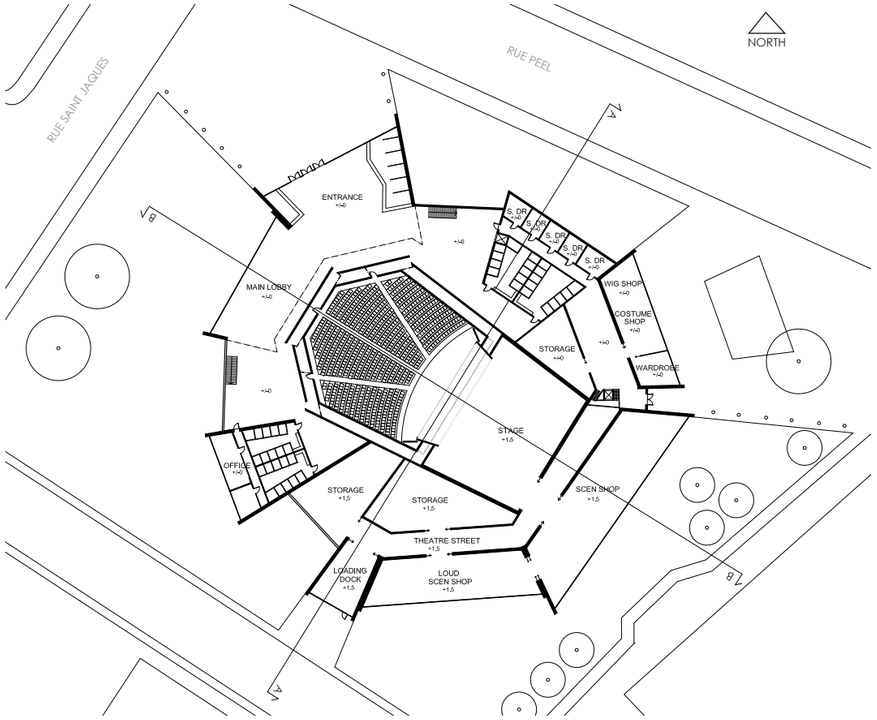
LIGHTBOX UNIVERSE

BACHELOR'S PROJECT ARKX01

Period	VT 2013
Credits	15 hp/ECTS
Teachers	Morten Lund, Mendel Kleiner
Groupmembers	Amanda Stehn, Anna Larsson, Oskar Andersson

LIGHTBOX UNIVERSE

This collage performance hall needs to meet complex needs. It should be both inclusive to the city and provide a brilliant and acoustically shielded auditorium. It should provide a venue for diverse university events, as well as traditional opera. The answer is a building that can be both a welcoming display of interesting activity and a secluded secret universe.



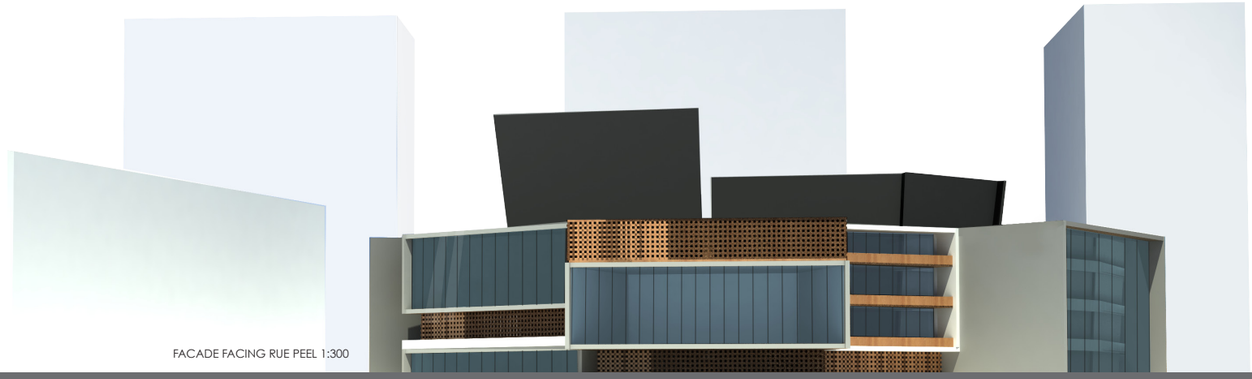
ENTRANCE FLOOR 1:600

A LIGHTBOX FOR EVERY NEED

The layout of the opera is based on a radial grid centered on the stage. The different acoustical requirements and characteristics of the spaces determine their place in the building. The auditorium finds its natural place in the center and the less sensitive functions acts as noise barriers to the outside. These functions are placed in different triangular segments; the lightboxes. The lightboxes are either open and connective or private and closed volumes, depending on the function inside.

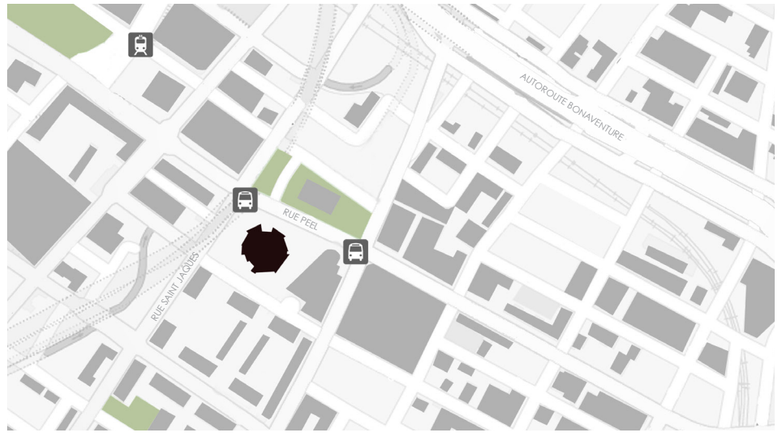
INCLUSIVE TO IT'S SURROUNDINGS

Because the plot is situated in a diverse area the building is open to it's surroundings in different ways. The entrance is facing the crossing between Rue Saint Jaques and Rue Peel, where the busses and cars are bringing people to the venue. In the eastern corner, a small public space is created between the building an the ETS campus, while the more private functions are facing the residential area.



FACADE FACING RUE PEEL 1:300

THE PERFORMANCE HALL AND THE CITY



SITUATION 1:5000

DIFFERENT FACES OF MONTREAL MEETS

The building is situated where downtown and the changing neighborhood Griffintown meets. Having the main building of Ecole Technologie Supérieure, the expo 67 planetarium and a residential area in the absolute vicinity, the performance hall should give something to all nearby stakeholders.

The building approaches it's surroundings by having a welcoming front in every direction, inviting the city of Montreal to be apart of it's activity.

ACOUSTICAL CIRCUMSTANCES

There are many sources of noise in the area, such as passing aircrafts, trains and cars. By estimating the traffic and speed on highways and railways and adding the different sound sources, the normal sound level on the plot can be calculated to be between 65 and 75 dBA.

- Train at 300 m distance ▸ 65-75 dBA
- Highway at 370 m distance ▸ 55-65 dBA
- Aircraft at 460 m distance ▸ 70-80 dBA

VALUES SHAPING THE PROJECT

ACUSTICAL REQUIERMENTS ▸ BECOMES THE PLAN OF THE BUILING

The heart of the opera is the spot on stage where the singer sings the last note. Rooms are close or far from that spot depending on acoustical requirements.

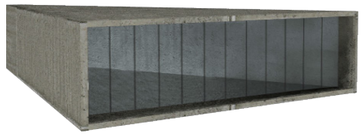
SOME OF THE USUALLY SECRET WONDERS OF THE OPERA ▸ BECOMES VISABLE TO THE CITY

Passing by on Rue Peel you can see a wigmaker in action or maybe a practicing dancer.

VALUES OF THE UNIVERSITY ▸ SHAPES A MULTI PURPOSE UNIVERSITY BUILDING

The university stands for new thinking, flexibility and diversity. Acoustically and spacially this building can house all of these aspects.

THE LIGHTBOXES AS BUILDING BLOCKS



CONCRETE AND GLASS - OPEN TOWARDS THE CITY

The open lightbox makes it possible to have a good view of the city, and for the city to have a good view of the activities inside. The concrete walls makes each lightbox acoustically isolated and flutter is naturally avoided by the unparallel walls.

FLUTTER ECO IS AVOIDED BY THE SHAPES OF THE LIGHTBOXES

INSOLATION BETWEEN THE LIGHTBOXES PREVENTS FLANKING TRANSMISSION TO SPREAD IN THE BUILDING

WOODEN GRID - PRIVATE BUT PERFORATED

The wooden grid is used where there is a need for both privacy and daylight, for example in dressing rooms. In the nighttime the grid allows light to pass through and the volume becomes a lightbox without displaying it's activities.

THE NATURAL UNEVENNESS OF THE LIGHTBOX DIFFRACTS THE SOUND

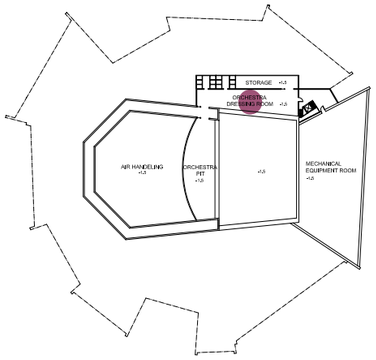
THE ABSORPTION IS REGULATED WITH POROUS BLOCKS THAT FITS IN THE HOLES

EVERY LIGHTBOX HAS IT'S OWN STORY

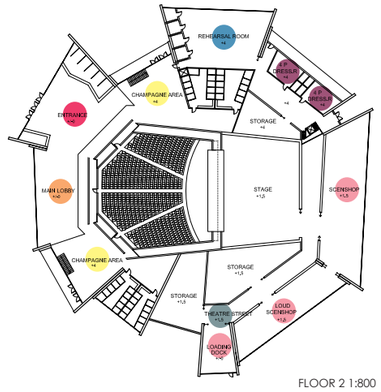
SECTION GREENROOM 1:200

GREEN ROOM

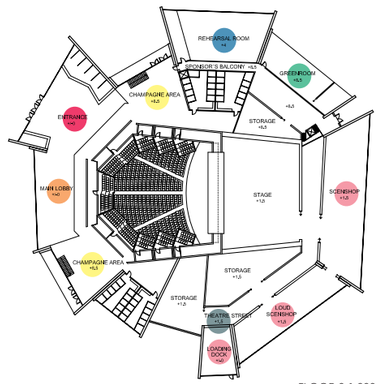
The green room is easy accessible from both the stage area and the main entrance. This allows for uses beyond post performance lounge, since visitors can get here without passing the really private functions of the building. Placed on the 4:th floor, the green room has magnificent view through it's open glass facade. Acoustically the green room has double ceiling height to allow for a good performance space if needed. The room continues the concept of the auditorium with squares lowered from the ceiling, this time as lighting and absorbers hanging over the lounge area to allow for good conversation acoustics.



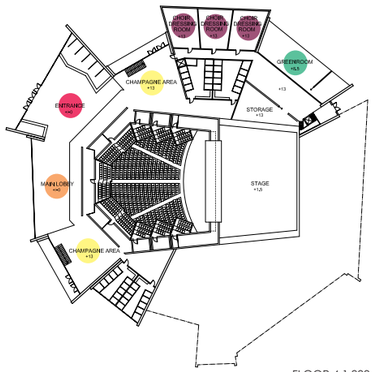
FLOOR -1 1:800



FLOOR 2 1:800



FLOOR 3 1:800



FLOOR 4 1:800

THE ENTRANCE

When entering the spacious volume the sight of the auditorium is the first thing that meets the visitor. To the left and right there is a natural access to both wardrobe and ticket sales.

THE MAIN LOBBY

The main lobby can, in addition to it's functions as a lobby, be used as a space for exhibits, dinners, fairs and more.

THE CHAMPAGNE AREA

This is the part of the lobby from which you enter the auditorium and to which you exit in the pause. On every floor there is a possibility to go outside for fresh air. While the rest of the lobby has a ceiling height of 16 meters, these spaces are more intimate and acoustically suitable for conversation and refreshments with a ceiling height of 4 meters.

LOADING DOCK AND SCENE SHOPS

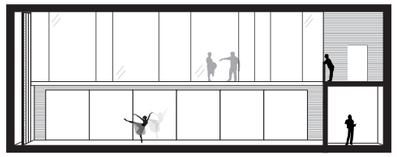
These functions need noise control to protect both the silence of the auditorium and the working environment of the employees. As a solution it is possible to divide the scen shop into two spaces, where the carpenter and other noisy activities has more barriers towards the auditorium. Less noisy activities can go on undisturbed, in the other scene shop. The sliding doors into the theater street have good sound insulation properties.

THEATER STREET

The theater street is used for communication between the different backstage spaces and the stage. It also functions as an extra sound barrier between the scene shops and stage. To prevent noise from building up and leaking into the stage area absorbers are installed in the ceiling.

DRESSING ROOMS

The dressing have good communications to the rehearsal room, as well as the wig and costume shop, through the backstage stairwell. From the orchestra dressing room there is an entrance directly into the orchestra pit.



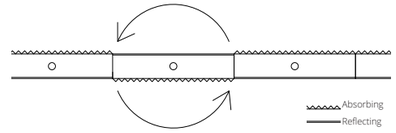
SECTION REHERSALROOM 1:200

REHEARSAL ROOM

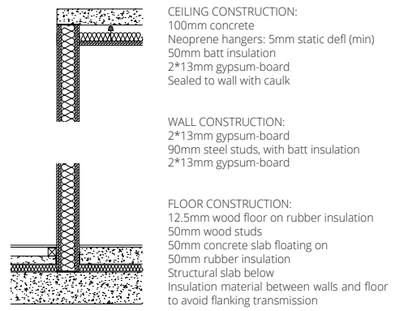
Facing the active Rue Peel, the rehearsal room functions as a showroom for the building. There is also a possibility to view the ongoing activity from the sponsor's balcony, a mezzanine that runs through the room.

The acoustic is mainly made for rehearsal situations with a large volume allowing for suitable reverberation time and acoustically insolated practice rooms. The room can also be adjusted to function for lectures and receptions when increasing the absorption by turning the double-sided wall (detail below) and dragging the curtains out. The curtains also gives the possibility to prevent insight.

The floor is constructed to be suitable for dancing, allowing some supporting deformation.



DETAIL : Absorbing and reflecting wallpanels in the reheasal room

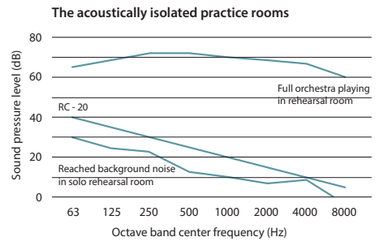


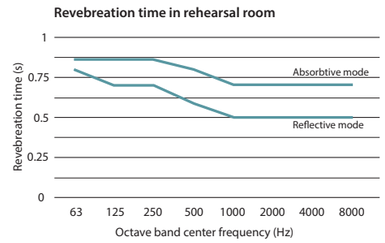
CEILING CONSTRUCTION:
100mm concrete
Neoprene hangers: 5mm static defl (min)
50mm batt insulation
2*13mm gypsum-board
Sealed to wall with caulk

WALL CONSTRUCTION:
2*13mm gypsum-board
90mm steel studs, with batt insulation
2*13mm gypsum-board

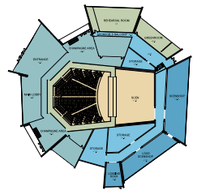
FLOOR CONSTRUCTION:
12.5mm wood floor on rubber insulation
50mm wood studs
50mm concrete slab floating on
50mm rubber insulation
Structural slab below
Insulation material between walls and floor to avoid flanking transmission

DETAIL 1:20 Isolating wall between the big and small rehearsal rooms



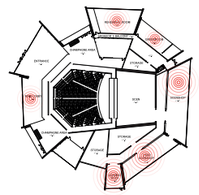


PROVIDING SILENCE FOR THE FUNCTIONS OF THE BUILDING



FULLFILLED ACUSTICAL CRITERIA
- RC 40
- RC 35
- RC 30
- RC 25
- RC 15

COMMUNITY NOISE
- 65-75 dBA



NOISE PRODUCED OVER 60 dBA:

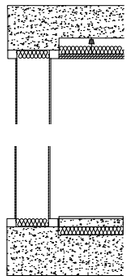
- Loading dock
- Scenshop
- Main lobby
- Rehearsal room
- Green Room
- Mechanical Equipment room

TAKING CARE OF THE NOISE FROM THE OUTSIDE

Due to the room organization, the community noise on the site is reduced step by step through the building to keep the auditorium silent. The natural character of the open lightboxes, with a significant amount of glass, requires an appropriate wall construction (see detail below).

TAKING CARE OF NOISE PRODUCED IN THE BUILDING

The functions that generate a lot of noise are placed far away from the auditorium with a lot of barriers in between. For additional sound insulation the lightbox type made of concrete is used for these functions. The Mechanical Equipment room is placed in the basement to take away it's influence on background noise levels in vital parts of the building.



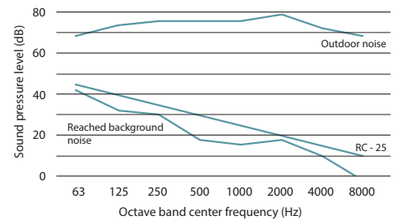
CEILING CONSTRUCTION:
Structural concrete
Neoprene hangers: 5mm static defl (min)
50mm batt insulation
2*13mm gypsum-board
Sealed to window mountings with caulk

WINDOW CONSTRUCTION:
6mm glass
20mm air gap
9mm glass

FLOOR CONSTRUCTION:
12.5mm woodfloor
50mm concrete slab floating on
50mm rubber insulators
Cavity filled with batt insulation
Structural slab below
Insulation material between walls and floor to avoid flanking transmission

DETAIL 1:20 Construction of the concrere and glas lightbox

Reached background noise due to community noise



The values are calculated for the most critical case, in a concrete and glas lightbox with RC 25.

THE MULTI PURPOSE PERFORMANCE HALL

Entering the performance hall feels like entering a separate universe. The way in is an intimate and separated walk between the double shell that surrounds the hall. When reaching the hall the silence is noticeable. The performance hall is, in it's original setup, made for opera and has a reverberation time of 1.5 seconds, but can me modified to fit different types of events by, among other things, opening the ceiling to the interior of the shell, with it's absorbing spikes.

CEILING TILES

The tiles in the ceiling splits up and reveals the absorbing double shell to vary the reverberation time. The individually moving tiles also makes it possible to get a unique expression of the auditorium, suitable for ceremonies, conferences, dance performances or other things the university can come to invent.

INHOUSE MIXING

The sound technicians booth is fitted in the double shell. This way the technicians can be in direct connection to the auditorium without disturbing the audience experience.

PROCENIUM

The procenium is designed to deliver sound to the audience and reflect some sound to the performers on stage.

ORCHESTRA PIT

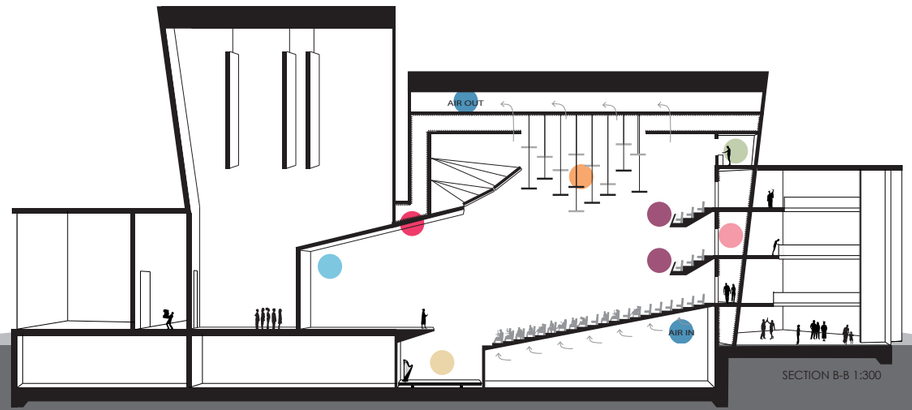
The orchestra pit has diffracting walls to blend the sound of the instruments and allowing the musicians to hear each other. Pitlifts makes it possible to have different settings of the orchestra, as well as allowing for a bigger stage when fully erected.

STAGE SHELL

To accommodate performances by orchestras a movable stage shell (for example the Diva model from Wegner) is provided. The shell can easily be set up by the stage workers and provides good communication between musicians, diffraction and reflection towards the audience.

AIR HANDLING

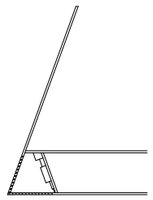
Air is brought into the auditorium via inlets under the chairs. The big volume under the floor allows for low speeds and silent airflow. The air outlet is located on the floor above the auditorium, where silencers prevents noise from getting in from outside.



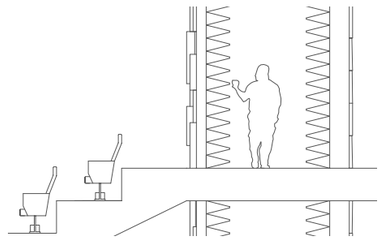
SECTION B-B 1:300

BALCONY FRONTS

The balcony fronts mainly reflects the sound upwards, to increase the reverberation time. The lower part is acoustically transparent and behind the perforated balcony front, the sound is diffracted and reflected downwards. Small lamps inside continues the lightbox concept with light that sprinkles out of the clean fronts.



BALCONY FRONT 1:50



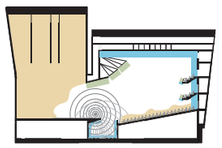
THE DOUBLE SHELL 1:50

THE DOUBLE SHELL

The double shell has two important purposes. First it acts as the final sound insolation between the auditorium, the hidden treasure of the opera, and the outside world. The second purpose is the variable acoustics, which is created by opening the auditorium cling and letting the highly absorptive elements take away some of the reverberation time. A bonus from these two combined functions is the special feeling of entering a new universe.

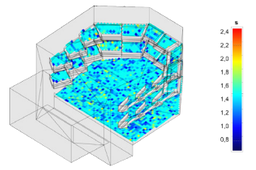
THREE ACOUSTICAL MODES

Diffracting Reflecting Absorbing

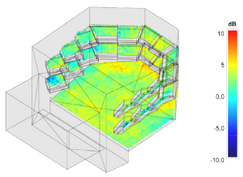


OPERA MODE

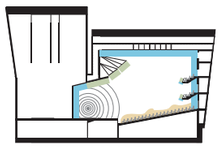
The orchestra is lowered into the pit to allow for a good balance between singer and orchestra. The clarity for the orchestra is 1-2 dB lower than for the singers.



RVEREBERATION TIME

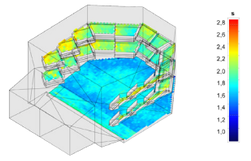


CLARITY C80



ORCHESTRA MODE

A stage shell supports and blends the sound of the orchestra, and slightly extends the reverberation time.



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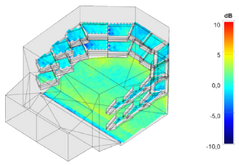

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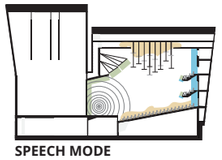
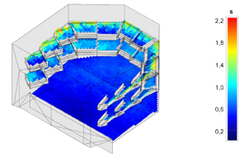


SPEECH MODE

The movable ceiling panels are lowered to expose the absorbing interior of the double shell. A reflective back is lowered behind the proscenium.



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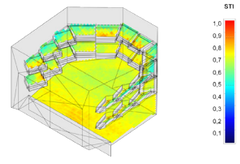
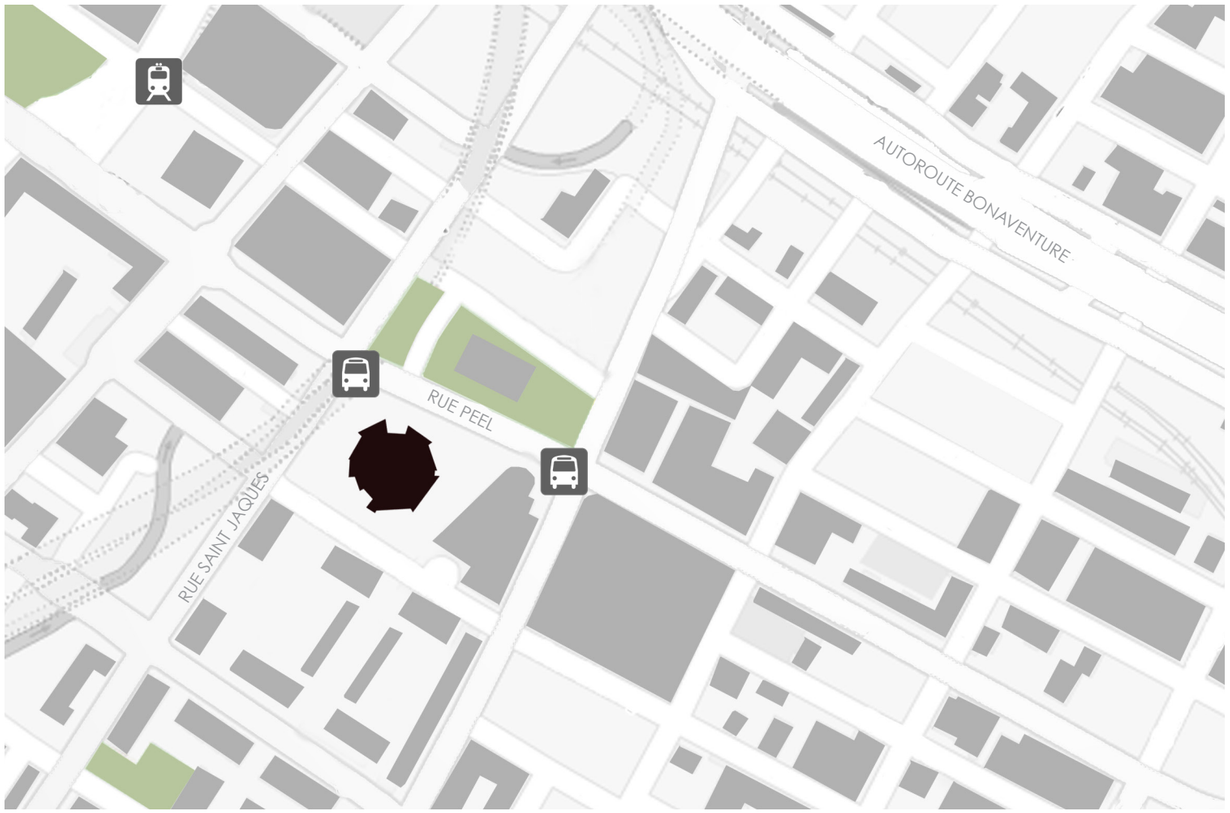


SPEECH TRANSMITION INDEX

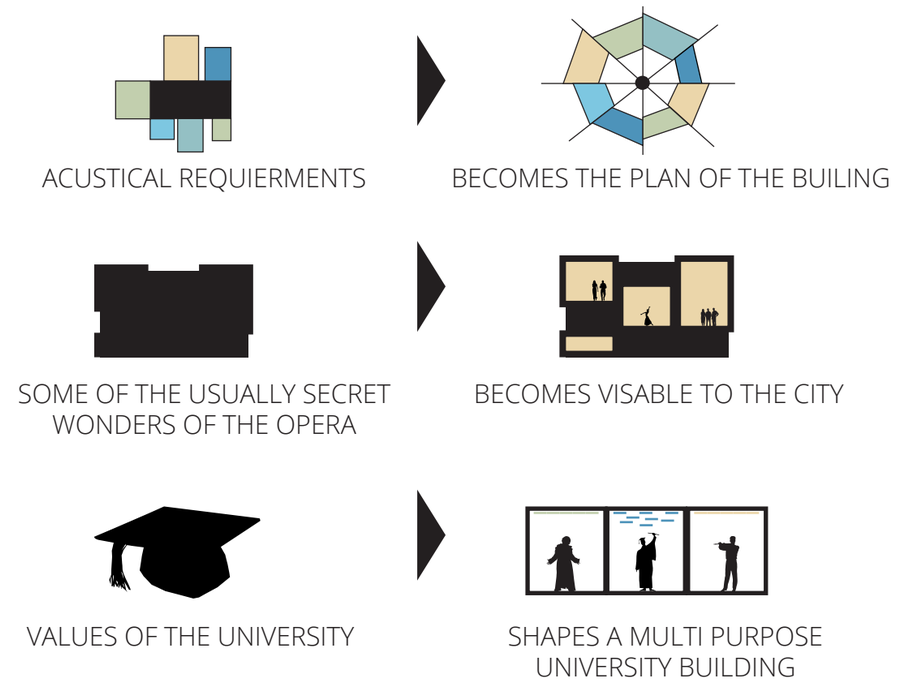
The task

The project was a entry to the yearly ASA design competition issued by the Acoustical Society of America. The competition brief was a multifunctional building, primarily to be used for opera, to a college in Montreal. In the project, two architecture and engineering students worked together with a student from the masterprogram in engineering acoustics.

CONTEXT



SITUATION 1:5000



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Highway at 370 m distance	55-65 dBA
Aircraft at 460 m distance	70-80 dBA

DIFFERENT FACES OF MONTREAL MEETS

The building is situated where downtown and the changing neighborhood Griffintown meets. Having the main building of Ecole Technologie Supérieure, the expo 67 planetarium and a residential area in the absolute vicinity, the performance hall should give something to all nearby stakeholders.

The building approaches it's surroundings by having a welcoming front in every direction, inviting the city of Montreal to be apart of it's activity.

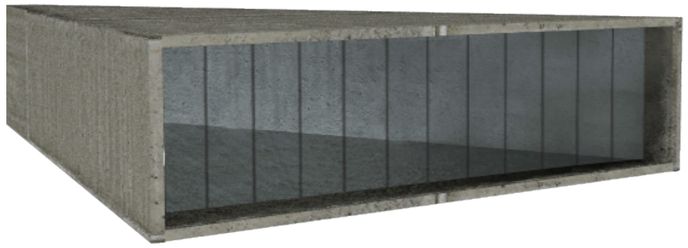
VALUES SHAPING THE PROJECT

1. Architecture and acoustics in close interaction
The heart of the opera is the spot on stage where the singer sings the last note. Rooms are close or far from that spot depending on acoustical requirements.

2. An open and inclusive opera building
Passing by on Rue Peel you can see a wigmaker in action or maybe a practicing dancer.

3. The The university is more than just the client
The university stands for new thinking, flexibility and diversity. Acoustically and spacially this building can house all of these aspects.

THE CONCEPT OF THE LIGHTBOXES



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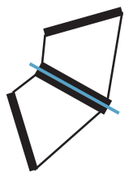

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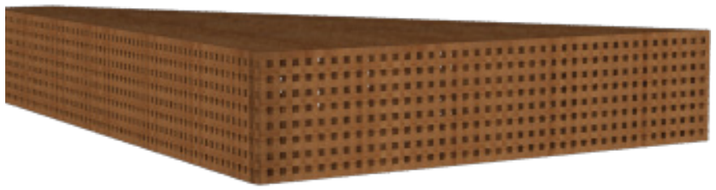
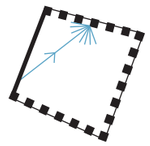


WOODEN GRID - PRIVATE BUT PERFORATED

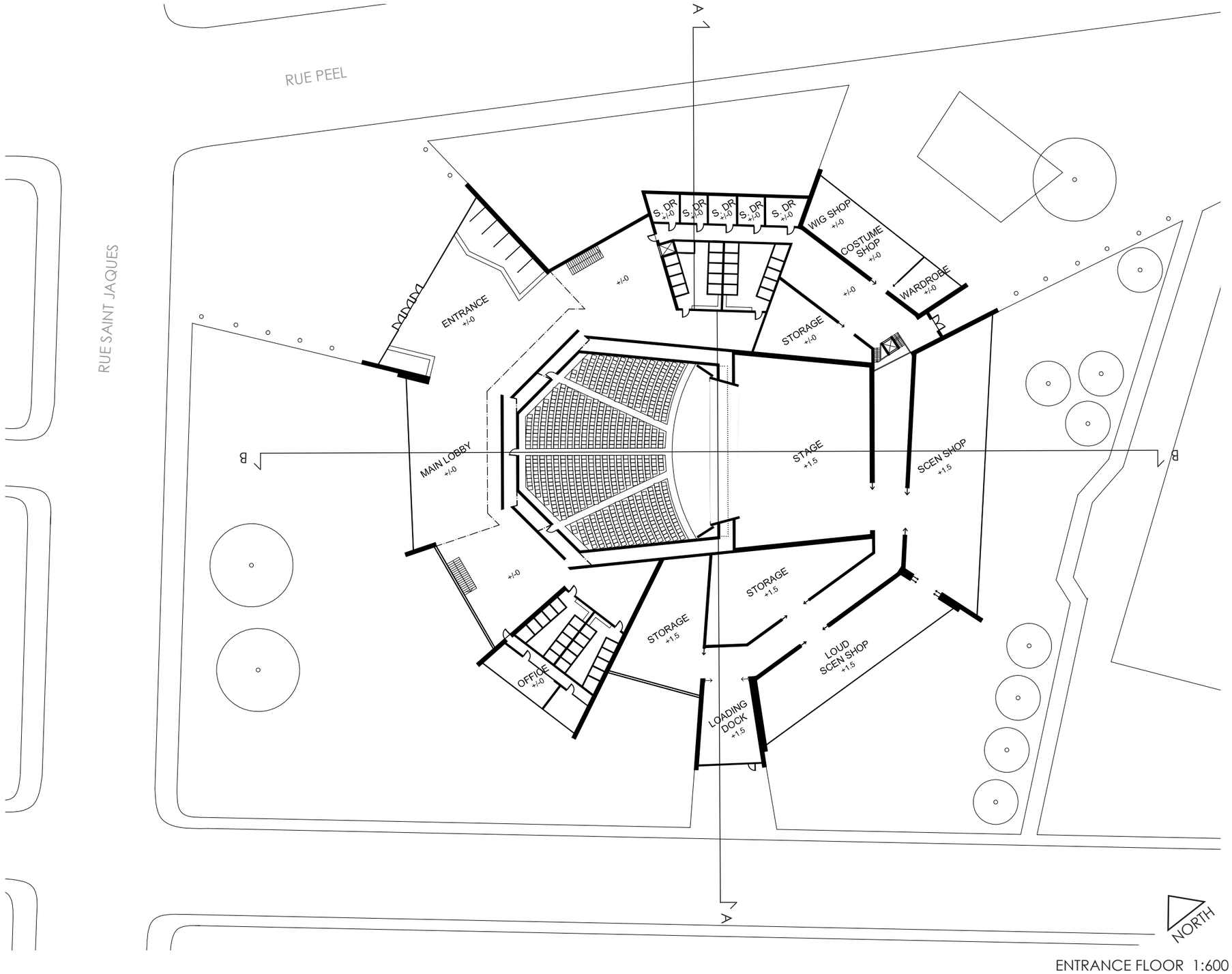
The wooden grid is used where there is a need for both privacy and daylight, for example in dressing rooms. In the nighttime the grid allows light to pass through and the volume becomes a lightbox without displaying it's activities.



THE NATURAL UNEVENNESS OF THE LIGHTBOX DIFFRACTS THE SOUND

THE ABSORPTION IS REGULATED WITH POROUS BLOCKS THAT FITS IN THE HOLES

FLOORPLANS



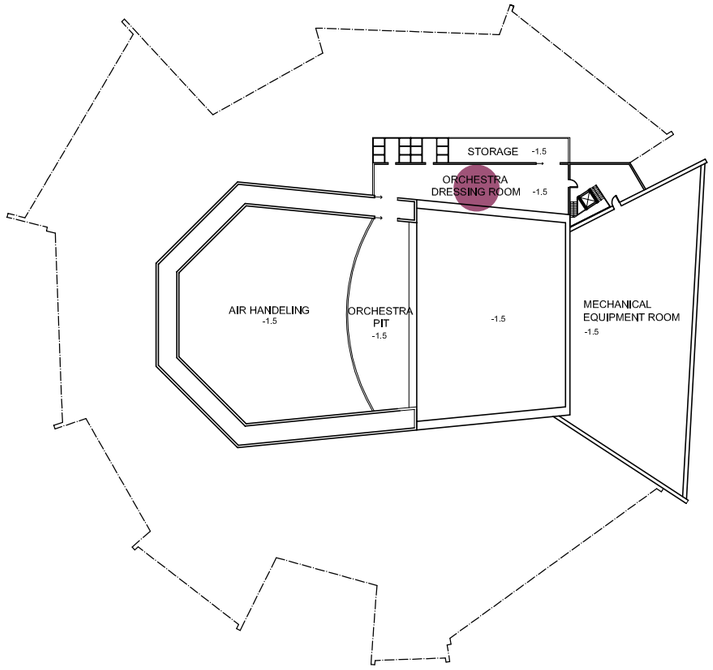
ENTRANCE FLOOR 1:600

INCLUSIVE TO IT'S SURROUNDINGS

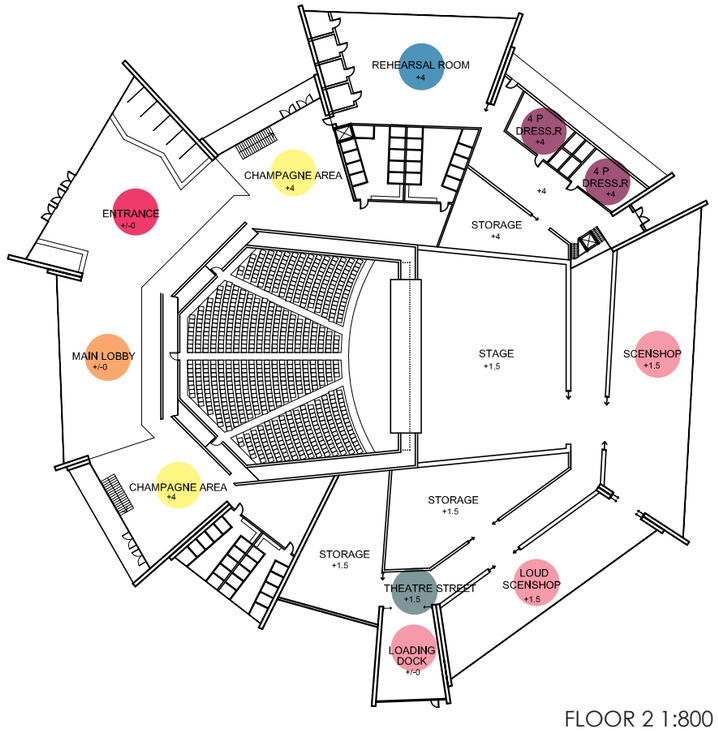
Because the plot is situated in a diverse area the building is open to it's surroundings in different ways. The entrance is facing the crossing between Rue Saint Jaques and Rue Peel, where the busses and cars are bringing people to the venue. In the eastern corner, a small public space is created between the building an the ETS campus, while the more private functions are facing the residential area.

A LIGHTBOX FOR EVERY NEED

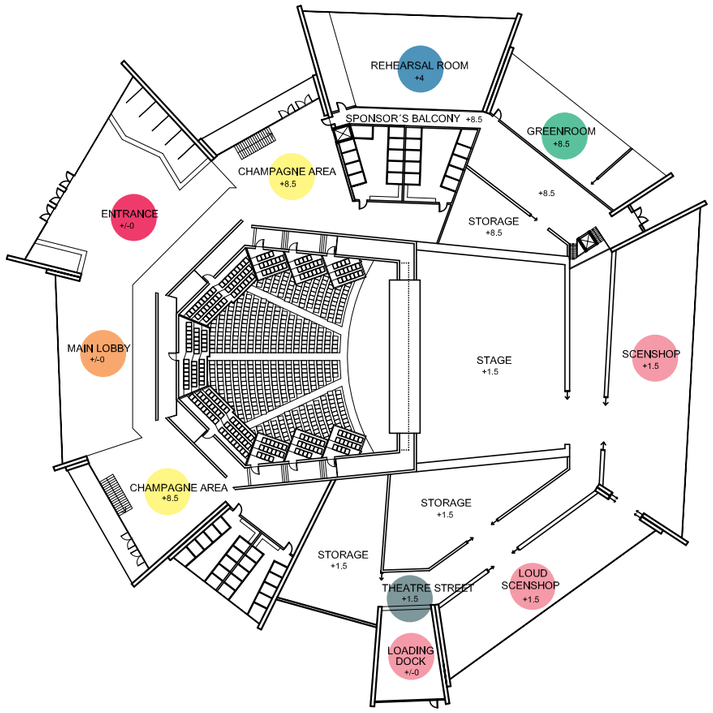
The layout of the opera is based on a radial grid centered on the stage. The different acoustical requirements and characteristics of the spaces determine their place in the building. The auditorium finds its natural place in the center and the less sensitive functions acts as noise barriers to the outside. These functions are placed in different triangular segments; the lightboxes. The lightboxes are either open and connective or private and closed volumes, depending on the function inside.



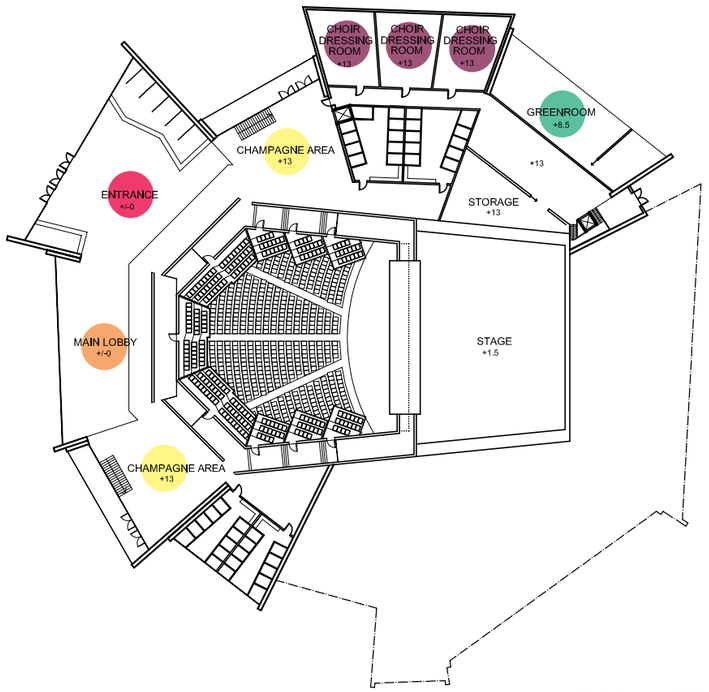
FLOOR -1 1:800



FLOOR 2 1:800



FLOOR 3 1:800



FLOOR 4 1:800

THE ENTRANCE

When entering the spacious volume the sight of the auditorium is the first thing that meets the visitor. To the left and right there is a natural access to both wardrobe and ticket sales.

THE MAIN LOBBY

The main lobby can, in addition to it's functions as a lobby, be used as a space for exhibits, dinners, fairs and more.

THE CHAMPAGNE AREA

This is the part of the lobby from which you enter the auditorium and to which you exit in the pause. On every floor there is a possibility to go outside for fresh air. While the rest of the lobby has a ceiling height of 16 meters, these spaces are more intimate and acoustically suitable for conversation and refreshments with a ceiling height of 4 meters.

LOADING DOCK AND SCENE SHOPS

These functions need noise control to protect both the silence of the auditorium and the working environment of the employees. As a solution it is possible to divide the scen shop into two spaces, where the carpenter and other noisy activities has more barriers towards the auditorium. Less noisy activities can go on undisturbed, in the other scene shop. The sliding doors into the theater street have good sound insulation properties.

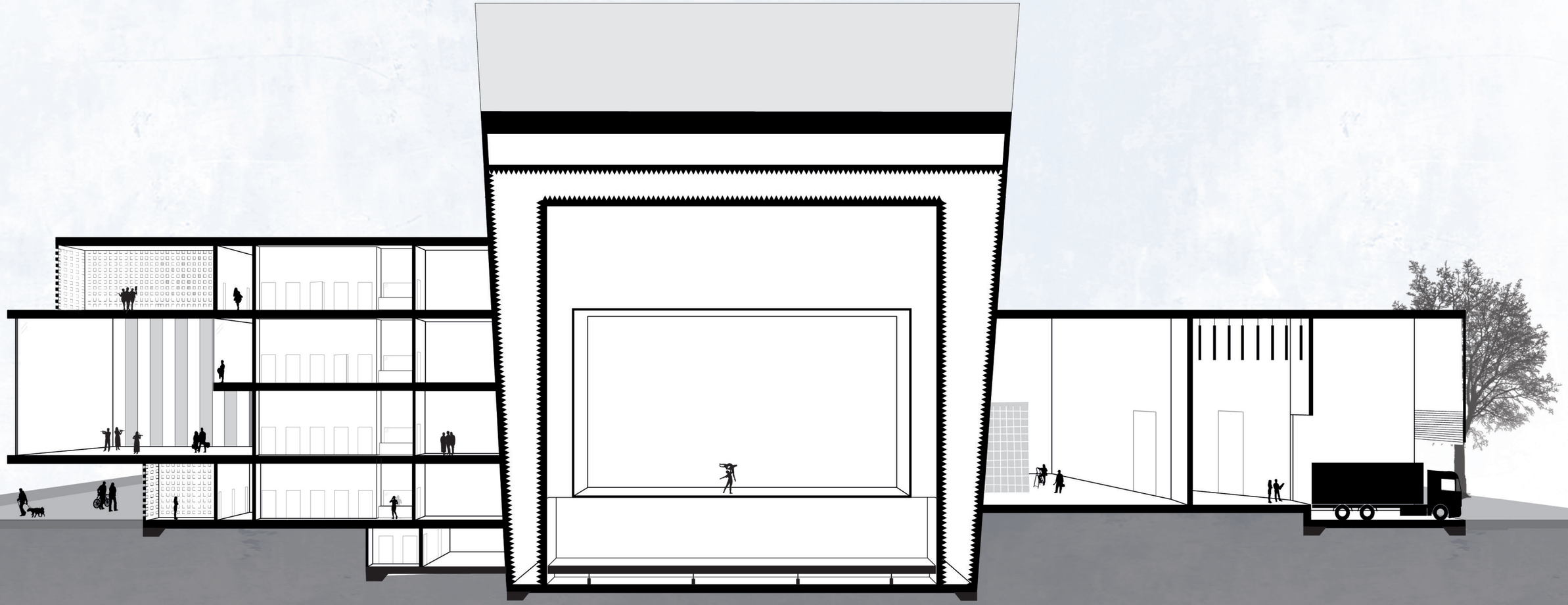
THEATER STREET

The theater street is used for communication between the different backstage spaces and the stage. It also functions as an extra sound barrier between the scene shops and stage. To prevent noise from building up and leaking into the stage area absorbers are installed in the ceiling.

DRESSING ROOMS

The dressing have good communications to the rehearsal room, as well as the wig and costume shop, through the backstage stairwell. From the orchestra dressing room there is an entrance directly into the orchestra pit.

SECTIONS



SECTION A-A 1:250

PROCENIUM

The procenium is designed to deliver sound to the audience and reflect some sound to the performers on stage.

STAGE SHELL

To accommodate performances by orchestras a movable stage shell (for example the Diva model from Wegner) is provided. The shell can easily be set up by the stage workers and provides good communication between musicians, diffraction and reflection towards the audience.

BALCONY FRONTS

The balcony fronts mainly reflects the sound upwards, to increase the reverberation time. The lower part is acoustically transparent and behind the perforated balcony front, the sound is diffracted and reflected downwards. Small lamps inside continues the lightbox concept with light that sprinkles out of the clean fronts.

ORCHESTRA PIT

The orchestra pit has diffracting walls to blend the sound of the instruments and allowing the musicians to hear each other. Pitlifts makes it possible to have different settings of the orchestra, as well as allowing for a bigger stage when fully erected.

AIR HANDLING

Air is brought into the auditorium via inlets under the chairs. The big volume under the floor allows for low speeds and silent airflow. The air outlet is located on the floor above the auditorium, where silencers prevents noise from getting in from outside.

INHOUSE MIXING

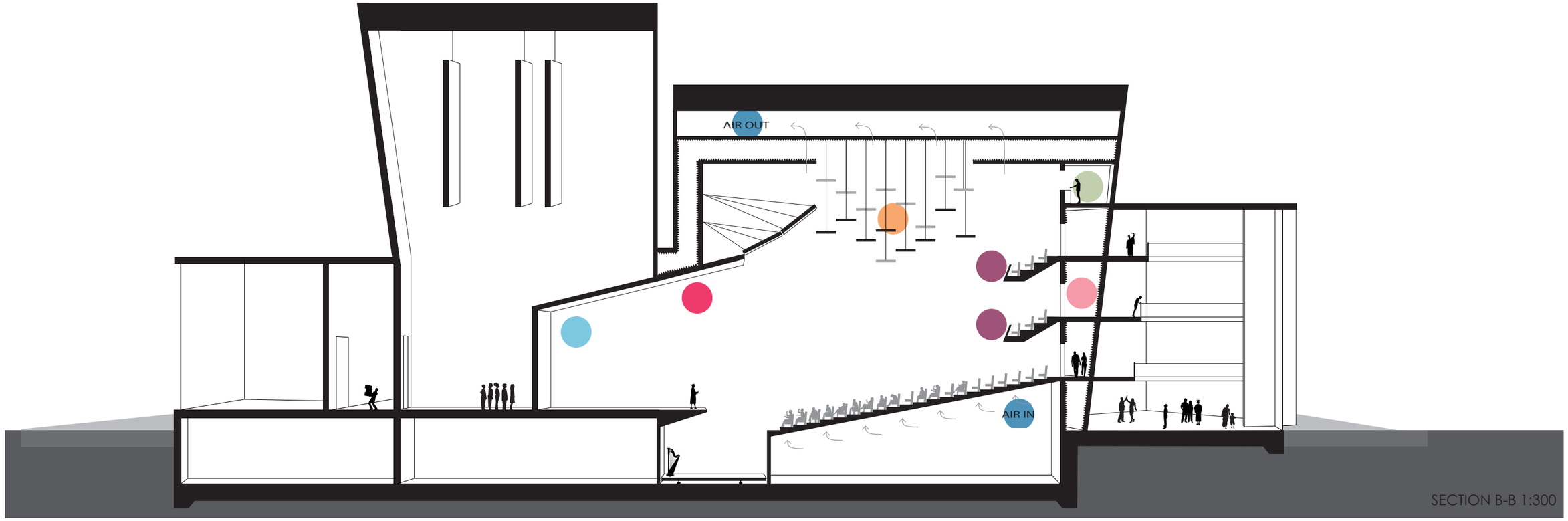
The sound technicians booth is fitted in the double shell. This way the technicians can be in direct connection to the auditorium without disturbing the audience experience.

CEILING TILES

The tiles in the ceiling splits up and reveals the absorbing double shell to vary the reverberation time. The individually moving tiles also makes it possible to get a unique expression of the auditorium, suitable for ceremonies, conferences, dance performances or other things the university can come to invent.

THE DOUBLE SHELL

The double shell has two important purposes. First it acts as the final sound insolation between the auditorium, the hidden treasure of the opera, and the outside world. The second purpose is the variable acoustics, which is created by opening the auditorium cling and letting the highly absorptive elements take away some of the reverberation time. A bonus from these two combined functions is the special feeling of entering a new universe.



SECTION B-B 1:300

THE WORK PROCESS

One aim of the bachelor thesis was to create a structured work process and see what it could provide. We have systematically set and followed goals, developed realistic schedules and reflected within the group. This has provided an incredible value for both the quality of the project, but also for me personally. It has, through the whole process felt inspiring and fun, and the project has grown out of conscious choice. The group has worked well and we have challenged both each others strengths and weaknesses. We have consciously worked with the group dynamics and taken the time to talk about our goals and aims.

1. Site analysis

The first week began with a site analysis. We looked at Montreal as a city, the neighborhoods where the site is set and the nearby surrounding area. On the site itself, we examined the light and sound conditions identified important outlooks, found paths and patterns of movement of both people and traffic.

2. Values and goals

From the analysis, we identified a number of issues we found important to take advantage of. These were defined as values, we continuously in the process came to reconcile against. We also began the group dynamic process by implementing an interactive exercise where we together formulated the goals for the project, as well as for the group.

3. Concept phase

During a week, there was a concept phase where we produced over 50 concept models. These were later evaluated against a list of criteria, developed from our defined values. 3 models came to play a major role, although we in the process drew inspiration from several of concept models.

4. Itterations

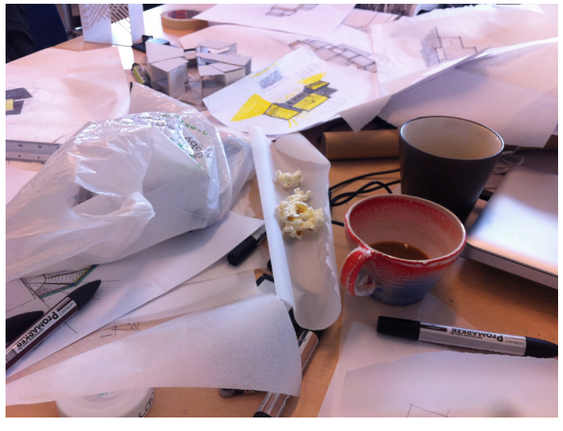
During a 4-week period the project was itterated 3 times, where the end of each itteration meant a collection and printing of the material in the correct format. The project was also presented to the class and feedback captured from teachers and co-students.

5. Production phase

As we continuously improved our material, the production phase was somewhat paralellt with the itteration phase. Prior to deadline, there was a more concentrated period in which the materials were developed and tuned.

6. Critic and evaluation

The last but not least part was to get a final critic of the project. Afterwards we evaluated the final product against our values and golals together in the group



CONCLUSION AND REFLECTION

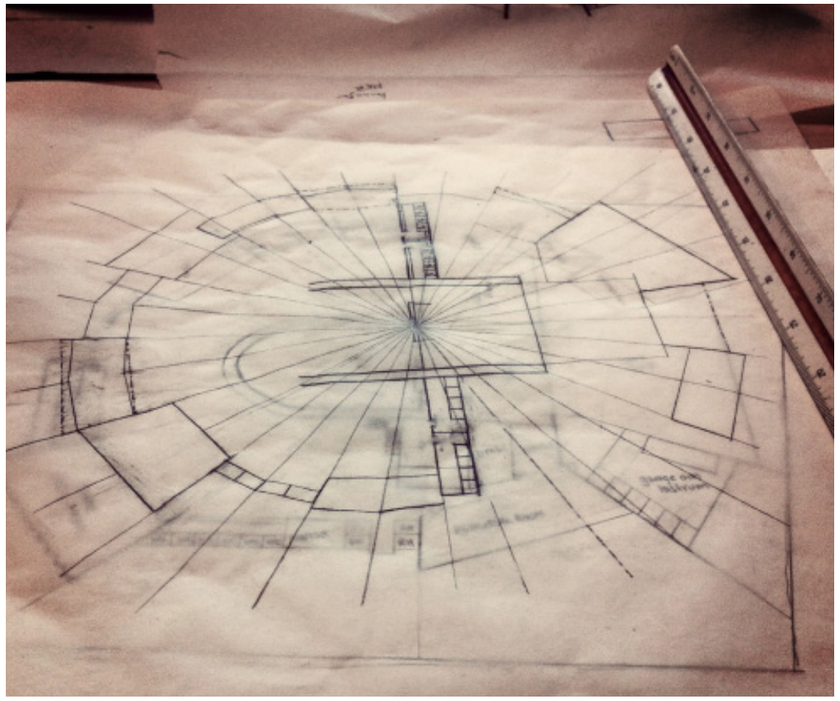
The process

I have learned a lot about acoustics, and especially how architecture and acoustics can be combined. I really enjoyed this way of work- to create something living out of hard theory.

I think that the iteration cycles, with three mid-critiques was something we really took advantage of, when seeing them as internal deadlines. That really made us reach speed early in the process.

I was also happy that we successfully worked at a distance. We had all the material at our own computers. Allthough there were a lot of sketches and drawing by hand. I think that the fact that we did so, made us forced to use clear communication and deadlines.

I learned a lot to work together with a person from another education, the sound and vibration master. It's easy to assume that everybody thinks in the same way, when you only work with the same kind of students in the projects.



The product

The final result wouldn't have been the same if I would have done it by my self, which I really think that is a strength in a project created together in a group.

I felt we put more effort on the design of the opera building in detail, in it's soul, it's special features and other stuff, then what was really expected nor able to communicate thought the competition format.

A big challenge was to combine the concept of thoughts with the visual concept. We had quite clear ideas about what values we wanted the opera building to stand for, but how this values would be created in an visual way was harder.

Due that the concept was clearly defined a bit late in the process, some of the decisions in the design process should, when looking back, have come a bit earlier. During the time, some other concept grew strong in themselves, like the concept of the plan and the concept of breaking up the big scale with smaller volumes, and the concept with a auditorium differing from the other form language.

If I would have more time I would look at the concept and try to make it more pure. I would also want to investigate the question how you can see that the building has to do with music, from the outside. Maybe the answer would be that it shouldn't, but then it would be an conscious answer.
If I could restart I should have analyzed the scale of the site more, when I personally feel that I was a bit unused to work in such a big scale.