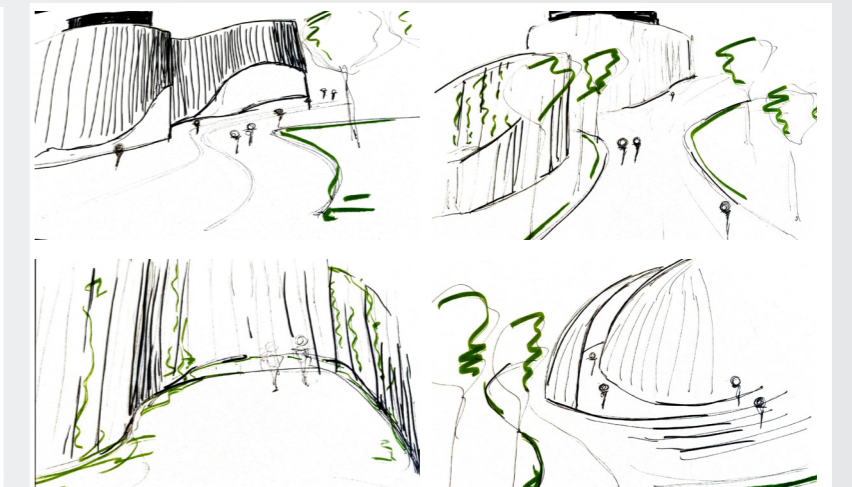
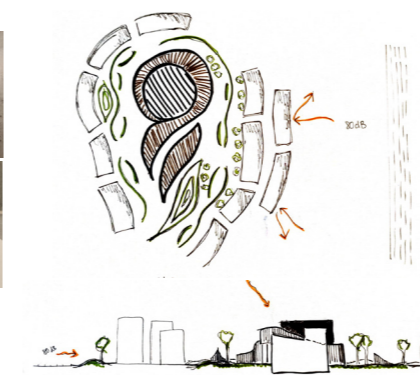
Efter diskussion med masterstudenten från Sound and Vibration var "The Seashell" det konceptet vi valde att fortsätta utveckla. Detta var ett relativt enkelt beslut då både jag och Felicia ville utmana oss själva med de organiska formerna.

The Seashell



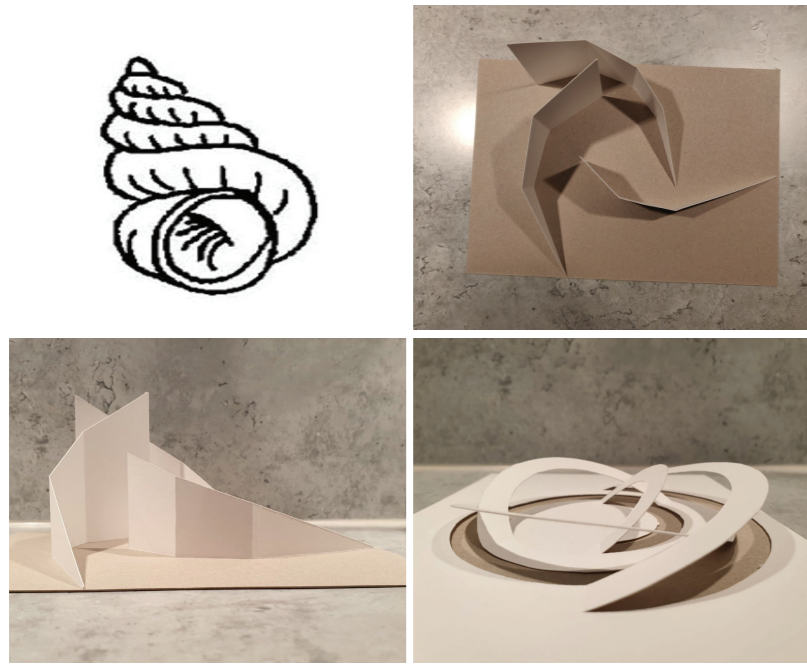
Process: When visiting Steingraben and exploring the phenomena of light by observing the way that the sunlight hit the water surface, we started discussing the feeling of being underwater. You can somewhat see and hear what's going on above water, but not that well. You're in your own microclimate and it creates a feeling of being enclosed. We started exploring this feeling by creating simple conceptual models. The models reminded us of a seashell, with a hidden gem in the middle (the concert hall) that's being embraced by the protecting outer shell.

Acoustical concept: Our third acoustical design concept for the opera hall is "The seashell". The concert hall is placed above ground and makes up the core of the building, that's being protected by multiple acoustical shells. Numerous layers of acoustical timber panels on the facade take care of the noise on the site and creates a diffusion of sound. The positioning of buildings on campus and the landscaping around the opera house follow the same concept, surrounding the opera house in a shell-like way. Smaller free-standing wooden trellises creates smaller rooms in the park-like environment where students can meet up and hang out. The vegetation around the opera hall contributes to a good acoustical environment as it leads to a diffusion of sound.



Scenario: You're going on your afternoon walk through campus to clear your head, it's been a stressful day. The smooth and soft landscapes and the vegetation surrounding the new opera house in the middle of campus, give you inner peace. A relaxing environment. You decide to meet up with a few friends during your break, they are enjoying the outdoors in one of the many pergolas/trellises in the park. Afterwards you decide to have a look at the interior of the new

DET UTVALDA KONCEPTET, SEASHELL



UTVECKLING AV PROTOTYPER

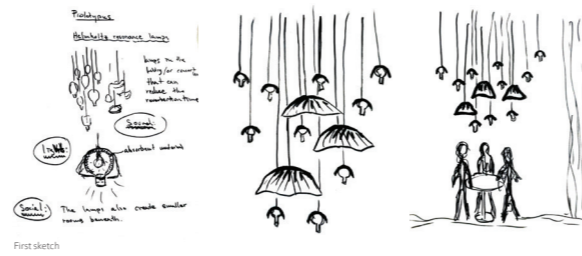
Prototype 1 - Acoustic chandelier

Functions:

- Acoustic: Absorbent
- Light: Light source
- Architectural: aesthetic and social

The chandelier is designed to take care of the noises in the lobby to create a good acoustical environment in these areas. The lobby is a social place where the audience will spend their time until the performance starts, but will also occasionally be used for smaller events, dinners and gatherings of different kinds. The chandelier contains a combination of multiple kinds of lamps, that individually take care of different problematic frequencies in the lobby. The biggest lamps in the chandelier are covered with a porous material on the inside to absorb higher frequencies, that can occur when handling porcelain during dinners in the lobby for example. The smaller lamps in the chandelier are lamps combined with Helmholtz-resonators. They are varying in size, to take care of different low frequencies created in the lobby, for example from people talking.

Other uses:
Other than the acoustical properties of the chandeliers they will also create smaller spatialities within the big and open space of the lobby. Smaller tables can be placed underneath them where the audience can enjoy each other's company in smaller groups before the performance starts. Regarding the design of the chandeliers, they will relate to the concept of seashells by their organic shapes reminding you of actual seashells. The many multi-functional chandeliers will make nice statement pieces in the lobby, creating a wow-factor when you enter the opera house.



Prototype 2 - The seashell wall

Functions:

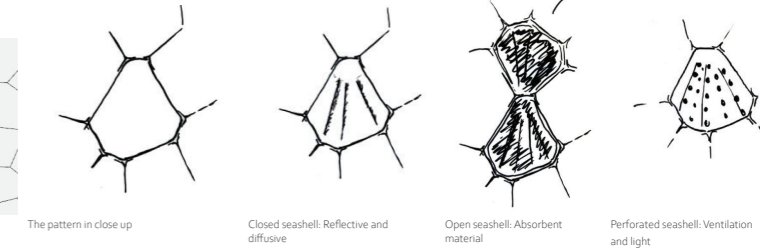
- Acoustic: Absorbents, reflective and diffusive
- Climate: Passive ventilation
- Light: Light source



Towards the back of the concert hall the walls and the roof are covered in a three-dimensional pattern inspired from seashells. The seashell wall consists of reflective surfaces that will diffuse the sound to get an even sound pressure level and to avoid echoes. Different parts of the wall can be opened, to add absorbent materials to the hall to be able to adjust the reverberation time for different kinds of performances.

The ventilation inlets will be placed close to the floor to be able to reach the criteria regarding indoor climate in the residence zone, for T₀₂. The ventilation outlets are incorporated in the seashell wall where the surfaces closest to the roof are perforated, so that the air can leave the room through natural convection.

Furthermore, lights will be placed behind a few perforated surfaces distributed evenly on the wall to create a shimmering light effect at the back of the hall.



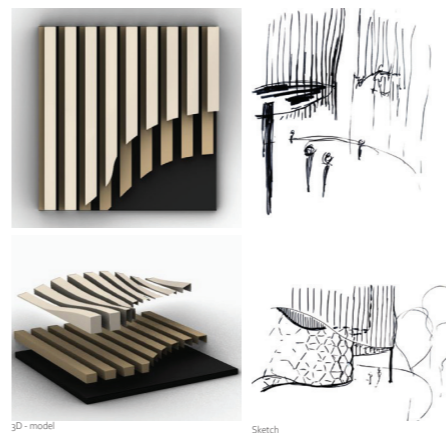
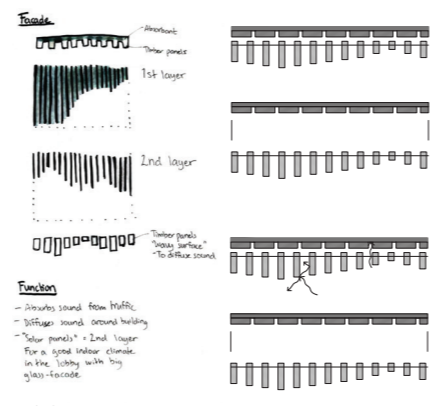
Prototype 3 - Timber panels in different layers

Functions:

- Acoustic: Absorbent and diffusion
- Climate: Prevent heating in the lobby
- Architectural: aesthetic and social

The timber panels are a multifunctional facade element that is built in several layers. The layers can be combined in different ways to get out several functions of the same design. The element consists of three layers where the first layer acts as an absorbent, which is then covered with two additional layers with timber panels. The panels work as a diffuser with a wavy pattern but also for aesthetic and social reasons. The third layer can also be used as a type of solar panel to prevent the sunlight from entering through a glass facade.

Other uses:
The idea is to use this element as a recurring theme both around the building but also inside. The flexibility of the wood panels creates the conditions for reproducing good acoustic environments but also creating beautiful rooms that are connected to our concept. The building will be covered in these wood panels in different layers to protect from traffic and aircraft noise. The wood panels will be extended to the landscape where they will serve as a protective umbrella around the building where students can have various activities. The outer layer will act as a solar panel to prevent the daylight from entering the lobby. In the lobby, the opera hall will be covered by these wood panels to create a better sound environment.

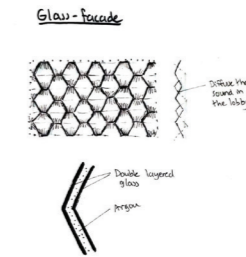


Some more prototypes

4. Glass facade:

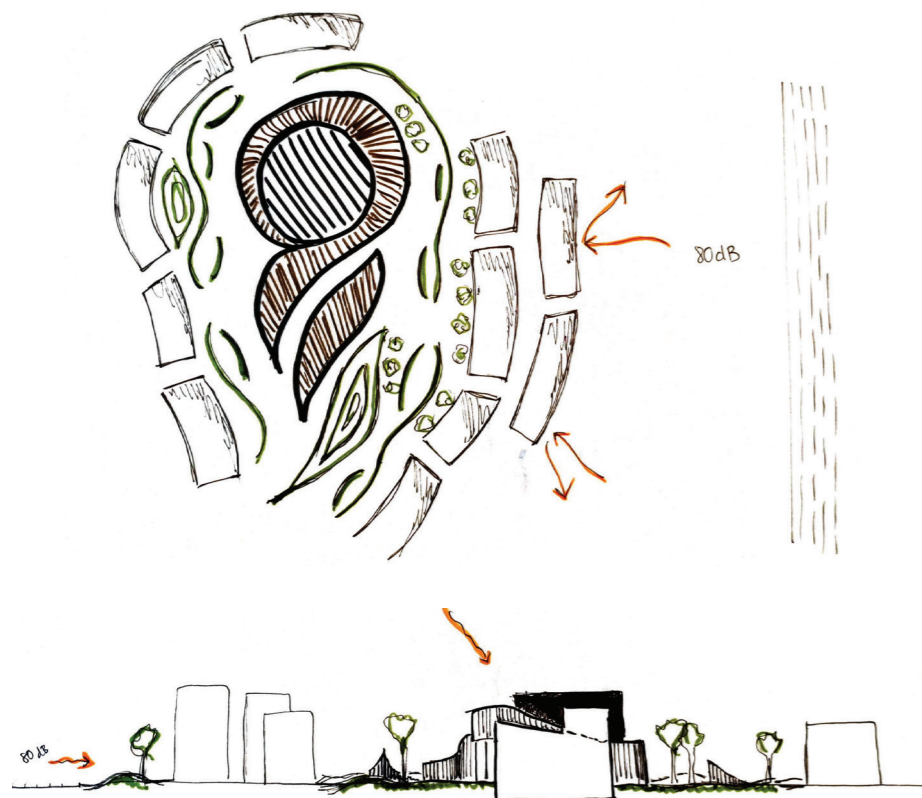
- Acoustic: Diffusing and partly sound insulation
- Climate: Prevents heating
- Light

The lobby is a bright and open room with a larger glass facade, where people can gather for upcoming events. Overheating and acoustical problems may occur in such a room due to the big and reflective glass facade. To solve these problems, we intend to have a glass facade consisting of three-layered glass. By tilting the elements slightly in different directions echo is avoided and they create a diffusion of sound in the lobby. The glass facade contains a sound isolating material and the layers are filled with argon gas to shut out noise and to prevent heating in the lobby.



5. Adjustable roof:

- Acoustic: Reflective surfaces
- Light: Light pattern



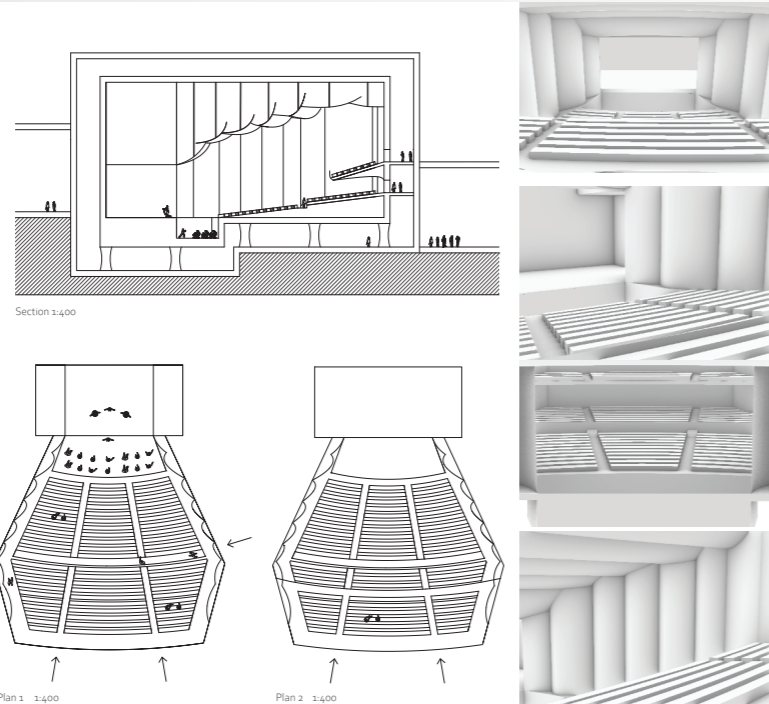
UTVECKLING AV KONSERTSAL OCH EXTERIÖR DESIGN

Concert hall

The concert hall shape is inspired in a seashell and so the walls and ceiling do. The primary use of the concert hall is opera, focusing its design in obtaining optimal reverberation times (1.2 - 1.5 s), strength and clarity for this use, but being able to adapt it for other uses as symphony orchestra or chamber music. This can be done by elevating the pit, reducing the amount of sound-absorptive material and adjusting the height of the ceiling to change the volume and the reverberation time (1.8 - 2.0 s) when needed. The number of seats would be approximately 2000 for the first case and 1200 for the second one.

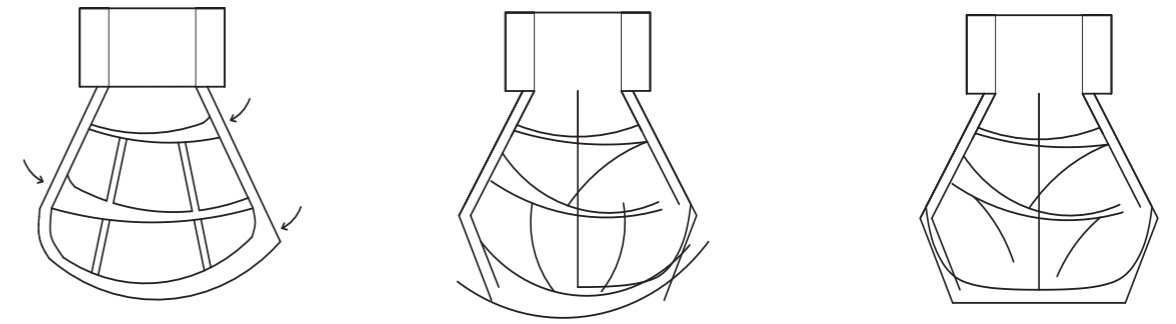
The ceiling is designed with several areas of different slopes, which work as reflectors in order to achieve the same sound pressure level and clarity also in the furthest seats. In addition, these areas have convex shapes to contribute to the diffusion in the hall and thereby, to avoid echoes and the sensation that the sound is coming from above. The walls follow the same concept and have also irregular shapes to help diffuse the reflected energy and make the reflected waves reach the rear part of the audience.

The audience is inclined with an approximate slope of 7°, helping the reflected energy to reach the furthest seats of the hall, and contributing at the same time to a better visibility of all the audience. There is also a balcony in the rear part, which is also inclined with a slightly different slope to optimize the reflection from the ceiling. Absorbent materials are placed below that to improve the sound quality in the seats beneath it.

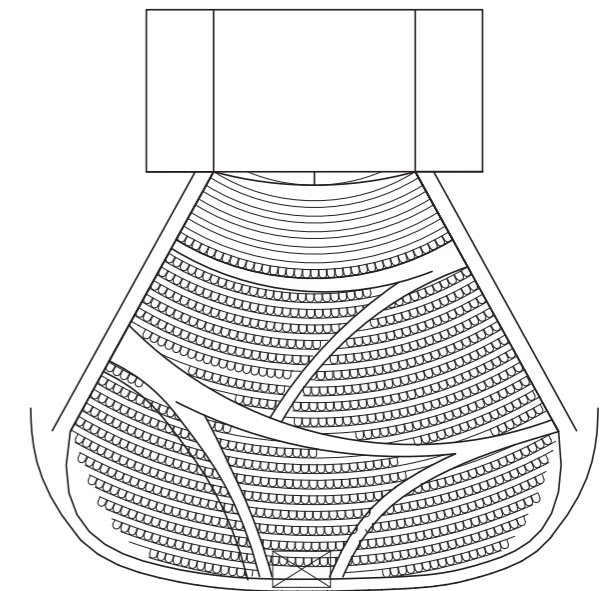


Efter en handledning fick vi kritik att vi hade tappat konceptet i utvecklingen.

DIGITAL UTVECKLING

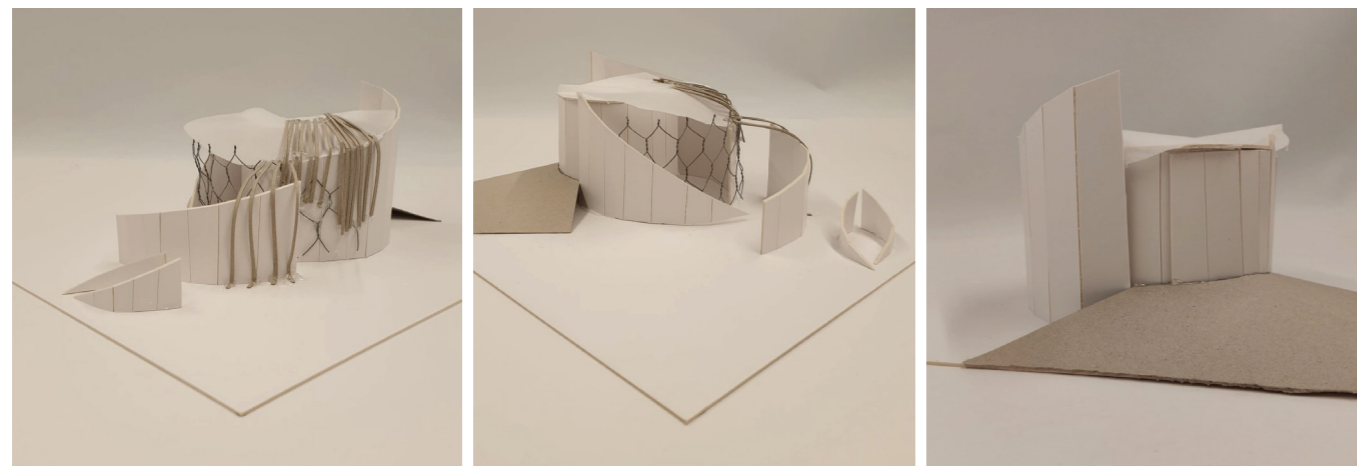


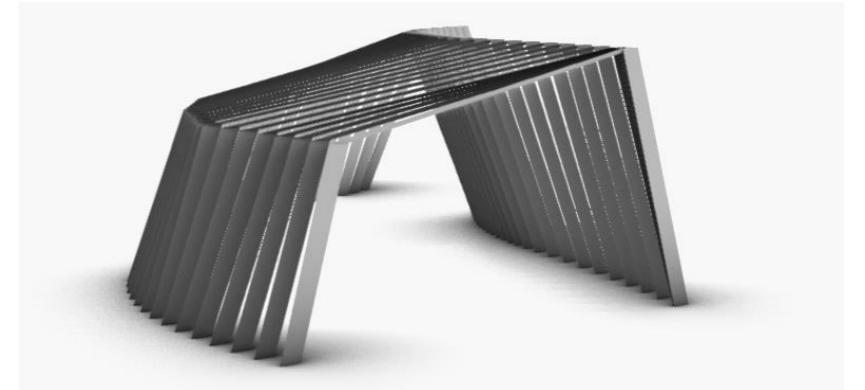
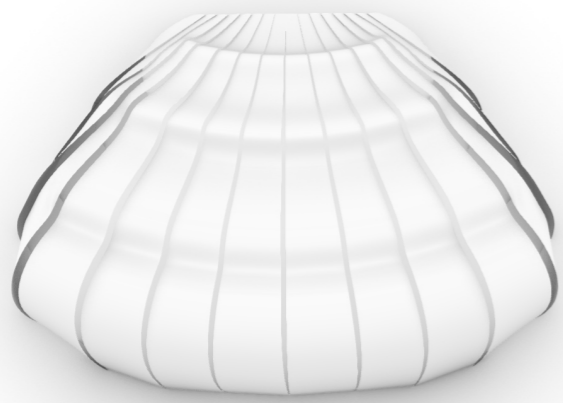
I utvecklingen av planen försökte vi dra konceptet till sin spets med ett mjukt rörelsemönster. Syftet var att gångarna skulle vara anpassat efter flödet av människor.



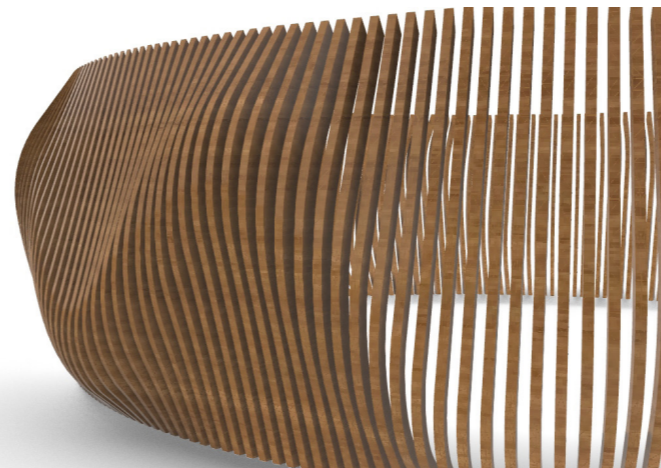
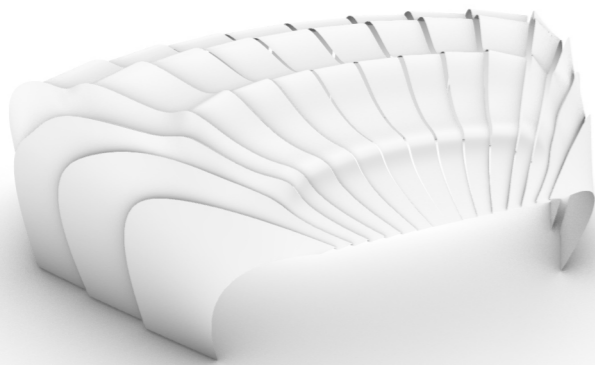
Physical model

We decided to experiment with the layout of the opera house and the surroundings by building a quick physical model. We used our first conceptual sketch as a starting point and by extracting the different lines in the sketch into surfaces, we created a volume. The idea is to design a building with a gradual transition from being on the inside to the outside, a journey through the shells that are embracing the building.

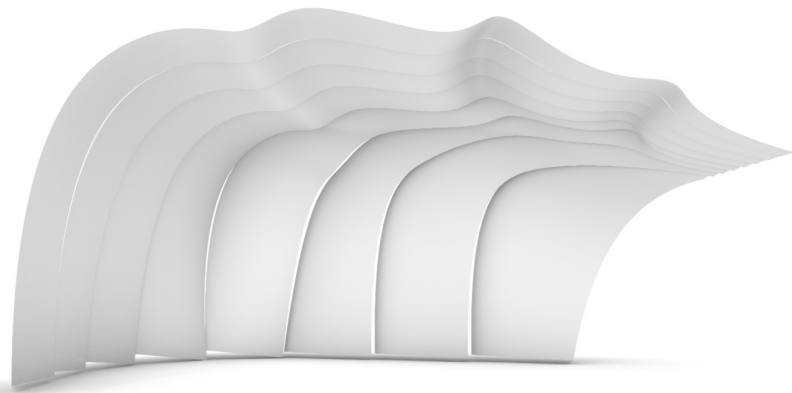




Träpaviljong för den exteriöra miljön



''Timber panels'' för exteriöra fasaden



Konsertskalet

REFLEKTION

ARKITEKTUR OCH AKUSTISK DESIGN

Som helhet är jag väldigt nöjd med projektet såväl arkitektoniskt som akustiskt och särskilt hur vi lyckades förena dessa två till en slutgiltig konceptuell design. Vi fick mycket positiva omdömen rörande hur vi förmedlade projektet både i form av bild och text. På kritiken upplevde åhörare att projektet var väl genomarbetat i alla detaljer på ett professionellt vis. Riktigt kul att vårt projekt blev ett av de tre projekten som valdes ut att skickas vidare till tävlingen.

Ur en akustisk synvinkel lyckades vi skapa miljöer, såväl inne som ute, med goda akustiska kvaliteter. Exteriört skapade vi en miljö som var avskärmad från den stora motortrafikleden och dess buller. Vi undvek parallella ytor mellan byggnader för att det inte skulle uppstå fladdereko. Ojämn mark med flera träd och mindre träpaviljonger bidrog också till ett bättre ljudklimat. När det kommer till byggnaden så placeras den långa glasfasaden vänd från vägen och skyddades på så sätt även av en mindre byggnad så glasfasaden inte blev särskilt exponerad. En styrka med detta projekt, är att vi arbetat med akustiken i hela byggnaden, exempelvis i lobbyn, där det kan uppstå ett ljudklimat med hög efterklangstid, som kan upplevas besvärande av besökare. I konserthallen uppnådde vi våra önskade värden när det kommer till en justerbar efterklangstid för att kunna passa såväl opera som symfoniorkester. När det gäller klarhet har vi inga uträknade värden men med hjälp av ett logiskt resonemang och värden på ITDG är det sannolikt att vi lyckats komma mycket nära den nivå på klarhet vi önskar.

Arkitektoniskt tycker jag vi lyckades skapa en samlingsplats på campus där elever och andra besökare kan njuta av den organiska och dynamiska miljön. Exteriört har vi lyckats kombinera ett arkitektoniskt uttryck med funktioner som ljusavskärmning vilket förhindrar uppvärmning av inneklimatet. Jag tycker också vi lyckades förmedla konceptet bra genom de omslutande formerna och lagren som går utifrån och in. Dessa organiska former, vilka speglar själva kärnan i vårt koncept, kan upplevas såväl när man från vägen närmar sig byggnaden, som när man rör sig inne i konsertsalen. Interiört tycker jag vi lyckats riktigt bra med lobbyn där vi, med hjälp av våra prototyper, kombinerar det arkitektoniska uttrycket med funktioner som akustik, ljus, klimat, samt olika sociala aspekter. Utöver detta tycker jag vi hittat ett bra samspel mellan det arkitektoniska uttrycket och de akustiska kvaliteterna i konsertsalen. Tyvärr har vi inte med en rendering av taket i konsertsalen vilket skulle visat känslan i konsertsalen ännu mer. Detta hade vi velat ha med i presentationen, men blev tvungna att välja bort på grund av platsbrist.

METODEN

Ett av de första stegen var att utforska de fyra fenomenen ljud, ljus, mikroklimat och geologi i närområdet i Göteborg. När vi utforskade fenomenet ljus genom att observera hur ljuset träffade en vattenyta ledde det fram till en diskussion om hur det är att leva under vattnet, det vill säga att vara omfamnad av vatten och leva i ett eget mikroklimat. Det var just denna egenskap som vi ville utforska vidare och illustrerade denna i några enkla konceptuella modeller, som förde våra tankar till en snäcka och dess egenskaper. Att ta en sådan utgångspunkt i ett designprojekt har jag upplevt som mycket givande då man kan träna sig i att bli mer medveten om vad vi har runt omkring oss i vår närmiljö, samt hur man kan använda sig av det för att hitta inspiration.

I nästa steg fokuserade vi på platsen och vilka möjligheter den gav för att skapa en bra miljö utifrån både ett arkitektoniskt och ett akustiskt perspektiv. Vidare började vi utveckla multifunktionella prototyper som bidragit med många viktiga detaljer och på flera olika sätt förbättrat projektets helhet. Dessa prototyper hade en särskilt stor betydelse för vårt projekt eftersom de genomsyrade projektets alla delar och därmed skapade en stor bredd av funktioner och uttryck.

Den iterativa arbetsprocessen har fungerat väldigt bra för oss. Våra lärare har genom den också fått bra möjligheter att granska och vägleda oss i de olika stegen. Jag har speciellt uppskattat den långa konceptuella fasen där vi fick möjlighet att tänka genom alla olika delar av projektet. Det har också underlättat för oss att hålla en tydlig röd tråd och förankring i vår ursprungsidé allteftersom projektets alla delar tar form.

SAMARBETET

Generellt har samarbetet i gruppen fungerat bra. Jag och Felicia kompletterar varandra väldigt bra och har haft en god kommunikation genom hela projektets gång. Detta tror jag bidrog till att projektet blev så väl genomarbetat i alla sina delar. Samarbetet med akustik studenten har också fungerat bra och det har varit väldigt givande och roligt att samarbeta med en student från ett annat program. Vi har haft en regelbunden kommunikation med zoom-möten flera gånger i veckan. Personligen hade jag önskat att akustikstudenten skulle varit mer involverad i början av projektet. Jag upplevde att mastersstudenterna kom igång ordentligt först i slutet av projektet då många delar i både design och tekniska lösningar var satta och även små justeringar ledde till mycket extra arbete. Kanske beror detta på brist på erfarenhet av den arbetsprocess som krävs för den arkitektoniska delen av designprojektet.