REVERBALLOON

I det avslutande projektet i Arkitektur och Teknik var uppgiften att gestalta en utomhusarena för en musikorkester. Här ska arkitektur och akustik förenas för att erbjuda en arena med naturlig akustik för 5000 människor och koncerter för upp till 25 000 besökare.

Arkitetkur och Teknik handlar mycket om det interdisciplinära arbetet mellan ingejörer och arkitekter och i det här projektet blir det en verklig del då arbetet görs i samarbete med masterstudenter i akustik från Sound and Vibration. För att bygga en förståelse för rumsakustik och samarbetet med akustikerna blev vi introducerade i ämnet i en kort två veckors grundkurs.

Programmet för projektet kom från Acoustical Society of Americas tävling ASA Student Design Competition.

COURSE Bachelor's thesis in Architecture and engineering

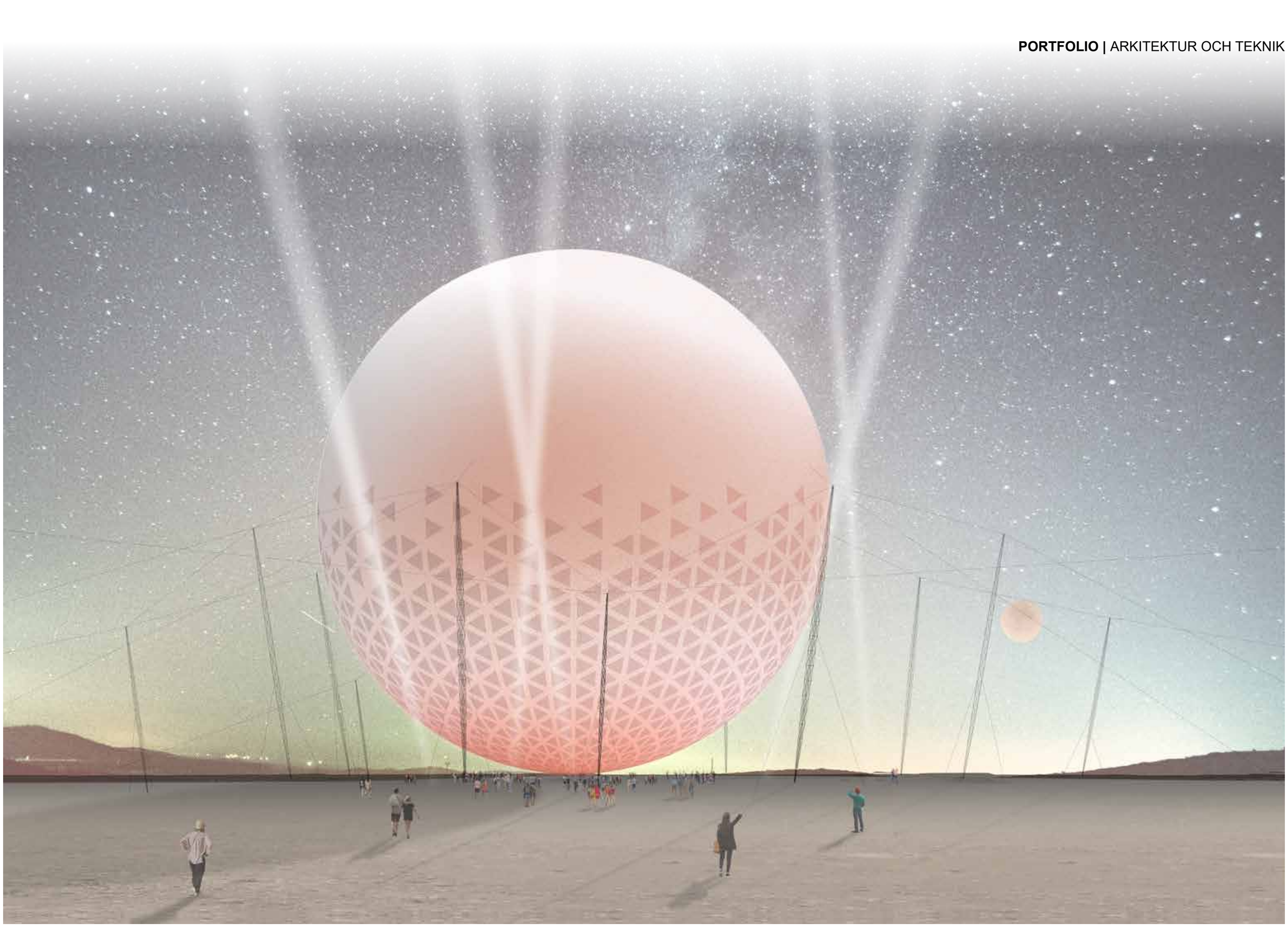
SCOPE 15 HP

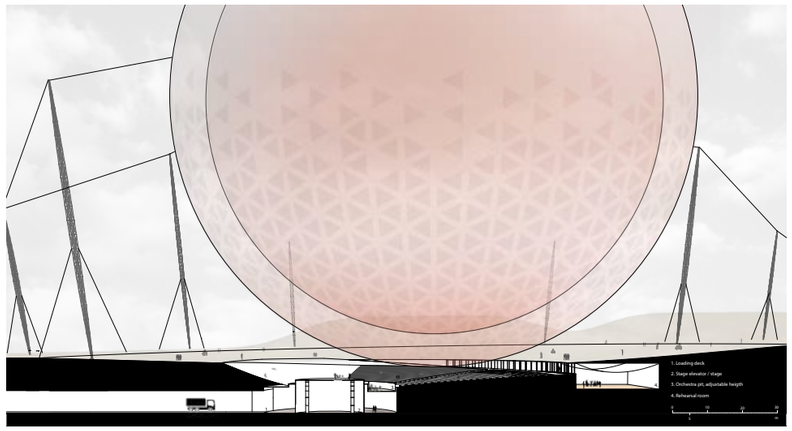
SEMESTER Spring 2020

TEACHER Morten Lund, Peter Christensson, Wolfgang Kropp

EXAMINER Morten Lund

TYPE Group (Ida Ylenfors, Max Gren)





A MONUMENTAL AND ACOUSTICAL BALLOON

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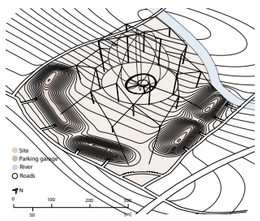
It is impossible to miss this concert arena. The Reverballoon is seen from miles away. Music thirsty or just curious people who are entering the site is welcomed by the acoustical and monumental balloon and they gather around and beneath it.

A bounce of the balloon has formed the venue beneath it where the audience can enjoy live performances covered by the dominating balloon. For bigger concerts the balloon ascends and shrinks which leads to a big and welcoming site. For smaller concerts the balloon descends and expands and creates an intimate venue. The balloon can adjust the natural acoustics depending on its size and height which makes Reverballoon able to accomodate a wide range of music genres.

SITUATION

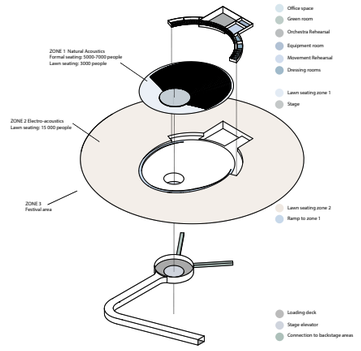
The site is used different depending on what type of concert is going on. The excavated venue protects the stage and audience seatings from the surrounding environment. Parking garage in east and south works as a noise barrier between the venue and the new residential housing area. In addition the hills creates good spots for a picknick with background music from the ongoing concert.

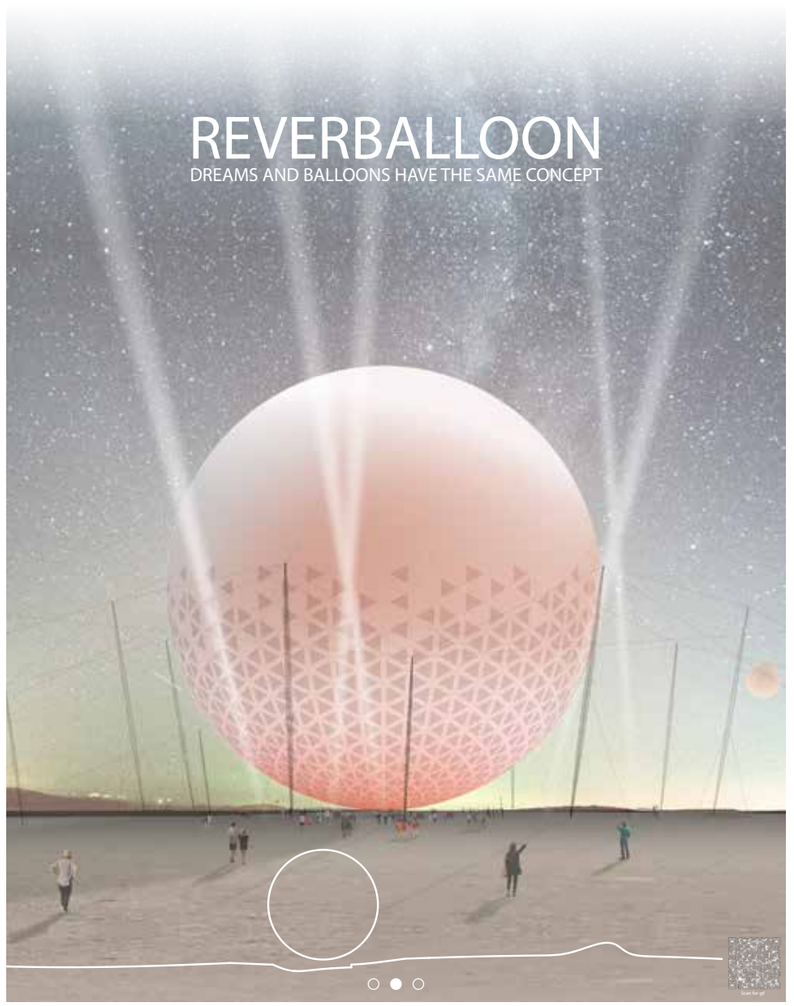
The site is under constant movement as the events replace each other and consists of 3 different social and acoustical zones. Zone 1 is located in the excavated area and accomodates 10 000 people standing. The excavated terrain around the perimeter of the stage makes the area variable and free. In zone 2 additional 15 000 people have a glimpse over the ongoing concert. Zone 3 is the festival area. Here people mingle around with music in the background. Interaction is focus in this zone.



ORGANIZATION

Different functions are located around and beneath the excavated area. Trucks reach the loading deck by a tunnel from the road in west. The adjustable stage works as a lift for equipment and backdrops. Ramps leads the audience to the seatings where everyone have a good view 360 degrees around the stage. Backstage areas are located at the back of the venue and a glass covered corridor leads the musicians and dancers between the different functions. The corridor also works as a acoustic barrier between the venue and backstage areas.





BALLOON COVERED AMPHITHEATRE

Amphitheatres are well-proven in music venues through history. Reverballoon is designed with a terraced seating area transitioning into lawn seating in a 360 degrees venue. This creates an informal audience experience. A bounce of the balloon has formed the asymetrical seating area where the eccentric position of the balloon contributes to advantageous sound reflections.

However it is all subordinate to the gigantic balloon pushing down towards the people and shaping the spacial impression of the site. The combination of the amphitheatre and the balloon as a roof provides up to 10 000 people with natural acoustics. Enough for all different performances except the rock and pop concerts which is reliant on electroacoustic amplification.

ACOUSTICAL CONCEPT

By having the adjustable volume and absorption/reflection surfaces our aim is to create an acoustic balloon. Depending on the upcoming performance the balloon will give the opportunity to tune in the acoustics to match the requirements of the art genre.

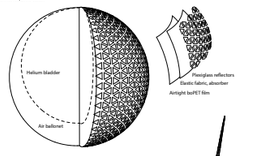
When expanding the balloon, the absorption area, in form of the elastic fabric, increases and the room volume decreases which leads to less reverberation time. Perfect for speech where you have an audience of less people and requires less reverberation time. Therefore the balloon expands, encloses the venue and decreases the reverberation time to the required level. On the contrary orchestra music requires higher reverberation time and attendance, then the balloon decreases in volume, the venue gets bigger and the reverberation time reaches its required value.

ANATOMY OF THE BALLOON

The balloon works conceptual as todays modern blimps and has the same principal build up with envelope, bladder and ballonet.

The upward (buoyant) force is created by the constant volume of helium contained in the bladder.

Outside of the bladder and inside the protecting envelope is the ballonet. Its function is to adjust the buoyancy of the balloon by changing the amount of air in the ballonet. When the volume of the ballonet is decreased, air is pumped in and vented and desired towards the stage and vice versa. This contributes to the acoustic effect of the balloon.

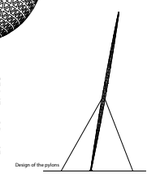


ELECTROACOUSTICS SYSTEM

For large concerts, the audience is spread out 360 degrees around the stage and beyond the excavated venue. Six main speakers are placed around the stage, radiating sound in all directions. In addition, loudspeakers are mounted at the pylons distributed over the area.

Their space truss structure provides connections on several height levels and are enough for amplifying rock and pop concerts.

A delay of 150 ms is required for the pylons closest to the stage, about 60 meters from the stage center, and 300 ms for the second set of pylons.



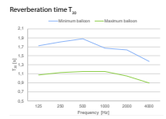
ACOUSTICAL PROPERTIES

When the balloon is inflated to its maximum size, the reflectors mounted to its surface are spread out, resulting in a reverberation time varying between 0.9 and 1.2 seconds over the frequency spectrum. The clarity, C50, is in the range 0-8 dB, which is suitable for theatre and other acts requiring good speech intelligibility. Since the balloon moves closer to the audience at its larger configuration, the amount of late reflections is reduced, improving the speech transmission quality.

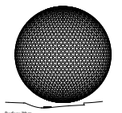
When the balloon volume is decreased, the reflectors cover the whole surface and the reverberation time increases. The low absorption clarity is decreased, and the strength increases over the audience area due to the reduction of absorption and increased height of the balloon, making the pavilion more suitable for acoustic musical performances like opera.

The adjustability of the balloon offers a variable venue with a range of acoustical properties, clearly shown in the reverberation time graph to the right. Which makes it a venue suited to accomodate theatre, ballet, opera, orchestra and rock/ pop concerts.

Reverberation time T_{30}

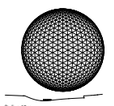


MAXIMUM SIZE



Radius: 70 m
Height: 6 m
Reflector area: 73%

MINIMUM SIZE

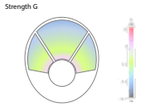


Radius: 60 m
Height: 11 m
Reflector area: 100%

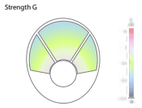
Clarity C50

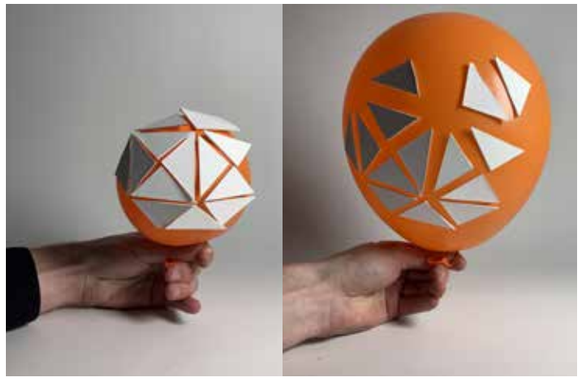
Clarity C80

Strength G



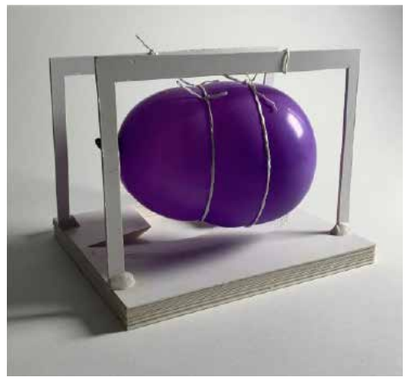
Strength G





Ursprungsidén med variabel akustik utifrån en expanderande ballong täckt med paneler. En funktion som intresserade oss för att undersöka vidare.

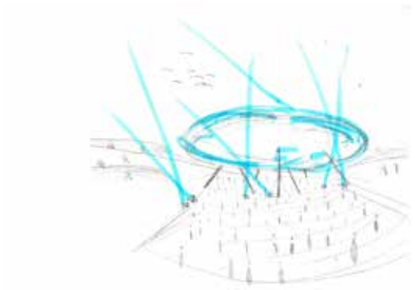
Tanken kom från att kunna justera efterklangstiden genom att ändra rumsvolym samt mängden exponerade absorbenter.

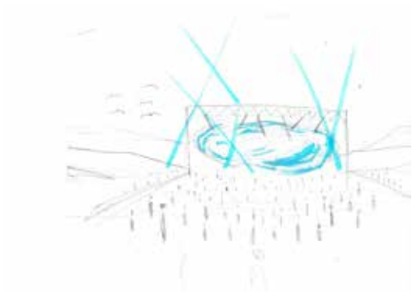


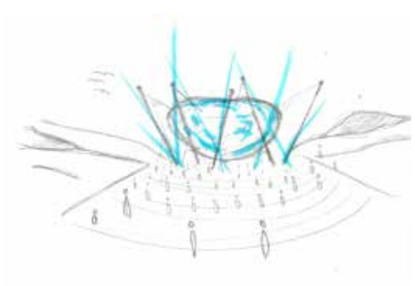
Olika konstruktionsideer för ballongen.

Valet föll på att fortsätta med ballongen upphängd i ett mastsystem som också skulle kunna bära elektroakustiken.

Mastarna skulle kunna placeras fritt på platsen och genom att koppla ihop dem och ballongen med vajrar får man ett föränderligt system.







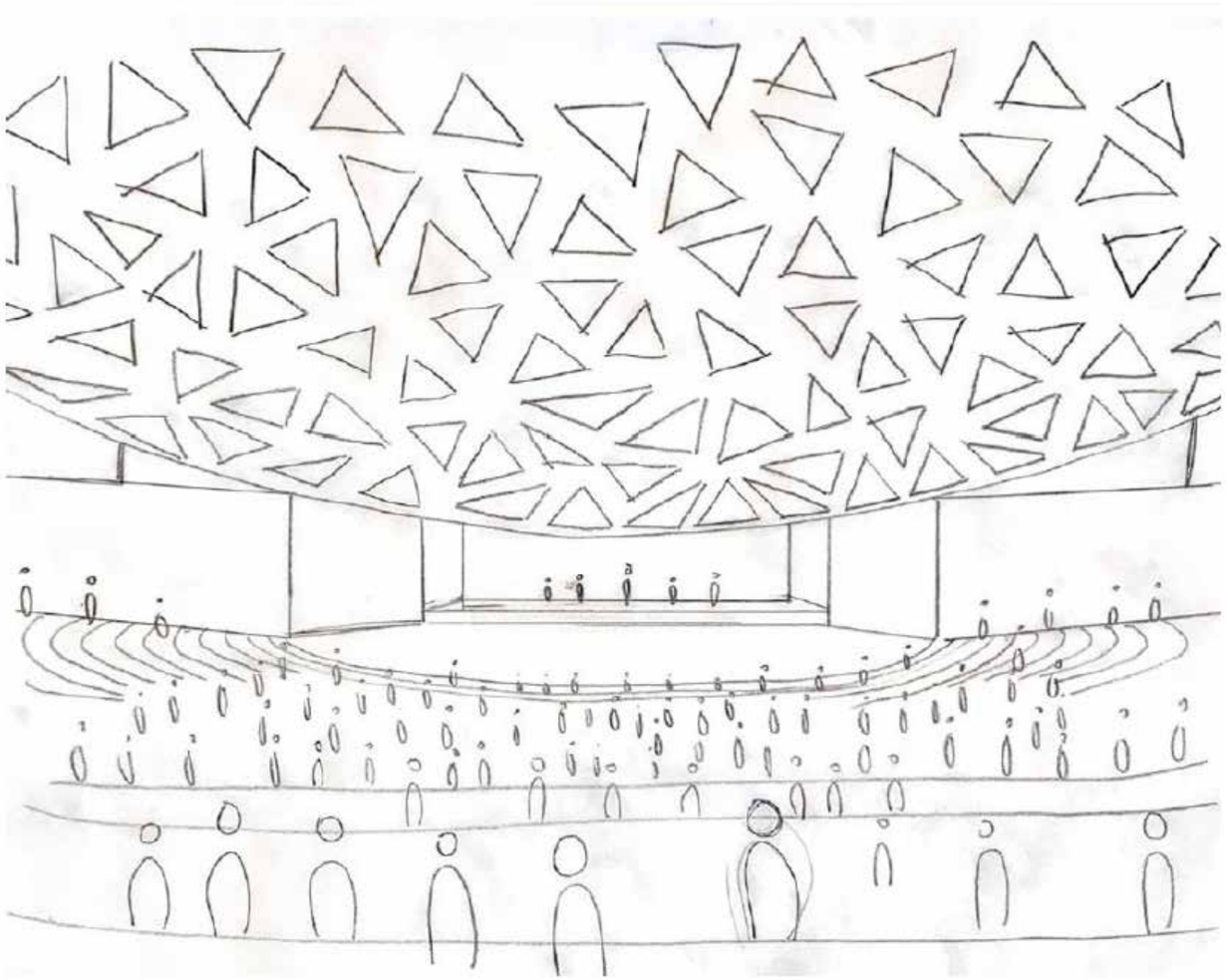
Tanken var att låta ballongen vara det akustiska styrmedlet och att låta det vara centrum i den arkitektoniska gestaltningen. Därav skulle akustiken betonas och belysas.

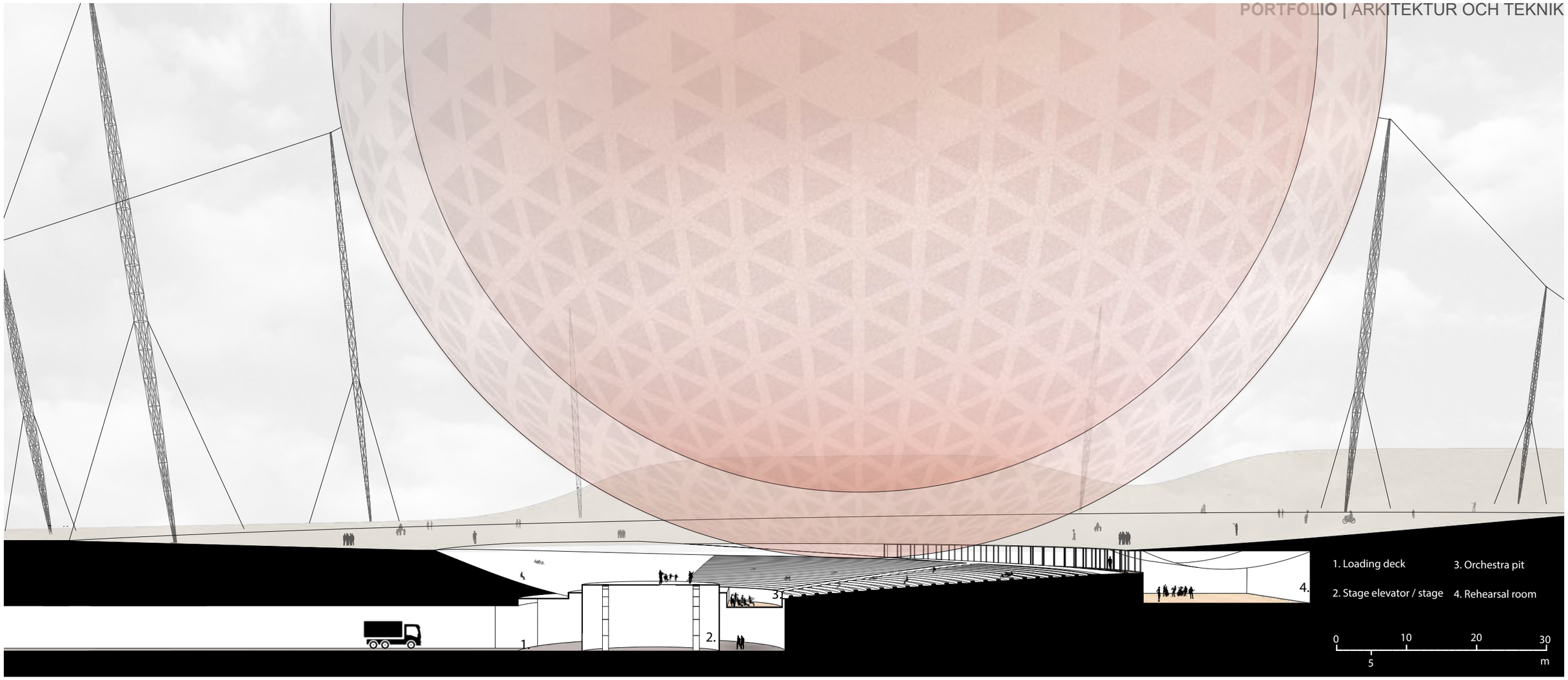
Skiss som representerar hur platsen ska upplevas. Som ett öppet orört landskap där ballongen placerats lätt svävande över marken och fastållen av slanka master. Inspiration har tagits från när massor av människor drog zeppelinare med rep ut ur sina garage och hur alla samlades under och runomkring dom enorma luftskeppen. Krocken mellan det enorma och den mänskliga skalan.

Till höger syns en tidig skiss på musikpaviljongen med naturlig akustik. Efter designen av själva ballongen var utformningen det viktigaste beslutet gestaltningsmässigt. Både för att uppnå en rumslighet som domineras av ballongen samt för att skapa rätt akustiska förutsättningar.

I detta tidiga skede var idén en traditionell amfiteater som var nedsänkt men vi ville arbeta fram en form av sittarrangemang som förstärkte ballongens form och tog större nytta utav den. Så vi gick till det motsatta med att skapa en helt cirkulär arena med väldigt ledig och informell sittning.

Efter det arbetade vi fram en en slags blandning av de båda med en amphiteater som övergår i en grässlänt med fri sittning. På så sätt finns amfiteaterupplevelsen med den beprövade akustiken, men också 360 graders uttnyttjandet av ballongen.





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Movement rehearsal room


Orchestra rehearsal room

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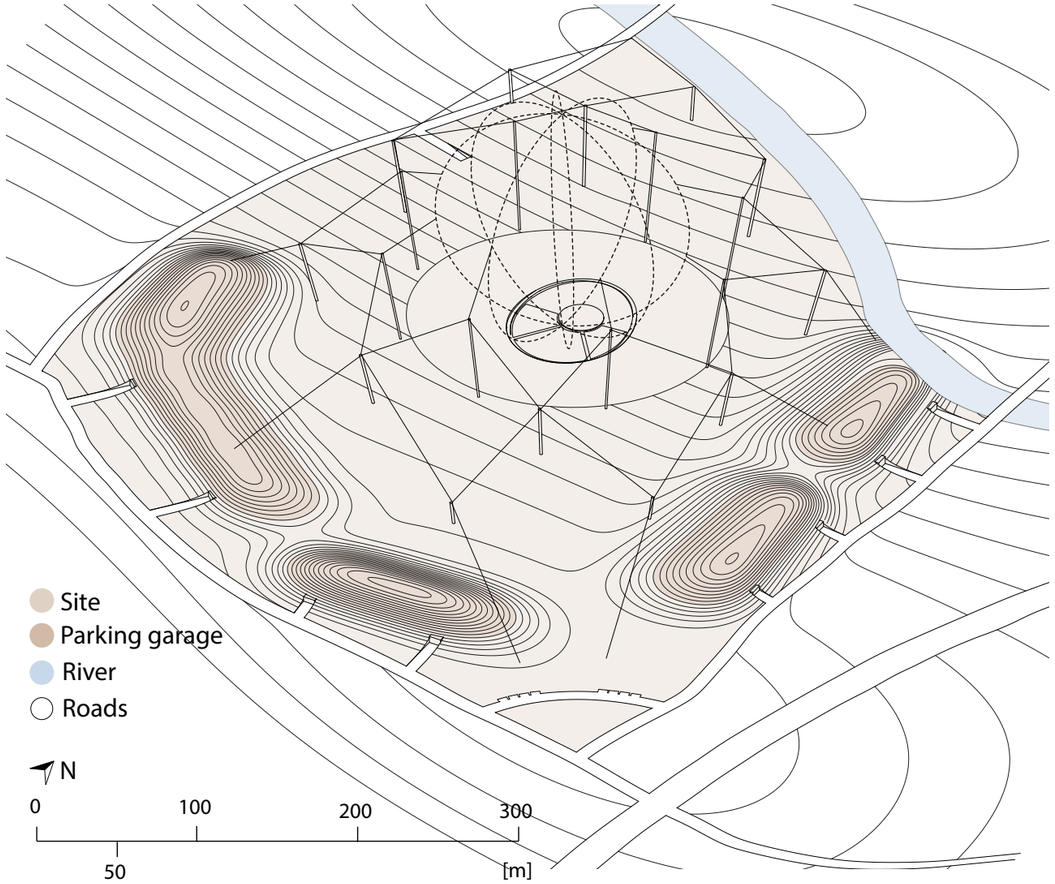

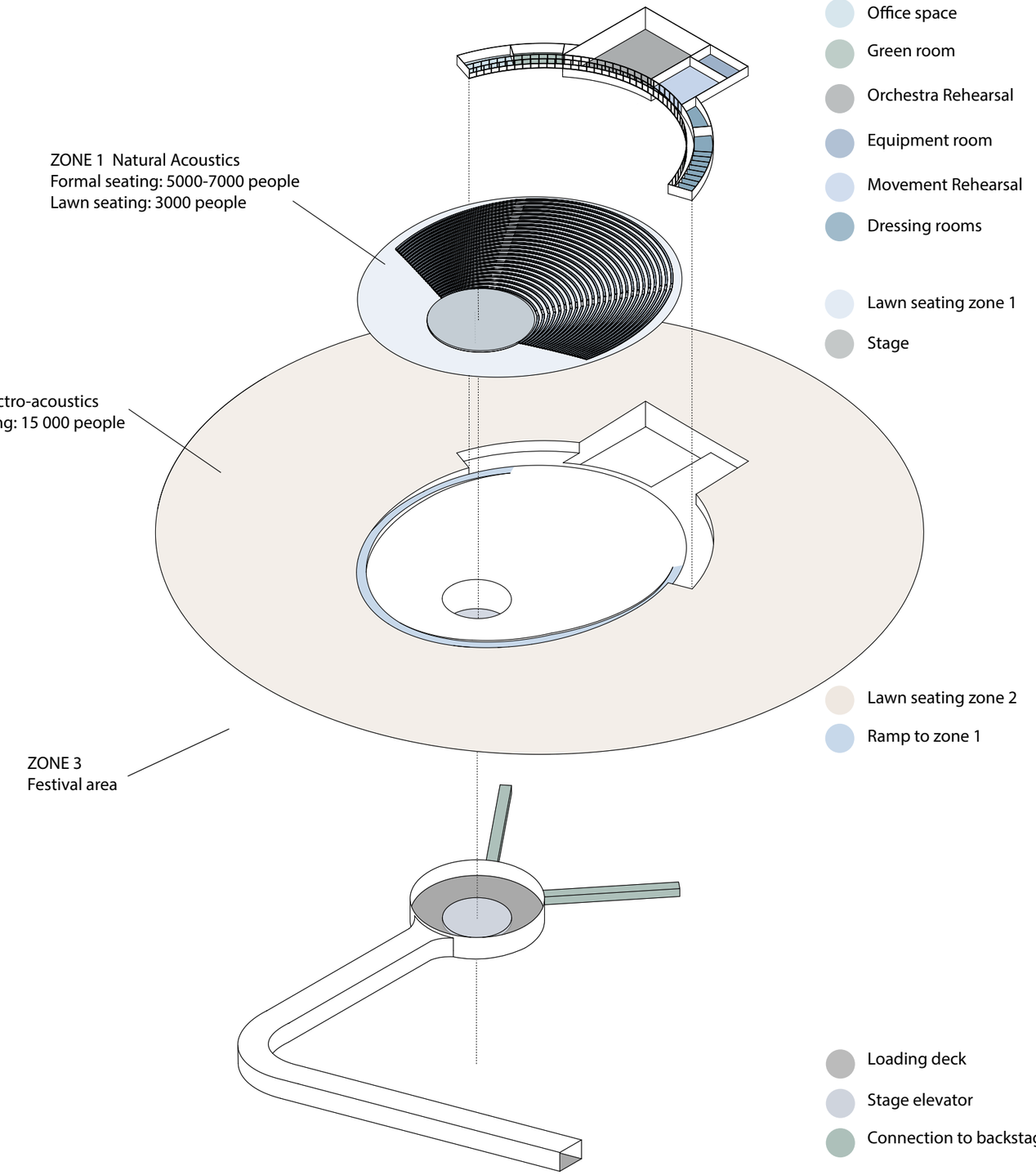

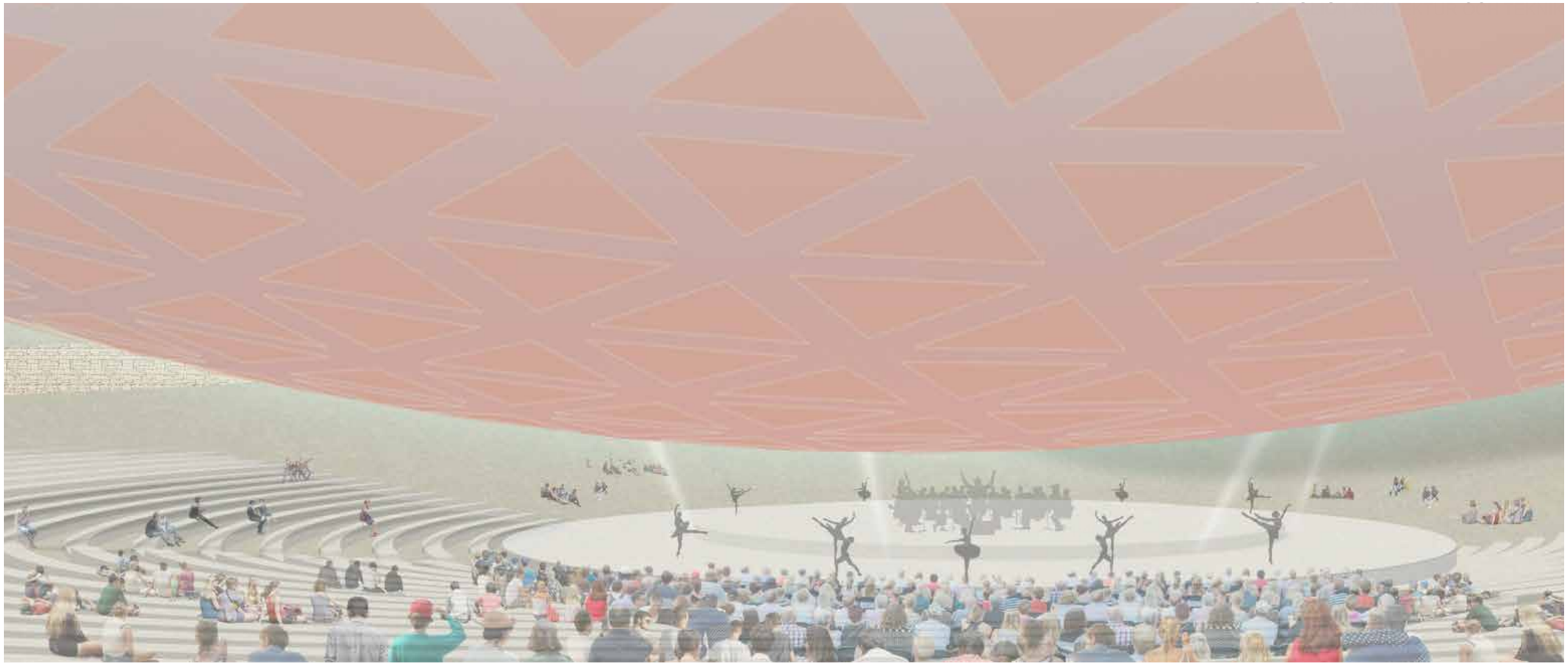

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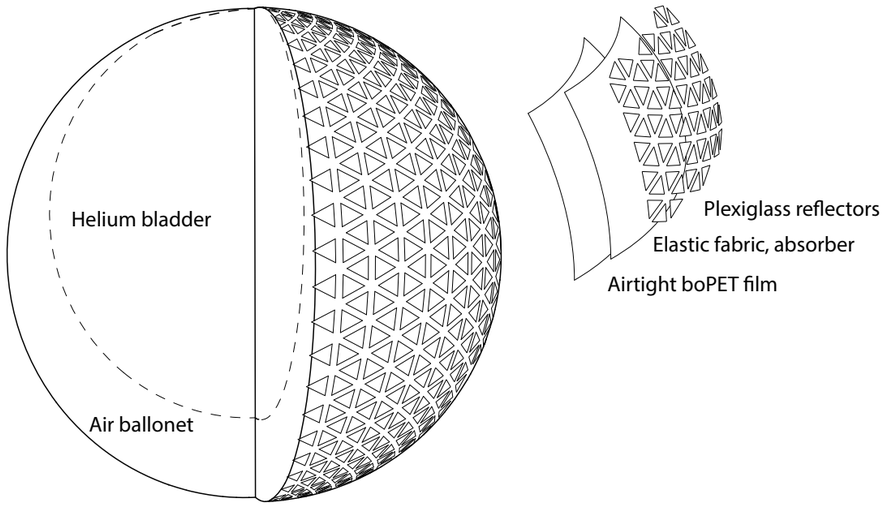

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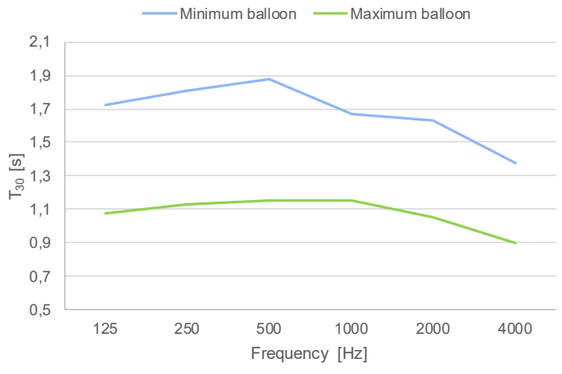

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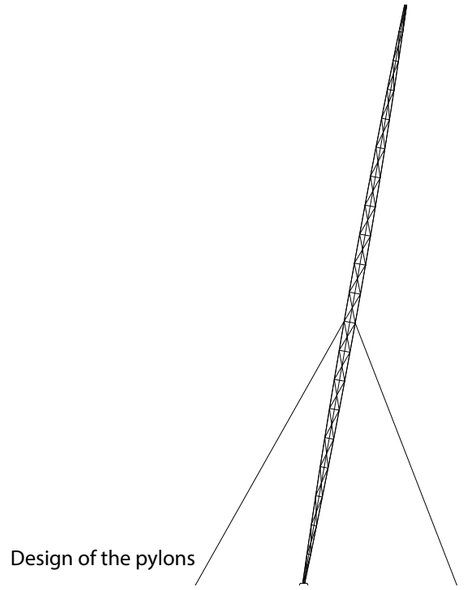
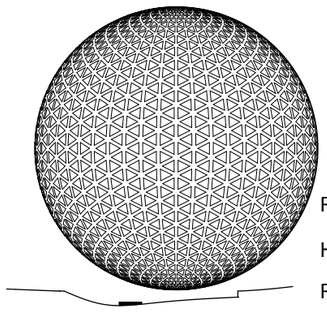


Design of the pylons

MAXIMUM SIZE

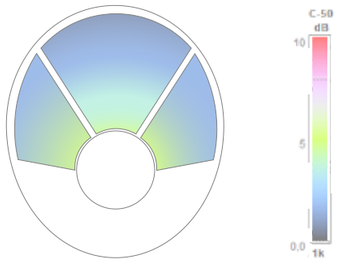


Radius: 70 m

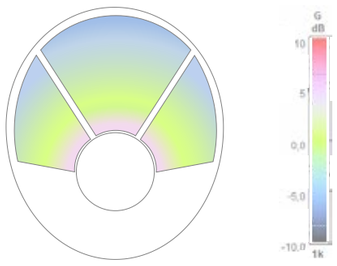
Height: 6 m

Reflector area: 73%

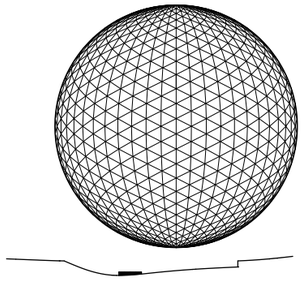
Clarity C50



Strength G



MINIMUM SIZE



Radius: 60 m

Height: 11 m

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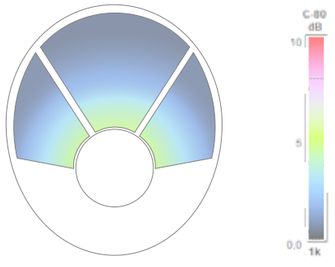
Clarity C80



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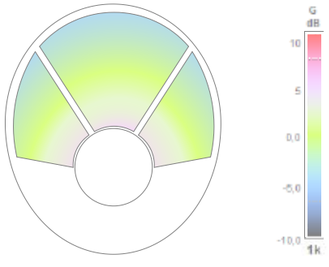

REFLEKTION

Vi jobbade längre för hand i projektet än vad jag gjort i tidigare projekt med ett mer genomgående skissarbete. Det gjorde att jag personligen hade lättare för att undersöka flera olika alternativ och snabbt se resultat och att man sen i efterhand lägger mer fokus på presentationsmaterialet. I skissarbetet identifierade vi några olika fenomen eller rumsliga effekter vi tyckte det var intressant att jobba med som vi sedan hade som fokus i vår gestaltning. Som exempelvis den föränderliga akustiken och rumsligheten och den mänskliga skalan i relation till en gigantisk volym. Utifrån detta valde vi att hålla projektet på en övergripande konceptuell nivå för att kunna studera dessa effekter och inte fokusera så mycket på funktionsprogram. Vi såg det som en konceptstudie av en ballong som rumsbildare och akustisk effekt. Något som jag också tycker vi genomförde och skapade ett projekt som belyser de här intressanta punkterna som också förmedlades i våra planscher.

Att ha ett sådant extremt koncept gör att man måste jobba mycket med trovärdigheten som vi kanske inte lyckades förmedla i samma nivå som vi jobbat med det i vår presentation. Det var ju också på grund utav det som vi valde att fokusera på de effekter vi ansåg intressanta för att de gav mer för projektet och som jag kan ta med mig vidare till kommande projekt.

Svårigheten med det interdisciplinära samarbetet tyckte jag handlade om detaljeringsnivån i relation till arkitekturen. Verktygen som akustikern hade tillgång till under projektet krävde många förenklingar och antaganden som kanske påverkade i vilken detaljeringsgrad vi arbetade med arkitekturen. De separata modellerna för akustikberäkningarna, kan jag nu i efterhand uppleva, influerade vår utveckling i projektet. En del problem samt begränsningar gjorde att vi var tvungna att sänka komplexiteten i det interdisciplinära samarbetet och då förlorade en del detaljer i projektet i helhet. Även om jobbade mycket konceptuellt kunde vi ha identifierat några fler detaljer att studera som exempelvis gestaltningen av reflektorerna, vilket var en stor del av kommentarerna vi fick på den avslutande kritiken. Kanske skulle samarbetet i ett tidigt skede utgått mer från akustikerns egna kunskap istället för att i så stor del vila på simuleringarna som ändå var inexakta.

Men i samarbetet i gruppen tyckte jag vi tidigt fick en bra gemensam förståelse och målbild med projektet. Vår akustiker blev snabbt införstådd i arbetet och kunde därav jobba utifrån konceptet.