TENSION GROVE

ACEX15: Bachelor project in Architecture and Technology

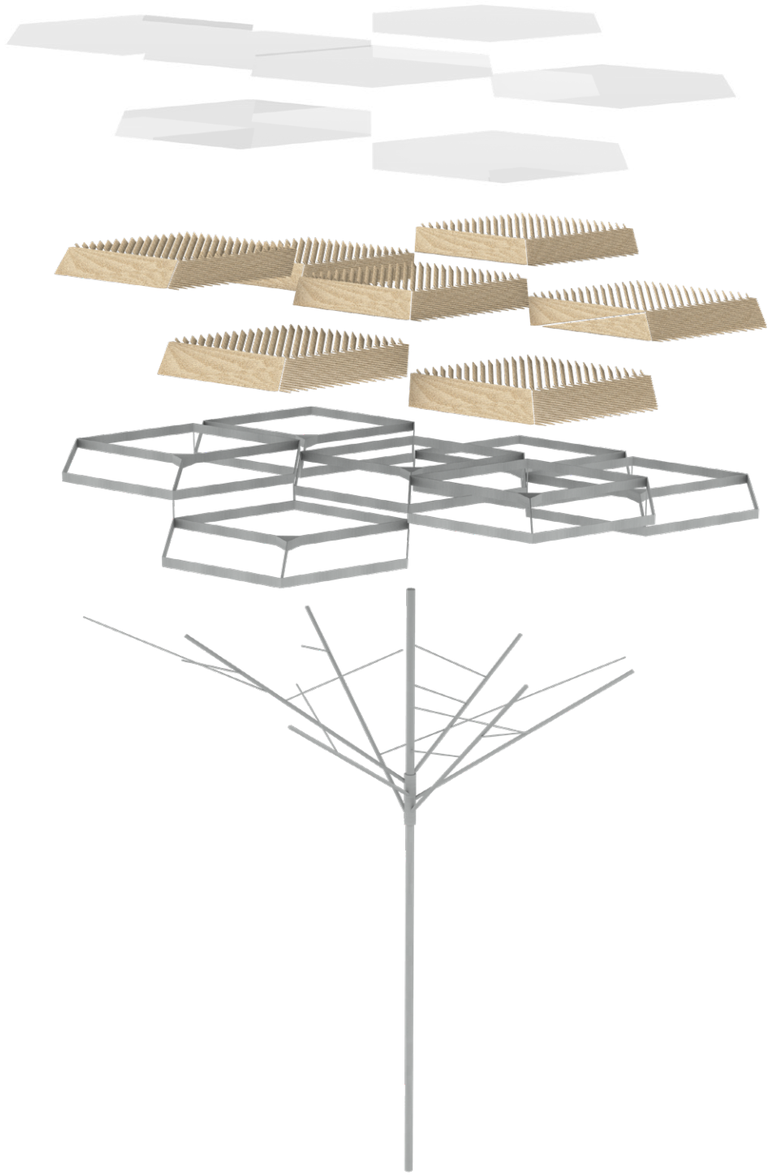
2020 Year 3

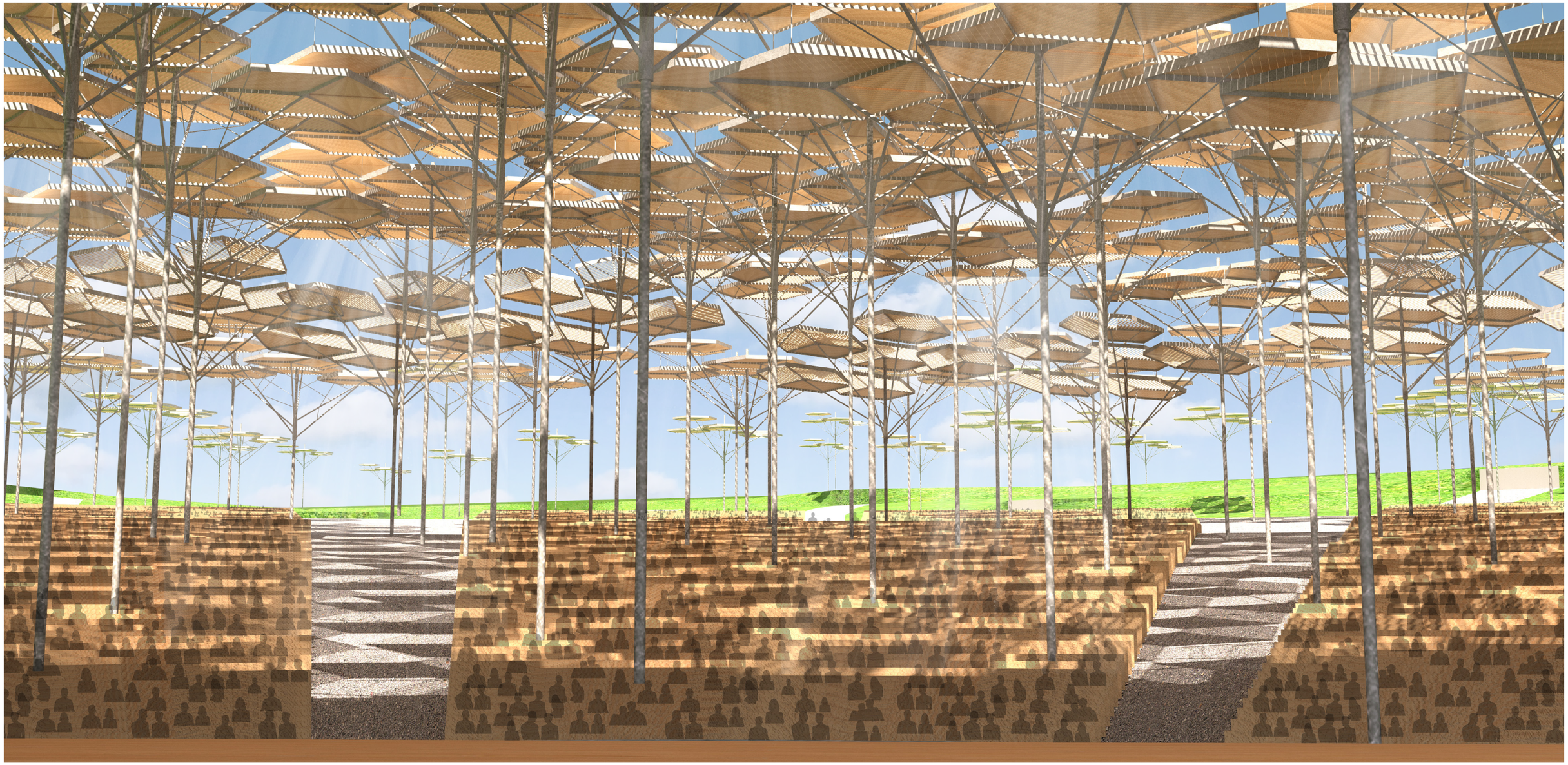
Examiners: Morten Lund, Peter Christensson

Tools: Physical Models, Rhino, Vray, Autocad, Illustrator, Photoshop, Indesign

Group project with Lina Eriksson and Shivam Bahuguna

Imagine listening to a concert in a forest that adapts to the sound. A canopy of ever changing structures where music and space creates an experience unlike anything else. Never giving the feeling of being inside, but embracing the outdoors. This is a place where nature plays the symphony.





THE TASK

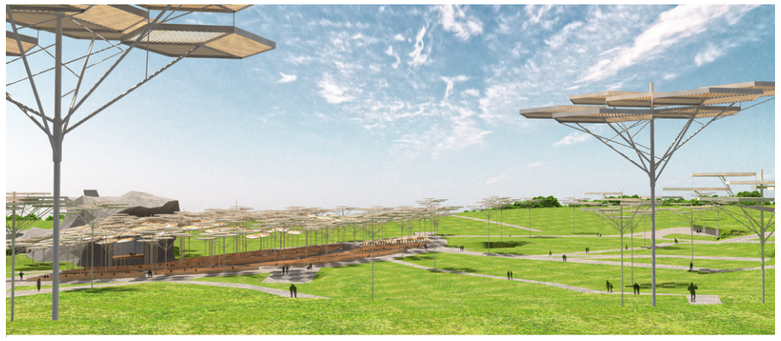
The assignment was to create a proposal for the 2020 Newman Award Fund Student Design Competition. The competition program was as follows:

A city orchestra wishes to construct a music pavilion, with covered and lawn seating, to serve as its summer home. It will host concerts from the orchestra, ballet, theatre and larger acts of jazz and rock.

The pavilion shall be sized to accommodate 5,000 seated audience members under a roof. An open lawn shall be capable of holding up to 20,000 audience members. Natural acoustics are desired for the seated under the roof with electro-acoustics amplifying the remaining.

Backstage areas as well as parking for the patrons was also to be incorporated in the design.

PRESENTATION



ADAPTABILITY

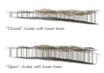
Using the rotating ribs with different absorption, we get the variable acoustics of the pavilion. These are modeled with the same height of the trees for the different acts, meaning the values could be improved even further with different configurations.

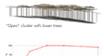
Optimized absorption coefficient for the tree panels was achieved upon various iterations among different materials, and the same material was used in the modeling for all different acts.

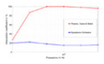
ROCK & JAZZ

For these performances, electro-acoustics are used as the sole source of sound. The values can be completely adapted using the speaker-forest system. The roof of the pavilion will be raised for these performances to give a better view for the people on the lawn and to minimize reflection from the panels. In addition, High absorption coefficient for the tree panels enables direct sound field dominance.

The "closed" pavilion below is an example of the height used for the acoustical models and the "open" one is for the rock and jazz acts.

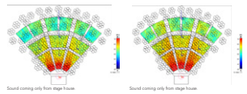


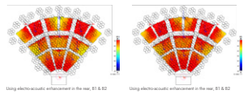


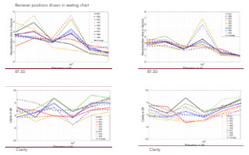


THEATRE, OPERA & BALLET

For these acts, a low RT was desired with higher sound strength and clarity. In addition to natural acoustics from the stage, sound reinforcement was required further back to reach the acoustical experience desired for all 7000 guests. This was achieved using electro-acoustic sources with optimized delay and gain







SYMPHONIC ORCHESTRA

For orchestra performances, an increased RT with clarity between -4 and 1 dB was desired. For the 5000 people seated under the dense pavilion, the natural acoustics from the stage is adequate for a good acoustical experience. Further back, amplification was achieved for the next 5000 seats using speakers with delay in the trees.

SITE

Covering the underlying structures is the tensile landscape that creates plateaus with good visibility all over the area. Using the added height, the landscape grows upwards from the pavilion and connects to the parking underneath.

There are many entrances throughout the area creating an even flow of people moving down the pathways, culminating in the Grove. The ground on top of the garage acts as an acoustic barrier for the noise from within.

When arriving at the site, the car lights up the massive walls of the parking garage and flashes a hint of the trees above. Through the tunnels into the open, you suddenly stand in the middle of a green savanna looking towards the dense pavilion below, with the river in the distance.

The audience is divided into three groups. The first 5000 guests are seated in the compact forest of the pavilion providing natural acoustics. An additional 5000 are seated in a more sparse forest area with a few speakers. For jazz and rock acts, 15 000 people can use the lawn sparsely covered by trees providing electro-acoustical sound.

NOISE

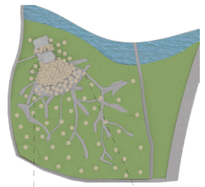
With the parking structure towering four floors above ground level, a barrier is created shielding from the rumbling of the roads. The height of the structure combined with the sloping of the area towards the pavilion eliminates the unwanted noise. To the west of the pavilion, the ground is additionally raised to shield the traffic sounds from the smaller road. The stage and backstage areas become a natural screen from the river.

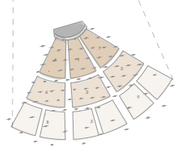
The values provided for the traffic noise of the interstate have been included in the acoustic analysis of the pavilion.

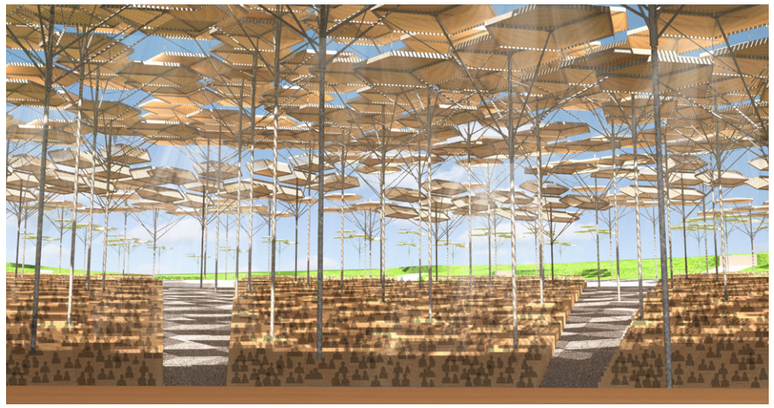
ELECTRO-ACOUSTICS

The trees outside of the pavilion are utilized for the sound-distribution using the speakers installed. With many individual speakers, this creates an even sound distribution throughout the area as an integrated part of the design. They are also used in the back of the grove to create enough sound strength for the 5000 people seated outside the compact cluster.

As seen in the contours, the speakers drastically increase the quality and with even more fine-tuning of the delay and gain setting, they will create an equal experience for all of the 10 000 seated audience.







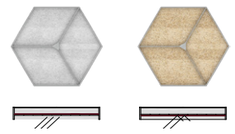
TENSION GROVE

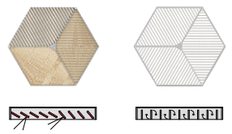
Imagine listening to a concert in a forest that adapts to the sound. A canopy of ever changing structures where music and space creates an experience unlike anything else. Never giving the feeling of being inside, but embracing the outdoors. This is a place where nature plays the symphony.

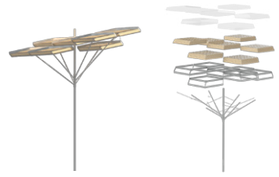
The pavilion is a cluster of acoustic trees creating an open and light landscape where no two seats are the same. The light seeps through the ribs creating a dance of rays as the sound changes. The grove then sparsens and gradually changes into the green savanna with electro-acoustics providing equal sound throughout the venue.

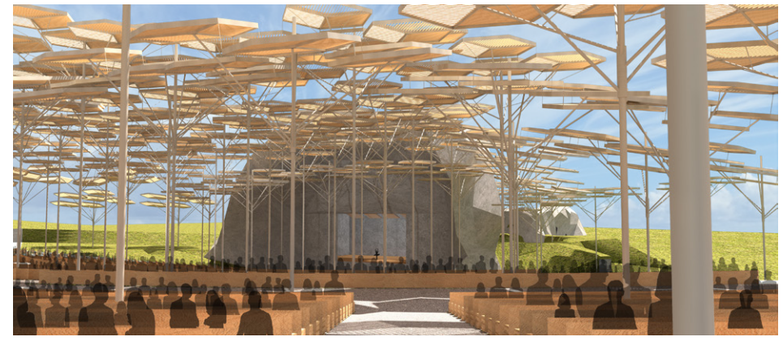
The artificial forest is an open place, a unique pavilion built on flexibility. Each tree has seven panels, placed in an angle to reflect the sound from the stage in a certain way. Each panel is covered with twistable ribs, where the two sides have different materials and grades of absorption. When the ribs are completely open, the sound is reflected from the glass instead.

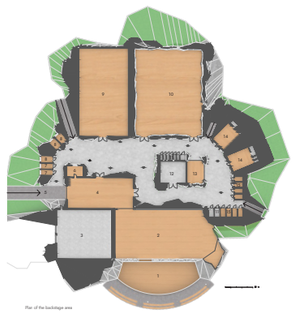
Vertically moveable trees provide various placements and sound directions, while rotation around the pillar offers different angles for maximum control of reflections. The flexibility of the forest gives the ability to control the acoustical environment.











Plur of the backstage area

1.	Stage 576 m2	6.	Lobby 24 m2	11.	WC/BWC
2.	Orchetra pit 315 m2	7.	Office for resident company staff 9 m2	12.	Mechanical equipment room 75 m2
3.	Parking garage, 3 floors 360 m2	8.	Office for facility staff 12 m2	13.	Green room 69m2
4.	Multipurpose area 270 m2	9.	Movement rehearsal room 576m2	14.	Chorus dressing rooms 68 m2
5.	Loading dock	10.	Orchestra rehearsal room 800 m2	15.	Solo dressing rooms 6.6 m2

BACKSTAGE

The area for performers and staff is located behind the stage and reached from a private road. Materials and surfaces reflect the rest of the site, with grass tensioned over the volumes and the rehearsal rooms as extensions of the cliff. Being a place for connection and performance with focus on sound and movability, the backstage area can house anything from large symphony orchestras performing on the big stage to intimate music gatherings.

With a lobby to welcome guests/performers or sell tickets to smaller concerts and the green room being an open place for connection, the backstage becomes an arena for socialising. The multipurpose area with a direct link to the loading dock is a versatile space usable for storage, preparation and movement. Along with the large open areas and private parking garage this becomes an area with good transportation.

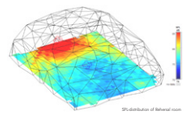
REHERSAL

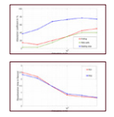
The movement rehearsal is a space for theatre and ballet, equal in size to the stage for easy practice. It is acoustically shielded from the other rehearsal for them not to disturb one another.

The music rehearsal is a significantly larger space in order to both house smaller performances with an audience and rehearsal space for a large symphonic orchestra. This enables the hosting of intimate concerts for benefactors, not requiring the full size of the stage.

The space is constructed with triangles consisting of different materials for acoustical reasons. This gives a room with the same look and feel as the stage, with acoustics similar to the pavilion when adapted to the symphonic orchestra.

Presented below are values from our acoustic modeling of the music rehearsal.





STAGE

Rising up as a majestic cliff in the forest is the stage house constructed to increase and focus the sound towards the audience. The rock walls are made of reflective panels to maximize the sound reaching out with hanging panels from the gridiron as additional directive surfaces.

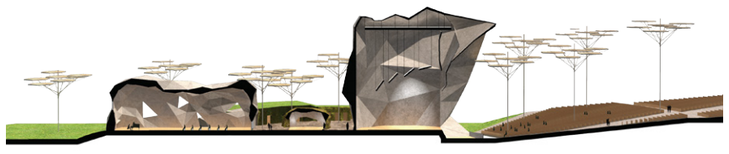
Around the proscenium is a line array of speakers to amplify the sound when required. Additionally, mounting areas for speakers brought by touring acts are located here for easy installation. The proscenium walls are rasable, enabling the size to change depending on the space required for the act.

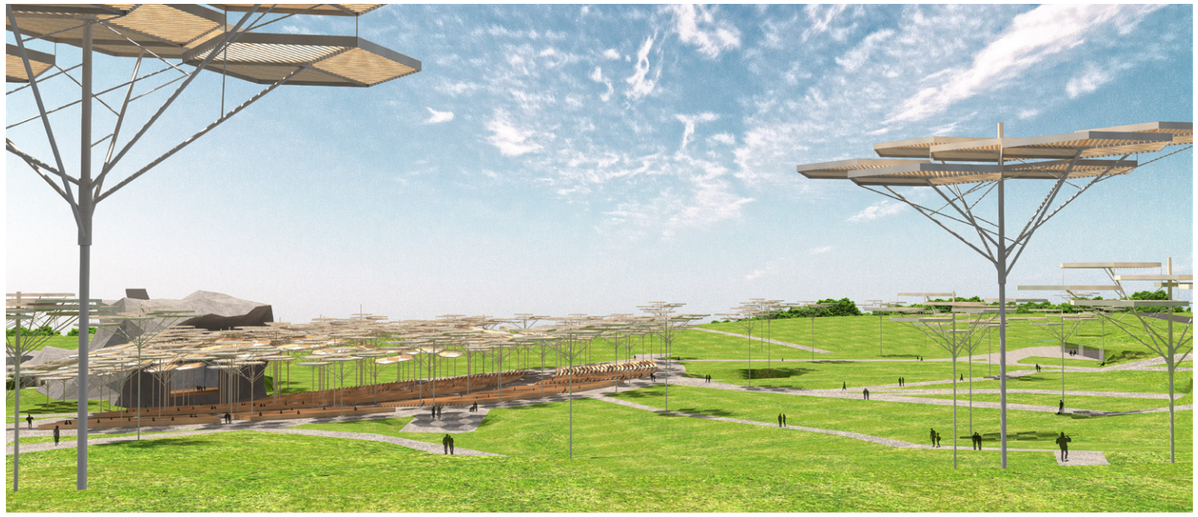
ORCHESTRA PIT

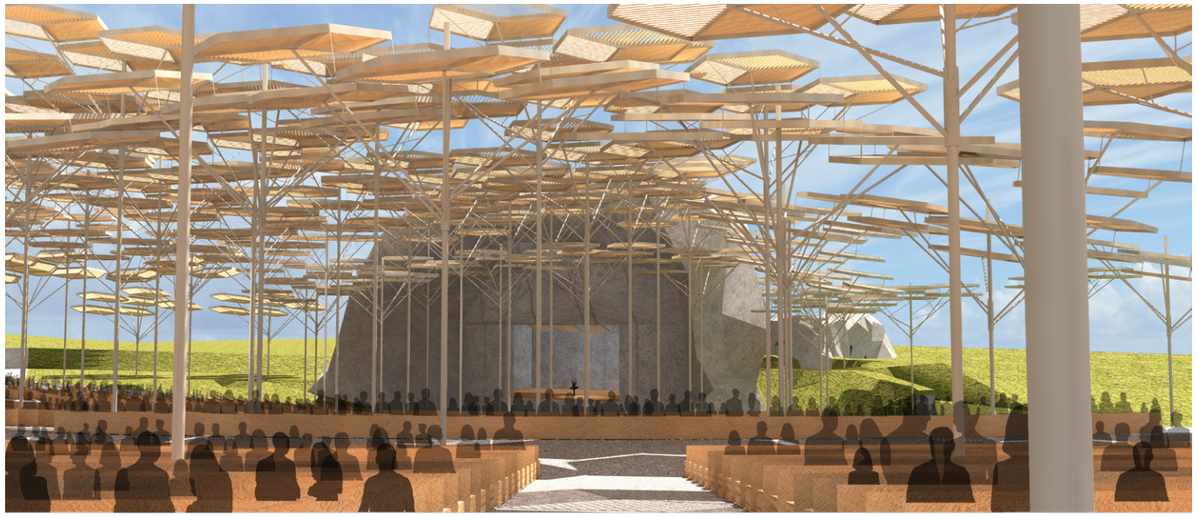
The entire orchestra pit works as a lift with three positions. The lowest is the pit level, a performance height below the audience for stage performances requiring live music.

The second is ground level for when the pit is not used, the same height as the first row of the seated audience.

Lastly it can be raised to connect with the stage both for transporting the instruments and as a possible extension of the performance area when desired.







THE RESULT

I am really pleased with the result we produced. We managed to explore and present our concept in a believable and thought through way. Managing to keep the original idea throughout the entire process while constantly improving upon it was one of the biggest strengths. I can agree with the response we got about sight in the pavilion but it is also something we made a choice about not to center the project around. In a continued process it would have been interesting to explore how to optimise this aspect as well since it is probably the area with the biggest possibility of architectural improvement.

Our acoustic values were good, except for the slightly long reverberation time. This is probably because our trees were too adaptable for the time available and not being able to use their full potential. We only played with the materials for the trees and not the height or angles of them. With more time we would have been able to get really great values for every single act. This might be the biggest weakness of the trees, that they were simply too complex for the task at hand.

"Open" cluster with higher trees

"Closed" cluster with lower trees

ADAPTABILITY

Using the rotating ribs with different absorption, we get the variable acoustics of the pavilion. These are modeled with the same height of the trees for the different acts, meaning the values could be improved even further with different configurations.

Optimized absorption coefficient for the tree panels was achieved upon various iterations among different materials, and the same material was used in the modeling for all different acts.

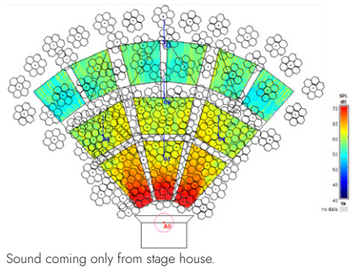
ROCK & JAZZ

For these performances, electro-acoustics are used as the sole source of sound. The values can be completely adapted using the speaker-forest system. The roof of the pavilion will be raised for these performances to give a better view for the people on the lawn and to minimize reflection from the panels. In addition, High absorption coefficient for the tree panels enables direct sound field dominance.

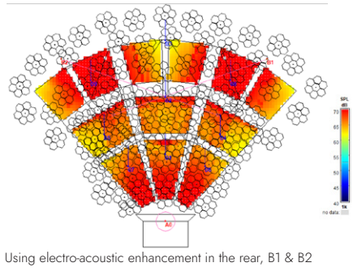
The "closed" pavilion below is an example of the height used for the acoustical models and the "open" one is for the rock and jazz acts.

THEATRE, OPERA & BALLET

For these acts, a low RT was desired with higher sound strength and clarity. In addition to natural acoustics from the stage, sound reinforcement was required further back to reach the acoustical experience desired for all 7000 guests. This was achieved using electro-acoustic sources with optimized delay and gain.



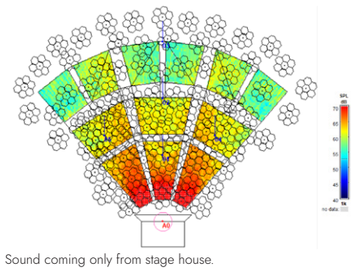
Sound coming only from stage house.



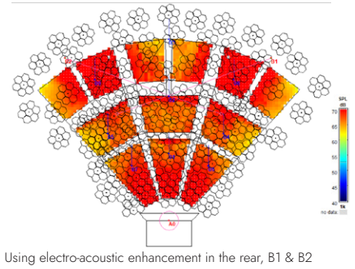
Using electro-acoustic enhancement in the rear, B1 & B2

SYMPHONIC ORCHESTRA

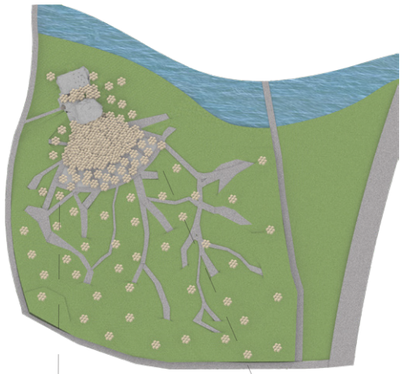
For orchestra performances, an increased RT with clarity between -4 and 1 dB was desired. For the 5000 people seated under the dense pavilion, the natural acoustics from the stage is adequate for a good acoustical experience. Further back, amplification was achieved for the next 5000 seats using speakers with delay in the trees.

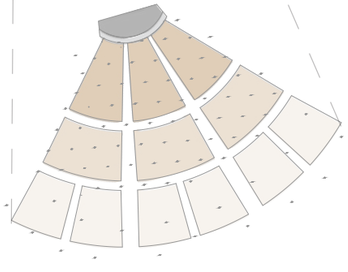


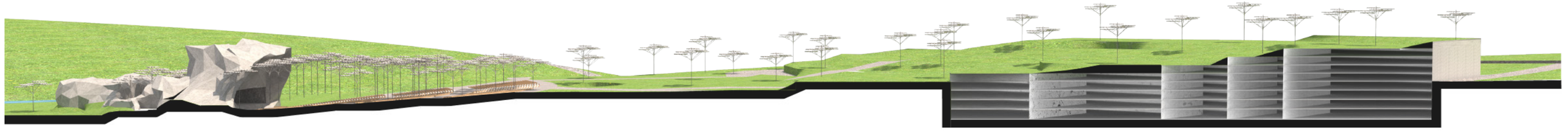
Sound coming only from stage house.

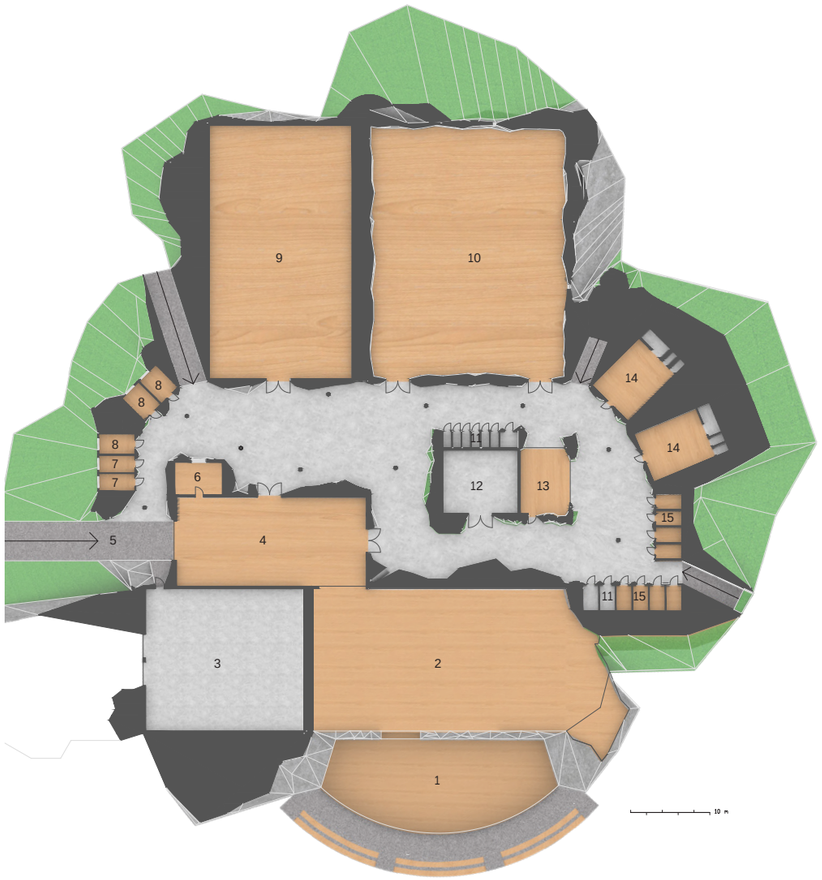


Using electro-acoustic enhancement in the rear, B1 & B2

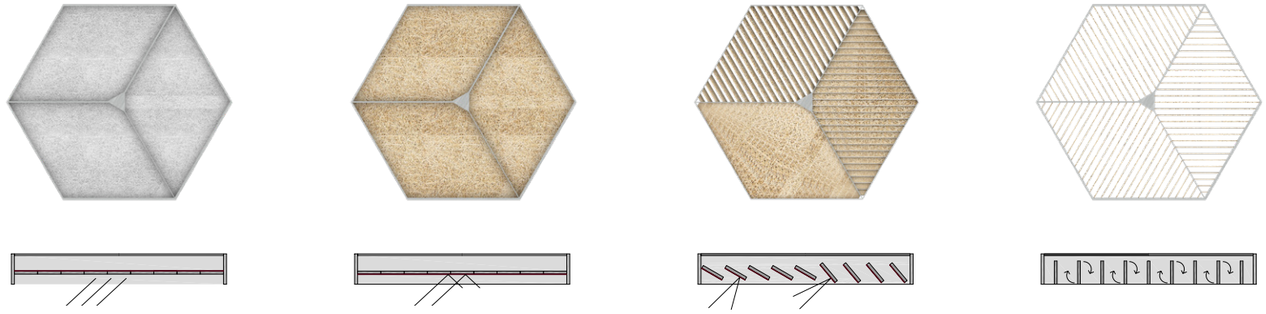








1.	Stage 576 m2	6.	Lobby 24 m2	11.	WC/RWC
2.	Orcehstra pit 315 m2	7.	Office for resident company staff 9 m2	12.	Mechanical equipment room 76 m2
3.	Parking garage, 3 floors 360 m2	8.	Office for facility staff 12 m2	13.	Green room 48m2
4.	Multipurpose area 270 m2	9.	Movement rehearsal room 576m2	14.	Chorus dressing rooms 68 m2
5.	Loading dock	10.	Orchestra rehearsal room 800 m2	15.	Solo dressing rooms 6.6 m2



COLLABORATION

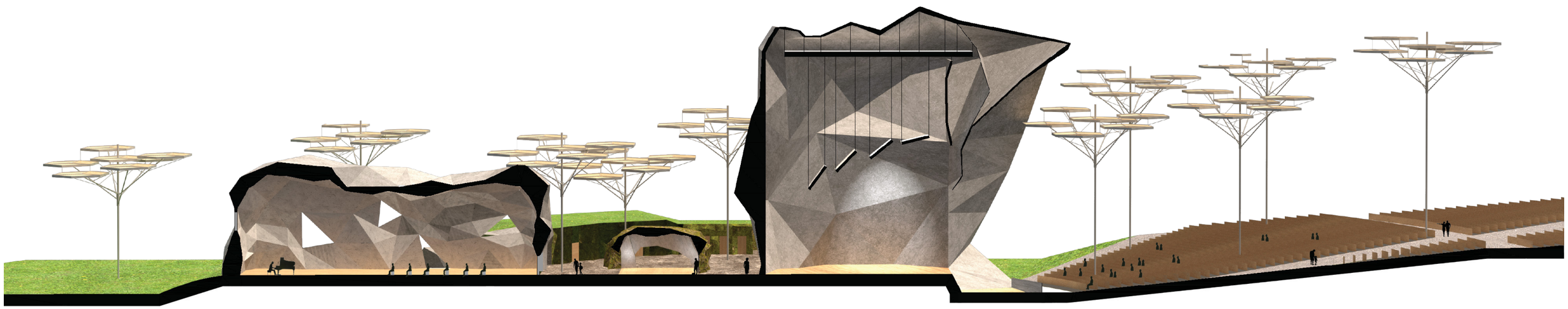
The collaboration in our group worked really well and it was a great learning experience to have a person with a different role in the group. For us it meant constant feedback, discussions, initiatives and making each others processes easier. The design/process was still very much the domain of me and Lina but it adapted to the acoustical input in a very natural way. The technical details could both change the way we thought and what choices we made to make it a believable concept.

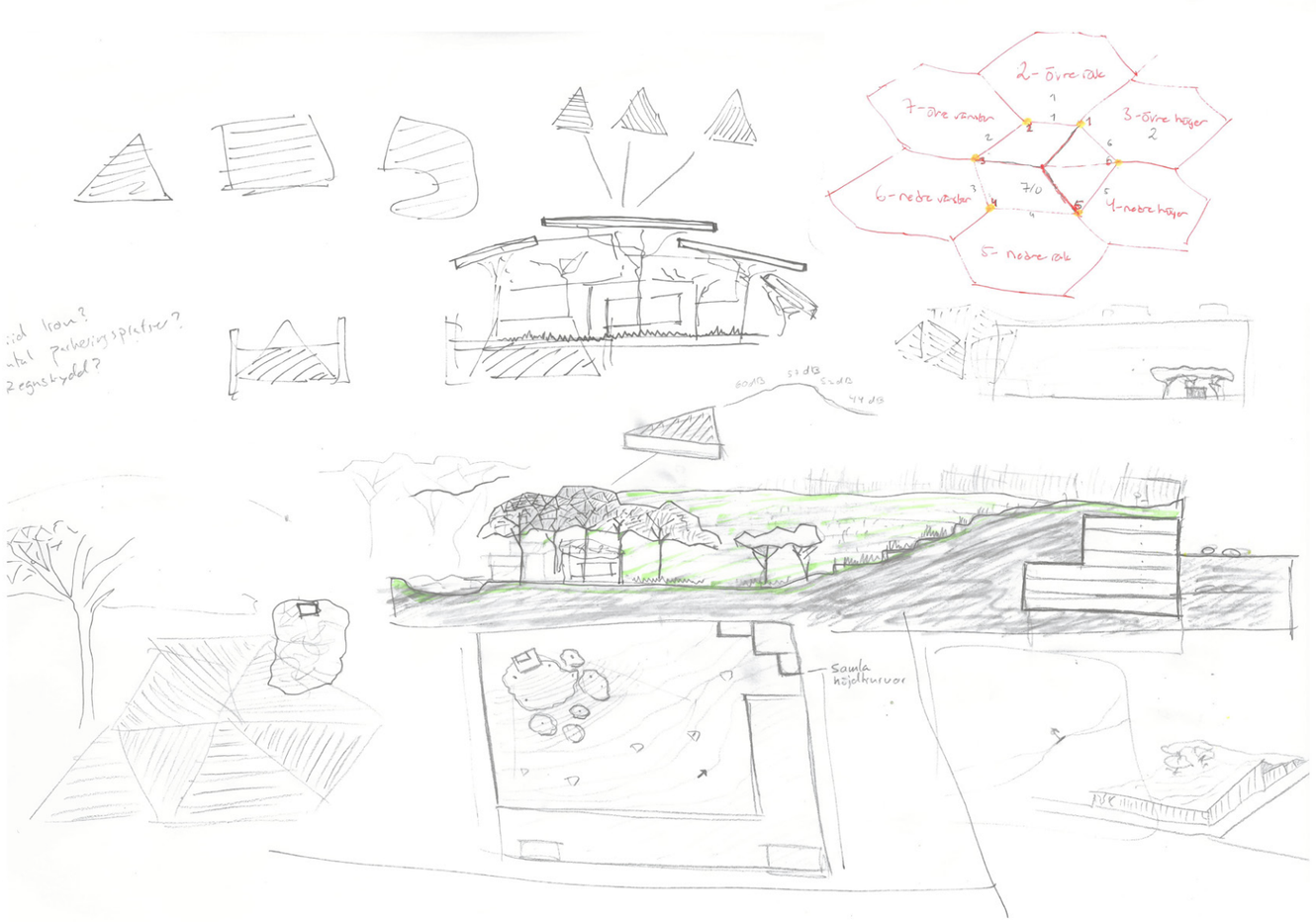
It was exciting to have a person with a different competence to rely upon and adapt to as well. A new way of working compared to having full control of the time and process that we are used to. I learned so much from getting a view of how it is in real life with multiple disciplines working together, learning from one another and getting feedback from someone with a different perspective all together. Constantly having to explain and present your ideas to someone from a different field was also very rewarding.

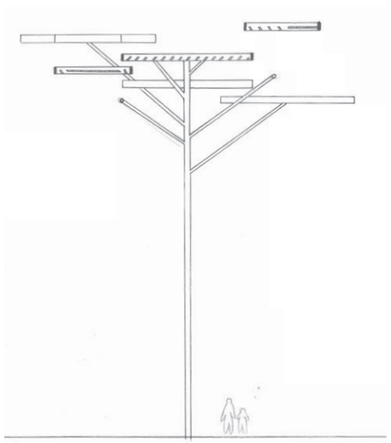
THE TREES

The artificial forest is an open place, a unique pavilion built on flexibility. Each tree has seven panels, placed in an angle to reflect the sound from the stage in a certain way. Each panel is covered with twistable ribs, where the two sides have different materials and grades of absorption. When the ribs are completely open, the sound is reflected from the glass instead.

Vertically moveable trees provide various placements and sound directions, while rotation around the pillar offers different angles for maximum control of reflections. The flexibility of the forest gives the ability to control the acoustical environment.



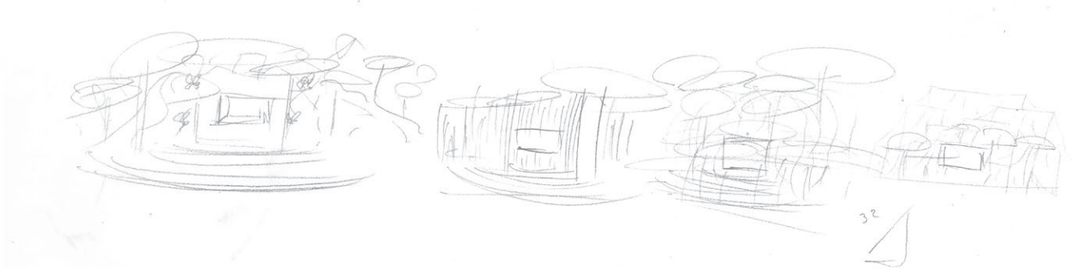




GROWING THE FOREST

I think the most important decision for us was to keep holding on to the idea of the trees as a pavilion. We tested other ideas and solutions but still kept the original concept intact. Here, the project could have developed into something else entirely than the result that was.

We did always have in mind the drawbacks of this decision and tried to develop them into something thought through and not just what became. We did try to elaborate a bit around it but decided not to focus on it too much and instead knowingly keeping it with the knowledge of it not being optimal.



BUILDING A NARRATIVE

During the project there was many iterations in every step. We had an idea, tried a few variants and then questioned them in different ways. In the beginning it was completely separate concepts which were later developed into more thought through ideas with aspects of them being tested. For example: how many trees, how big, the shape of the canopy, the stage and backstage expression as well as the way the ribs should function.

Me and Lina often had a different view on things and having multiple focus areas greatly enriched the project. If I was more out there, Lina could be more mathematical and exact and vice versa. This led to ideas never being certain but questioned and thinking of what was the best iteration with many aspects in mind, sketching both mathematically, exactly, artistically and architecturally at the same time.

Working for a competition was both different and fun. Focusing extra on presentation, easy understanding and convincing the people being responders. It gave a greater freedom when it came to what we chose to show and meant the project was more tailored to our view.

The process built upon the foundation of the concept. How could it be applied in all aspects and fully be a part of the architectural expression. This means thinking what we wanted with everything and what connected the project. This led to a project growing to something with strong parts of us both and that we were really proud of.