VERTICAL - CONCERT HALL

Year 3, Spring
Group project with: Kalle Thorsager & Hannes Helmholz (acoustician)
Course: Bachelor's thesis in architecture and engineering, Indoor climate, Acoustics
Tools: Grasshopper 3D, Rhinoceros, Sketching by hand, Photoshop, Illustrator
Teachers: Morten Lund, Peter Christensson

PURPOSE

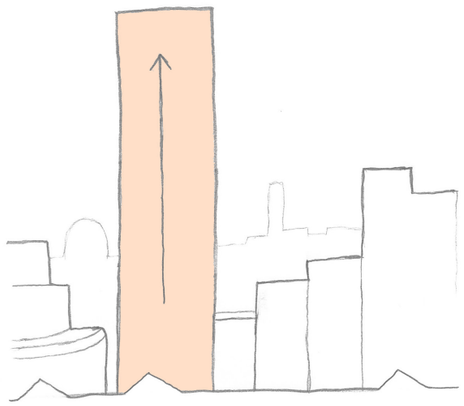
The purpose of this projects was to investigate a new way of experiencing a concert. The context of the building was to follow the competition for “Center for Music”, in which the project was to be located in Barbican, London, United Kingdom. The functions within the building had as purpose to regard the context and also, most importantly, enabling the projects investigation.

CONCEPT

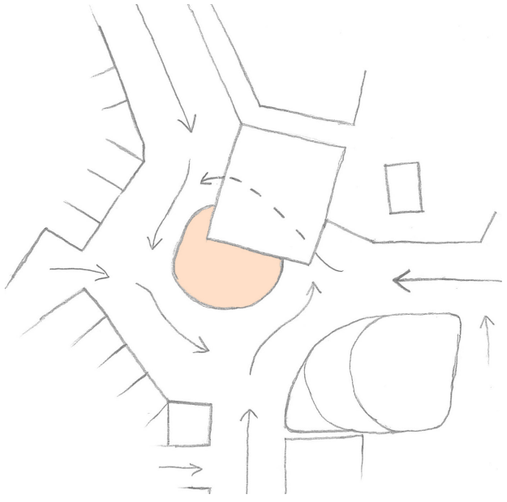
The concept of this project was to investigate the experience and acoustics of vertical concert hall, i.e. a tall and narrow room. We wanted the building to reflect unique experience and the verticality of the auditorium. We broke the visual connection between musicians and audience completely. Instead we wanted to transform the room into a more vivid experience with projections. As for transportation concept we developed a solution with semi continuous flow of platforms traveling in a set direction on a periodic path.

CENTER FOR MUSIC

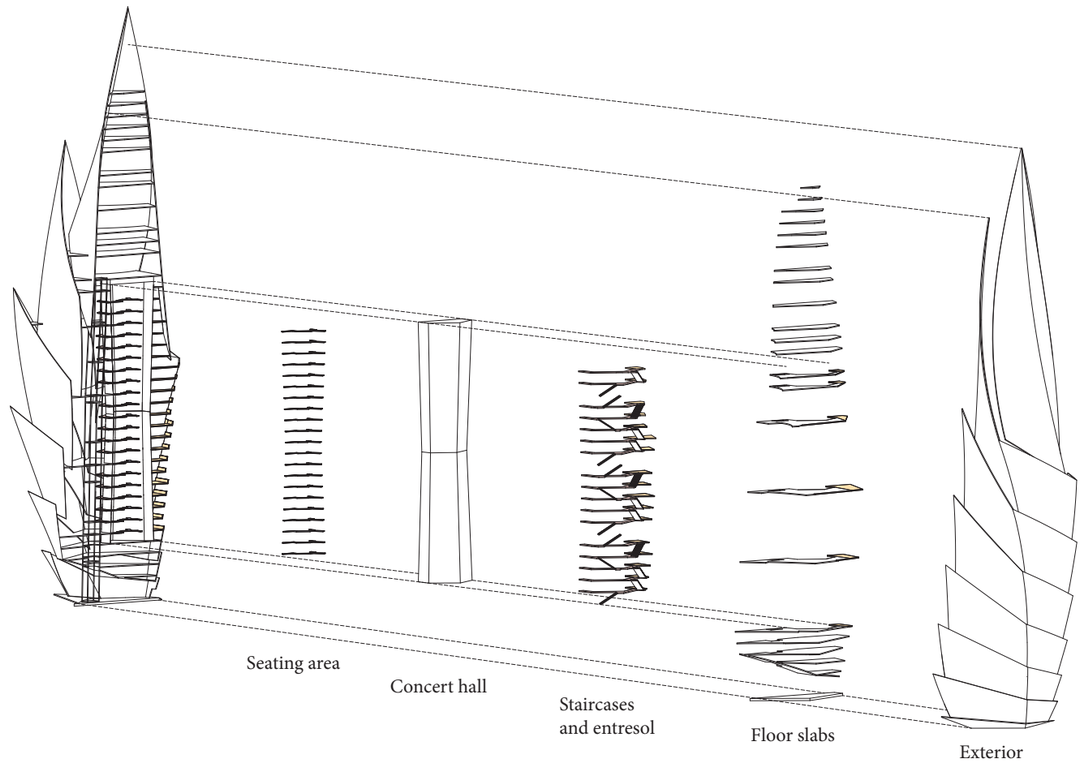
The Concert hall is to be a part of what is described in the foreword of the competition for the Center for Music: “long-term economic plan for the future of London as a world-class city, aiming to make London a centre of the world’s creative and commercial life, with new investment in science, finance, technology and culture. As part of that plan you asked us to create a world-class new concert hall at the heart of the capital. You asked the Barbican Centre, with its resident orchestra the London Symphony Orchestra, to consider the case for a new state-of-the-art Centre for Music that would ensure London’s leading role in the future and inspire a new generation.”



Using height to stand out and save footprint space.

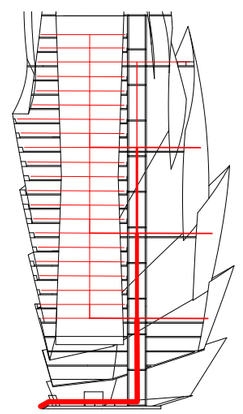


Capturing the rotating nature of a roundabout and connecting it to the lucidness of performance.

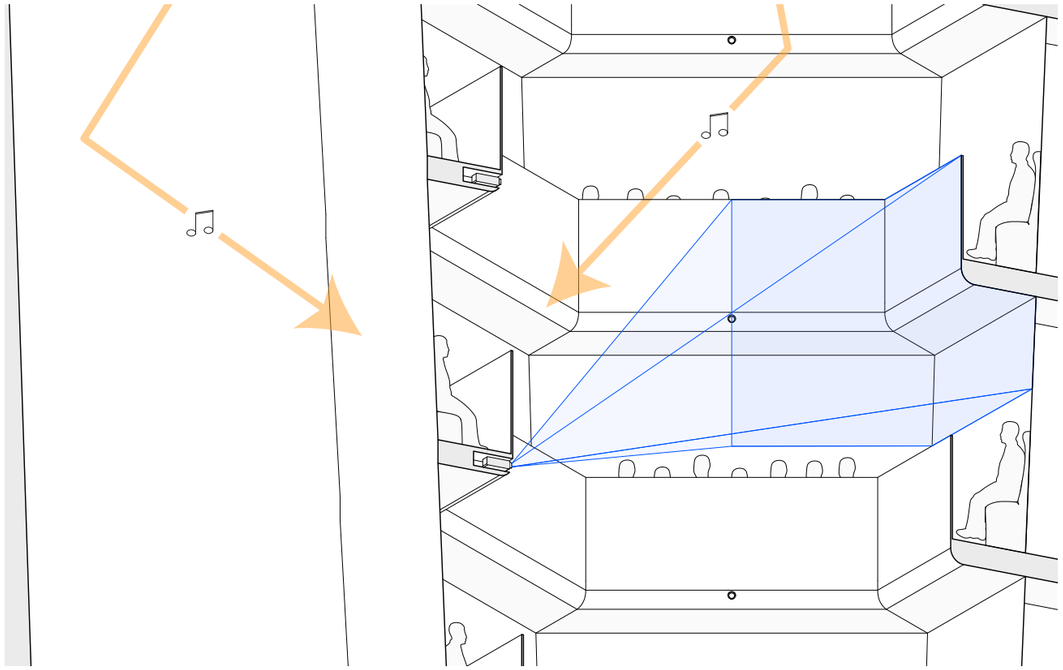


A CITY FLAME

There is three ways towards the building, all of which are with long sightlines making the building stand like an obelisk at the end of them. The building stands tall and with its unique expression it will attract people who is not usually interested in music or concerts. The building exterior represents the experimentation inside and hopefully does not only attract but also inspire people who normally would not attend a concert.



Flowchart for the audience movement



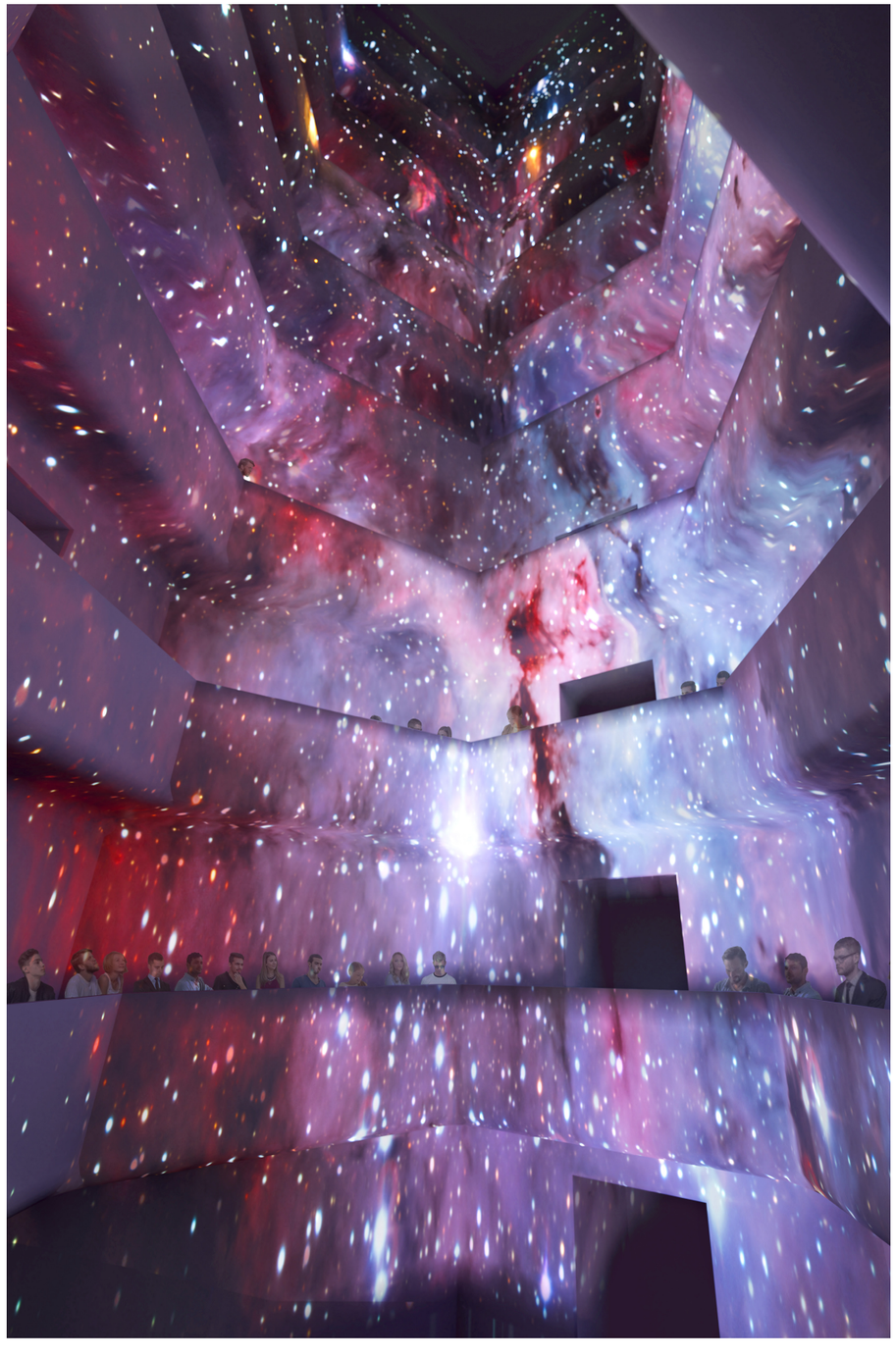
Projector setup and acoustical situation

EXPERIENCE

The sealing and fence are covered in panels which are projection screens making the experience of the hall not only a acoustical experience but also a visual. Since there is no visual connection with the orchestra or musicians the projections will be in focus and as such they should be customized for each different concert in a collaboration of visual artists and musicians. This hall unites the two arts creating a unique experience.

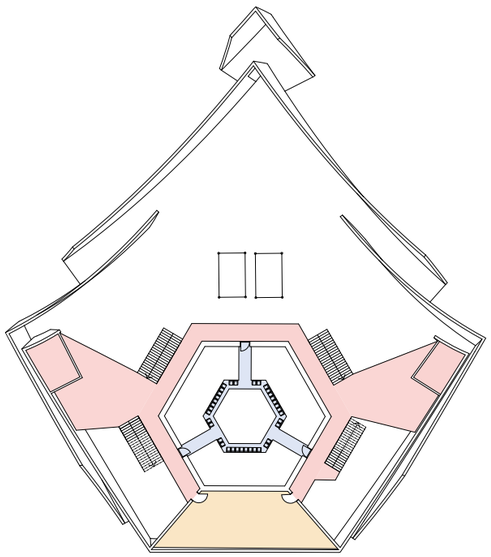
AUDIENCE

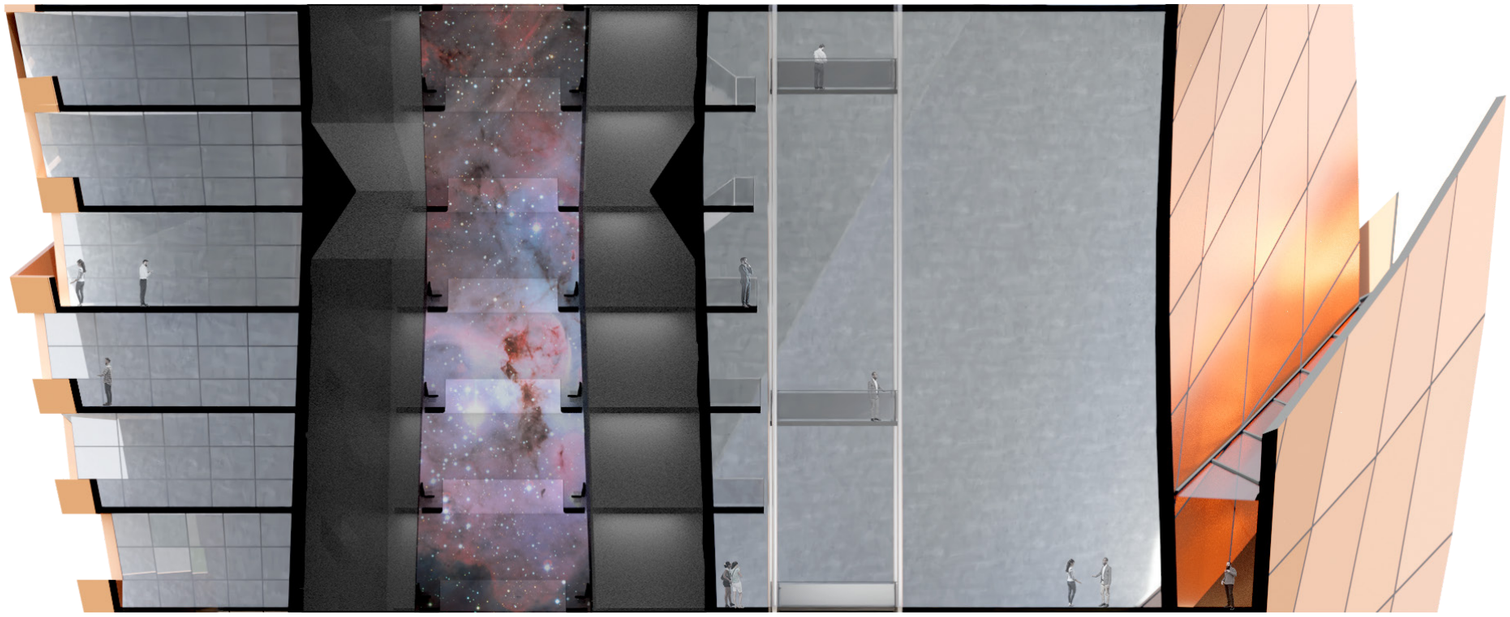
You enter the auditorium through a rather small corridor which breaks your conversation and guides you to your seat. The room is tightwith a hole in the middle and the seats are placed in a circle around it. With the help of an acoustically transparent wall sound arrives to the audience from all directions. The projection system is based on dividing the hexagonal donuts into thirds. The projectors themselves are hidden within the floor slabs to maximize panel area and avoid dazzling.



ASCENSION

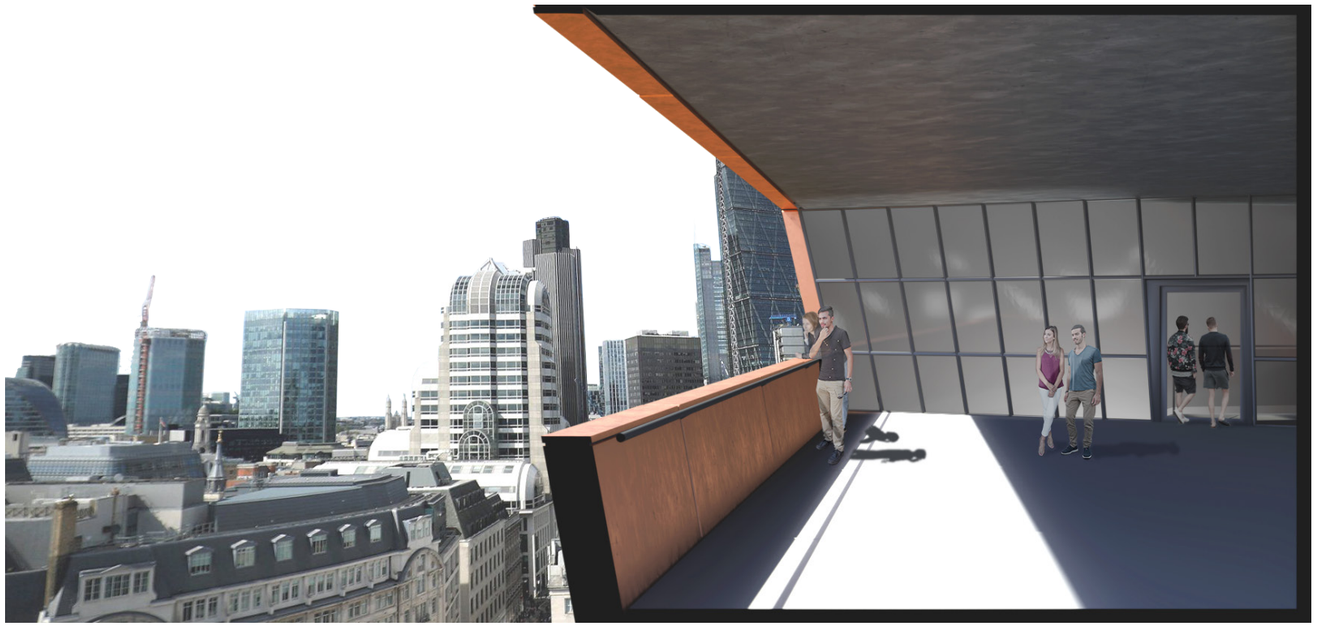
You ascend the building upon the custom platform elevator that transports you to one of the four lobbies. The elevator is basically a periodic path on which platforms travels in one direction slowing down on floor levels for you to get on or off. The lobbies feature a terraced stair situation letting one continue the journey upward through the rooms or enter ones seat in the auditorium. All lobbies have a cloakroom, café, bathrooms and every level has an balcony looking towards the Thames.





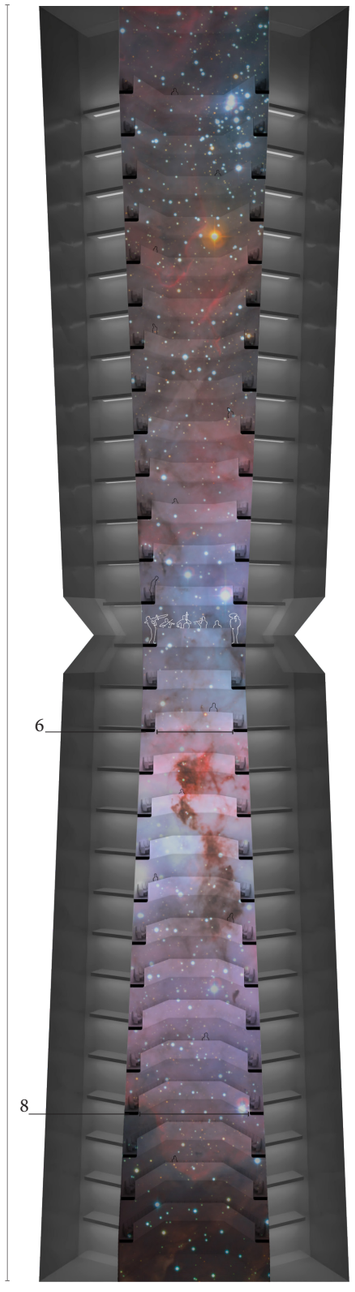
VOID

The lobbies have large volumes and their curved walls lets light through where there are gaps in the shells of the exterior shape, this makes the rooms main source of light the raking light enabling the focus of the void. The entresols around the auditorium allows visitors to experience the volumes from many different heights and perhaps find qualities not easily recognized from the main floor.



BALCONIES

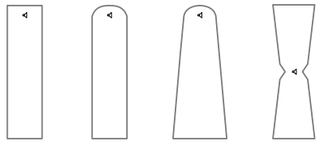
All main floors and entresol levels have a balcony towards the south. The shorter walls of the room are glass walls allowing for more raking light in the lobbies. The room gives you a look at the skyline of London with buildings like St. Pauls Cathedral, The Shard and Tate Modern.

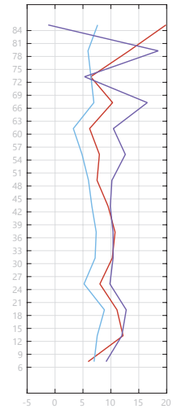


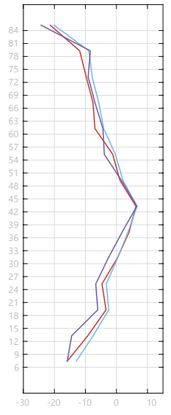
Consert hall
900 seats

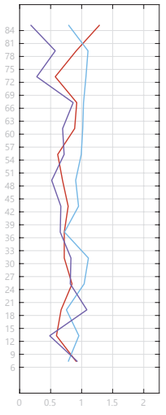
EXPLORING ACOUSTICS

The abnormal proportions of the hall made achieving a sufficient sound quality difficult. The main problems we identified were sound strength, reverberation and containing standing reflection patterns. We opted for an iterative process where we identified different elements that we evaluated separately, both with graphs and a subjective evaluation of simulated auralizations. The graphs below are a final model with an extra detailed simulation and model including diffusers. The result is overall good on all frequency bands but is exhibiting some decrease of loudness far away from the source. We are also seeing a surprisingly low reverberation time with respect to the room volume. However, this can be adjusted with a less absorptive wall material.

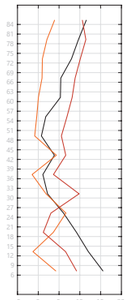


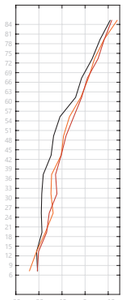


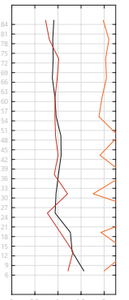




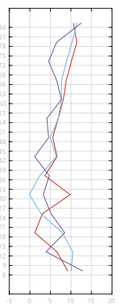
ELEMENT ANALYSIS

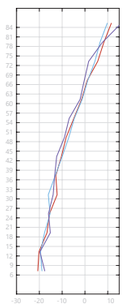


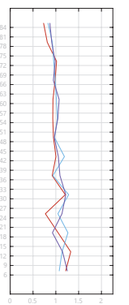




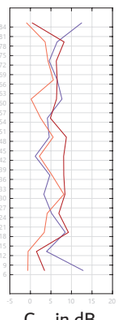
Evaluating the roof shapes effect on sound projection down through the room. The roundness of the roof must not be great enough to accumulate reverb (orange, T_{20}), but project the sound early to help the clarity (red, C_{80}).

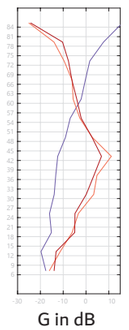


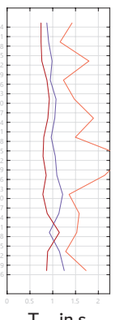




Adjusting the tapering of the walls. The graphs show little difference from one another. However, the auralization differentiated from each other and tapering from the top (purple) stood out as better.







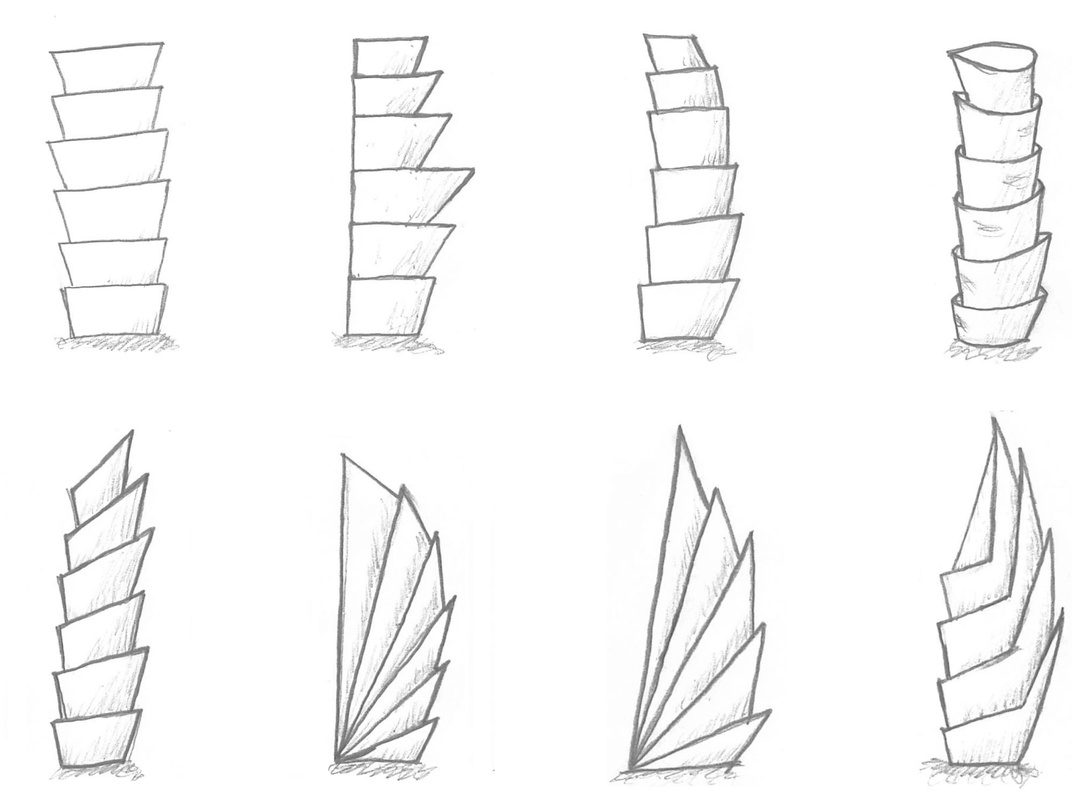
Moving the sound source. We expected that decreasing the length that the sound has to travel would improve the sound quality, but it also forces the sound to expand in a new direction. We choose to continue with hourglass (red) mainly due to loudness equality.

REFLECTION

The main focus of the project was to explore the experience at a concert hall the expression of the exterior was to reflect what is happening inside. Thus a large part of this project has been experimenting with geometry, both in the auditorium, to optimize the acoustics, and in the exterior to find the desired expression. Since the proper acoustical calculations were made in a program unfamiliar to me and Kalle we created a grasshopper script that generated lines to simulate in 2D the soundwaves in our auditorium, this is reasonable because of the rooms symmetry. With this script and the plug-in Galapagos we created a algorithm that generated geometry based on just a couple of boundary conditions. It tried optimizing the amount of sound arriving at the areas representing the audience (fitness). These geometries could then be discussed and tested in the real acoustical program CATT. This proved to be very efficient and gave us time to test many different ideas and boundary conditions.

The architectural qualities around the auditorium were found quite naturally because the shell shape was a clear boundary conditions to work with. The shell, the large curved surfaces and the verticality opened up opportunities for interesting qualities that we probably would have had difficulty finding without this form concept. In this project we made our own program which enabled us to focus on what we found interesting and as we faced trouble with different boundary parameters affecting one another we were able to dissect them and lock in what was necessary for progress.

The presentation poster



ENERGY AIMS

The energy usage in the building should aim to be as low as possible. The transportation system probably uses the most energy. To optimize it one should design the system to take advantage of the potential energy for the platforms traveling downwards and generate energy with the slowdown mechanism. The lights and projectors should be as energy saving as possible and perhaps some of the facade panels could be swapped for coloured solar panels.

ENVIRONMENT

The indoor climate of the rooms should all be customized for their desired function. To acquire the best possible indoor climate it is important that the building is constructed with care allowing all solutions to be well implemented and all risks concerning fire, mold and other possible problems should be thought about in all stages of the project. It's important that every step of the project is documented and analyzed such that others can learn and improve from it.

DESIRED VALUES

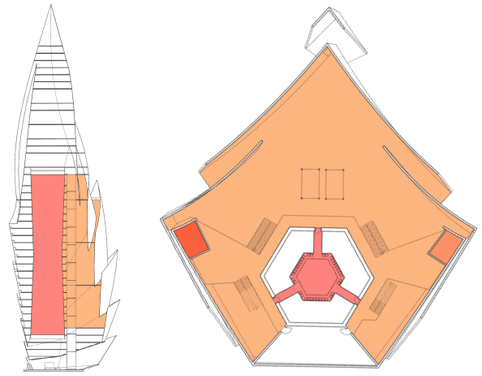
Room	Person [st]	Time [min]	Operative temperature summer [C]	Operative temperature vinter [C]	Acceptable noice level [dB]	RF summer [-]	RF vinter [-]
Lobby	250	45	22 ±3	21 ±3	50	40-60%	30-40%
Concerthall	900	60	22 ±2	22 ±2	25	40-60%	40-60%
Workspace	2 per space	180	22 ±3	21 ±3	50	40-60%	30-40%
WC	5 per level	45	22 ±3	21 ±3	30	40-60%	30-40%
Balcony	40	45	Outdoors	Outdoors	55	Outdoors	Outdoors

Lobby: People are moving here so the room should be slightly colder.

Concert hall: Low movement thus the operative temperature can be higher.

Workspace: working in a cloakroom or café makes you move around and warm machines should be taken into account.

WC: Sitting still but short time and high flow of people in and out of the room.

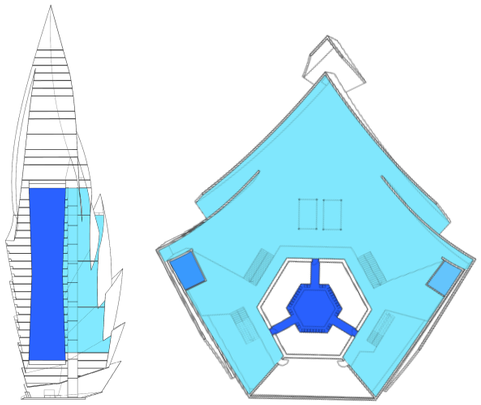


Lobby: a lot of people moving and walking stairs for a quite long duration.

Concert hall: Low movement and airspeed should be kept very low and some instruments are sensitive to humidity.

Workspace: High airflow and air quality since working people in rather small rooms.

WC: Airflow towards these rooms such that the air don't spread any smells.



Lobby: Large and open room with people talking.

Balcony: Open for the sound of the city.

Technics: Room for technics.

Concert hall: Should not be disturbed by any other sound.

WC: Should not let any sound in to the lobby.

Workspace: Should not be disturbed by noise in the lobby.