

# OPERA MONTREAL 3:RD YEAR

COURSE Bachelor project 15 hec

YEAR Spring 2013, 3rd year

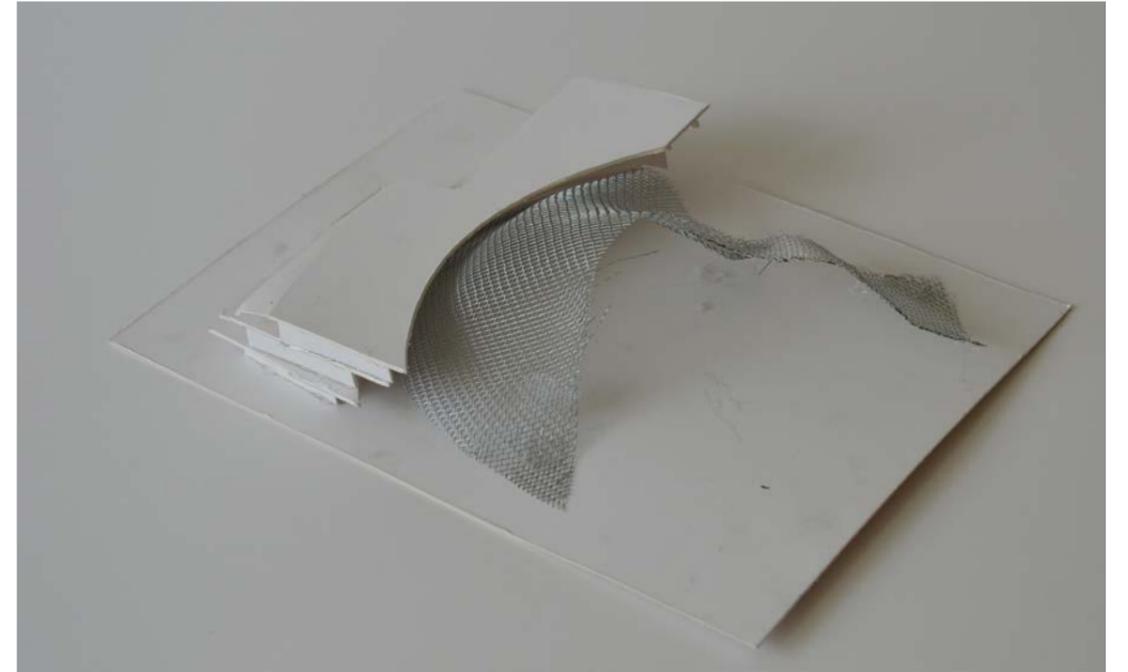
EXAMINER Morten Lund

TOOLS AutoCAD, Rhinoceros, Grasshopper, Photoshop, Indesgin, Illustrator, SketchUp, CATT

TEAM Alexander Gösta  
Emil Adiels  
Tania Kalafata (acoustics)

PROGRAM A collage in Montreal with a strong music program desires a performance hall with related facilities primarily for opera. The hall should be a mutipurpose hall able to include musical theatre, orchestral concerts, dance and occational lectures for 1200 guests. It's to be constructed in downtown Montreal, thus a noisy enviroment. Focus is on the acoustical performance of the building and sound insulating capacities.

AIM To create a spectacular building with great acoustical properties. It should use layering to gradually reduce incoming noise and step by step remove the city from the visitors perception to introduce a wold of music.



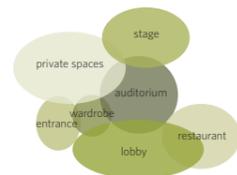


# DOUBLE NATURE

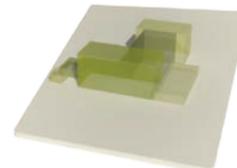
There are few events which play so much with human emotions as the Opera. Loved by many, avoided by others. Our design for the Student Opera in Montreal invites all, enthusiasts and others join in the Opera experience in a modern building.

The building needs to answer some questions. How can we keep the mystery of the established and much appreciated event of the Opera and still reach the new generation? How do we make the site a living play during daytime and during student vacation? How do we keep the privacy of the students and the workers but still be inviting to the public?

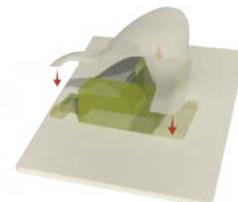
Our solution is a meeting between two shapes surrounded by a public park. The auditorium is enveloped by functional rooms and a green barrier to protect it from the city noise. We propose the public park to stretch out from the site and connect it to nearby public transportations. In that way the Opera gets anchored in Montreal and becomes an obvious part of the city plan.



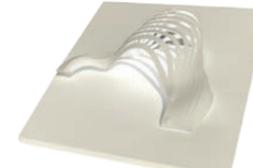
The auditorium is protected by the other functions. Noisy rooms are placed in the circumference.



The spaces are placed on the site and given necessary heights.



The public spaces are enveloped in a common shell.



This shell is striped to get a lighter appearance.



The structure is anchored to the ground by letting the enclosing park grow over it.



The private spaces are added in another volume to emphasize their different function and give them privacy.

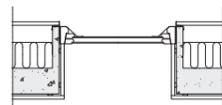
## USE THE PARK AS SOUND BARRIER

In order to protect the auditorium and achieve the preferable background noise levels we use several materials and screens with suitable STC-values. The traffic noise is buffered by surrounding hills and trees before it reaches the building facade. The acceptable noise levels in the large lobby are relatively high, keeping the city still present both by visual transparency and by sound. The auditorium consists of a separated body with thick walls to reduce the remaining noise.

Rooms marked in red are noisy environments where we need to take care that they don't interfere with main hall. They are placed in the circumference and have suitable walls. A corridor provide communication and sound buffering.

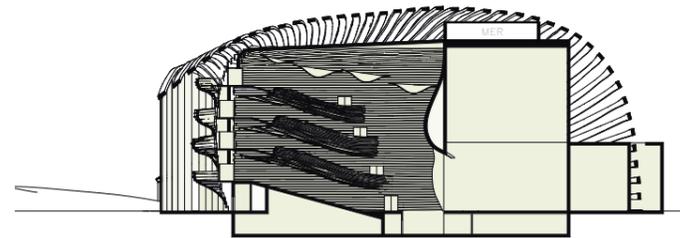
## DETAIL FACADE

Important for our concept is to lighten up the large building and let light in. It is crucial to achieve water proofing in the window sealing. We have solved this with two metal lists that covers the attachment and protects the insulation.



Section 1:20

HIGH PRESSURE LAMINATE BOARD	20 [mm]
CAVITY	100
MOISTURE BARRIER	1
MINERAL WOOL	150
FIBER-REINFORCED CONCRETE	150
HIGH PRESSURE LAMINATE BOARD	20



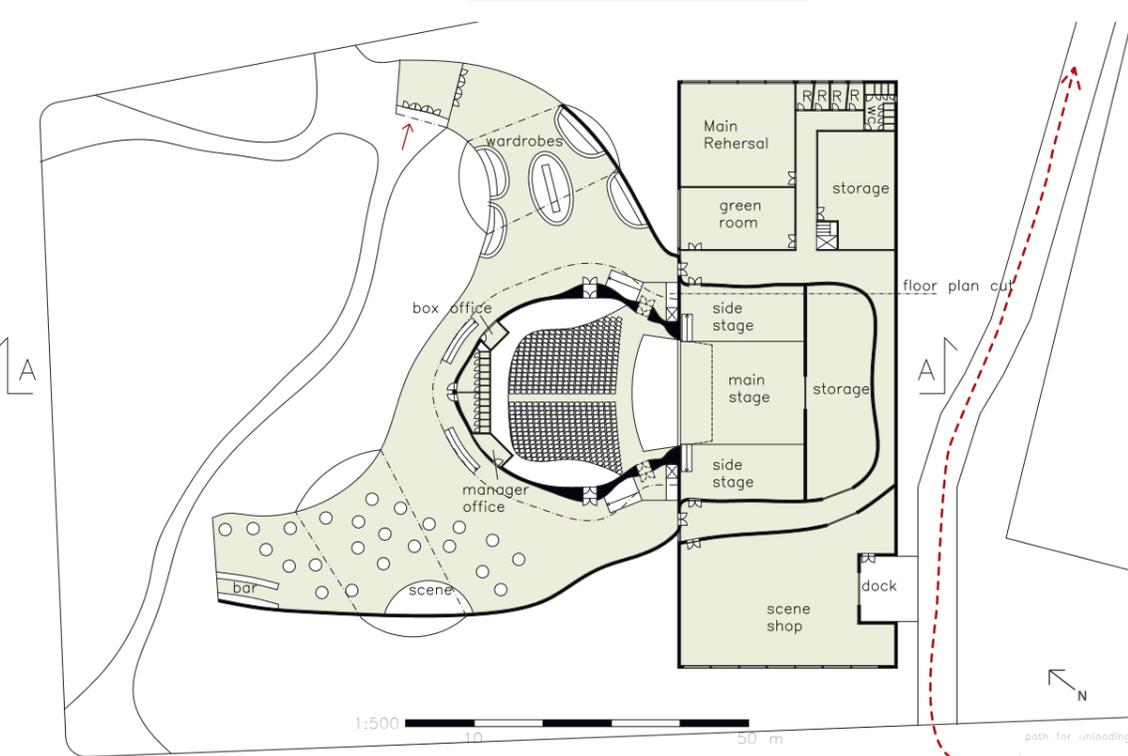
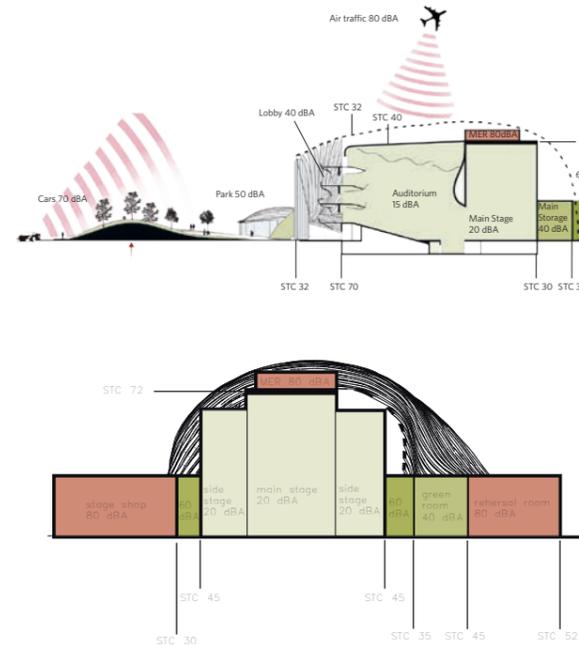
## CONNECTING THE CITY

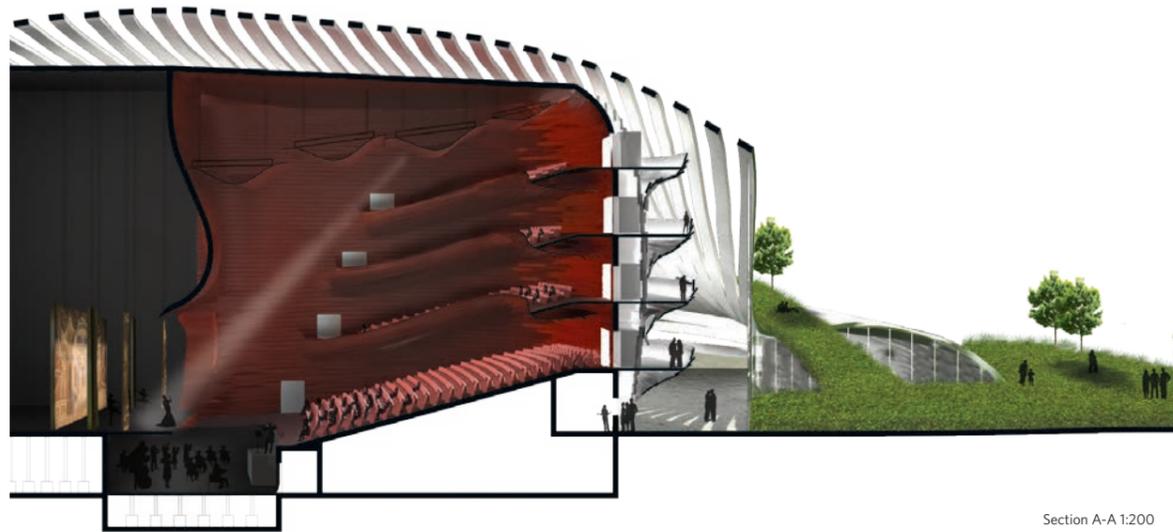
The opera is placed in close distance from the metro and bus stations at Bell Centre and the Bonaventure Station.

We propose that the city make the connection more accessible. This could be green parkways that will be a nice entrance to Opera.

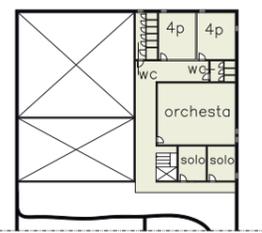
We believe that the opera could be the centre piece of a new green area in the middle of Montreal.

We believe this also could connect the parks at Square Chaboillez and Place du Canada.

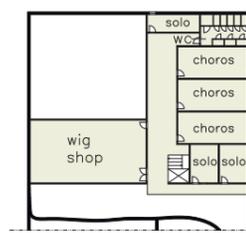




Section A-A 1:200



Second floor 1:500



Third floor 1:500

### TWO VOLUMES

The building consists of two volumes, one containing the lobby and the auditorium for the public, and the other all the private rooms. This way we can easily separate different acoustical environments.

### THE LOBBY

Directly after entering the building you reach the wardrobe. Moving from there the lobby rapidly expands in height and offers a full view of the external of the auditorium body. In order to achieve a reverberation time of one second in this large room we use acoustic plaster on all surfaces. The large glass facade and the good accessibility to the park makes the lobby well connected to the outside. This gives the visitors a memorable experience.

### GREEN ROOM

The Green Room is located at the bottom floor with easy access from and to the stage. The performers and special guests can quickly get there to mingle in the break. There are two doors connecting the green room, one with the stage and the other with the dressing rooms.

### DRESSING ROOMS

The dressing rooms are placed on two different floors. It's most important for the orchestra and the solo performers to have quick access. Therefore are they on floor below. All rooms have sufficient areas and windows to make them pleasant.

### MER

The MER is placed on the roof of the stage tower beneath the external shell. The roof of the stage tower is reinforced to reduce noise from the machines. We use a floating floor to handle the vibrations.

### SCENE SHOP

The scene shop produce a lot of noise which affect the workers and the nearby rooms. We use a rubber floor to reduce vibrations and sound absorptive baffles in the ceiling to reduce noise.

### LOADING DOCK

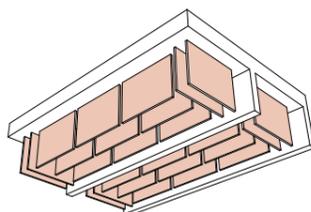
Located at the backside road it's easy to load and unload undisturbed. It's located with direct access to the Scene shop which is most demanding supplier.

### STORAGE

There is two kinds of main storages. One for the scenery and one for the rehearsal rooms. The first one is in direct connection and easy access to the scene shop and the stage. The second one is located with easy access to the rehearsal rooms and the green room.

### WIG SHOP

The wig shop is located near the dressing rooms so they could easily try out new costumes on the performers.



### REHEARSAL ROOM

Located at the first floor the main rehearsal room has a nice view to the Square Chaboillez with it's beautiful park. It gives a connection between the Opera and the neighbourhood. It's shows activity even in daytime.

The room functions as a practice room for the orchestra and also for dance. Depending on the use the room is adjustable with a view to fulfil different needs.

Next to the main rehearsal room there are four individual practice rooms. They all have access to daylight and tilted walls to avoid flutter echo. They have curtains to make it possible to reduce the sound level of the small spaces.

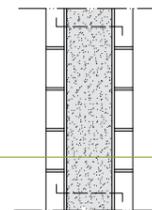


### EXTERNAL WALL

The external wall is consisting of a double brick wall. This will get that solid feeling of walking in to stone. The external wall has STC 52.

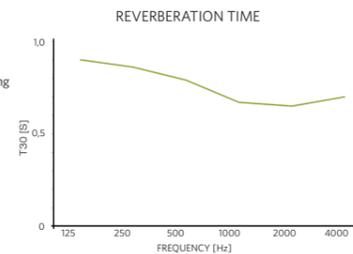
BRICK	105 (mm)
PLASTER	15
PERLITE	260
BRICK	15
PLASTER	105

Plan 1:10



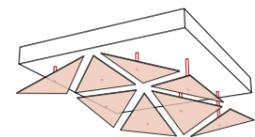
### RESULTS

The reverberation time of the rooms is 0.62 s in 1 kHz. This can be adjusted using curtains covering the mirror wall. Moreover a good speech transmission index of 0.75 is achieved.



### CEILING

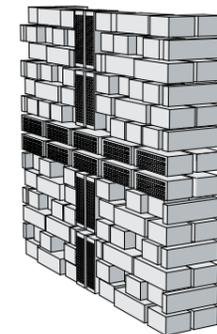
The ceiling is covered with a pattern of triangular wooden panels, angled randomly, to achieve a good sound scattering. Above it the ceiling has a layer of absorption. This creates a strong architectural expression as well.



### INTERNAL WALL

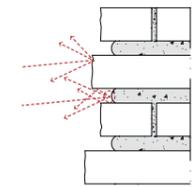
The concept for the internal wall is to combine absorption and scattering and at the same time create an interesting look.

The wall consists of 20 % air bricks to increase the absorption. The bricks are placed irregularly to make a scattering surface and to avoid flutter echo on the parallel walls.



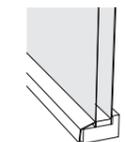
### BRICKS

The bricks used are recycled bricks. The rough beaten texture, large gaps with mortar that has big ballast and a convex shape will increase scattering even more. It will also be a good environmental choice and give character to the new house.

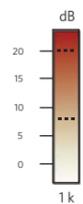
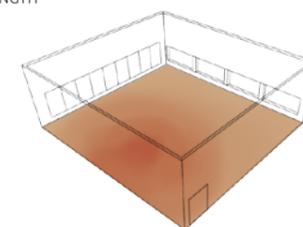


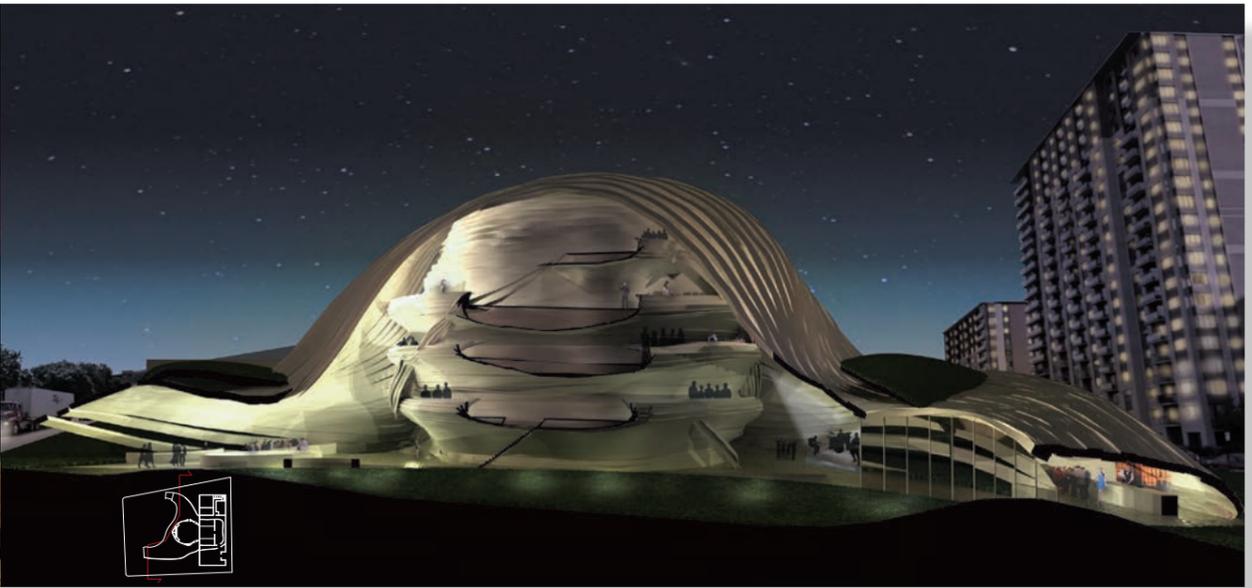
### WINDOW

The window is of two double glass panels with thickness 5 and 10 mm. There is a gap of 100 mm with insulation on the sealing to avoid flaking transmission. This design makes for very good airborne sound insulation.



### STRENGTH





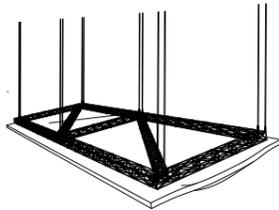
## AUDITORIUM

The expression of the auditorium is coherent with the external shape. But in contrast to the wide gestures of the outside the stripes on the inside is more delicate and made of warm red wood to create an intimate feeling.

The auditorium is also a multi-purpose hall. The acoustical elements are adjustable to be able to serve different purposes such as Opera, orchestra music, speeches and gatherings.

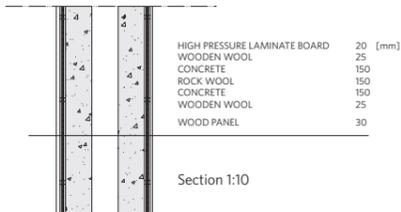
### ADJUSTABLE CEILING

To be able to change the acoustical properties the auditorium has an adjustable ceiling. Thereby you can change the volume of the auditorium or the angle of the reflection. It can even block of the upper balcony for smaller events. The reverberation time can be adjusted as well.



## AUDITORIUM WALL

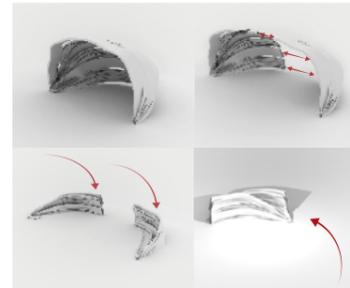
The auditorium wall has as main purpose to shield out noise from the outside. Therefore it is a double concrete wall with rock wool between which makes for high sound insulation. The wall has STC 72. The interior of the wall is covered with a 40 mm thick irregular wooden panel which reflects and scatters sound and creates a diffusive sound field. This also makes for an enveloping look which enhances the experience of the sound.



## DIFFUSIVE ORCHESTRA SHELL

The acoustic shell is inspired to fit into the theme of the auditorium. One purpose of the shell is to optimize the sound produced in the shell during concert. It is both diffusive and reflective to help the listening relationship between the musicians and the conductor. Another is to spread the music out towards the audience.

The shell has the property of being split in to two parts. Then it's folded and can be transported to the storage behind the stage.



## ORCHESTRA PIT

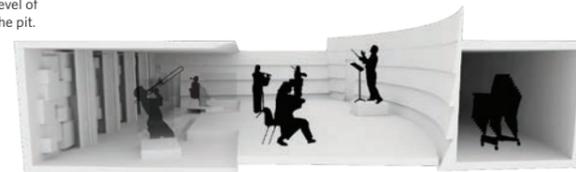
The pit is designed to optimize sound for the musicians and send sound towards the audience. The pit floor is divided into sections which can be elevated by hydraulic lifts. Depending on the use of the auditorium you can elevate the open part to the level of the stage and thereby close the pit.

## FLUTTER ECHO

To avoid flutter echo and reflect sound upwards the side walls are tilted and the front wall has a zig zag profile.

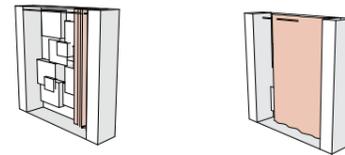
## STORAGE

The orchestra pit has an easy access storage behind the front wall. There you can store chairs, moveable walls or even instruments.



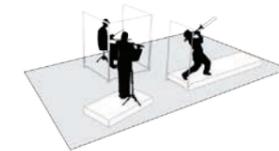
## DIFFUSIVE BACK WALL

Depending on the orchestra set it is possible to adjust the amount of absorption. The back wall is divided in to cells that can be either diffusive or covered with a curtain to be absorptive.



## SOUND LEVEL

A common problem in the pit is high sound power level for the musicians. Therefore it's possible to use moveable transparent walls to shield low level instruments from high level instruments. 40% of the pit is beneath the overhang of the stage and the other is open. The ceiling of the closed part of the pit is absorptive to keep the sound at an acceptable level.



## AN EVENING AT THE OPERA

"It started at the wardrobe where I left my heavy clothes and my everyday life behind. With my finest dress I enter the grand lobby. All the voices and people that become one. Mingling with friends and other enthusiasts.

From the slightly chilly lobby into the fiery red and warm auditorium we go. There we are sharing love, hate and all human emotions you can imagine experiencing the play. Transcribed to us with light but strong voice of the singers and the gentle but determined conductor.

In the break I take glass wine in the restaurant listening to soft pause music. Looking out in the park. Taking some fresh air till it gets to cold for my light dress. The final act is more thrilling than the first and I leave the opera saying "Why Jose? Why did you kill Carmen?"

Then I comfort myself telling me it was a night at the opera, just as it should be."

- Opera visitor

## DIFFERENT SET UPS

### OPERA

For opera the pit is open and the ceiling is in its highest position to make good reverberation time.

### CONCERT

For concert the orchestra pit is raised to stage level. The Orchestra shell is covering the proscenium opening blocking the tower.

### SPEECH

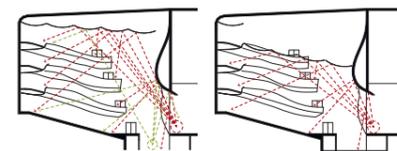
For speeches and lectures the pit is closed and the ceiling lowered. The proscenium curtains are covering the complete stage and tower.

### RESULTS

Having made a 3D model for CATT Acoustics we have received good values for our opera. The clarity is in good levels and evenly distributed in the large parts of the seating. The strength of the sound is evenly distributed as well. We have achieved a good balance between singing and music with a little higher strength in singing than in music. We have a fair spaciousness with a lateral fraction of 24-42%.

The clarity for the concert setting is lower than for Opera which gives a better audibility for the music. As in the opera results the sound is evenly distributed the biggest part of the seating and the lateral fraction values is between 15-36%.

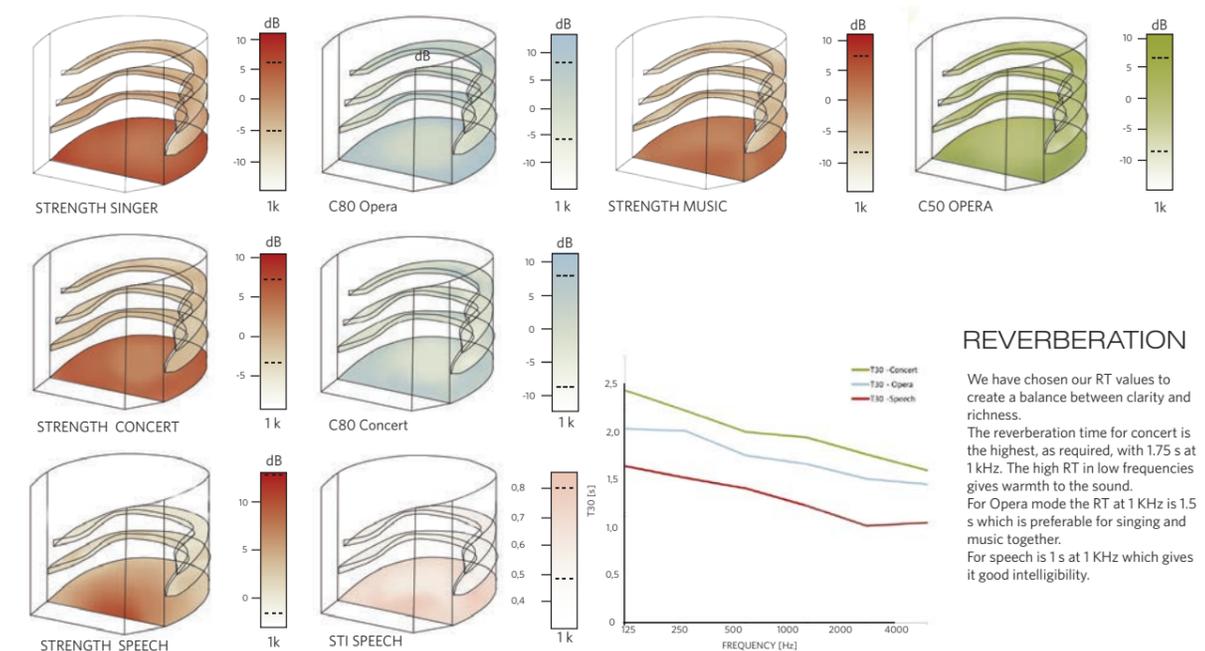
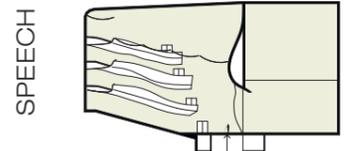
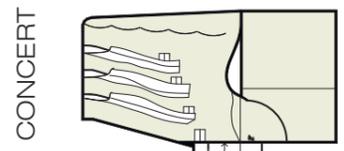
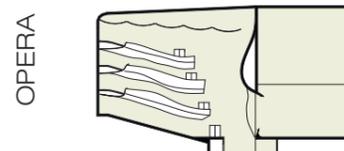
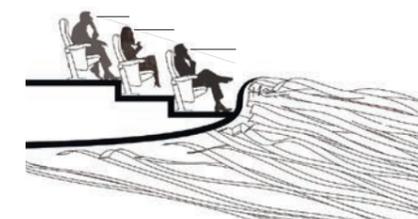
For speech mode the Speech Transmission Index is between 0.6-0.7 which is fair for this large room.

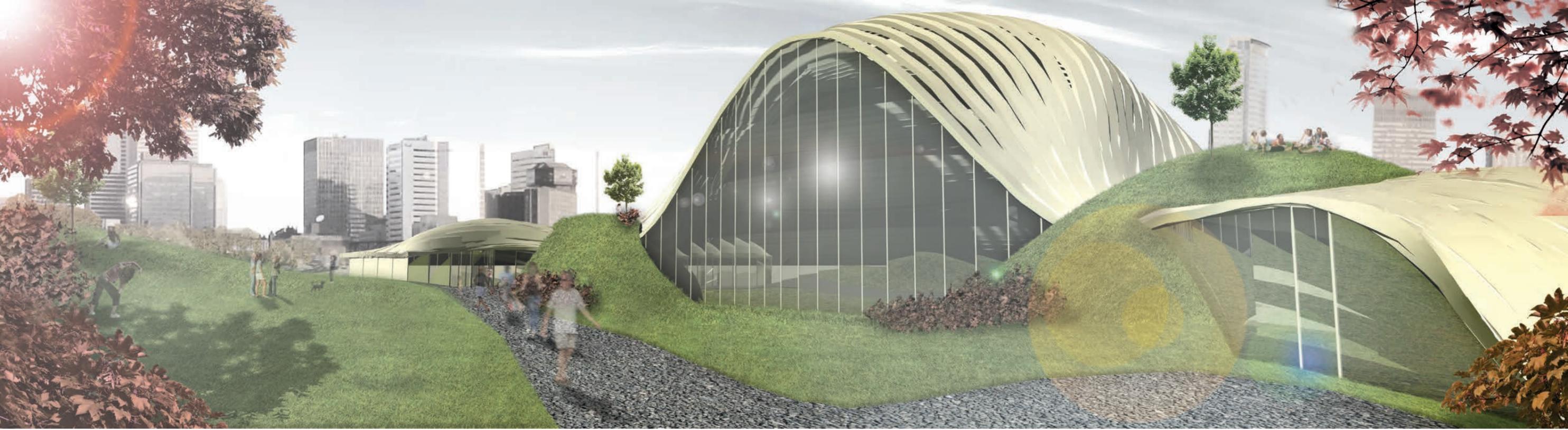


The shape is designed to scatter the sound to the base floor and the lower balconies.

### BALCONIES

The balconies, and the rest of the auditorium is covered stripes of wood that is randomly bending out and tilting. That kind of surface is efficient because it's diffusive at all frequencies. The balconies are tilted as well to give good sightlines for all the seated. The parts closest to the doors are handicap accessible.





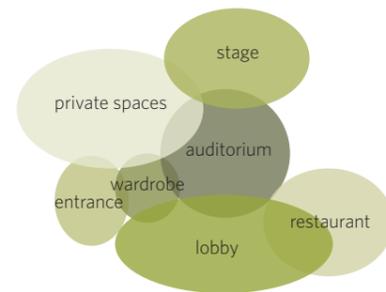
# SITUATION AND CONCEPT



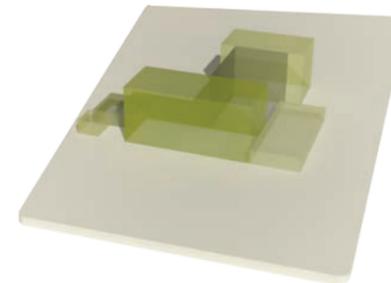
The opera is placed in close distance from the metro and bus stations at Bell Centre and the Bonaventure Station.

We propose that the city make the connection more accessible. By making a park that connects the metro stations with the opera entrance the building will be integrated with the city. We believe that the opera could be the centre piece of a new green area in the middle of Montreal.

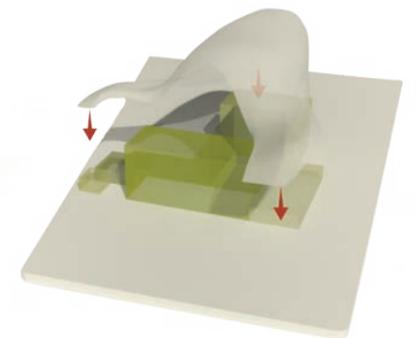
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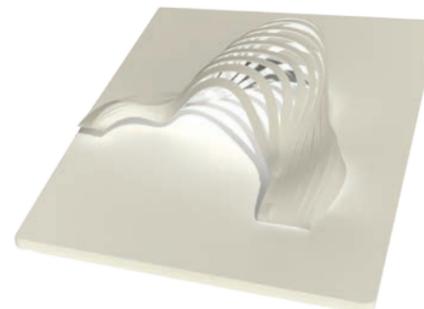
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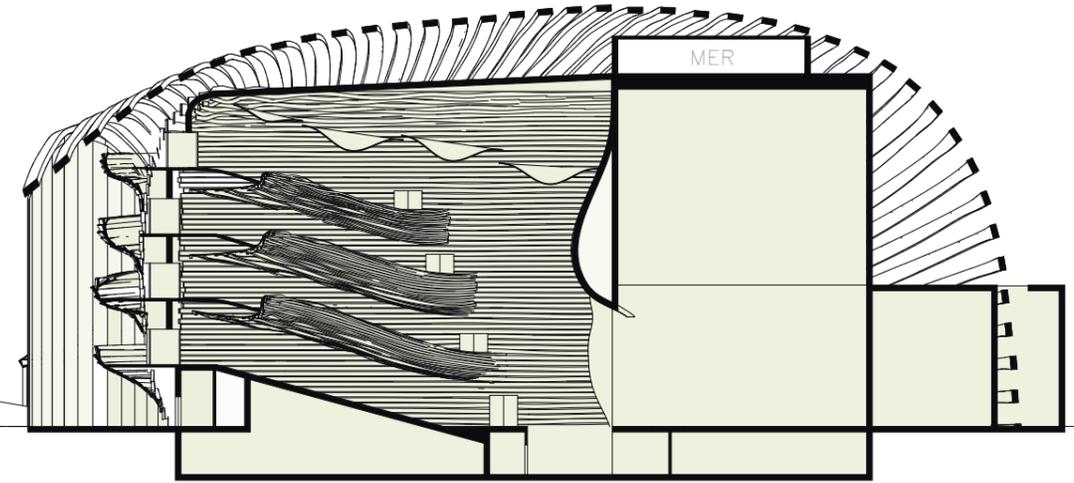


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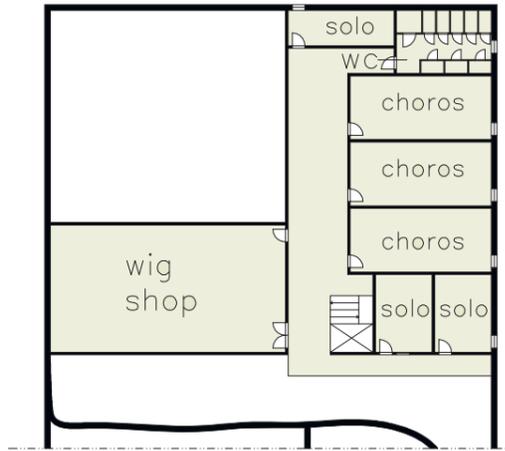
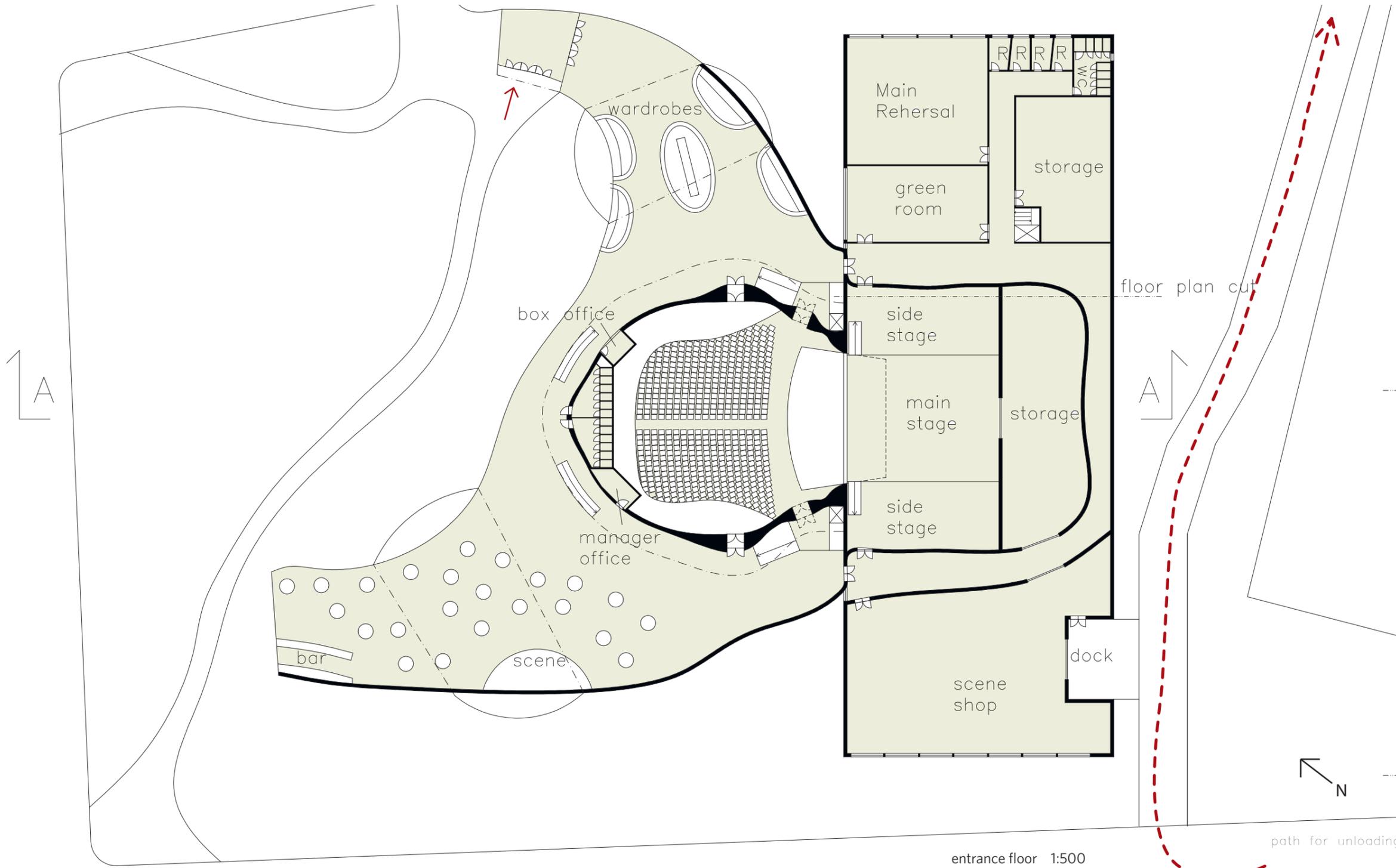


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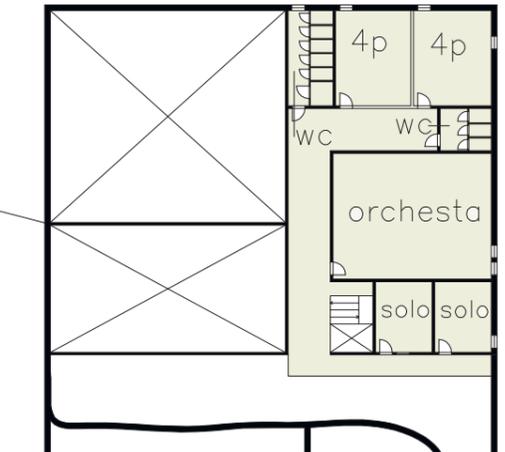
# FLOOR PLANS AND SECTION



Section A-A 1:500



Second floor 1:500



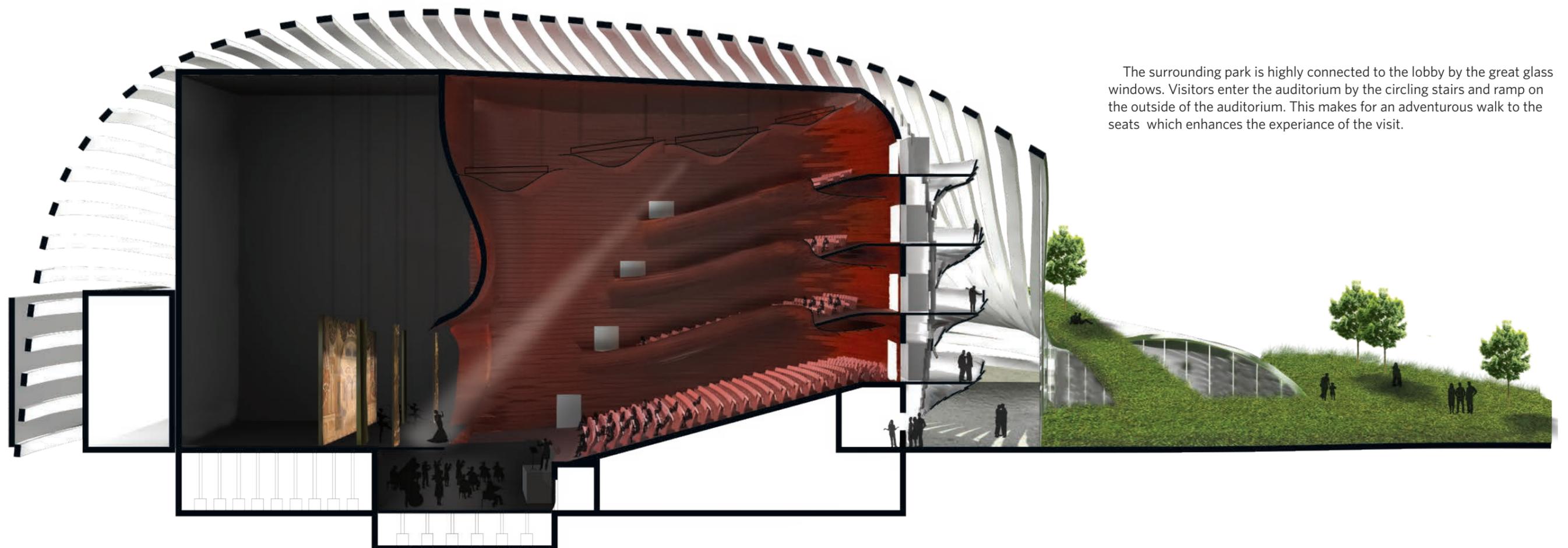
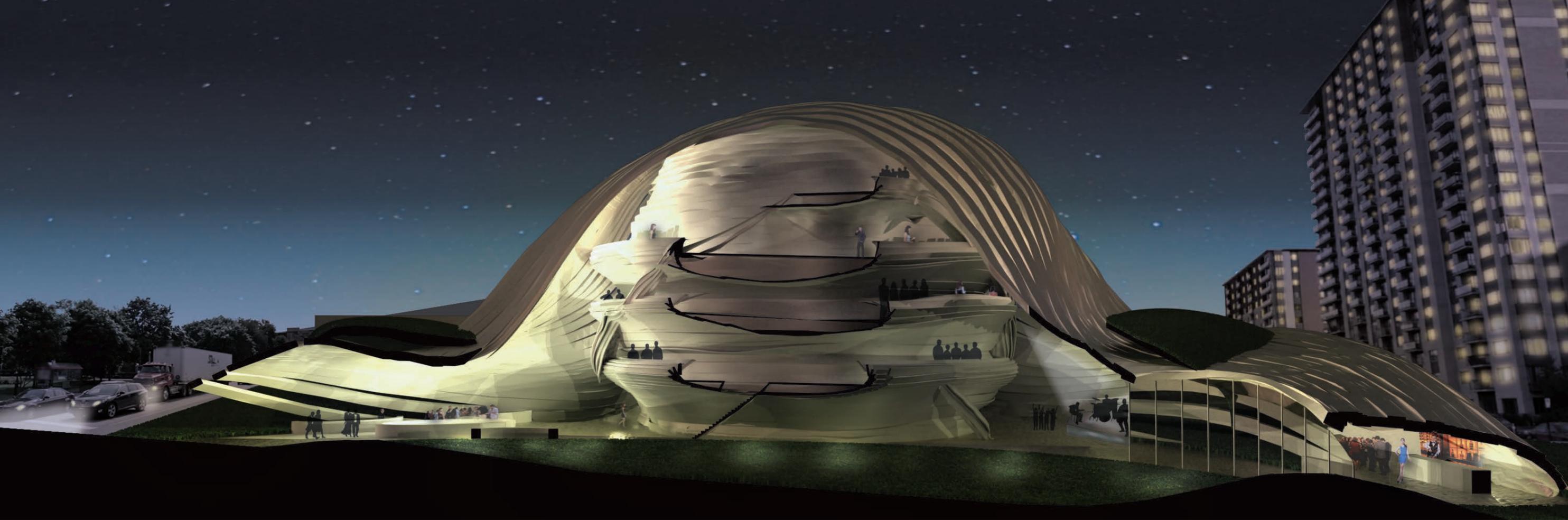
Third floor 1:500

floor plan cut

A



path for unloading



The surrounding park is highly connected to the lobby by the great glass windows. Visitors enter the auditorium by the circling stairs and ramp on the outside of the auditorium. This makes for an adventurous walk to the seats which enhances the experience of the visit.

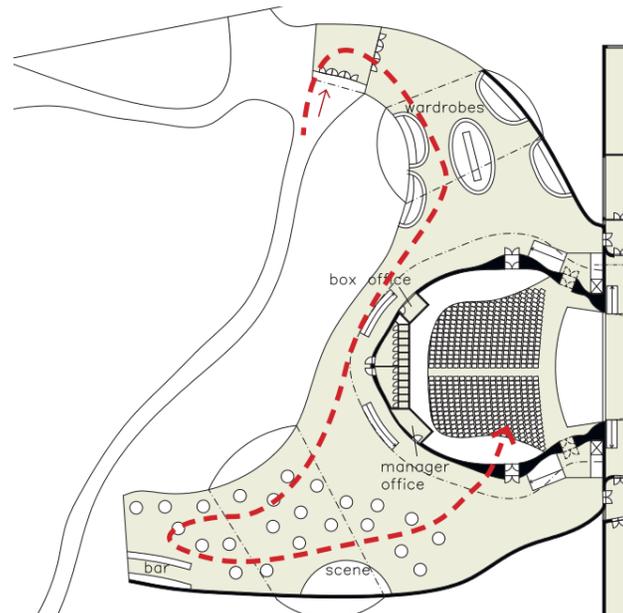


## LOBBY

The lobby is about light, movement and connection the the city. By a great glass window it shows the city and the park outside. Visitors get constantly changing perspectives of the outside as they walk up the balconies. The character will change from day to night as the light changes outside. At night there might even be peeks of a starry sky through the semi-closed roof.

The entrance is situated in one wing were you immediately reach the wardrobes, placed as furniture in the room. Leaving the wardrobes the roof drastically heightens to introduce the large auditorium outside.

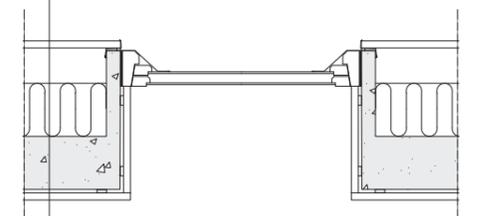
In the other wing lies the restaurant. Here the roof lowers again the create a more intimate area to dine in.



## ROOF

It is important for our concept to lighten up the large building and let light in. It is crucial to achieve water proofing in the window sealing. We have solved this with two metal lists that covers the attachment and protects the insulation.

HIGH PRESSURE LAMINATE BOARD	20 [mm]	
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MOISTURE BARRIER		1
MINERAL WOOL	150	
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HIGH PRESSURE LAMINATE BOARD	20	

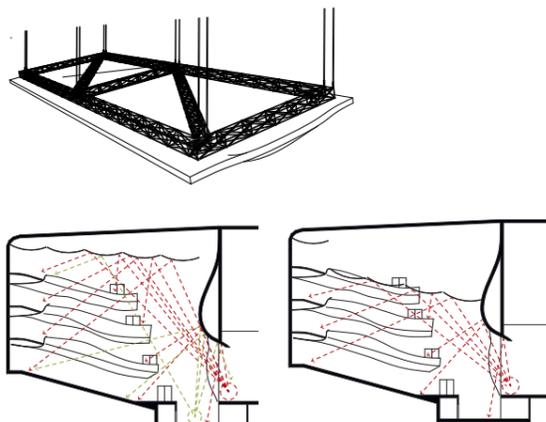


Detail 1:20



# AUDITORIUM

## ADJUSTABLE CEILING



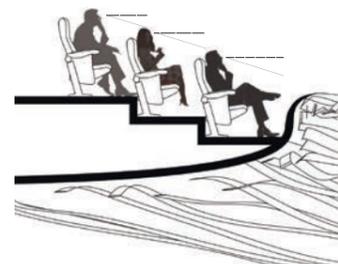
## AUDITORIUM WALL

	HIGH PRESSURE LAMINATE BOARD	20 [mm]
	WOODEN WOOL	25
	CONCRETE	150
	ROCK WOOL	150
	CONCRETE	150
	WOODEN WOOL	25
	WOOD PANEL	30

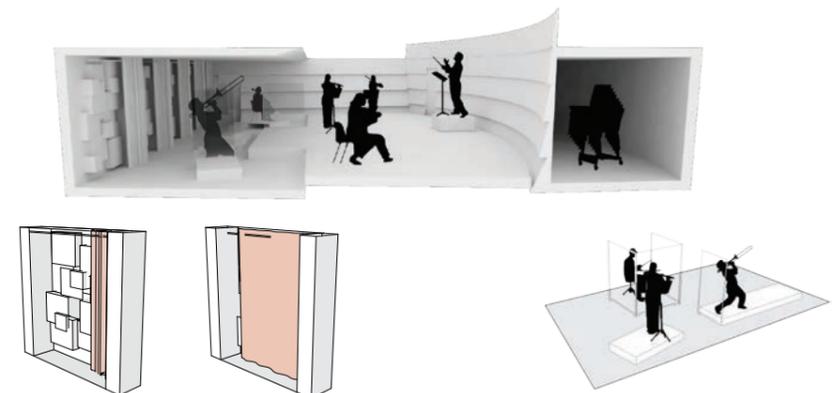
Section 1:20



## BALCONIES

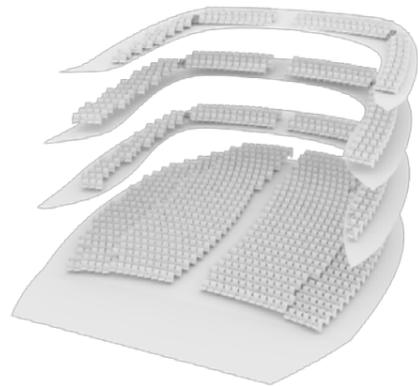
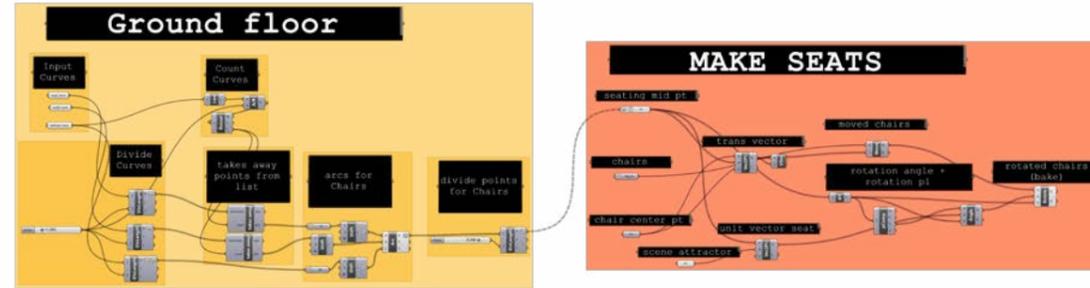


## ORCHESTRA PIT

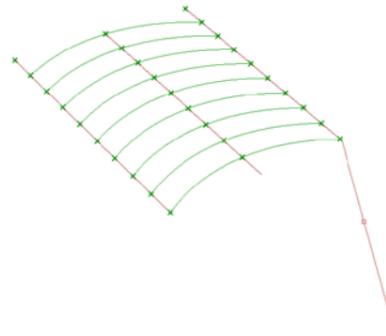


# WORKING METHODS

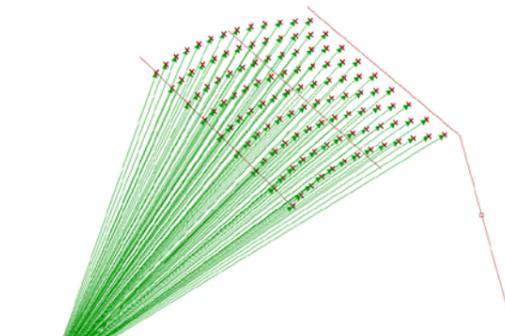
## MAKING THE SEATS



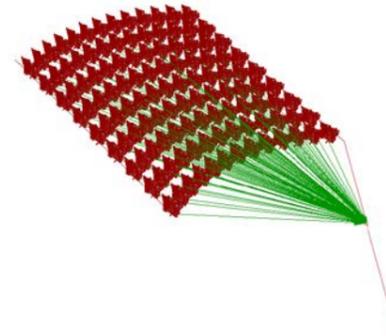
How to place 1200 seats in a computer model?



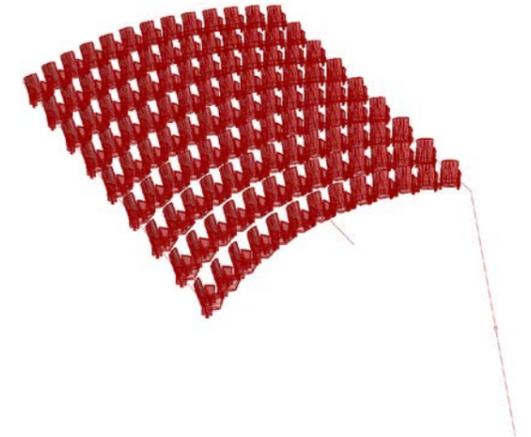
Start with making arcs on the seating area. From edge to mid to edge.



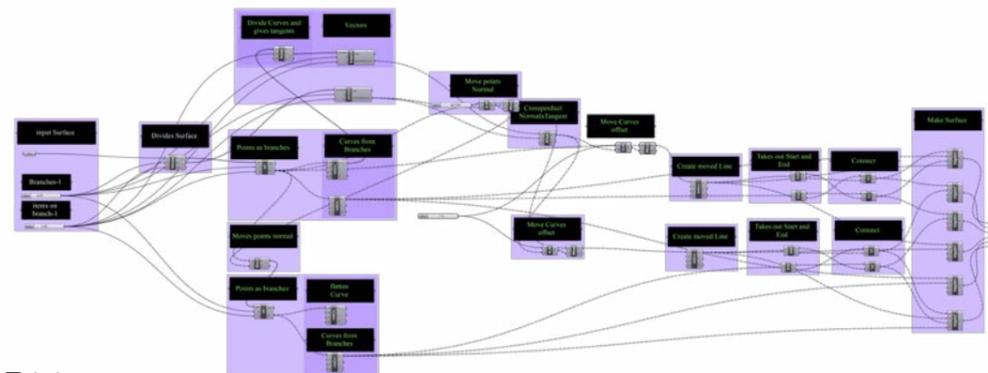
Then translate one model of the seat to points on the arcs



Now rotate them in relation to scene. Create a vector between the seat midpoint and the scene midpoint to inherit the angle.



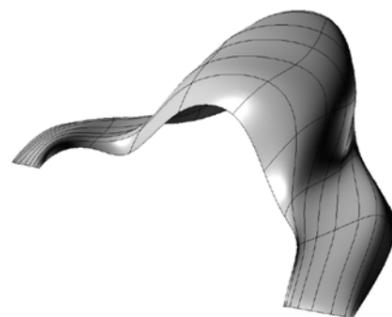
Tadaa!



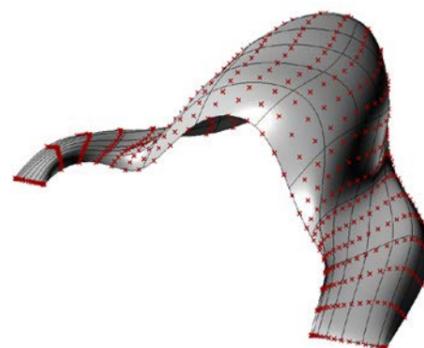
## MAKING THE STRIPES ON A FREE FORM



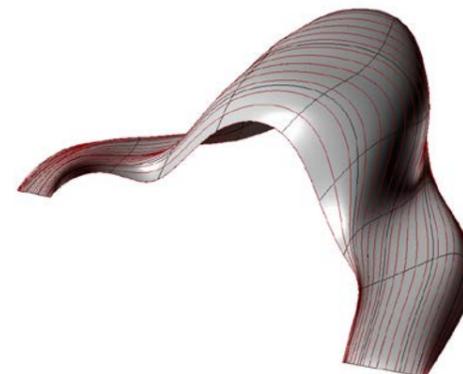
How do we do this?!



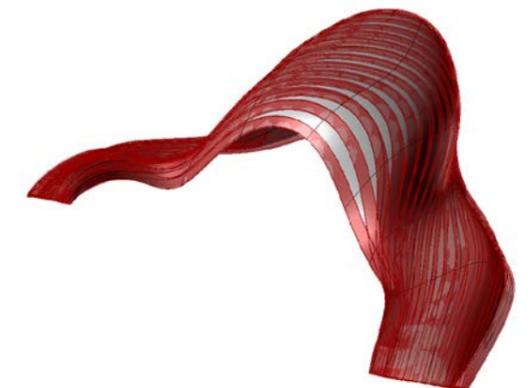
Find a form you like.



Evaluate the surface and find points on it.

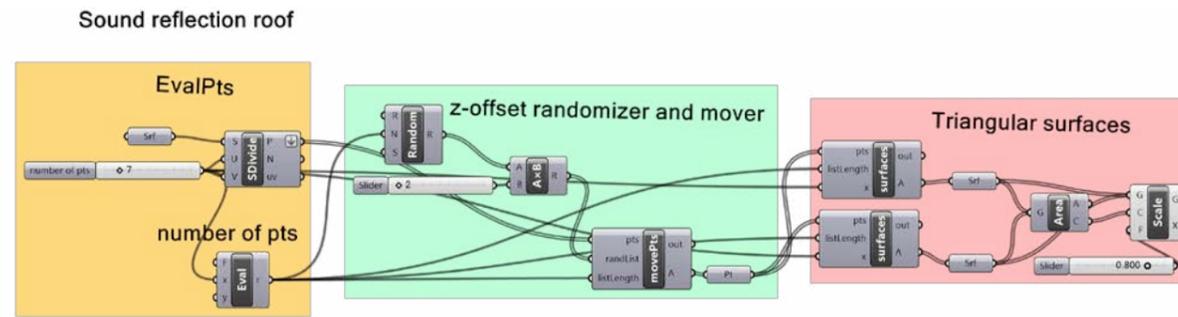


Create curves through the points in the direction where to stripe it.

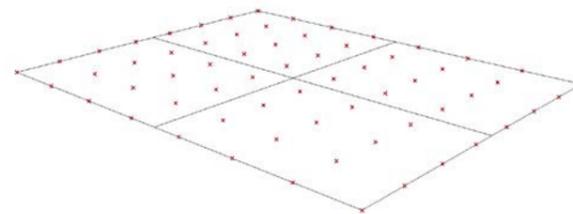


Now just extrude the curves in the normal direction and tangent direction.

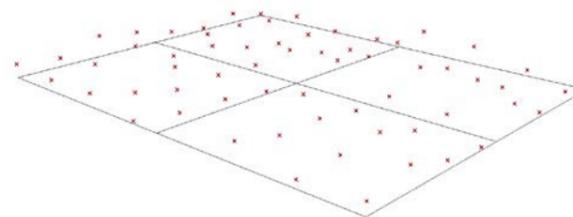
# WORKING METHODS



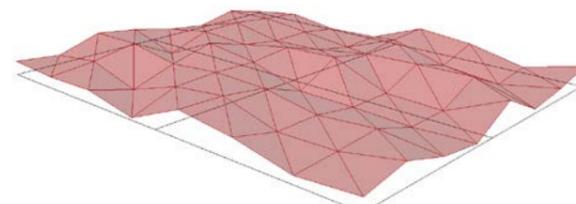
Inspirational model for rehearsal room roof.



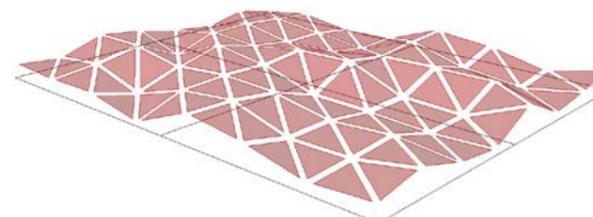
Start with a plane. Find points on that plane.



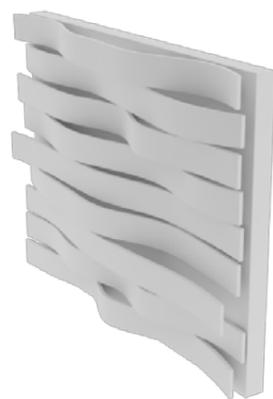
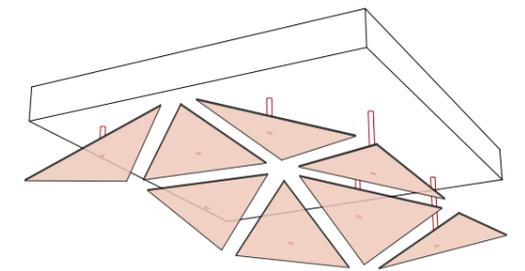
Translate the points randomly on the z-axis.



Connect the first with the second and the one to the right. Skip the last on every line. Make a surface between these points.



Shrink the surfaces to a desired shape. Depends on how much sound you want to let through.



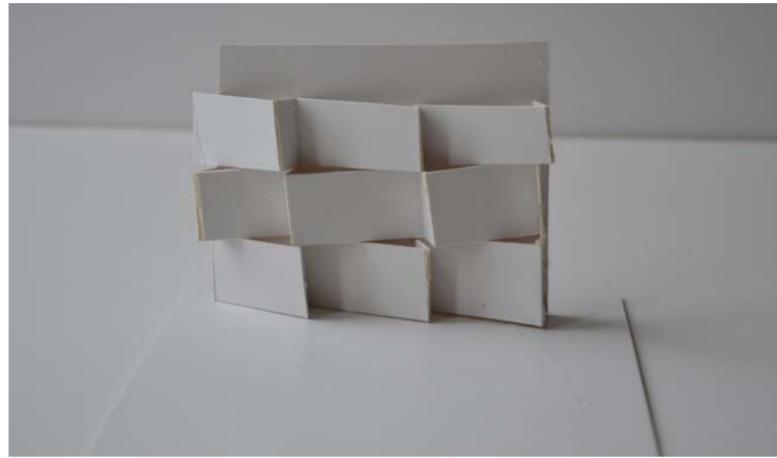
We could use the striping algorithm through out the project. We used it for the interior wall of the opera as well.

# WORKING PROCESS

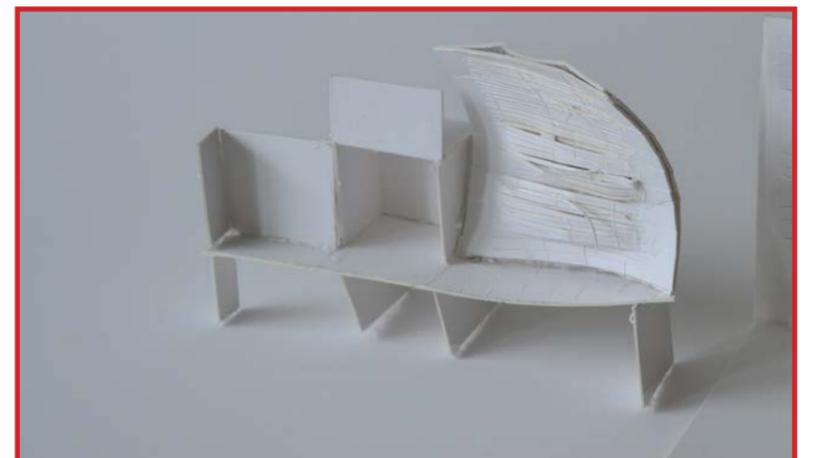
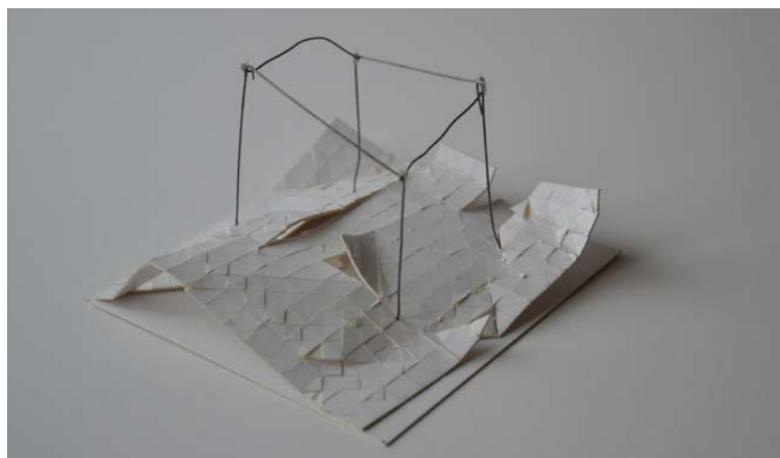
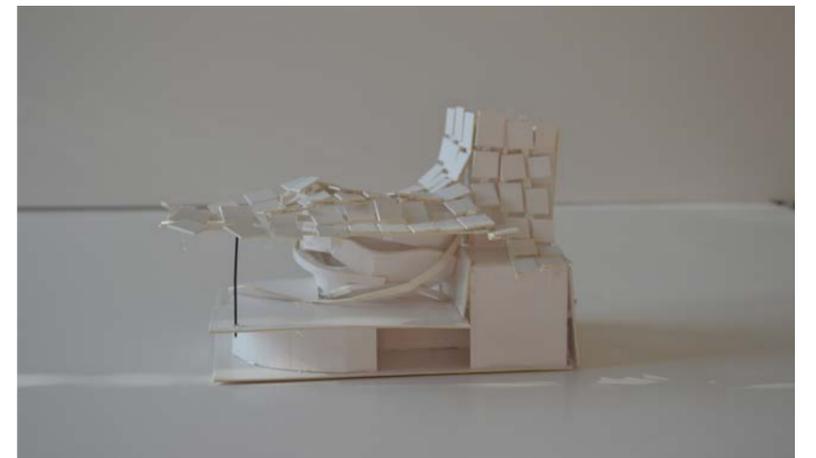
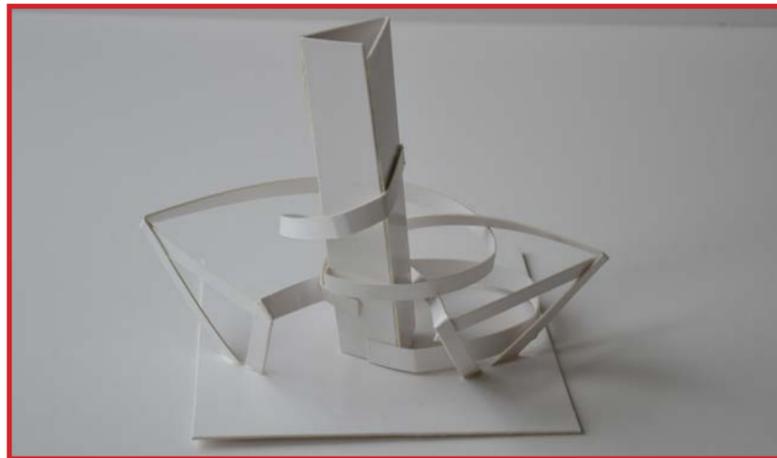
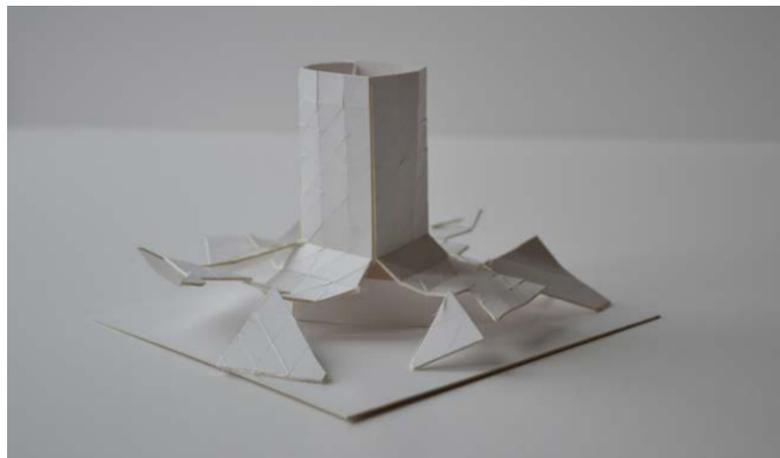
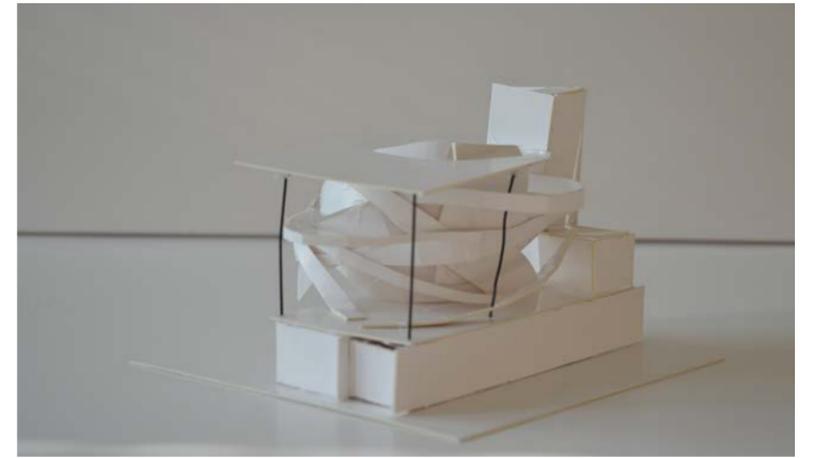
OUTSIDE AND IN



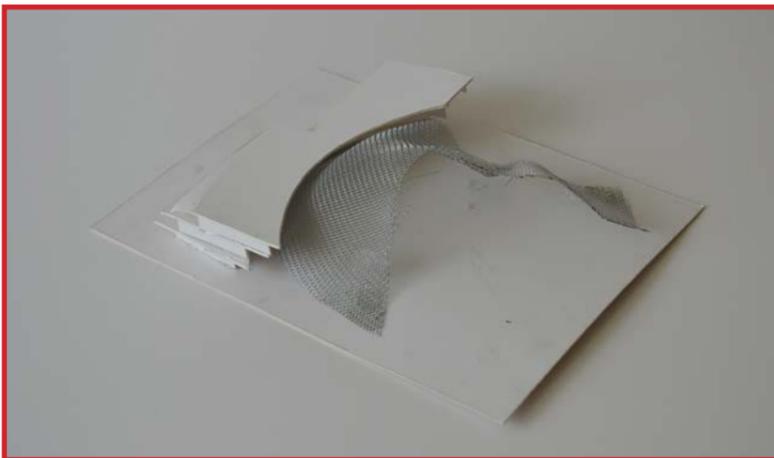
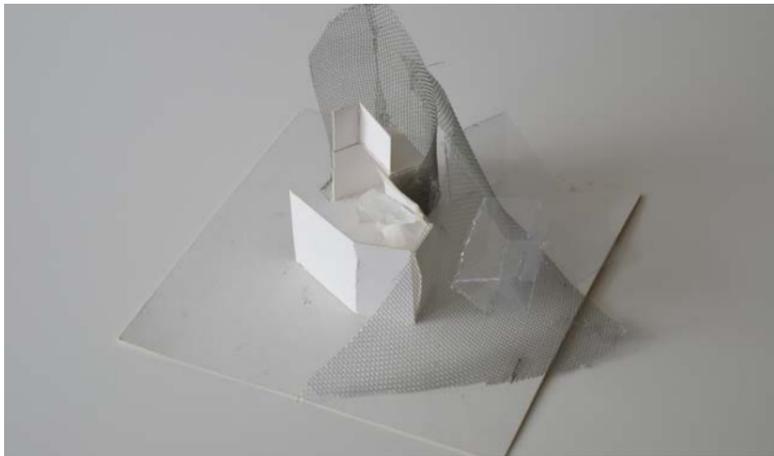
INSIDE AND OUT



SECTIONAL MODELS, MORE DETAIL



## FINGING THE FORM



# SLUTREFLEKTION

Operaprojektet kom igång bra. Jag och Emil hade roligt ihop. Vi började med att sätta upp gemensamma mål och gränser för att inte trampa varandra på foten. Sedan tittade vi på film om opera och gick på studiebesök i olika konsertsalar i Göteborg.

Efter den inledande fasen av att lära känna opera så började vi flitigt att göra skissmodeller. Vi gjorde inget mindre än 28 modeller tillsammans.

När Tania, akustikern, kom in i gruppen fungerade även det. Hon var från Grekland så vi fick tala engelska. Det var lite svårt till en början men hon hade en god förmåga att leva sig in i en pappersmodell och förstå en idé. Alltsom projektet fortsatte blev hon lite fegare och vågade inte riktigt föreslå något hon inte funnit i en bok. Men hon arbetade på engegerat och gjorde sina bitar.

Projektet var ett bidrag till en tävling som vi inte vann. Jag har funderat på varför vi inte gjorde det. Jag tycker vi hade ett djärvt förslag med genomtänkt rörelse och ett helhetsgrepp. Det är en häftig relation mellan in och utsida.

Jag tror att vårt bidrag föll på att inte varit tillräckligt lätt att förstå. Vi satt länge med att försöka förklara vårt koncept för oss själva. Det var inte lätt. Tillslut landade vi i konceptskissen som är med på planschen som jag ändå är ganska nöjd med. Den utgår enbart från hur formen kommit till. Det här var dock inte hela sanningen. Vi hade flera orsaker till att vi valt alla attribut på vårt opera men det gick inte att förklara allt. I vår presentation lämnades mycket osagt som jag tror tyvärr ledde till förvirring.

En annan mer övergripande del som vi brast på var att vi inte arbetat igenom vår idé om två volymer. Idén var en blob och en låda. Vi arbetade uteslutande med blobbens utsida. Lådans utida har vi inte en enda skiss på. Därför valde vi att inte visa den utvändigt någonstans. Detta medförde att de flesta inte förstod att den fanns. Vi visade den invändigt men det ledde bara till ännu större förvirring.

Slutligen hastades slutpresentationen fram i sista stund. Jag vet inte varför det blev så då vi var i god tid hela tiden, arbetade som galningar och följde en bra tidsplan. Men så blev det. Det var en del småmissar som inte borde varit där som jag tror tillsammans tog ned kvalitétintrycket. Texten blev lämnat till sist vilket alltid är olyckligt men tyvärr ett återkommande misstag från mig.

THANK YOU FOR  
READING