ERIK ARLINGER
BACHELOR PROJECT
GUIDED BY
MORTEN LUND, PETER CHRISTENSSON

# BÄCKDALEN

*Bäckdalen,* or *Stream Valley,* consists of a terraced landscape where the presence of water and a translucent, movable roof allow extraordinary acoustic experiences to occur. The landscape is divided into 26 irregular plates. A waterfall stretches the back of the valley, creating an ambience of magnificence. From the waterfall, two meter wide streams separates the plates all the way down to the orchestra pit. From here the water returns to where it came from, the river right outside. The nine plates closest to the stage are separated into even smaller terraces, to create a discreet slope. This allows seating with a commonly good view of the stage. These plates are covered by the roof.

## ROOF

Suspended on a symmetrical network of wires, the roof sections can move to envelop different acoustic environments, depending on the type of event. The structural supports of the roof also act as mounting for the electroacoustic reinforcement system.

## TERRACES

The covered terraces are inclined towards the stage, improving both patron's line of sight and sound direct from the source. Reflective walls between each terrace step reinforce the direct sound with early reflections, improving acoustic clarity.

## BACKSTAGE

A stepped incline surrounds the rear of the stage. Surfaces are acoustically treated to absorb unwanted reflections which would reduce acoustic clarity. When higher reverberation is required, water is channelled to fall, almost silently, over the edge of each step. The remaining water sound will be masked by the main sound source, while add a calm ambience during quiet and silent intervals.

## ORHCESTRA PIT

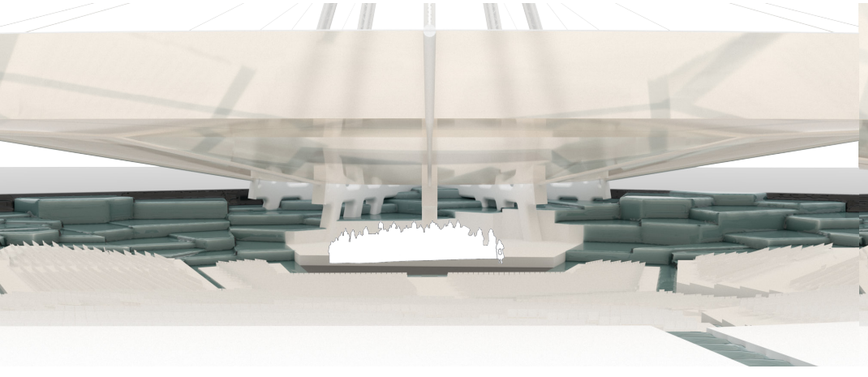
An orchestra pit lies between the stage and the front of the audience. During opera and ballet performances, this pit houses the orchestra. During orchestral performances, theatre, spoken word and larger concerts, the pit is filled with water to reinforce the direct sound from the performer(s) to the audience.

## ENVIRONMENT

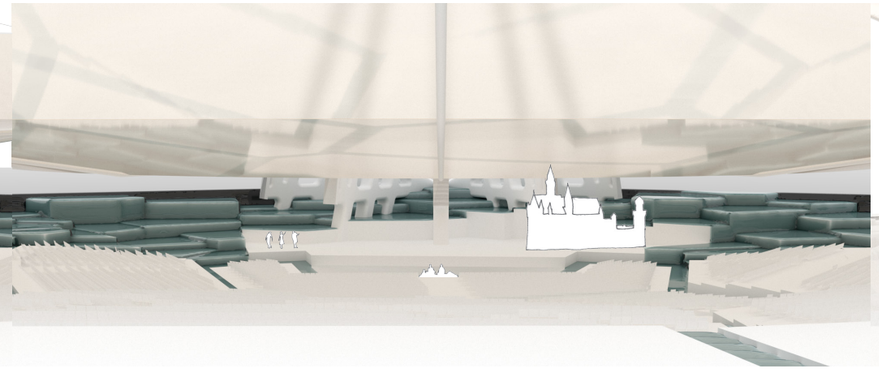
The stream valley is isolated from surrounding highways by a dense green belt of trees and foliage. The width of the green belt, coupled with the 4m waterfall (wall) surrounding the stream valley, will result in 30dB of interstate traffic noise disturbing the venue's patrons. This residual noise will be masked by the ongoing performance.

The audience directly face the riverway, via the stage. River traffic noise and natural sounds are typically of a calming, low intensity nature when compared to traffic noise. Any noise will not distract or disturb the patrons from an ongoing performance, but add to the surrounding ambience.

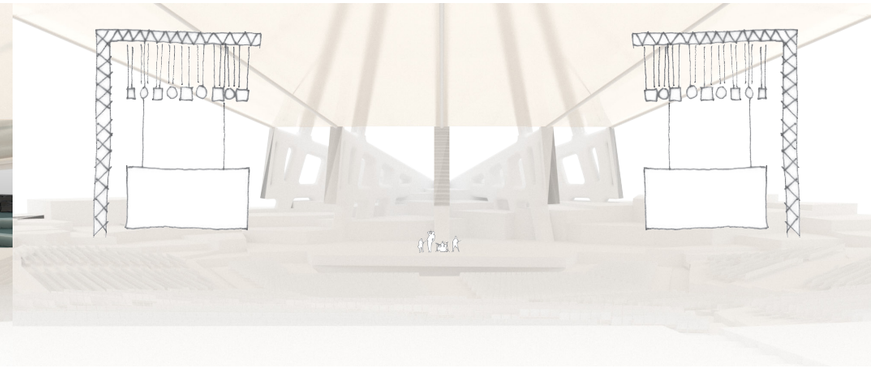
## SYMPHONIC ORCHESTRA

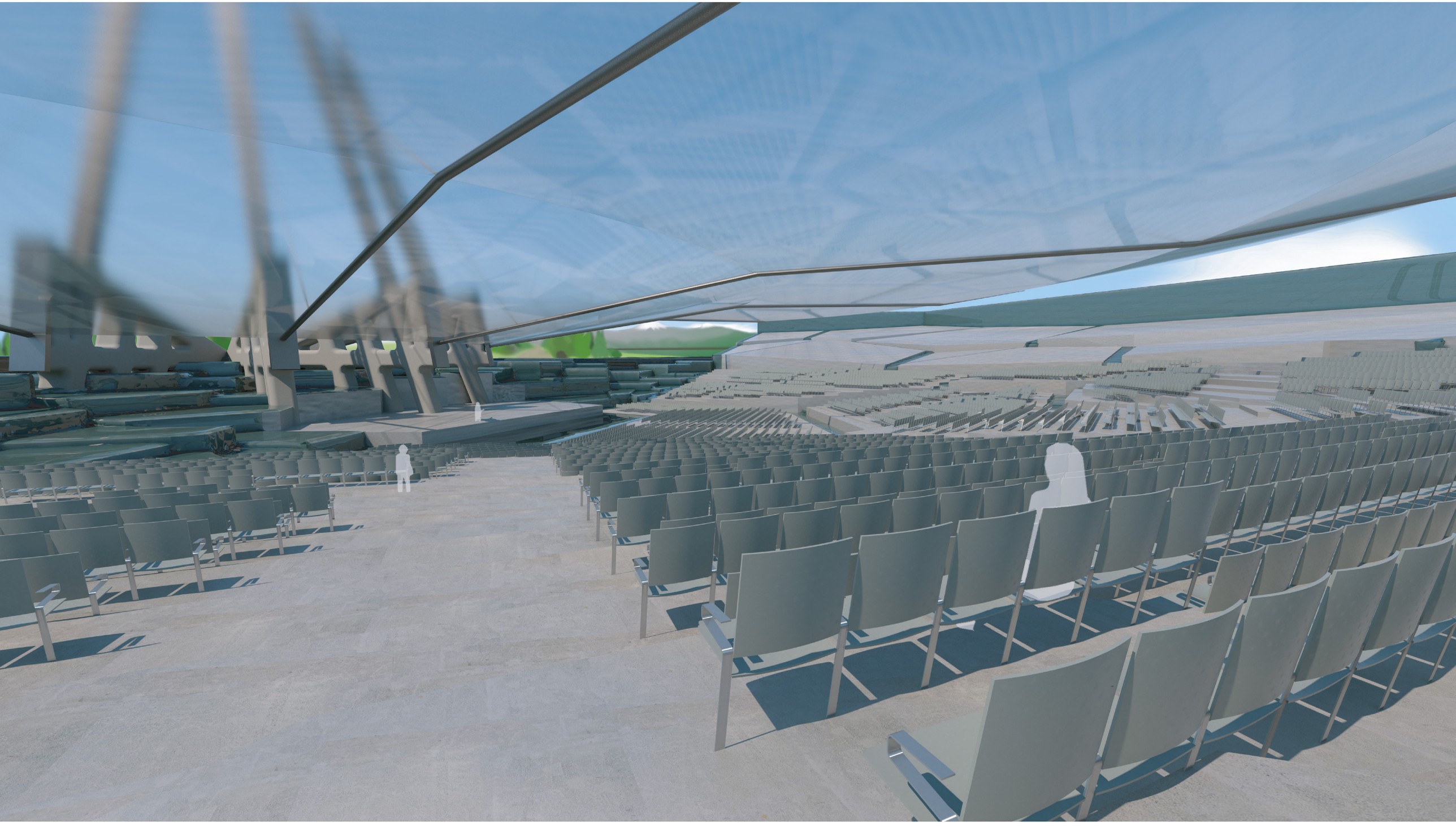


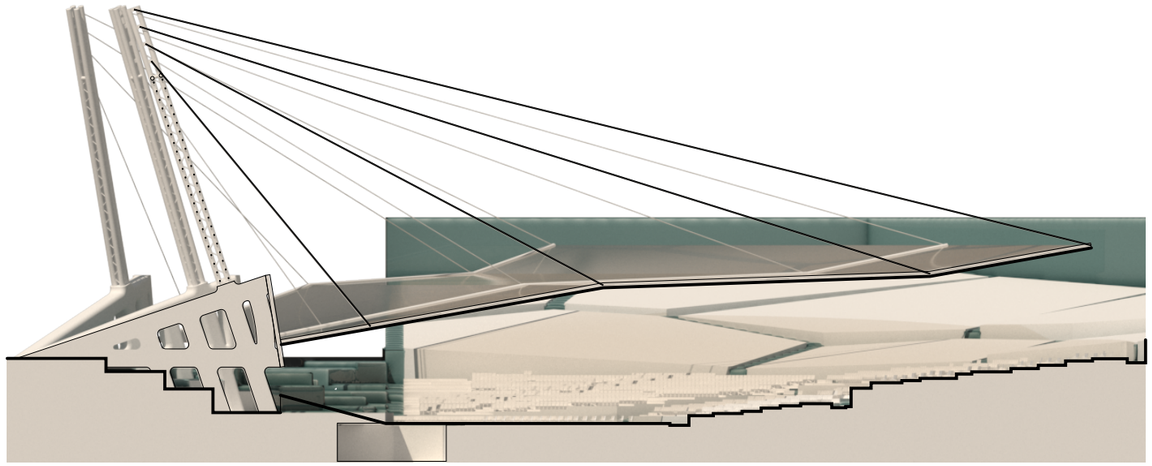
## THEATRE

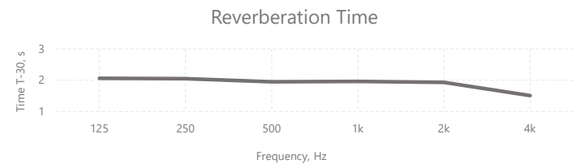


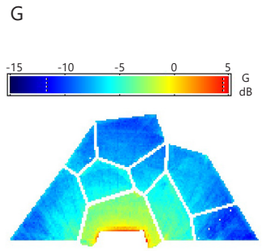
## POPULAR ACTS

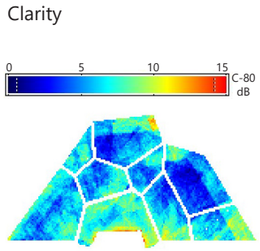








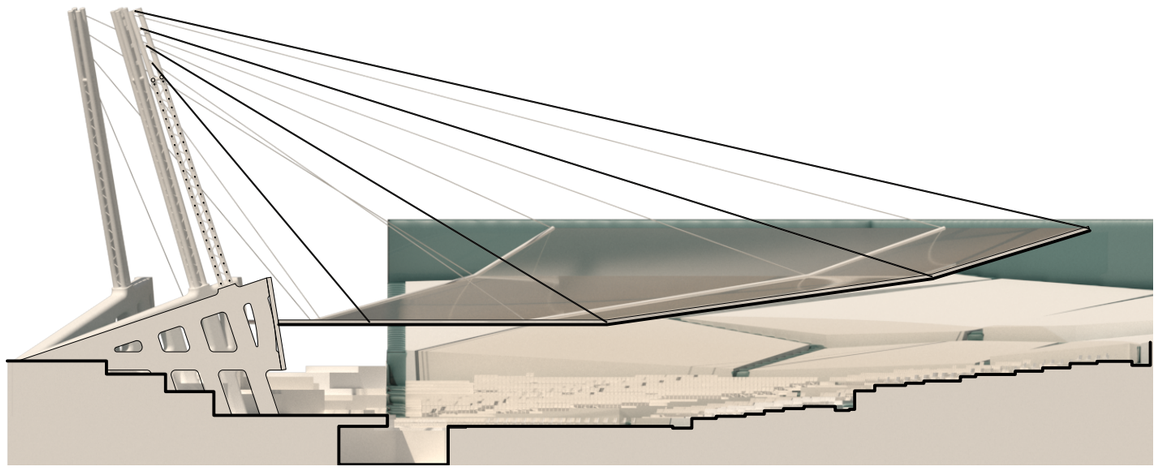



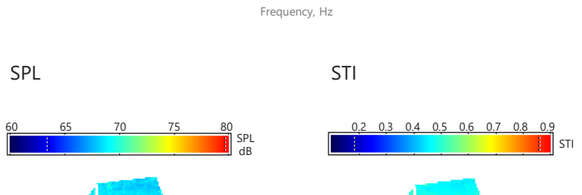

## SYMPHONIC ORCHESTRA

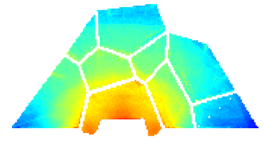
The sound is reflected towards the audience by the upwards sloping roof and the banked stage. Early reflections are re-inforced by the water-surface on orchestra pit, right before the stage.

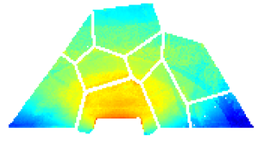
The shape of the semi enclosed acoustic chamber beneath the roof allows a suitable reverbera-tion to develop.

Early reflections are supported by the walls of the terraces and the waterfalls behind the stage, which generates preferable sound clarity





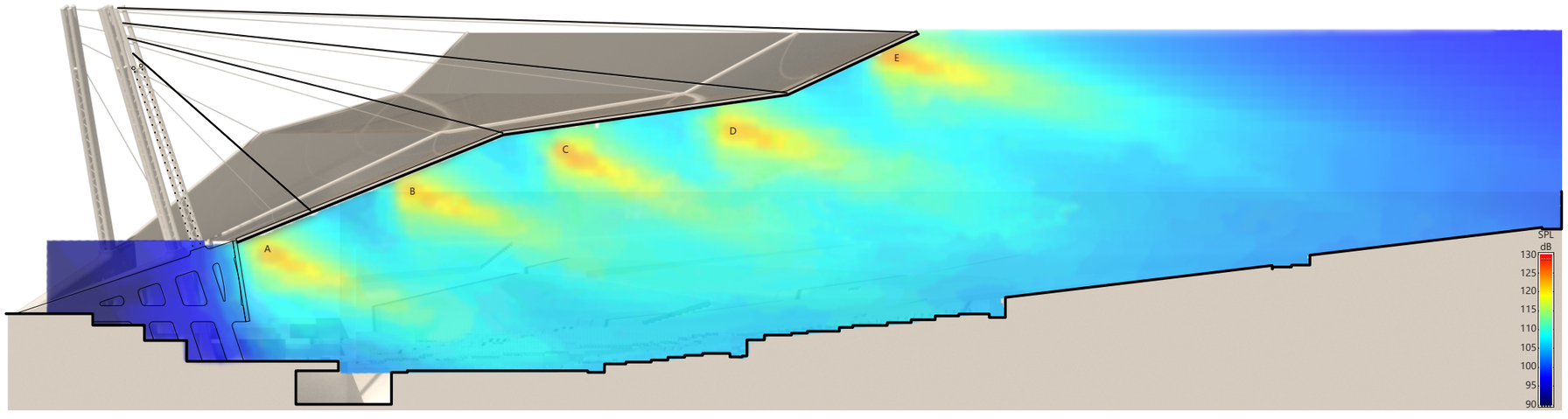




## THEATRE

An optimal roof height was cho-sen to house backdrops whilst keeping the roof volume and therefore reverberation time to a minimum.

The waterfalls behind the stage are turned off to reveal acoustic panels with low frequency res-onators. This improves STI by reducing reflections from these surfaces.

Loudspeaker arrays above the stage provide voice lift to achieve suitable sound pressure across the audience.




## POPULAR ACTS

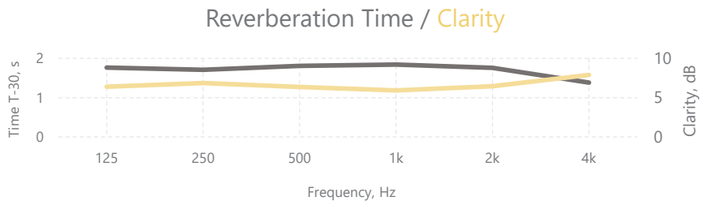
The roof is raised to its maxi-mum height, creating a rever-beration time of 2s <500Hz and 1s >500Hz. This results in strong warmth and envelopment.

A loudspeaker array system sup-ported by the roof provides a sound-pressure between 100 and 105dB(A) to all areas. The arrays have delayed timing to achieve a good sound image to-wards the stage.

- A - aligned with the stage
- B, C, D - delayed to 20ms af-ter array A
- E - delayed 60ms to generate a good sound image further towards the back.

# OPERA & BALLET

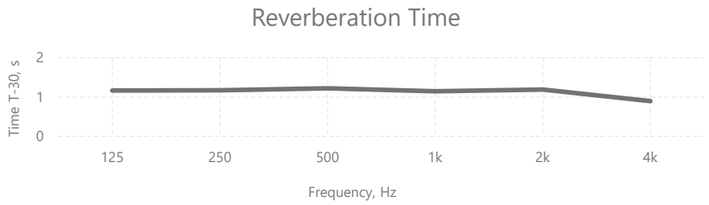
The orchestra are positioned in the pit before the stage. A roof height was chosen both to house the backdrops and provide a supportive reflector position directly above the orchestra pit. This results in a strong early reflection to the audience, improving musical clarity.

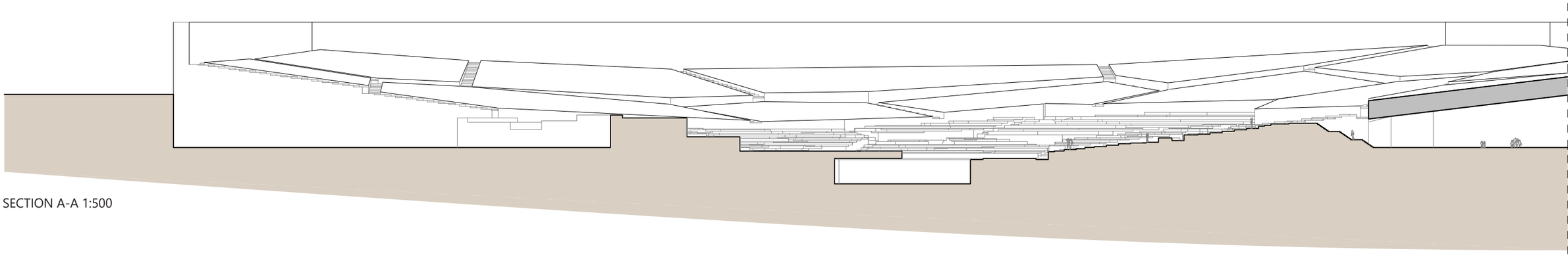



# SPOKEN WORD

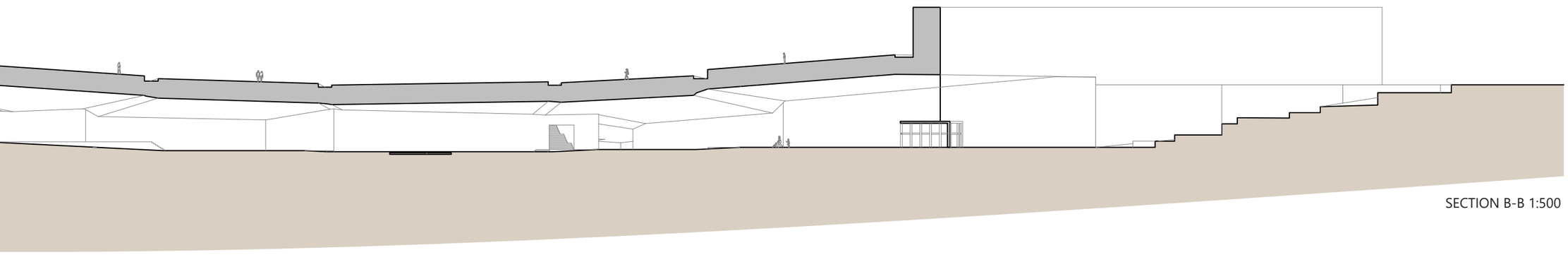
Similar to the theatre configuration, with the roof height minimised to reduce reverberation time and improve speech intelligibility.

The backstage panels are uncovered, improving STI and reducing reverberation.

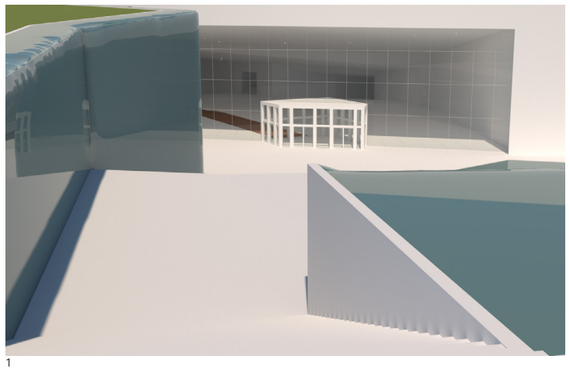


SECTION A-A 1:500

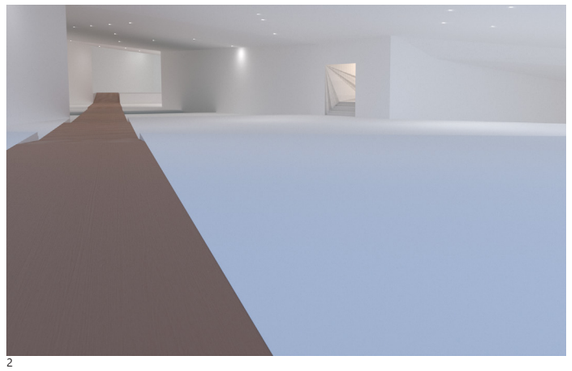


SECTION B-B 1:500



1

Since the facility is dug into the ground, you reach the entrance by stairs, elevators or ramps. The area in front of the entrance is spacious. You are introduced to the presence of the water, as it flows down the walls and edges surrounding the paths that brings you down.

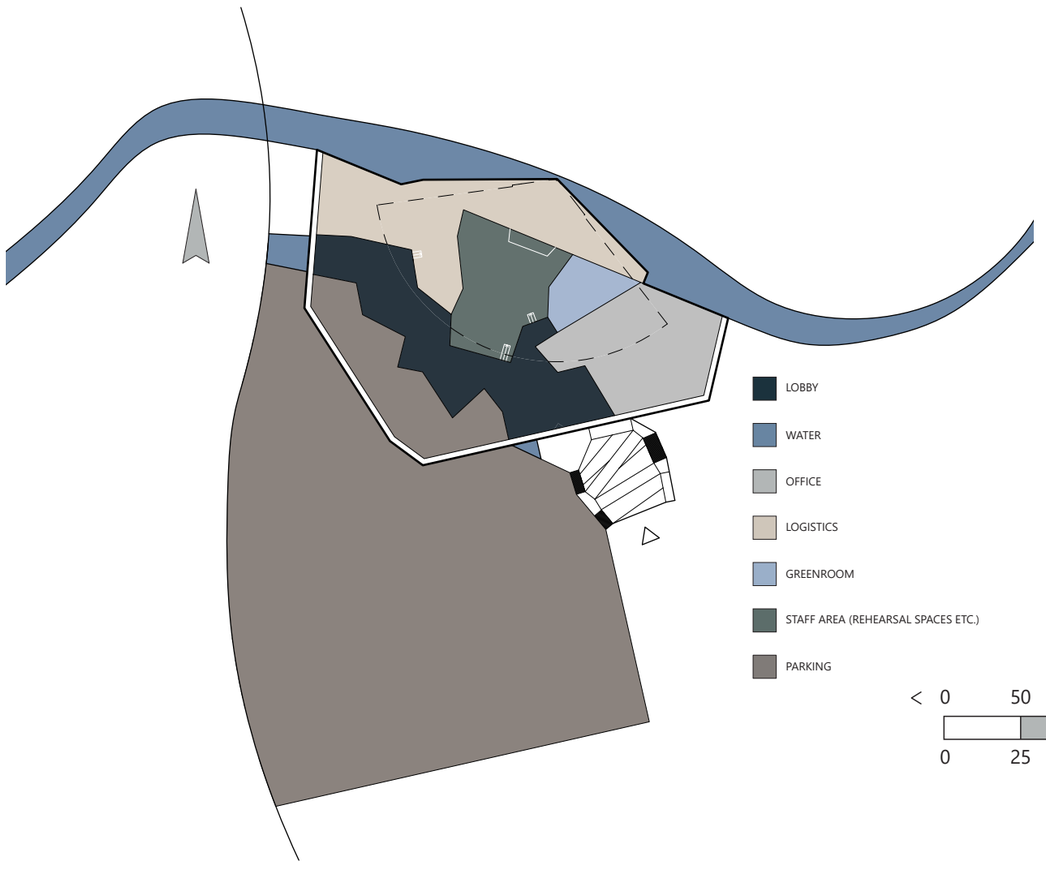


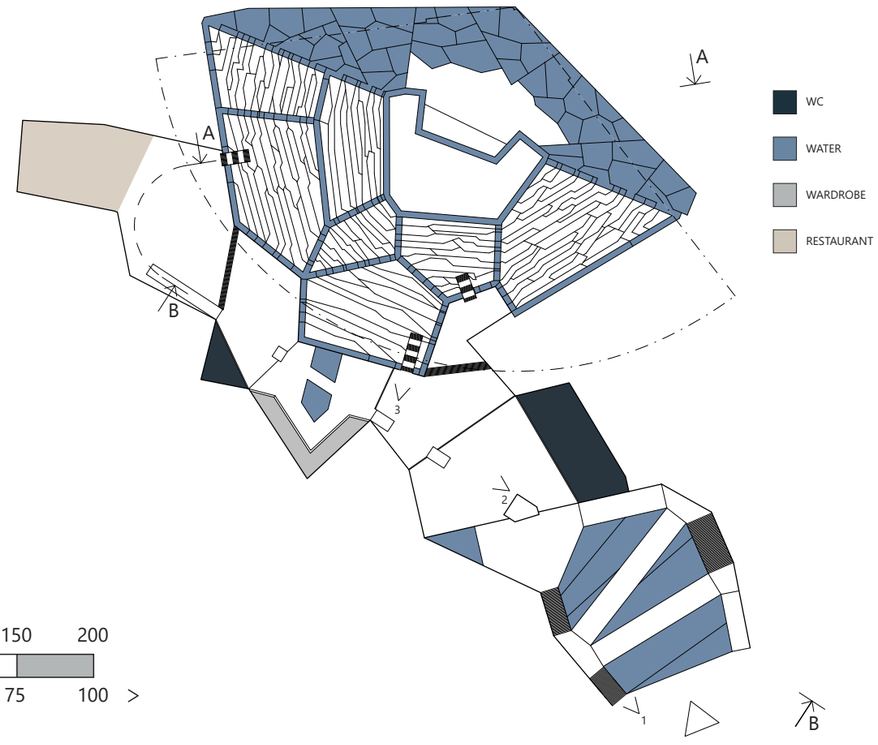
2

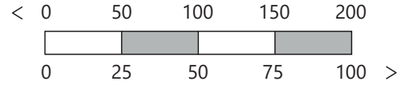
You enter the lobby through the glass facade and are greeted by the wooden path that guides you through the cave-like space closing in around you. The daylight is replaced by overhead lighting, and the sound of water is still present due to the lonely waterfall that marks the wardrobe.

3

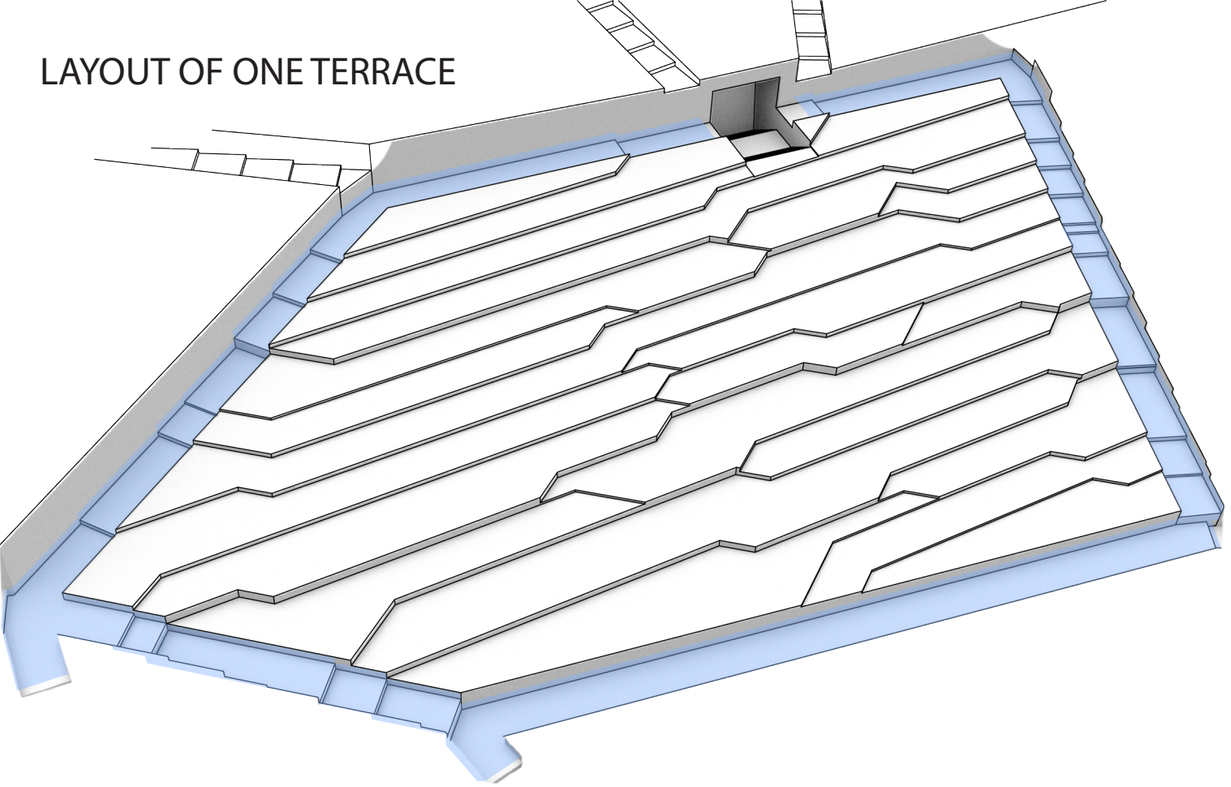
When you have passed through the dark cave, and found the entrance to your section, the light and sound from the landscape above guides you up the stairs.



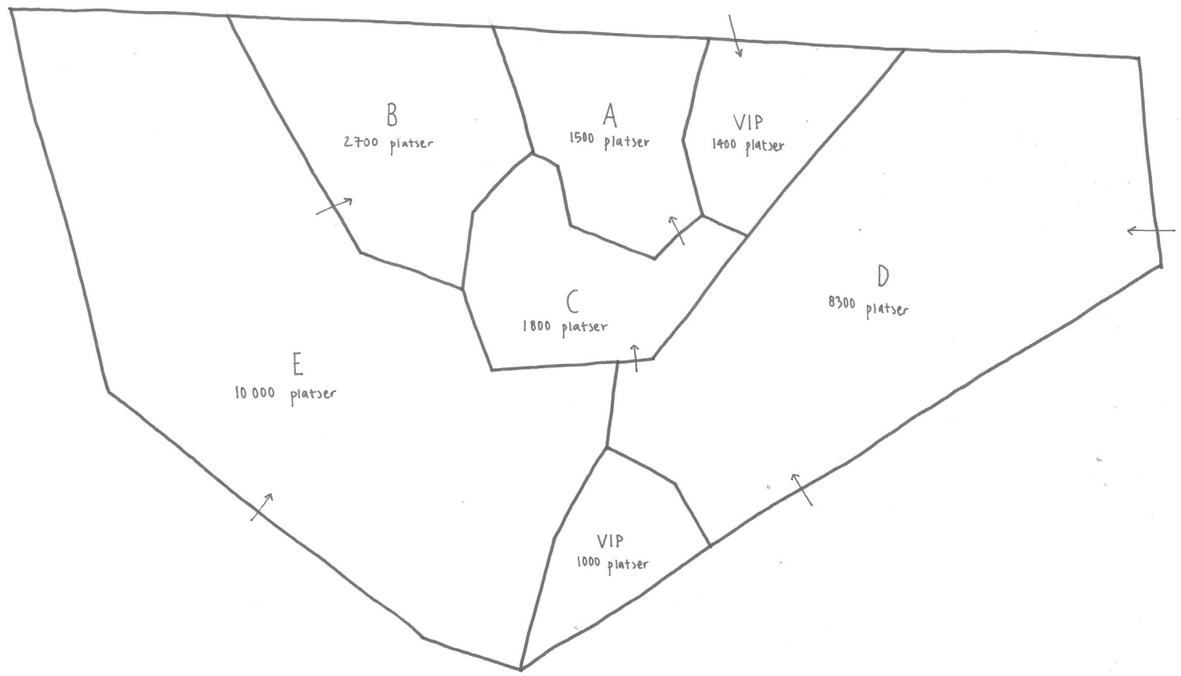



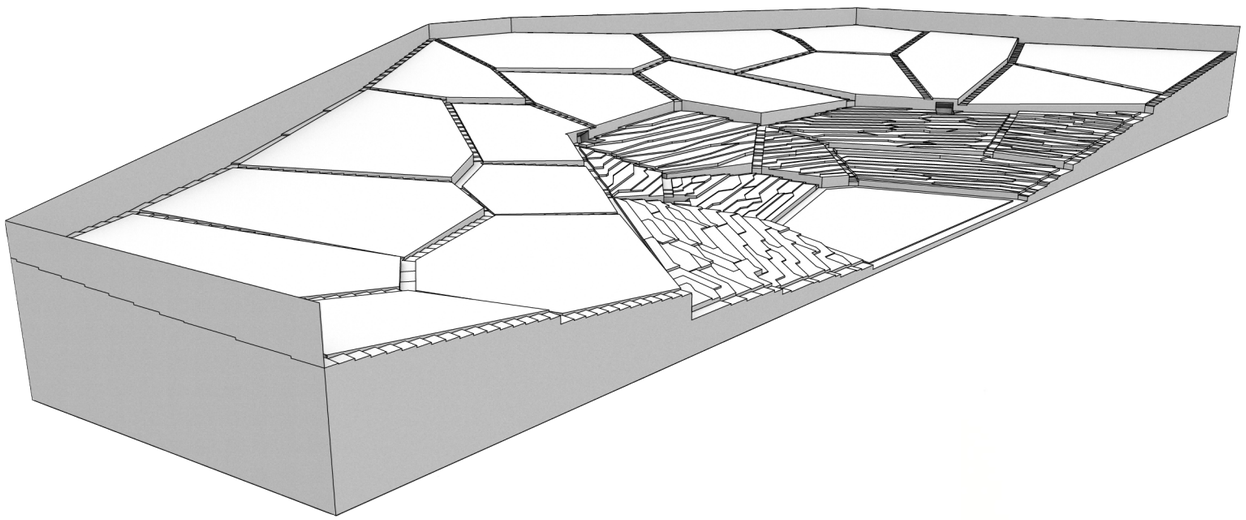
## LAYOUT OF ONE TERRACE

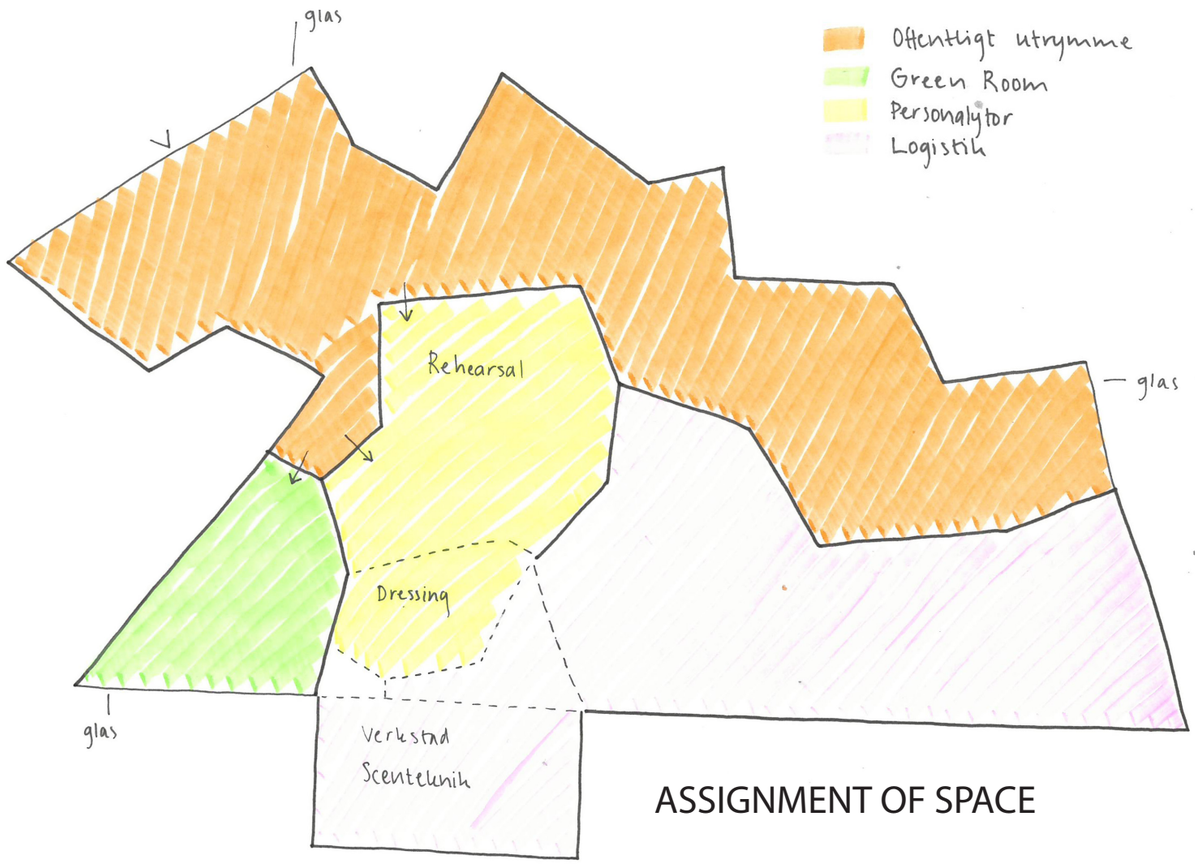


## DIVISION OF SEATING-SECTIONS




## BIRDSEYE VIEW OF THE VALLEY



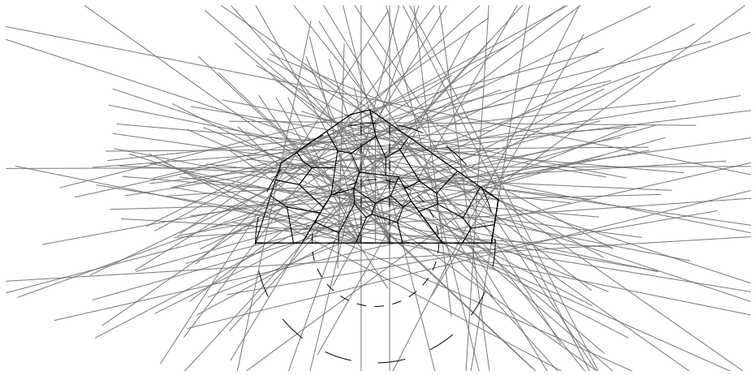



## ASSIGNMENT OF SPACE

# THE PROCESS

## BACKGROUND AND RULES

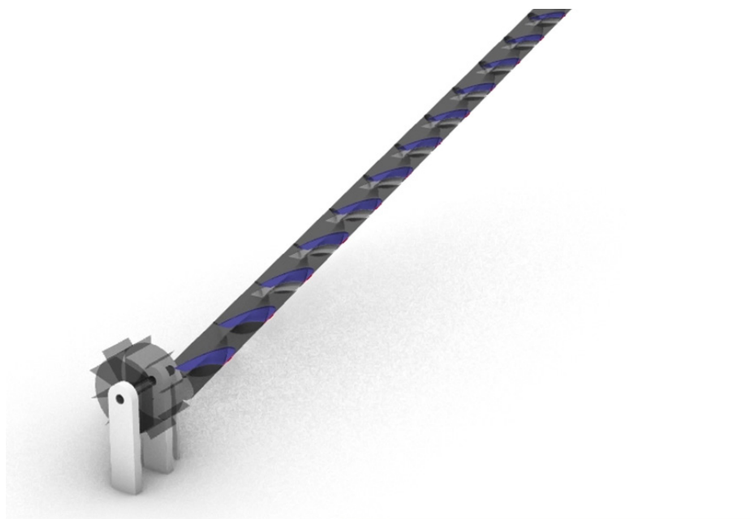
The concept with the audience area divided into surfaces surrounded by water originated from the realization of water prolonging sound, experienced on the "Bananpiren" on the northern bank of the inlet of "Göta älv". A system was developed for the layout of the streams that would divide the surfaces. Each stream would originate from a line in the system.



The program demanded a smaller area, containing seats, and a bigger open area outside. Two circles were created to represent the edges of these areas. The edge of the stage was placed in the middle of the circles. Now 4 types of lines were constructed:
Touching the stages' edges
Intersecting the inner circle
Intersecting both circles
Intersecting the outer circle

Lines were chosen so that the surfaces followed the following rules:
Max 4 surfaces meeting in a corner
No surface having more than 6 corners
(After offsetting the surfaces vertically) unobstructed line of sight of the whole stage for the entire area.

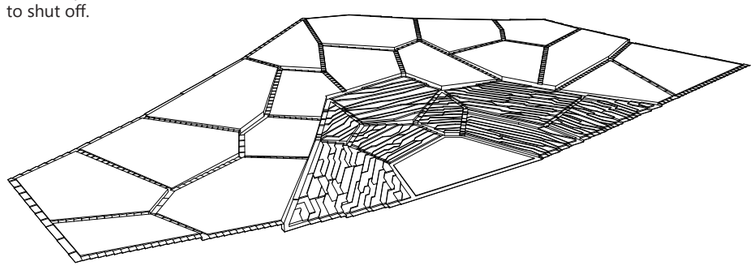
Different values of vertical offset was tried, and 500 mm was decided to be the best. The design of the program spaces was started, and the concept of the movement of the water was developed further. Different ways of transporting the water to the back of the area was explored and the decision to use two gigantic Archimedes' screws, one on each side, was made (this decision had to be left out of the final presentation due to space).



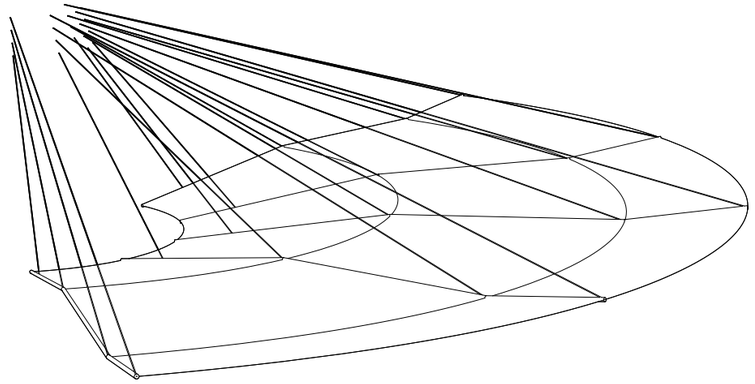
## APPLICATION OF ACOUSTICS

At this point in the process, the acoustician became involved in the process. A number of problems with the concept were discovered. The vertical offset was to small, and did not provide enough hight difference for the people in the back of each surface to have an unobstructed line of sight. The area of the steams was too small to affect the acoustics and the design did not provide enough reflective areas for the sound to bounce of of.

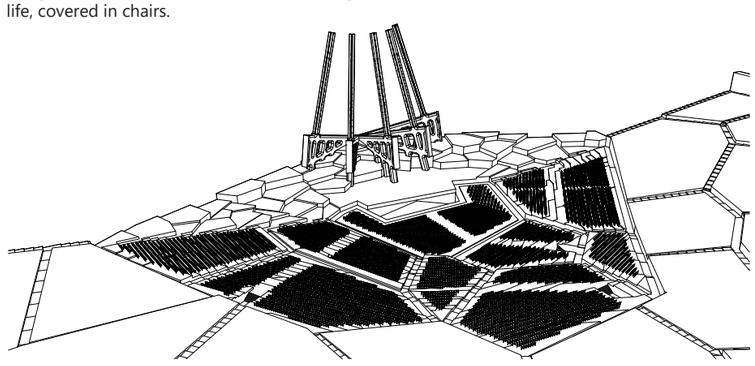
To address these problems the surfaces needed to be sloped, or stepped like an amphitheatre. The surfaces containing the seating were divided into smaller terraces, perpendicular to the line between the centre of the surface and the stage. The surfaces outside were rotated around those perpendicular lines. Some of the vertical offsets were increased to create more reflective area. The streams were preserved for their visual aspect, and their contribution to the ambience was realized. They were separated into smaller steps to enhance the sound and to make them convenient to shut off.



In the earlier stage of the project, an alterable roof that could change depending on preferred acoustic preference was discussed, but not developed. Now this idea was revived, and possible designs for this to be achieved were explored. This resulted in a gigantic suspended roof, in the shape of a hand fan. The area was held up by 5 arms, with 2 "knees" each arm. Each knee was connected to a wire which could be extended or reduced to alter the chamber beneath the roof.



The area behind the stage was designed, using a technique similar to the one for main area. The design was covered in water, and some very interesting acoustic properties were discovered. The water as a reflective medium was back in the project. Gigantic supports for the roof was designed, as well as a simple chair model to get an idea of how the lower area would look in real life, covered in chairs.



## METHODOLOGY

Developing a project in such a scale like this comes with a lot of problems. There are so many aspects to it, that no one can fully explore each and every one within a reasonable time-frame. Even when working as a group, many issues can be left unexplored. You can have many people contributing a little in every field, but this is not closely as effective as having different people digging deeper into different aspects. This is something I have learned much about during this project.

In the early stages of a project, most of the time is spent on developing the concept. But as soon as the outline of the concept is set, the different requirements of the program needs to be developed. I was not able to concentrate on one single aspect until it was fully discovered. The different assignments that this project consisted of were a good way to direct the focus on different areas, but each assignment contained more than what is possible for one person to discover during the given time.

It was also hard to interpret some of the aspects, that I felt were important for this project, into the assignments. For example the interior design and the placing of the functions stated by the program (which are therefore quite important), such as rehearsal space, offices, greenroom etc., was something that had to be explored outside of the assignments.

The "Integrated prototypes" assignment would probably have been more helpful for us if it came after the acoustician had entered the project. We focused mainly on the transportation of water, something that winded up not being included in the project. It would probably have helped us develop believable materials and details that could prove our acoustic concept stronger than it was perceived.

It was very nice to work so closely with someone from another field whose knowledge very much affected the quality of the project. To work back and forth to achieve the best results for our particular field, without trampling the other persons interests, was very rewarding. One of the most distinct examples of this is the roof, which I think turned out beautifully at the same time as being the most important tool for the alterable acoustic chamber.

## QUALITY

I am not sure whether it is possible or not to put this much time into a project without having a complicated relationship to it. Overall I am very happy with how it turned out. I like the water, I like the looks of the terraces and the roof, I like the depth of the journey through the facility and I am very proud of how the acoustics turned out.

There are quite a few things that I think lack in quality, but overall I am most disappointed with the level of detail. There are many things missing from the project that would be necessary to get it to the next level, for example the program functions I described earlier. I could not find time to develop them further myself, neither ambition enough in the project group.

I have during the project found that the best way to achieve a good overall picture is to not focus so much on the overall picture at all, but to dive deeper into the concept itself. This of course comes with another problem, the fact that the project hopefully will be realized one day. By then, you need to have solutions to all the problems that the program presents.

It all comes down to the balance of focus. Is this project going to answer all the questions in the program description or will it have a believable concept? Or will I work with a group of people that can work together and get both..?