



# SILENT CUBE

## CAMPUS OPERA

*together with David Edlund & Ella Stålhandske*

### **Bachelor's project** 2024

The program for this project was based on the annual student design competition hosted by The Acoustical Society of America. This year, the competition submission should be a proposed opera hall for a college. A fictional site with defined dimensions, but no context was given. The auditorium should accommodate approximately 1200 people, and some technical requirements regarding the opera hall were also given.

# COMPETITION POSTERS



## SILENT CUBE

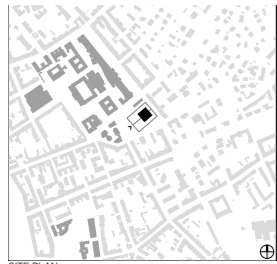
### CONCEPT AND LOCATION

The concept of Silent Cube is an intersection of two simple geometries: a substantial and heavy-looking cube housing the opera hall and a tent-like structure encapsulating the overall building and its surrounding functions. Combining these two structural shapes results in a distinct yet contrasting appearance.

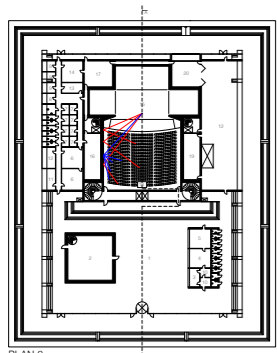
Silent Cube is imagined in the Austrian city of Graz, between the Universität Graz to the north and the Kunstuniversität to the south. The campus area between the two universities is located in the heart of the city and is both traffic and pedestrian dense, resulting in a vibrant environment.

### CONTRASTING BUILDING

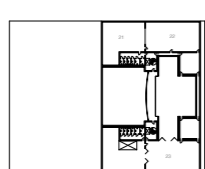
Whilst the walls containing the opera hall and the rehearsal room are heavily isolated, the surrounding spaces covered by the thin steel structure and polycarbonate panels are not. This emphasizes the quietness and isolation of the rooms partially hidden inside the larger opera hall cube and smaller rehearsal room cube. In addition to acoustical and structural contrast, there is also the experience of light. The polycarbonate roof is semi-transparent and lets in a uniform dimmed light over the hall during the day, and out towards the city during the night. Entering the cube, visitors are first faced with a dark passage, followed by stripes of light leading into the opera hall where more lights reveal the size of the room.



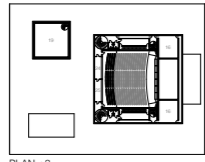
SITE PLAN



PLAN 0

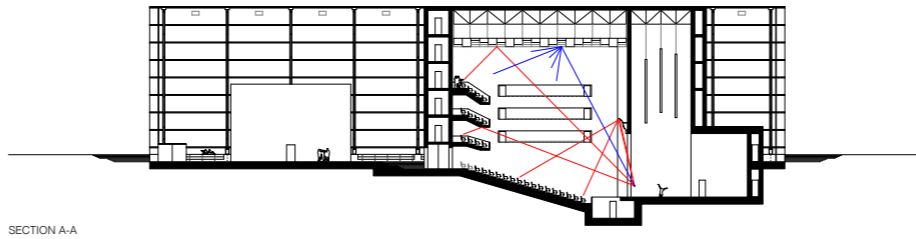


PLAN -1



PLAN +3

NOISE CRITERIA		NC-15	NC-30	NC-40
1	Lobby	1850		
2	Rehearsal Room	225		
3	Reception	21		
4	Cloakroom	46		
5	Cafeteria & Bar	46		
6	Chorus Dressing Rooms	102		
7	Solo Dressing Rooms	70		
8	Administration	10		
9	Offices Technical Staff	30		
10	Offices Company Staff	22		
11	Cleaning & Laundry	21		
12	Storages	546		
13	Conductor Dressing Room	25		
14	Green Room	51		
15	Opera Hall	1100		
16	Technical Rooms	256		
17	Staff Entrance	83		
18	In-house Audio Mix Position	6		
19	MER/MEPFIT	311		
20	Loading Dock	105		
21	Wig & Makeup	298		
22	Prep Pantry	321		
23	Scene Shop	621		
24	Lighting & Stage Manager Control Room	30		
25	Follow-Spot Booth	30		



SECTION A-A

### OPERA HALL

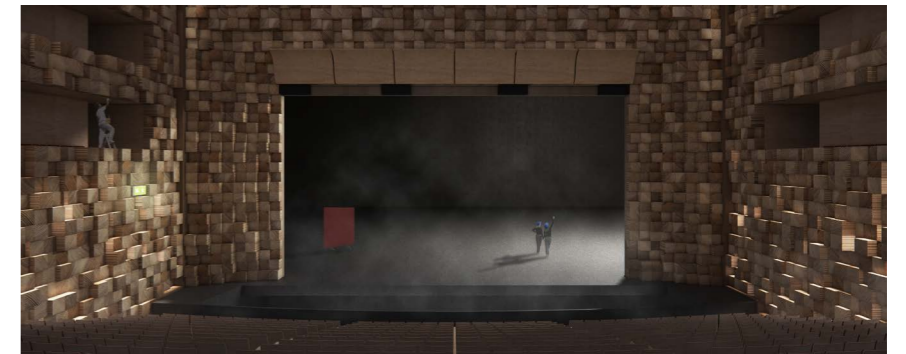
The opera hall is shaped like a shoebox and relies on its wooden elements to balance the soundscape. 55 percent of the 1178 seats consists of orchestra seating and the other 45 percent is divided on three balconies. There is a slope of 20 degrees downwards towards the scene and most of the seating is pushed to the back of the room, as opposed to the side walls. This is to make sure that everyone has good line of sight to the entire proscenium and stage.

### REHEARSAL ROOM

The rehearsal room is built by the same principle as the opera hall, but in a smaller size and with slightly tilted inner walls. It is placed inside of a sound isolating cube, free-standing in the lobby area. The same acoustical panels that are used in the opera hall are also used in the rehearsal room, but with a higher share of absorptive panels to reduce loudness. The reverberation time is variable, but generally lower than in the opera hall to accommodate for the smaller volume.

### MULTIPURPOSE USE

The building is designed to accommodate uses beyond rehearsals and scheduled events. Firstly, the opera hall serves a dual purpose as an auditorium, featuring a sloped room and variable acoustics that also make it suitable for speeches, presentations, or ceremonial events. Secondly, the open and inviting atmosphere of the entrance section creates a flexible space, allowing for smaller events, informal gatherings, or fairs to be hosted in the lobby area.



### NOISE AND VIBRATION

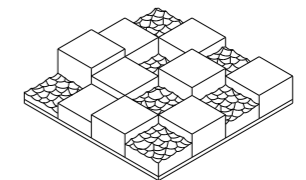
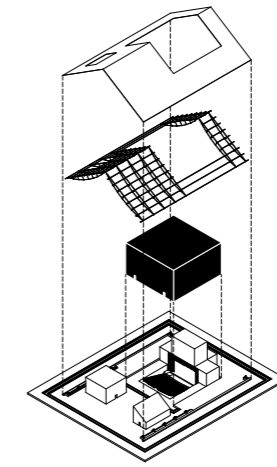
The opera hall and rehearsal room use a box-in-box design with double walls. The construction includes two layers of cross-laminated timber with a dampened cavity for noise control. This achieves noise reduction suitable for MER systems and outdoor noise, ranging from [28 38 46 58 70 64 53] dB across frequencies from 63 Hz to 4 kHz. The combination of decoupled walls and a spring-mounted inner structure help minimize noise and vibration transmission.

### ACOUSTIC PANELS

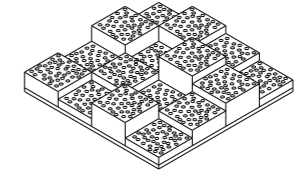
Both the opera and rehearsal halls use two types of wooden panels made from square timber beams of varying depths. The first type is diffusive and reflective with smooth and textured surfaces to reflect and diffuse sound. The other type is diffusive and absorptive, combining perforated surfaces with a layer of mineral wool underneath for enhanced sound absorption. Their modular design allows for easy combination to achieve the desired acoustical environment.

### VARIABLE ACOUSTICS

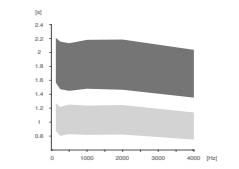
The inner ceiling of the opera hall can be lowered by up to 6 meters, allowing for adjustments in room volume between 11,000 m<sup>3</sup> and 14,800 m<sup>3</sup> to achieve varying reverberation times. Similarly, the inner ceiling of the rehearsal room can be adjusted by 2 meters, varying the volume between 800 m<sup>3</sup> and 1,250 m<sup>3</sup>. The strength of the sound remains consistent regardless of changes in room volume, while clarity slightly reduces with increasing volume.



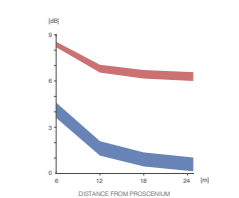
DIFFUSIVE AND REFLECTIVE PANEL



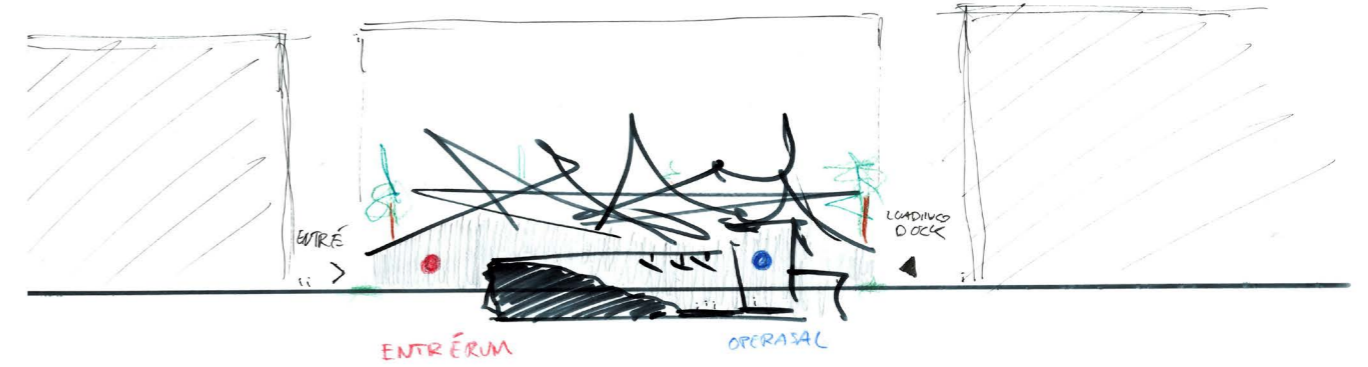
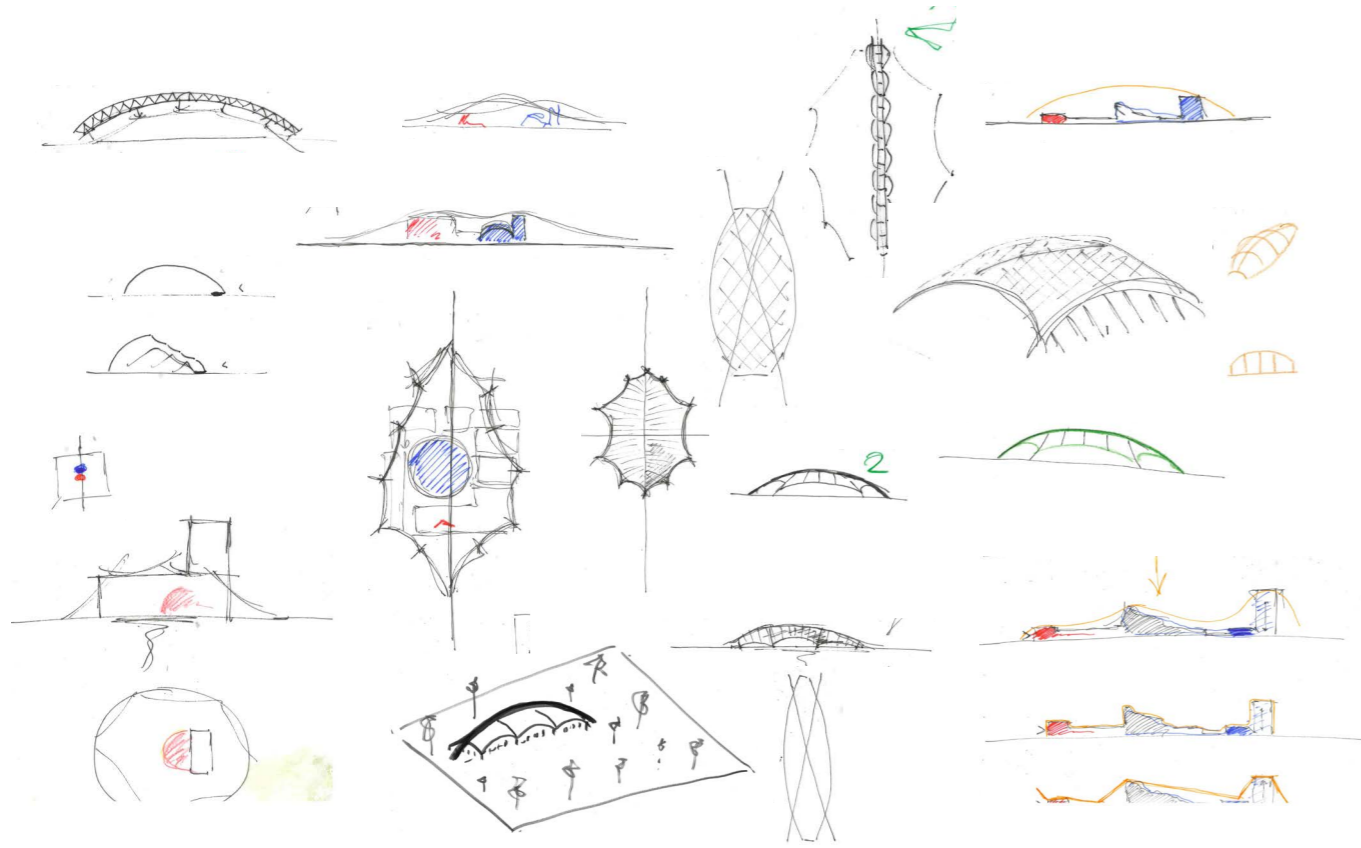
DIFFUSIVE AND ABSORPTIVE PANEL



VARIABLE REVERBERATION TIMES (T<sub>60</sub>)



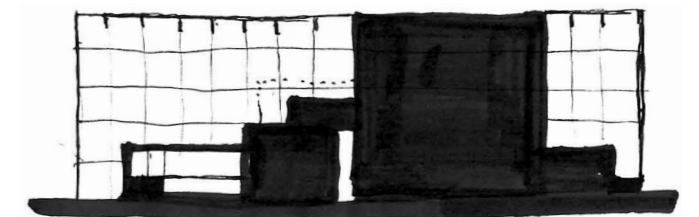
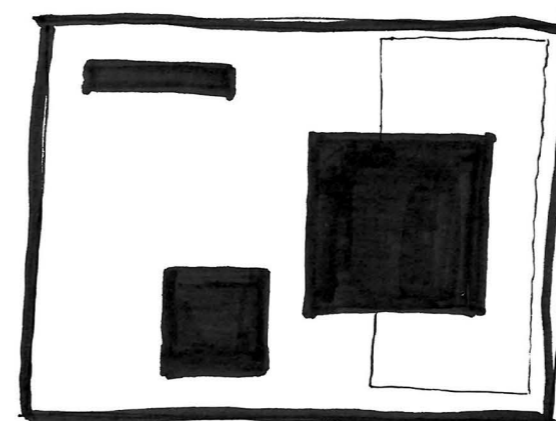
STRENGTH AND CLARITY



## CONCEPT AND PROCESS

Based on our early sketches on three different base concepts, we chose to continue developing our idea of placing the opera hall inside a sound isolating volume. A separate, light weight, roof structure would sweep over the lobby area and other less sound sensitive functions. The idea behind this was to emphasise the contrast between the acoustical environments and allow the lobby area to be used for all sorts of events.

We started to develop our idea by doing a lot hand sketches, but we soon realised that the scale of the opera hall is very big and would be a decisive factor in this project. Therefore, we continued our sketching process by building physical paper models to find geometries that would work with the large scale. That was when we found the geometry that became the base for Silent Cube: a single folder paper, intersected by a wooden cube. The shape is simple, yet striking, and further emphasises the contrast between the spaces.





## OPERA HALL

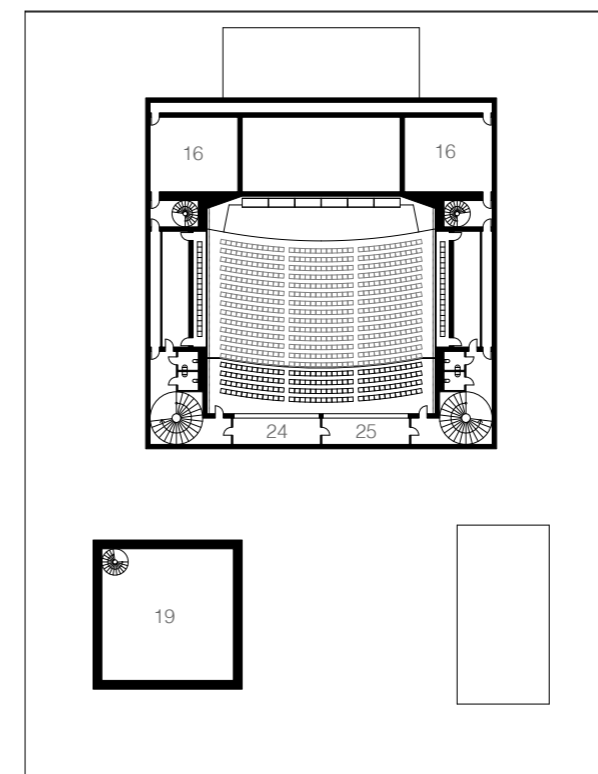
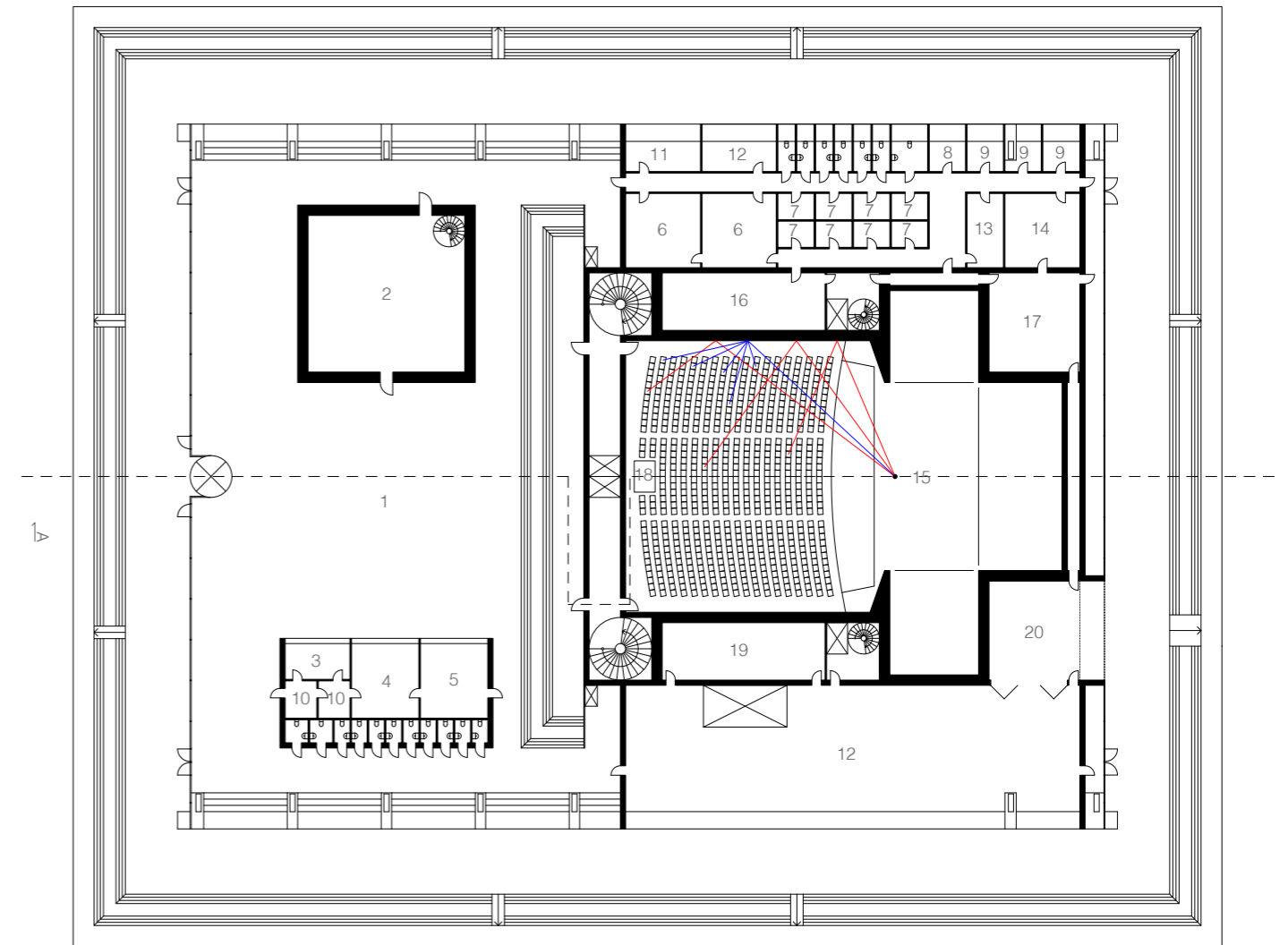
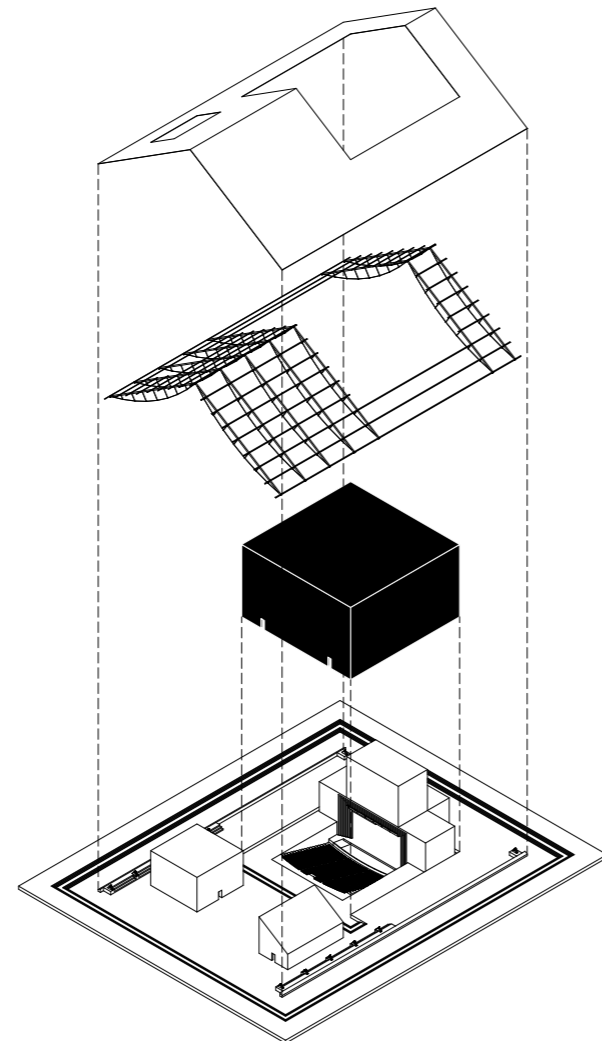
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## MULTIPURPOSE USE

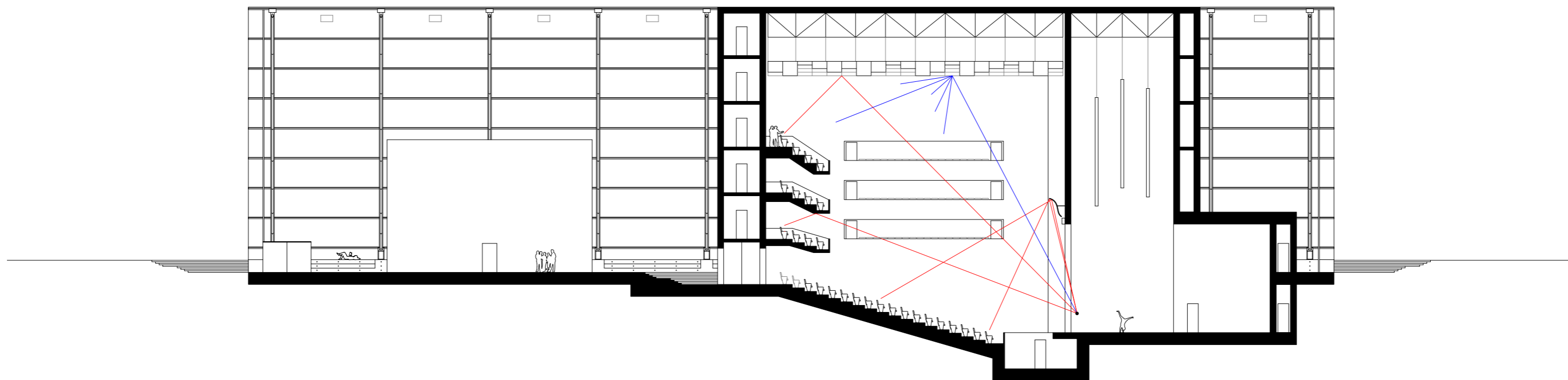
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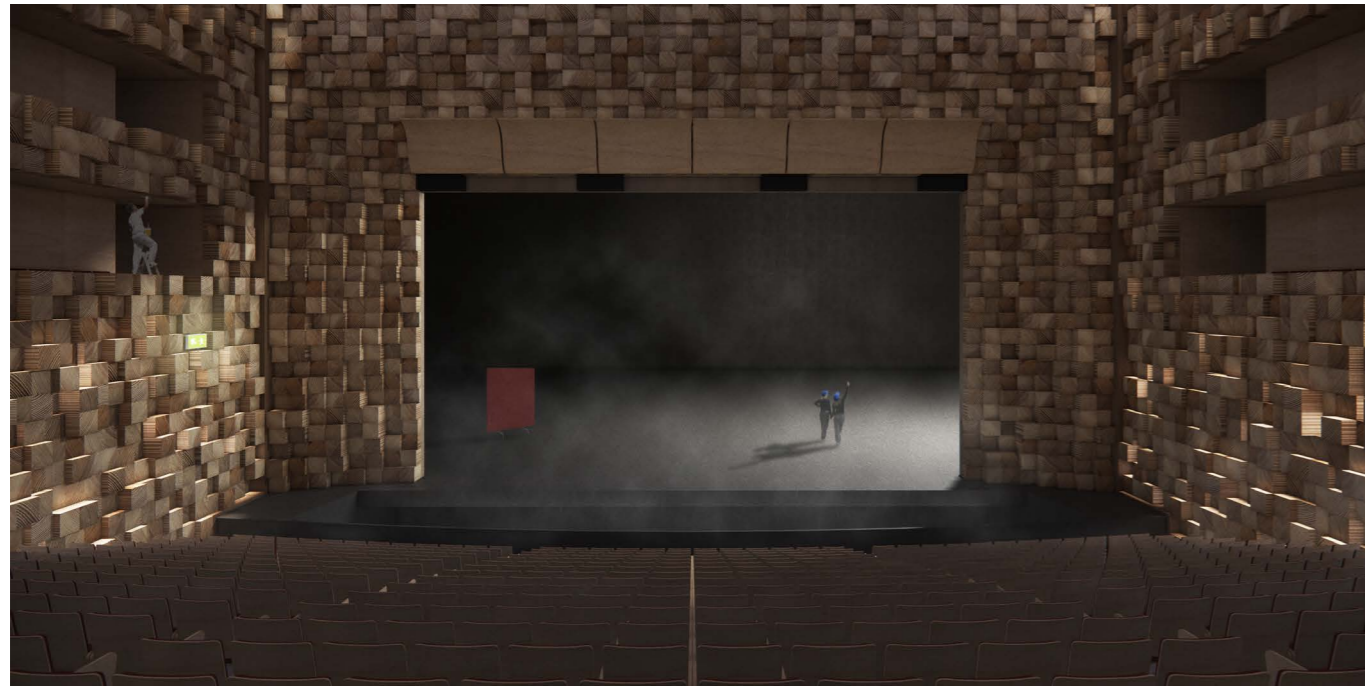


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[m<sup>2</sup>]





## NOISE AND VIBRATION

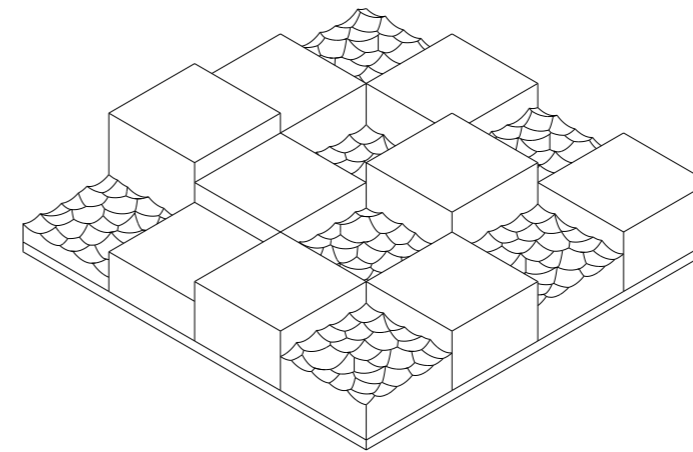
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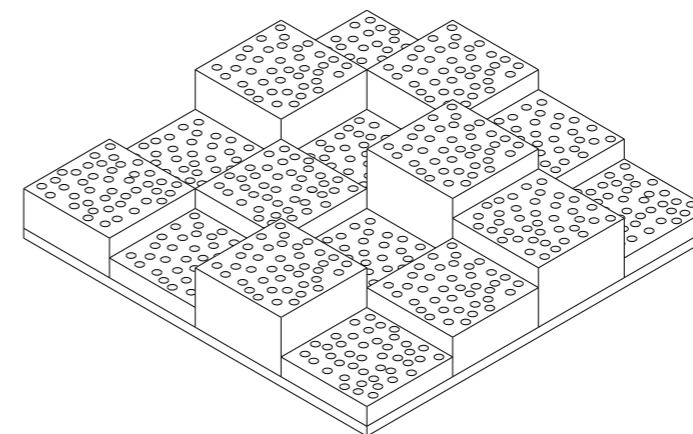
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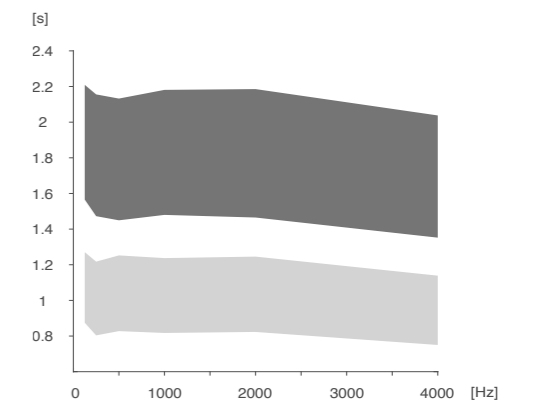
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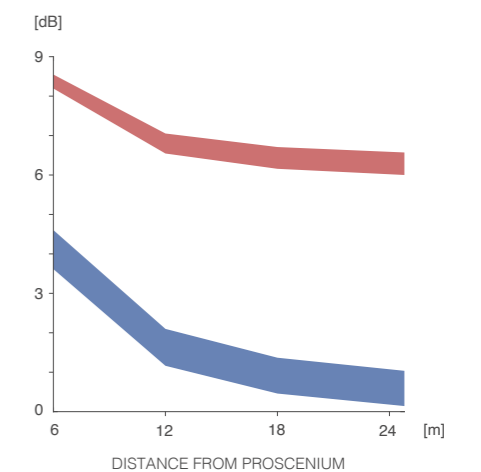
DIFFUSIVE AND REFLECTIVE PANEL



DIFFUSIVE AND ABSORPTIVE PANEL



VARIABLE REVERBERATION TIMES (T<sub>60</sub>)  
 ■ Opera Hall ■



STRENGTH AND CLARITY  
 ■ Strength (G) ■

# REFLECTION

The process of designing Silent Cube was quite different compared to how I have worked on my previous projects. This is mainly due to our decision to work with sketch models at an early stage, and we came up with a geometry that we really liked from the beginning. From that point, we had a very clear concept to work with. That very strong idea of the geometry allowed us to work more in detail with spaces, materials, and acoustics from earlier on. This resulted in a project that for me, feels very thought through. At least on those aspects that we chose to focus on in the time frame of the project. The structure for the roof over the lobby area is one important thing we didn't develop as far. Even though we spent a lot of time figuring out what type of structure that would be suitable for the span, and the atmosphere we wanted in the space, the design is far from finished. No calculations were made to estimate the spacing or geometry of the beams. Since the visible structure heavily influences the space, and the span is so big, I think it would be really interesting to evaluate that structure in the future.