THE GORGE

A SUBTRACTIVE PAVILION

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Bachelor's Project

2026 | Architecture and Engineering
Chalmers University of Technology

Bachelor's thesis at Architecture & Engineering

In the Architecture and Engineering programme at Chalmers University of Technology, the bachelor's thesis project has, since the programme's inception, been structured around an annual competition in acoustics. The class is divided into groups of two or three students who develop projects within the framework of the competition together with a student from the MSc programme in Acoustics. Over the years, the projects have ranged from opera houses and theatres to, as in this year's competition, outdoor pavilions.

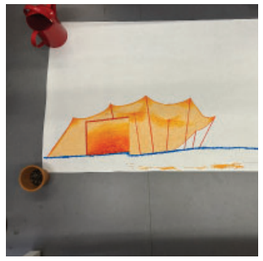
This years brief acquiered the pavilion to accommodate an audience of 13,000 people, of whom 3,000 are seated under a roof while the remaining spectators occupy surrounding grass areas, and was primarily intended for use by an orchestra and touring performances. Consequently, the project required the development and coordination of numerous complex components, including the stage, back-of-house facilities, roof structure, terrain management, grandstands, logistics, and many other elements, into a coherent and functional system.

To achieve this, the work was divided into a number of different assignments. These included exercises, study visits, and multiple iterations intended to advance the project throughout the process. In this publication, I summarise these assignments by dividing the bachelor's thesis project into three distinct phases.

In collaboration with: Lydia Persson, William Skoglund
Tutors: Morten Lund, Peter Christensson, Wolfgang Kropp

An early exercise where sound was explored at different strengths and distances.

Studyvisit at the concerthall in Gothenburg.



An early concept in development.

Phase 1 Process

The initial phase of the bachelor's project aimed to create ideas and inspiration through a number of exercises, study-visits and experiments.

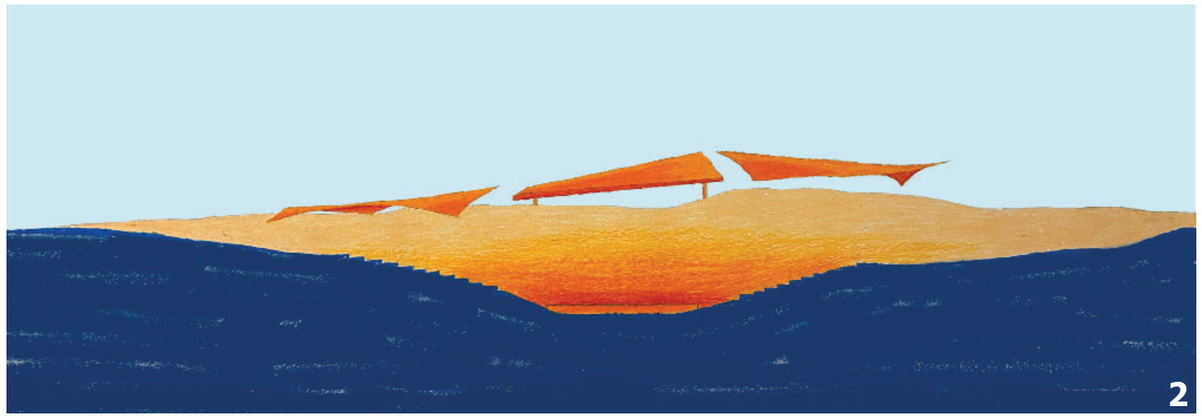
Phase 2 Competition

Ideas and concepts that were born in phase 1 were developed into finished illustrations within the frames of the competition.

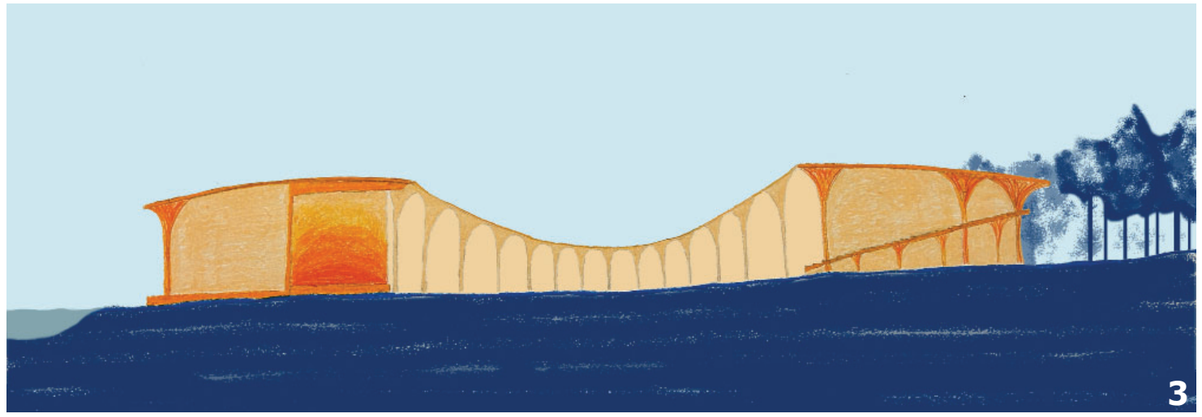
Phase 3 Development

Further development of the project and added illustrations were made after the competition, as well as a reflections of the project as a whole.

The inspiration for Concept 1 was derived from wilderness camping. The site was intended to be surrounded by trees, creating the atmosphere of a forest clearing. The stage, covered seating area, and back-of-house facilities were enclosed within a colossal tent structure, where the supporting columns referenced the surrounding woodland. Visitors would arrive through the forest and see the tent far ahead.



Concept 2 explored the possibility of excavating an arena rather than constructing one above ground. In this way, the silhouette of the landscape could remain largely undisturbed while noise from the adjacent motorway would be reduced. The concept investigated the feasibility of a bidirectional arena, in which the stage was positioned centrally, and examined how the roof structure could unify the different components.

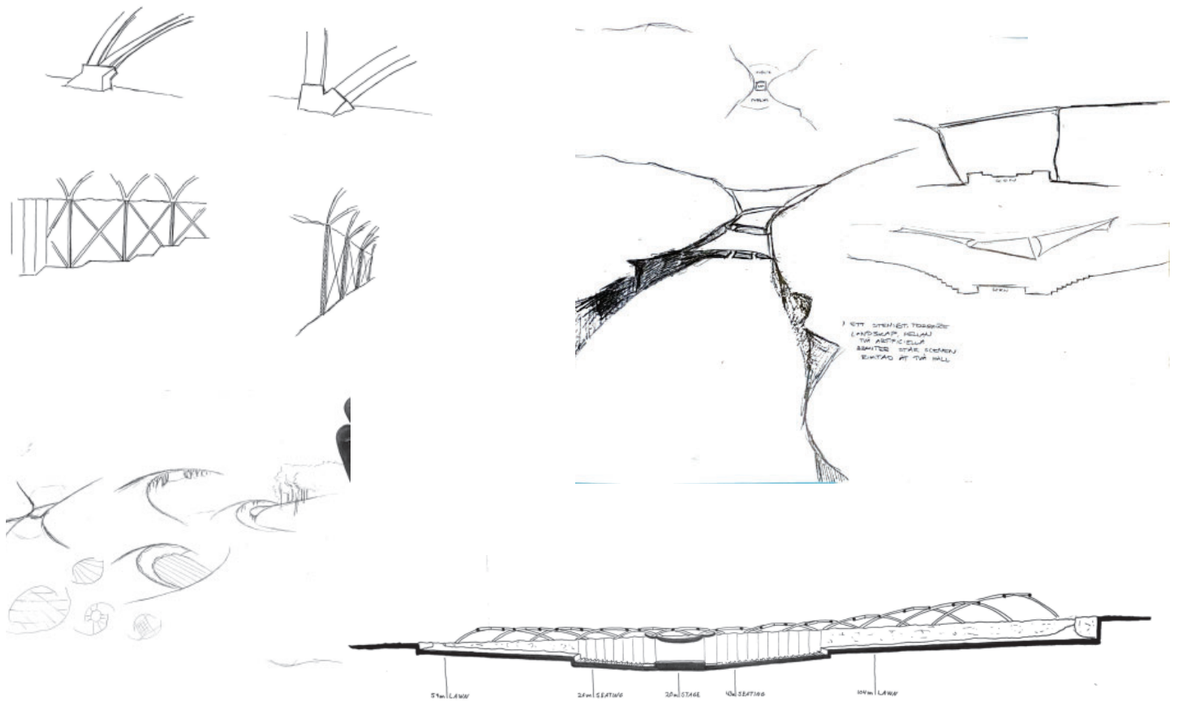


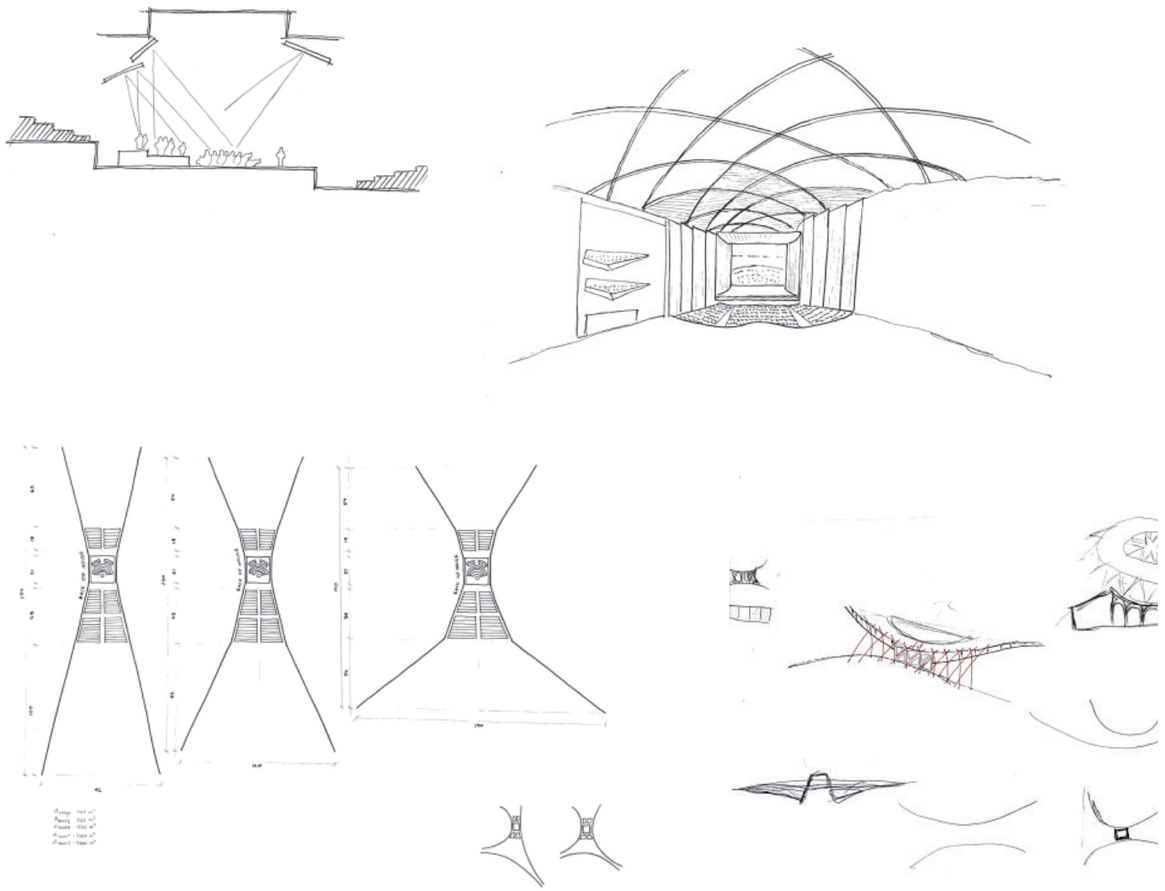
Similar to Concept 1, the third concept revolved around the idea of a clearing within the forest. In this case, however, the pavilion itself constituted the forest, where the covered seating area was positioned furthest from the stage and enclosed the remaining audience areas. Tree-like structural systems, inspired by the branching geometry of trees, were designed to support the roof structure.

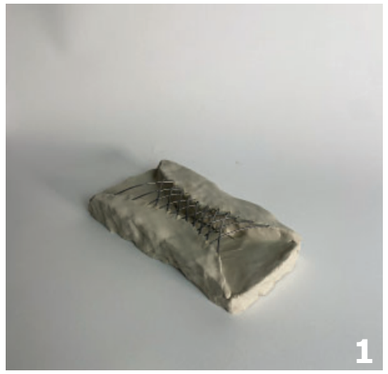
Three concepts

During the first iteration of our projects, three conceptual proposals were developed. This process involved producing illustrative sections using crayons on seven-metre-long sheets of paper, in which elements such as the stage, back-of-house facilities, seating areas, and roof structure were represented. We deliberately limited ourselves to only two colours, orange and blue, in order to emphasise form and spatial composition rather than materiality and colour. The concepts were then presented to the acoustics students, who subsequently divided themselves among the different project groups.

With our acoustics collaborator in place, the remaining task was to determine which concept should be pursued for further development. We chose to continue working with Concept 2 due to its significant potential for flexibility, exploration, and innovation.

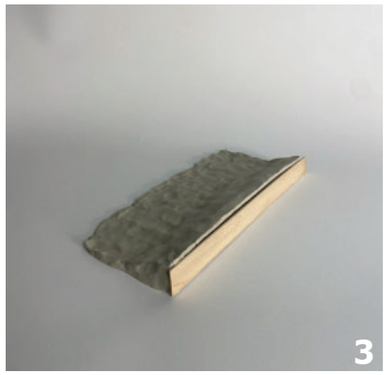






The first model illustrates a grid that stretches between the two main walls. The structure carries speakers, lighting and the roof.

A second model illustrates the proposed wooden panels that would be placed along the walls in order to improve the natural acoustics.

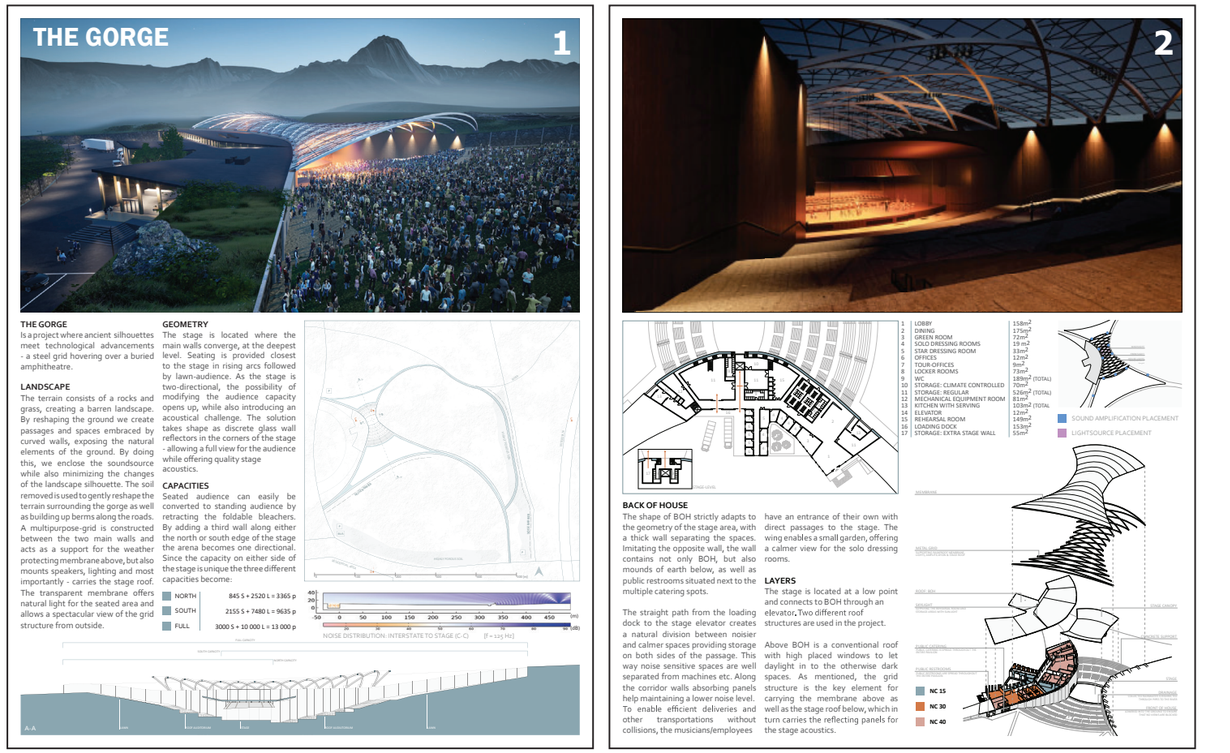


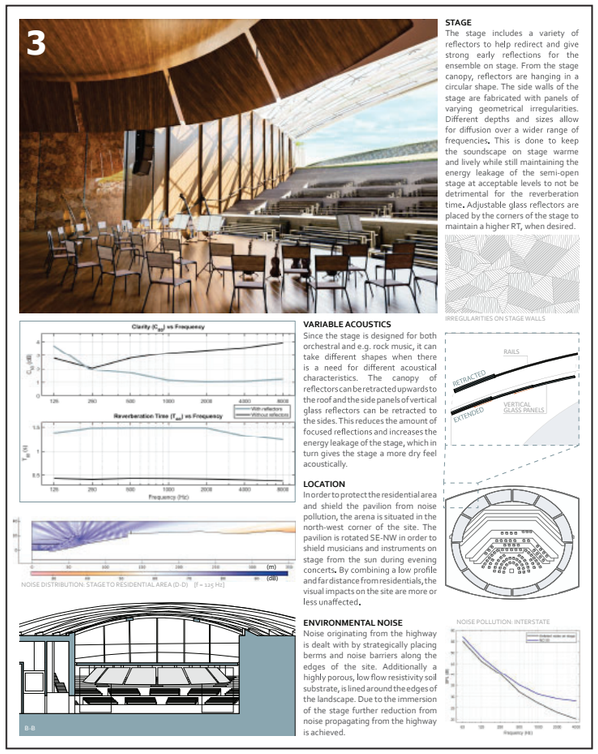
A noise-barrier, made using the material dug out from the pavilion, was proposed to be created along the interstate.

Three elements

To further develop the selected concept, the focus of the subsequent assignment was directed towards acoustic elements. These could include anything from roof structures to speaker-supporting columns, provided that the elements contributed acoustically to the pavilion. We chose to illustrate the three elements primarily through clay models, due to the material's ease of manipulation, as well as through the partial use of wood and steel.

In addition, numerous sketches and illustrations were produced throughout the project, particularly during its early stages, in order to further develop and discuss the emerging ideas.





Results

Page 8 presents the three competition boards that were submitted to the United States. Renderings, drawings, and the other illustrations communicate the architectural qualities of the project. These are complemented by diagrams, tables, and illustrations demonstrating the project's acoustic performance, produced in collaboration with our acoustics partner. The texts providing a more in-depth description of the project's various components are presented on the following spread, followed by the architectural illustrations featured in the competition boards.

Texts on the boards

Board 1

THE GORGE
Is a project where ancient silhouettes meet technological advancements - a steel grid hovering over a buried amphitheatre.

LANDSCAPE
The terrain consists of a rocks and grass, creating a barren landscape. By reshaping the ground we create passages and spaces embraced by curved walls, exposing the natural elements of the ground. By doing this, we enclose the soundsource while also minimizing the changes of the landscape silhouette. The soil removed is used to gently reshape the terrain surrounding the gorge as well as building up berms along the roads. A multipurpose-grid is constructed between the two main walls and acts as a support for the weather protecting membrane above, but also mounts speakers, lighting and most importantly - carries the stage roof. The transparent membrane offers natural light for the seated area and allows a spectacular view of the grid structure from outside.

GEOMETRY
The stage is located where the main walls converge, at the deepest level. Seating is provided closest to the stage in rising arcs followed by lawn-audience. As the stage is two-directional, the possibility of modifying the audience capacity opens up, while also introducing an acoustical challenge. The solution takes shape as discrete glass wall reflectors in the corners of the stage - allowing a full view for the audience while offering quality stage acoustics.

CAPACITIES
Seated audience can easily be converted to standing audience by retracting the foldable bleachers. By adding a third wall along either the north or south edge of the stage the arena becomes one directional. Since the capacity on either side of the stage is unique the arena can be converted and be "sold out" at three different capacities.

Board 2

BACK OF HOUSE
The shape of BOH strictly adapts to the geometry of the stage area, with a thick wall separating the spaces. Imitating the opposite wall, the wall contains not only BOH, but also mounds of earth below, as well as public restrooms situated next to the multiple catering spots. The straight path from the loading dock to the stage elevator creates a natural division between noisier and calmer spaces providing storage on both sides of the passage. This way noise sensitive spaces are well separated from machines etc. Along the corridor walls absorbing panels help maintaining a lower noise level. To enable efficient deliveries and other transportations without collisions, the musicians/employees have an entrance of their own with direct passages to the stage. The wing enables a small garden, offering a calmer view for the solo dressing rooms.

LAYERS
The stage is located at a low point and connects to BOH through an elevator. Two different roof structures are used in the project. Above BOH is a conventional roof with high placed windows to let daylight in to the otherwise dark spaces. As mentioned, the grid structure is the key element for carrying the membrane above as well as the stage roof below, which in turn carries the reflecting panels for the stage acoustics.

Board 3

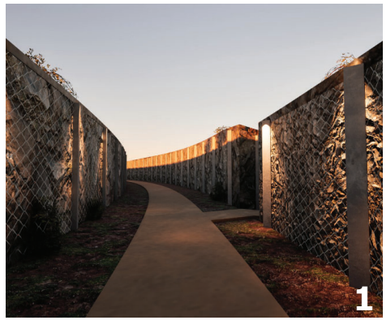
VARIABLE ACOUSTICS
Since the stage is designed for both orchestral and e.g. rock music, it can take different shapes when there is a need for different acoustical characteristics. The canopy of reflectors can be retracted upwards to the roof and the side panels of vertical glass reflectors can be retracted to the sides. This reduces the amount of focused reflections and increases the energy leakage of the stage, which in turn gives the stage a more dry feel acoustically.

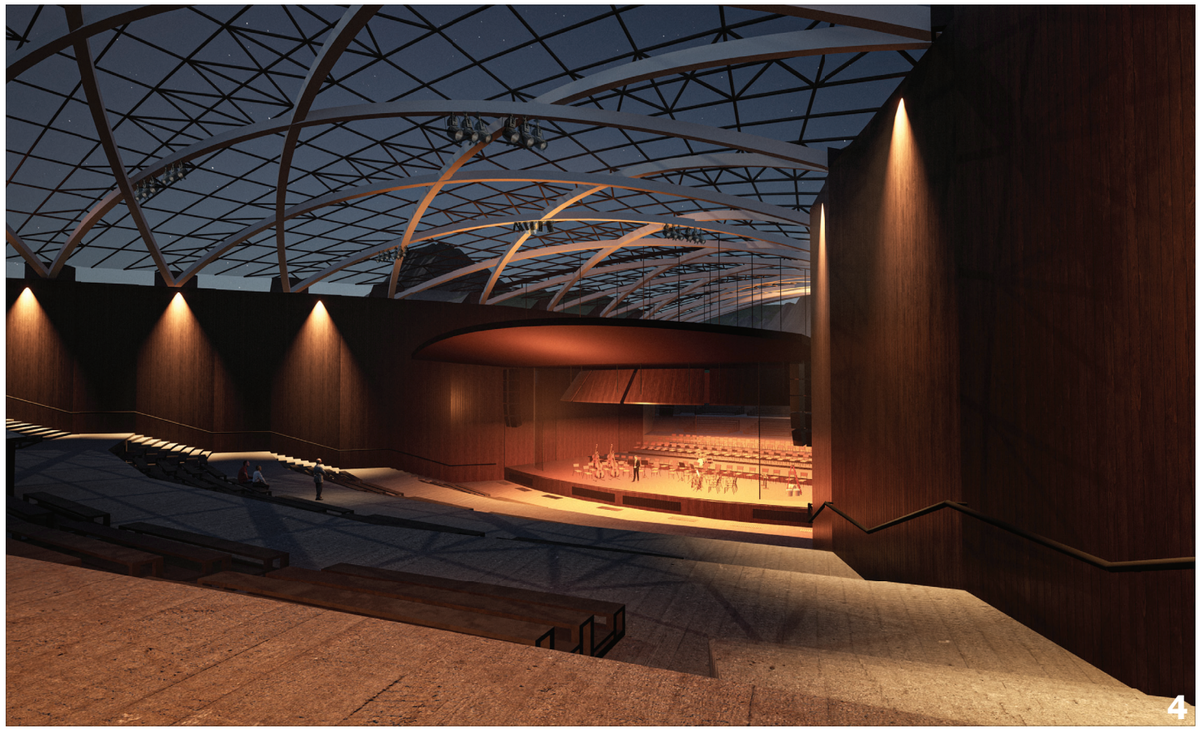
LOCATION
In order to protect the residential area and shield the pavilion from noise pollution, the arena is situated in the north-west corner of the site. The pavilion is rotated SE-NW in order to shield musicians and instruments on stage from the sun during evening concerts. By combining a low profile and far distance from residentials, the visual impacts on the site are more or less unaffected.

ENVIRONMENTAL NOISE
Noise originating from the highway is dealt with by strategically placing berms and noise barriers along the edges of the site. Additionally a highly porous, low flow resistivity soil substrate, is lined around the edges of the landscape. Due to the immersion of the stage further reduction from noise propagating from the highway is achieved.

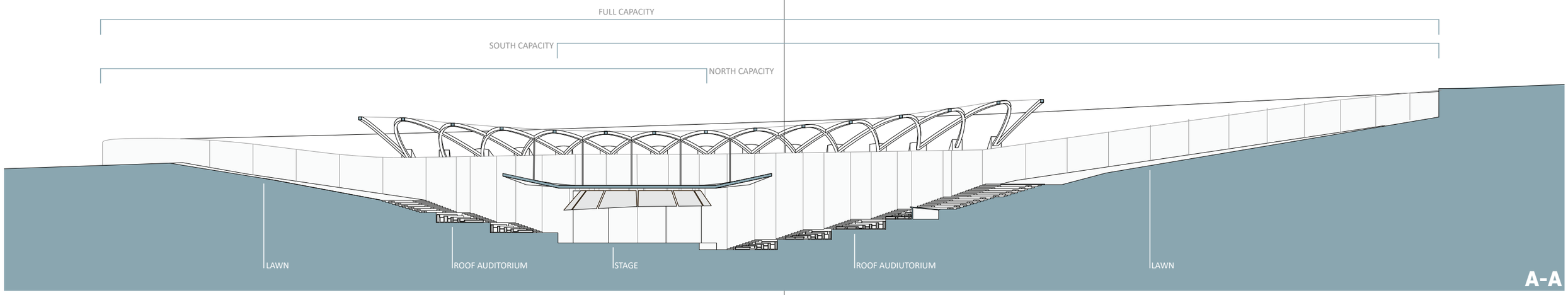
STAGE
The stage includes a variety of reflectors to help redirect and give strong early reflections for the ensemble on stage. From the stage canopy, reflectors are hanging in a circular shape. The side walls of the stage are fabricated with panels of varying geometrical irregularities. Different depths and sizes allow for diffusion over a wider range of frequencies. This is done to keep the soundscape on stage warme and lively while still maintaining the energy leakage of the semi-open stage at acceptable levels to not be detrimental for the reverberation time. Adjustable glass reflectors are placed by the corners of the stage to maintain a higher RT, when desired.

Site plan





The sequence visitors exprience divided into four stages, from parking to the southern seated area



Bird’s-eye view of the pavilion looking north

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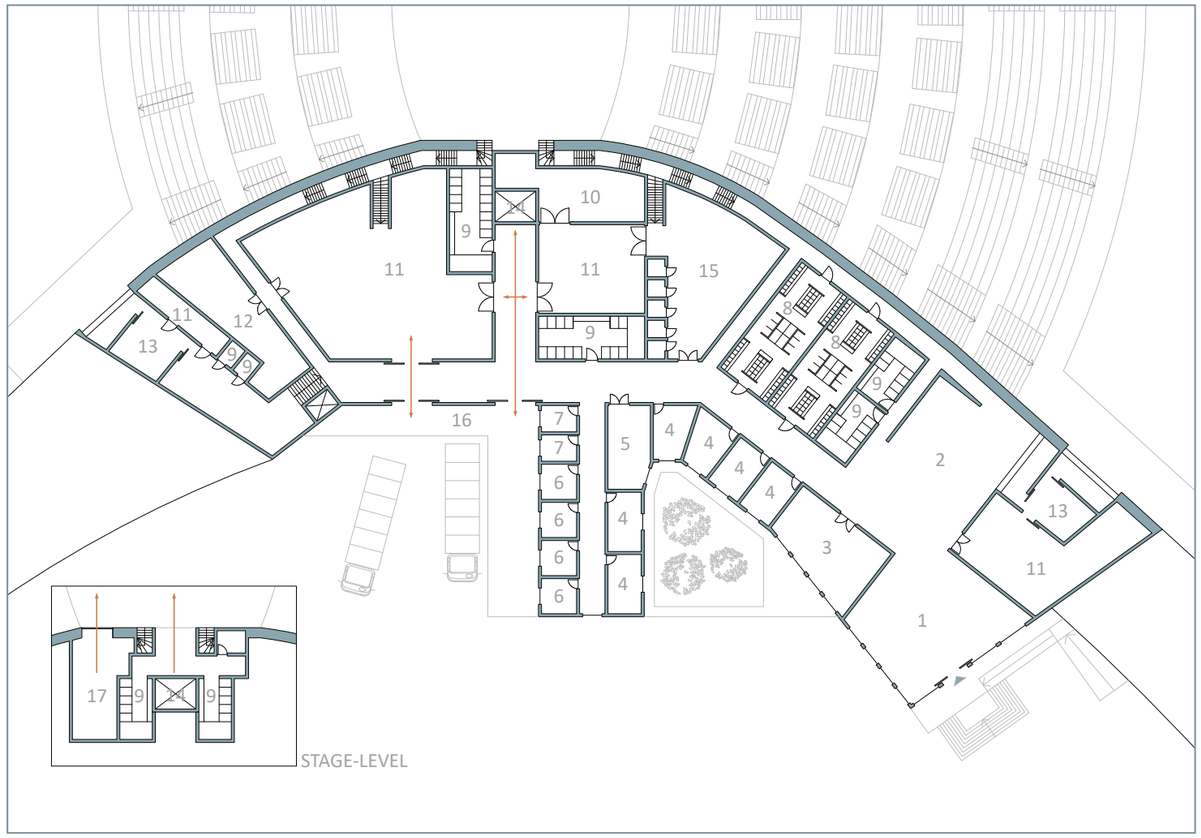
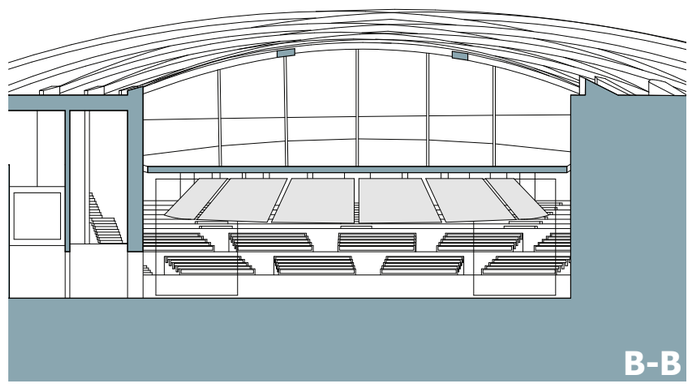
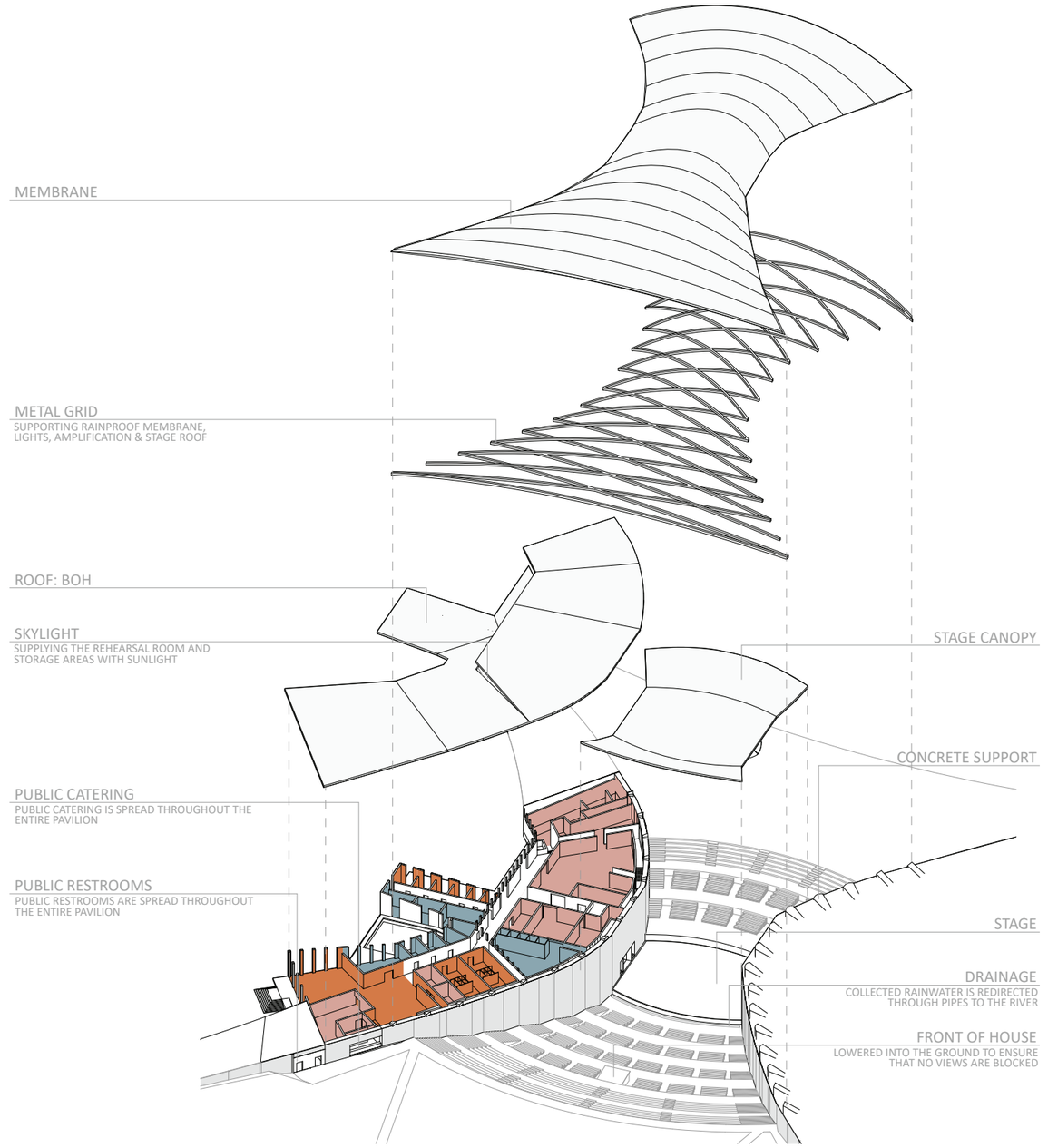


Plan: back-of-house

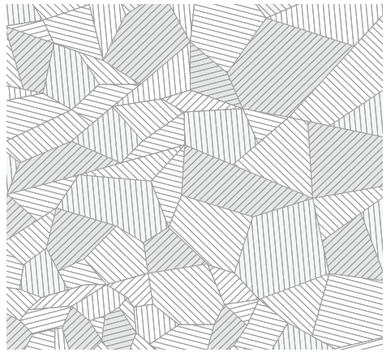
1	LOBBY	158m2
2	DINING	175m2
3	GREEN ROOM	72m2
4	SOLO DRESSING ROOMS	19 m2
5	STAR DRESSING ROOM	33m2
6	OFFICES	12m2
7	TOUR-OFFICES	9m2
8	LOCKER ROOMS	73m2
9	WC	189m2 (TOTAL)
10	STORAGE: CLIMATE CONTROLLED	70m2
11	STORAGE: REGULAR	526m2 (TOTAL)
12	MECHANICAL EQUIPMENT ROOM	81m2
13	KITCHEN WITH SERVING	103m2 (TOTAL
14	ELEVATOR	12m2
15	REHEARSAL ROOM	149m2
16	LOADING DOCK	153m2
17	STORAGE: EXTRA STAGE WALL	55m2



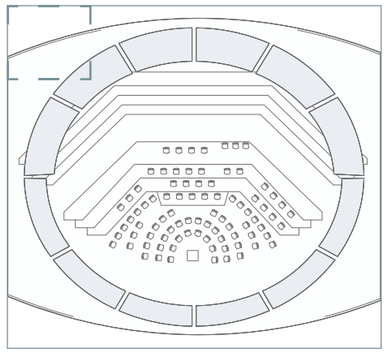
Differences in height between the stage, back-of-house and roof



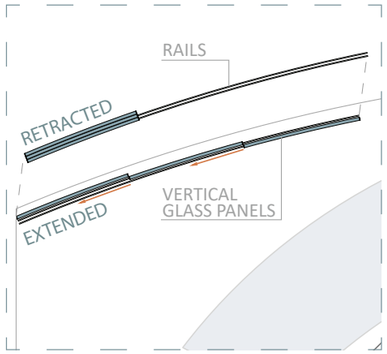
View from the stage



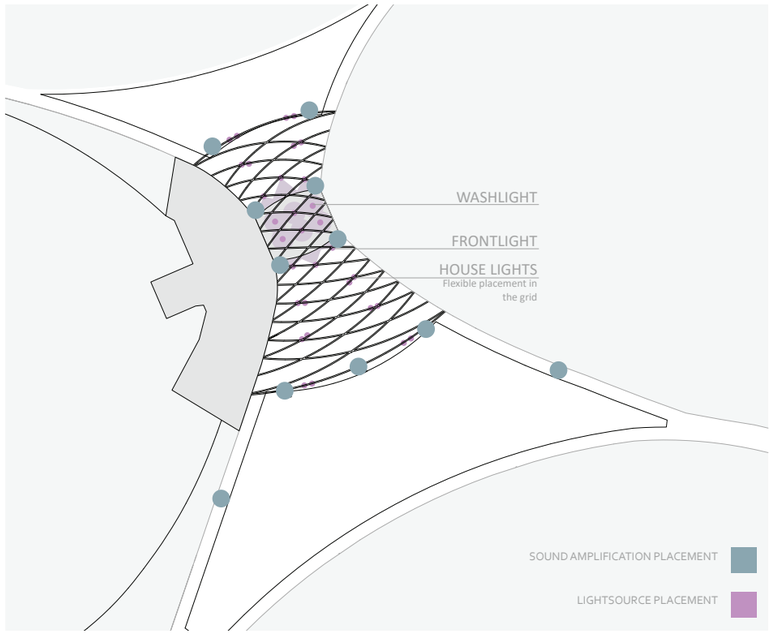
Irregularities on the stage walls

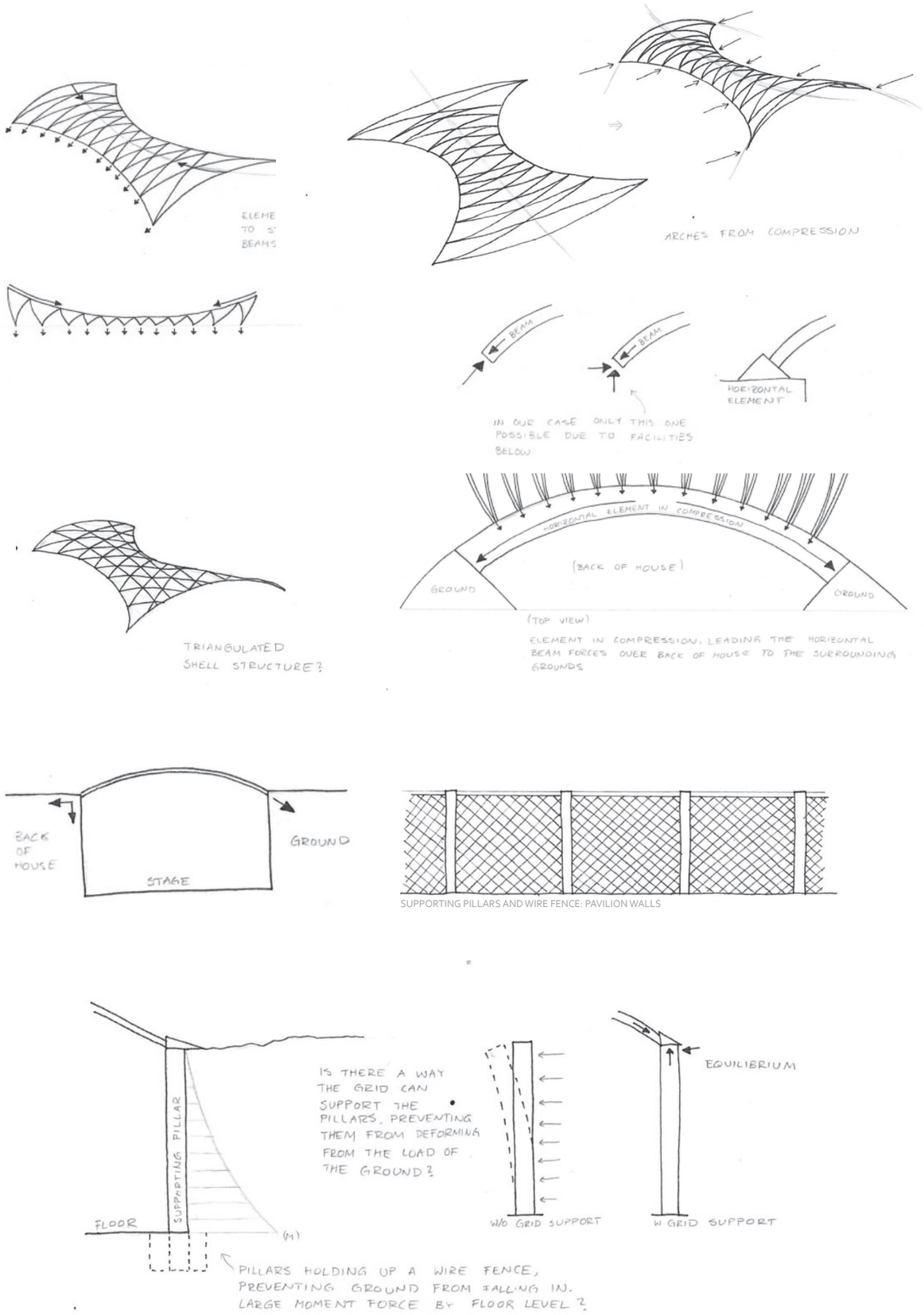


Stage plan

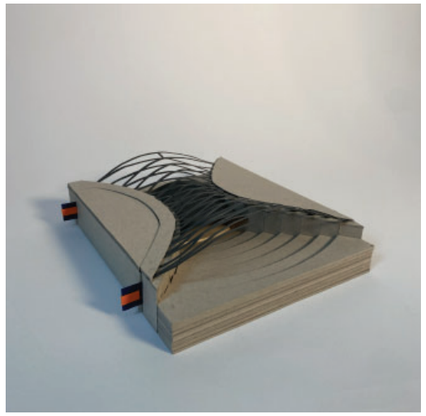


Adjustable glass panels on the stage to enable different acoustic properties





Booklets were designed and produced for the final critique



Model of the final design

Development

After the projects were submitted to the competition we were free to explore, develop and illustrate ideas that were earlier not going to fit on the boards. We chose to use this time to design and produce booklets, build a convertible model of the pavilion and discuss how our proposed elements, e.g. the grid, would perform structurally.

The time was also used to write a reflection regarding our chosen design methodologies, architectural qualities of the project and teamwork.

Reflection

DESIGN METHODOLOGY

In the early stages of the project, creative and exploratory methods were employed to investigate the relationship between sound, distance, and spatial environments. By experimenting with different forms of speech, sound levels, distances, and spatial conditions in Kungsparken, we developed a broader understanding of how various parameters influence sound propagation in open environments. These experiments were followed by the production of large sectional drawings of the visited sites, in which colours and symbols were used to represent sound distribution and its sources. This initial exercise became a broad and playful introduction to the project, encouraging us to continue working with colours, clay, and other creative methods as tools for developing and communicating ideas.

The initial exercise was followed by the first iteration of the project, during which three large-scale sectional concepts were produced, each spanning several metres in length. We deliberately limited the use of colour to orange and blue in order to emphasise the overall geometries and spatial qualities of the proposals. During this process, we collectively recognised that one concept in particular stood out to us — The Gorge. The idea of reshaping the terrain and "carving" the pavilion from the ground allowed us to explore geometry, spatial organisation, and innovation in ways that the other concepts did not. At the same time, this approach presented significantly greater challenges, both technically and architecturally.

To further develop the core ideas behind The Gorge, numerous sketches and clay models were produced before any digital modelling began. This process enabled ideas to be visualised rapidly and facilitated continuous discussion and evaluation. It also allowed us to communicate more effectively with the acoustician in our group, who provided general guidance regarding sound distribution and the acoustic requirements of the venue.

In order to produce the final competition boards and visualise the project in greater detail, a variety of digital tools were used, primarily Rhino, Grasshopper, and AutoCAD. By working closely alongside one another on a daily basis and continuously sharing files, we were able to develop the drawings efficiently as a collaborative team. Through ongoing consultation with our acoustician, we identified and prioritised the most significant aspects of the project for presentation on the boards. Acoustic calculations and visualisations were developed simultaneously with the architectural work, enabling an iterative design process in which, for example, the acoustics of the stage could be continuously refined and optimised.

To create visually coherent and engaging competition boards, the work was later divided between us: one team member focused on colour coordination, visual consistency, and layout composition, while the other concentrated on the production of additional detailed drawings. This workflow proved both efficient and successful due to the continuous communication maintained throughout the project.

In summary, the collaborative process and working methods functioned effectively and resulted in a final project with which all team members were satisfied. By employing simple illustrative methods and an iterative design approach during the early stages of the project, we were able to establish both the direction of the project and the methods required to realise it. Through a combination of parallel individual work, direct collaboration, and consistent communication, we were able to produce the required material without major complications.

ARCHITECTURAL QUALITIES

Subtractive / Additive
The venue combines two distinct architectural strategies — subtractive and additive construction — by first removing ground and then using the resulting volume to introduce new spatial conditions. Although the excavation has a significant impact on the site, the desired spatial experience could not have been achieved without it unless a natural canyon with similar qualities already existed. The process of moving through carved passages and remaining in direct contact with the ground materials creates a unique sense of immersion and exploration. Recreating these spaces through purely additive construction above ground would likely have produced a far greater visual impact on the surrounding landscape while lacking the same spatial authenticity and experiential quality.

Adaptivity
The project originated from the idea of a canyon enclosing the stage, connected by a lightweight roof structure while still allowing visual permeability through to the opposite side of the venue. In order to preserve this architectural quality, the design was intentionally kept as visually restrained and spatially coherent as possible. Consequently, all back-of-house facilities were integrated behind an artificial canyon wall designed to mirror the natural form of the opposing side of the stage. This arrangement creates an internal network of corridors and rooms that enables musicians and staff to move efficiently throughout the venue, while visitors primarily perceive the enclosing canyon walls as monumental spatial boundaries surrounding the performance space.

Hidden
As the majority of the venue is located below ground level, the project possesses a distinctly hidden character, minimising its visual impact on the surrounding landscape when viewed from a distance. In contrast to a large above-ground structure, the intervention allows the scenery to remain largely uninterrupted. Once visitors descend into the venue, however, the space transforms into an immersive environment of its own, where the underground world and the surrounding landscape coexist without significantly disturbing one another. This approach represents an attempt to engage with the landscape in a careful and respectful manner. The venue establishes a strong presence, but claims no more space than necessary.