Co-working Space for Musicians

Group 5
May 2023
Samar Singh Rana

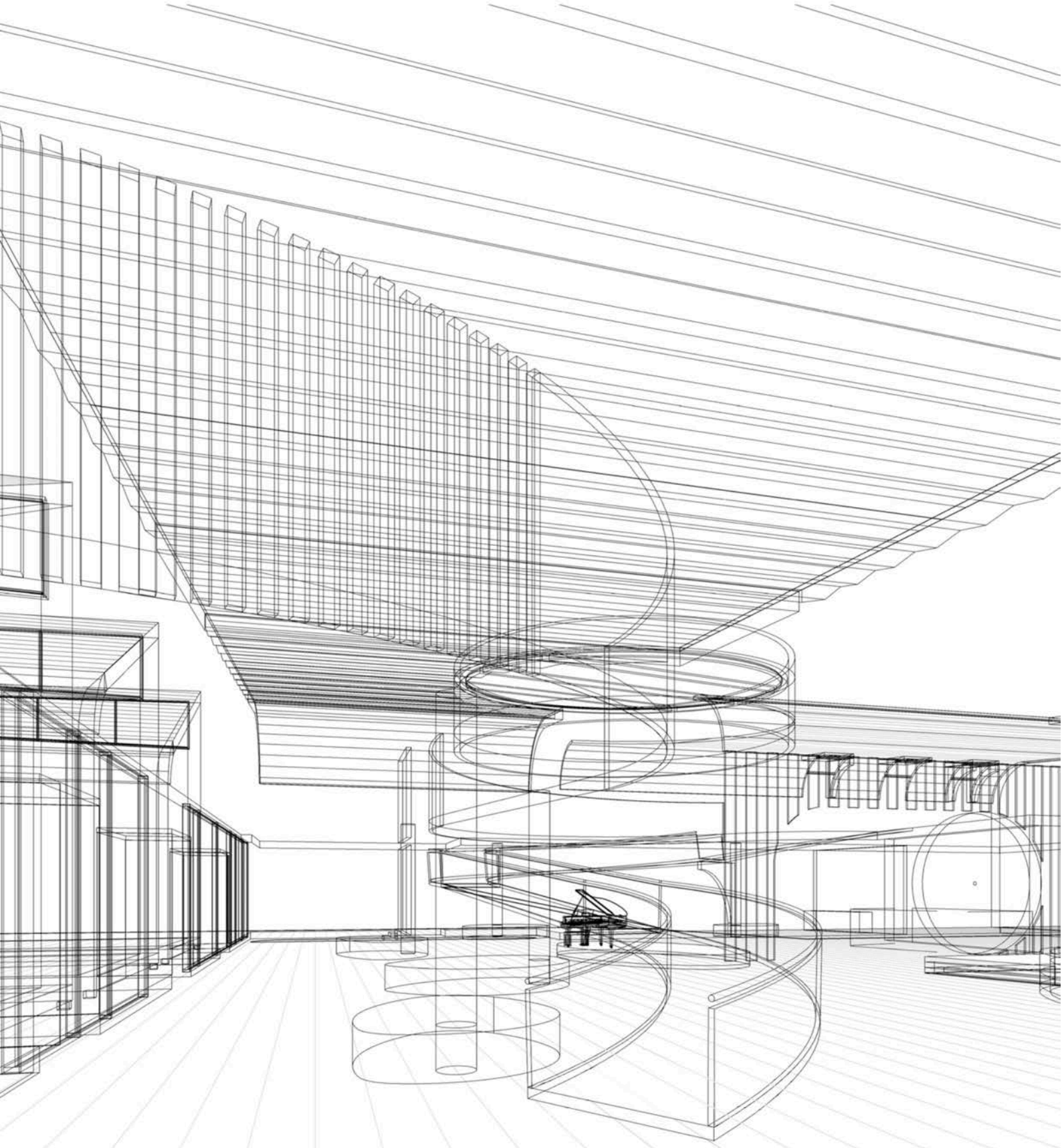

Fig 1. Koncertpladsen, Refshaleøen

report information

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abstract

The report is a result of the master thesis project for the degree in engineering architecture. Through analysis, process, presentation and conclusion, it explains the design of a cultural and creative centre for musicians, located at Refshaleøen in Copenhagen.

The project explores the creative process of musicians in relation to the architectural space. Besides that, sound being an active part of the architectural design is also being explored. Acoustics, aural architecture and co-working are the three main cornerstones of the project, based on which different analysis and results have been produced.

The project extracts into a co-working space for musicians, where the creative process and community aspects of musicians are being reinforced, by providing an acoustically and aurally sound facility.

For Refhaleøen, the facility acts as an important addition to its other cultural desitinations, and the agenda of it being a cultural hub for Copenhageners is also being strengthened.

In a nutshell, the facility acts as a doorway to the music and cultural scene of the future.

reading guide

The report comprises of 15 main chapters. It starts with a prologue and initial thoughts, giving a project overview, discussing the problem and finding potentials. It ends with the project focus and methodology.

Later, the 3 cornerstones of the project focus are being discussed as separate chapters, which is followed by case studies, site analysis and design process. This all yeilds into synthesis, where the analysis and design process is being concluded.

The presentation discusses the building in the order of conxtext, site and interior points of view. It discusses sound and acoustic considerations in the building at a conceptual level. Whereas, ensemble room is the critical case for the project, and it is being discussed and explored in detail. It is followed by acoustic simulation results and corresponding auralisations.

The report ends with an epilogue containing conclusions, reflections and appendix.

Please note that the report consists of time bound QR codes. These can be scanned to listen to the related audio files.

Since this project deals in aural architecture and acoustics, it is adviced to visualize material while listening to the attached audio references.

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prologue

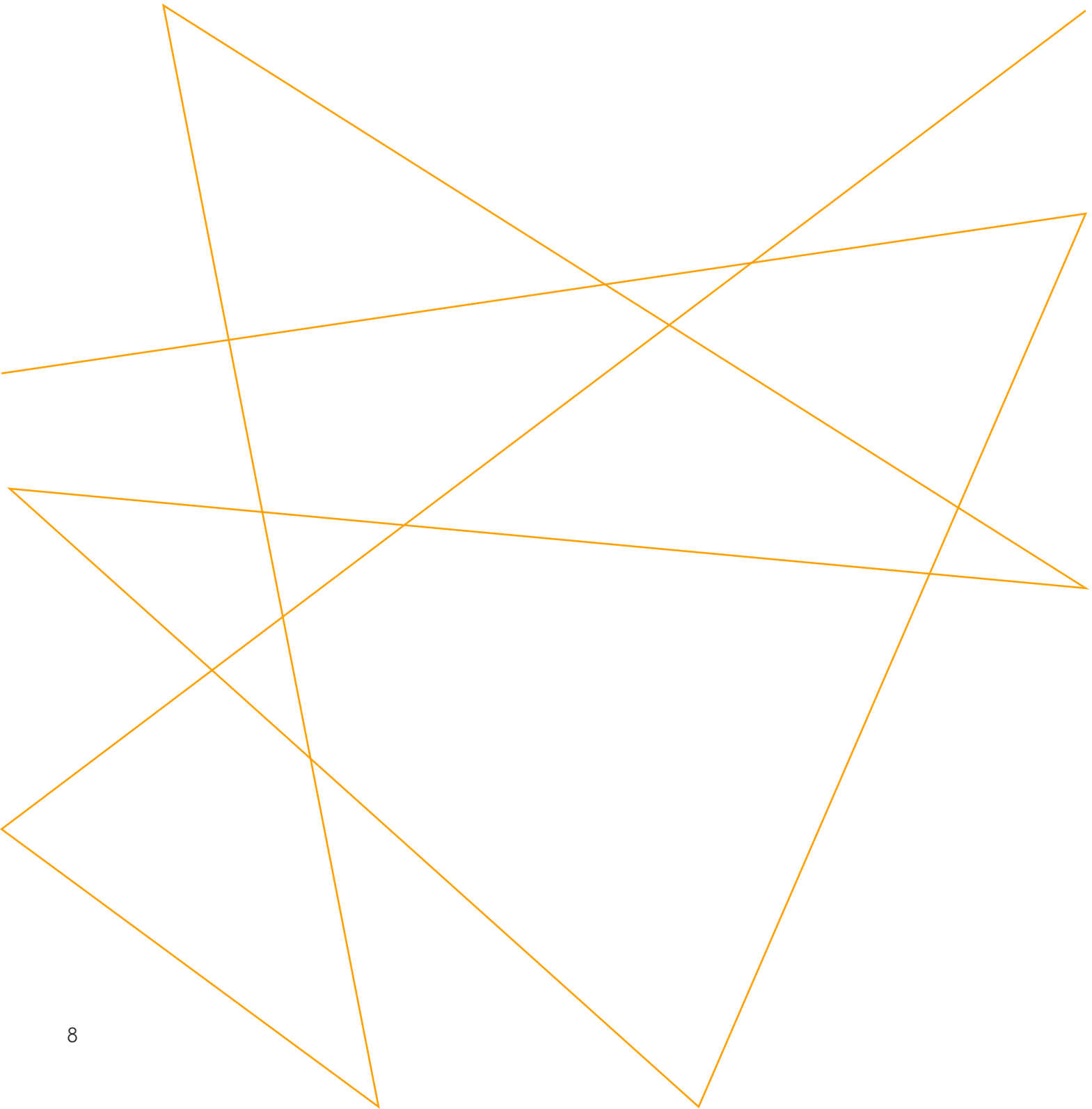


Fig 2. Sønder Hoved (project site), Refshaleøen

introduction

The project is an experimental and theoretical exploration within the realms of acoustics and aural architecture, by creating a "Co-working space for musicians" at Refshaleøen in Copenhagen. In recent years, this former industrial district island has become one of city's most bustling areas while being a significant hub of creativity. The project thereby intends to explore different site potentials and add to the cultural identity of Rafshaleøen, while also addressing to a problem at the same time.

Musicians are the main user group for the project and studies have been conducted to identify their needs, problems/issues and generate potentials to reinforce their creative process and assist them in achieving their goals. The project addresses the problem of lack of proper workspaces with community building opportunities during the writing, composing, production and distribution process of a commercial/ non-commercial music product.

The focus of the project is to explore different acoustic and aural considerations in an integrated design project, so as to achieve a richer, satisfying and user oriented indoor and built environment. It involves communicating the artistic, social and emotional aspects of the project by focusing on the aural aspects, in addition to the visual and utilitarian ones.

location

55°41’29.0”N 12°36’30.9”E

The site is called “Sønder Hoved” and it is located at the inner harbour area of Refshaleøen in Copenhagen. It is an open piece of land, which is temporarily being used for hosting concerts and festivals.
It is surrounded by water on three sides and has the view of Kastellet towards the west, accross the harbour.

Fig 3. Location
Google, ©2023 TerraMetrics SIO, NOAA, U.S. Navy, NGA, GEBCO

Refshaleøen

"the island has its name after its shape resembling a fox's tail."

Fig 4. Reshaleøen - 1945 (kbhkort.kk.dk)

Fig 5. B&W Halls (refshaleøen.dk)

history

It was formed in 1868, when Copenhagen's Port Authority began filling the shallow sea area around a sandbar between Nyholm and the sea fort Lynetten. In 1872, Burmeister & Wain A/S moved its ship building to Refshaleøen from Christianshavn, making it one of the biggest shipyards in the world by the end of 1960s. The island grew and so did the building infrastructure, inhabiting around 10,000 employees at its peak.

Unfortunately, the company started having financial difficulties during the 1970's and the island was taken over by Refshaleøen Ejendomsselskab, a collective of 4 pension funds. Despite their several efforts to lease it back to Burmeister & Wain A/S, they could not prevent the old shipping giants from filing bankruptcy in 1996.

Since then, Refshaleøen Ejendomsselskab owns most of the island till this date and their aim has been to transform it into a cultural and recreational hub for the city.

Fig 6. Copenhell (copenhell.dk)

"the new development phase focuses on climate awareness, communities, inclusion and health."

Fig 7. Reffen

the revival

Refhaleøen nowadays is an active creative hub of Copenhagen, bustling with numerous activities like alternative urban development, music festivals, art exhibitions, street food markets, gastronomy etc.

It consists of 4 open spaces for hosting events and fesivals as follows:

- Koncertpladsen - 45,000 sqm
- Sønder Hoved - 25,500 sqm
- Beddingen - 20,000 sqm
- Minefeltet - 5000 sqm


Fig 8. Reffen

Fig 9. Interview with Refshaleøen Ejendomselskab

interview with stakeholders

To get a point of view of the stakeholders and incorporate their dreams and ambitions in the project, an interview with Refshaleøen Ejendomselskab is conducted. Any development concerns and the prevailing issues at the site are being discussed as well.

Idea reception:
Future urban development of the island and the project site is presently under public hearing for new ideas and visions. Thereby, the idea of a co-working space for musicians is well received, especially because the site is as for now being used for concerts and festivals. The music community is the common denominator and their overall vision of creating cultural and recreational infrastructure is also fulfilled.

Intent and initiatives:
Their intent has typically been to keep the piece of land as open as possible, but they seemed open to new ideas. They have even rented a very small part of the site for small projects like a transitional shelter/cabin and some herb gardens. The herb garden part will be free to use for the intended project because the restaurant owning them has recently closed their business.
They would like to keep most of the premises vehicle free, whereby the parking spaces near the bus stop and the site entry can be used for visitors and only limited parking spaces can be allocated along the project site.

Issues:
Issues of smell from the adjacent cleaning plant is discussed. They are resolving the problem, but the project site is just outside the bounds of it and should not consider it as a big problem. Rising sea level is a potential future problem, and that is being resolved at the municipality level; There is a proposal of creation of a new island called Lynetteholm, an extention to Refshaleøen to prevent its inner harbour by placing gates at different spots in the harbour.

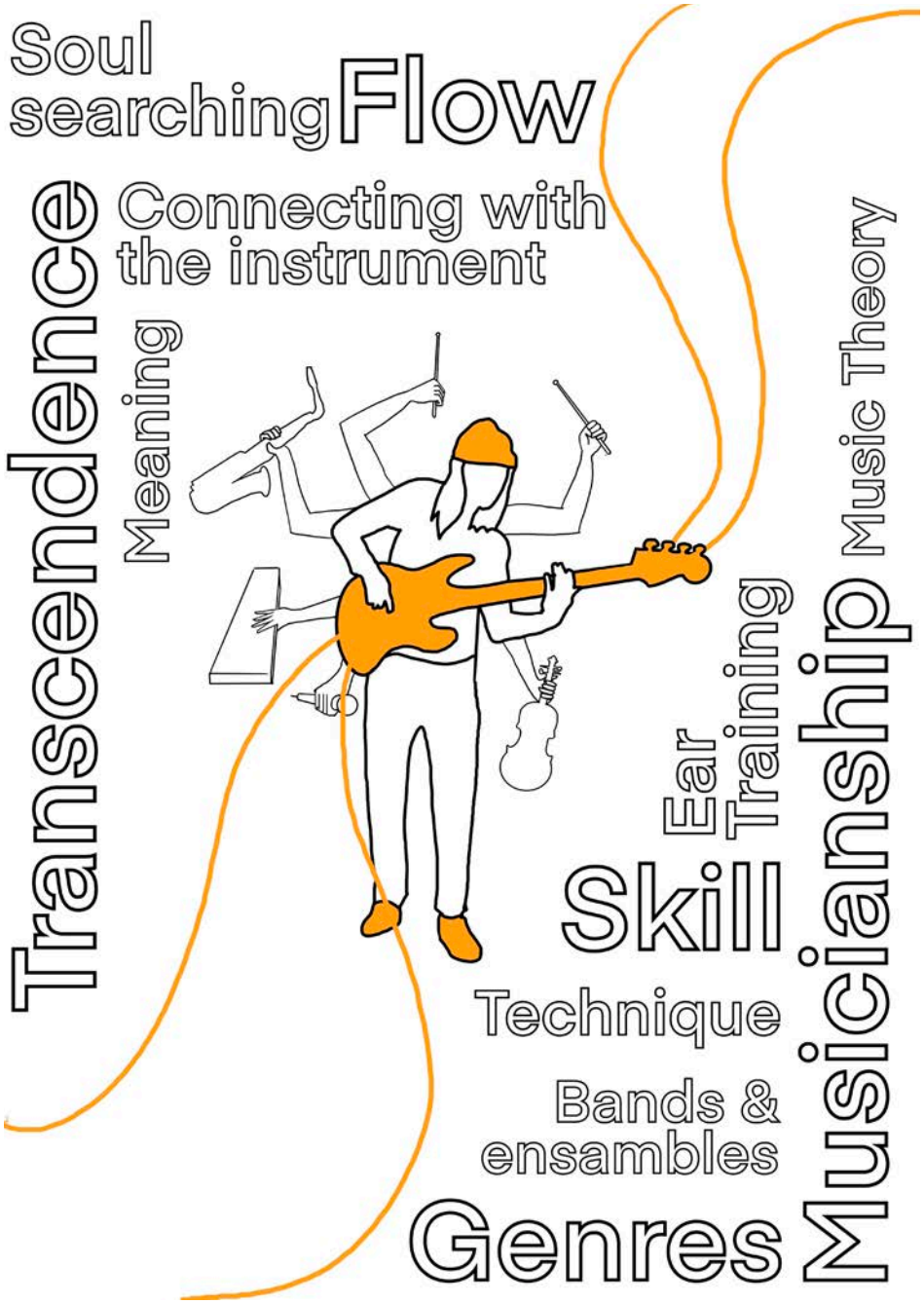
"the ideas competition will be launched in autumn 2023, inviting architects, town planners, landscape architects and others with professional experience in urban development to come up with design ideas and proposals for the further developmemt of Refshaleøen."

takeaways

- Refshaleøen posseses a strong historical identity, which can be something to work with while designing.
- The stakeholders have a vision and are actively seeking ideas and projects for its further development.
- How to create a synergy between the existing functions and the proposed project?

user(s)

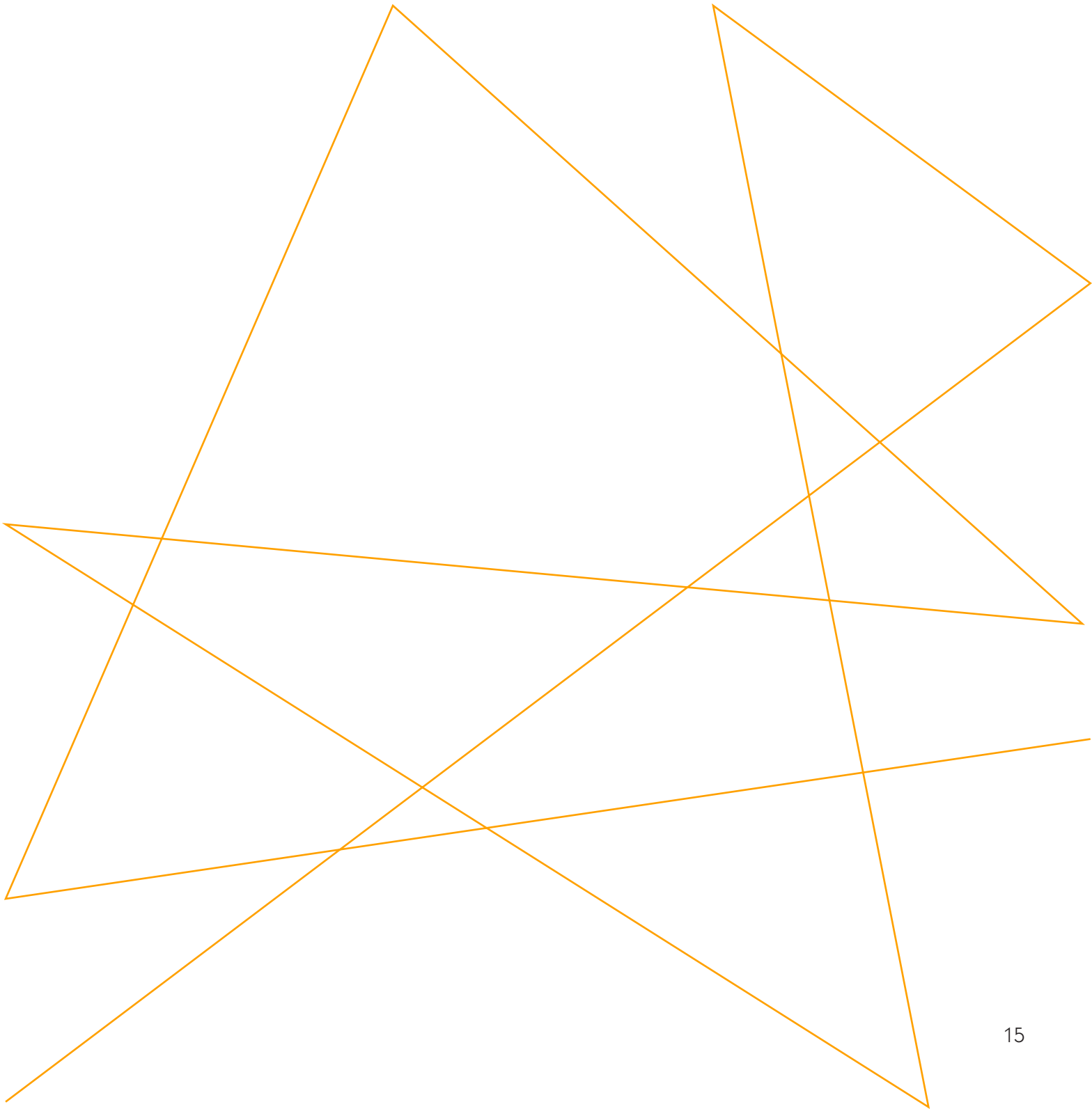
Fig 10. User (author)



musicians are the main user group of the project. A musician, in general is defined as the performer, composer or conductor of music. However, over the course of time it has become a broad category amassing multifarious sub-categories; Hobbyists, independent artists, independent label artists, major label artists, songwriters, session musicians, producer-composers, orchestra musicians, musicologists, teachers and the list goes on and on.

They all share the same essence but differ in their aims, objectives and methods. Being a musician is a very dynamic process, which involves a lot of exploration and a strong work ethic to arrive at one's chosen destination. Making music can take place at the individual as well as at the collective level; Each method comes with peculiar workflows, followed by their respective struggles and challenges during the creative process.

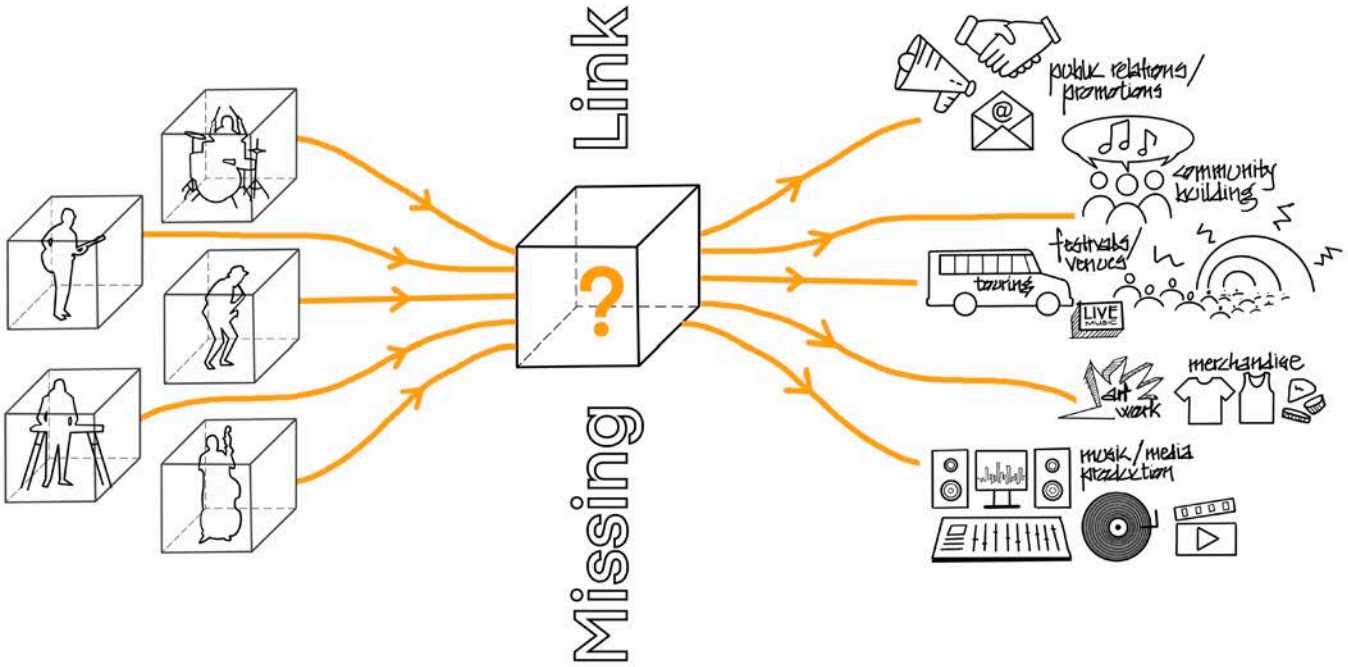
initial thoughts



Spaces with other primary function used for music making

Erratic creative flow

Isolation



Unsuitable built environments

Band aid acoustics

Noise, annoyance for neighbours

Fig 11. The missing link (author)

the missing link: here to there

The project focuses on the creative process of musicians to go from making music in one's living room, basement or garage to playing the same as a final product for people, via live or recorded performance.
A problem of lack of proper workplaces with community building opportunities during the writing, composing, production and distribution process of a commercial/ non-commercial music project is being identified and further discussed.

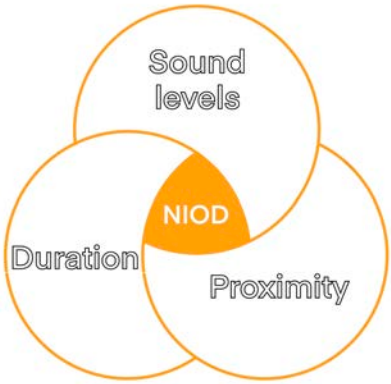


Fig 12. Noise induced otologic damage (author)

hearing problems in musicians

There are studies and research to support the fact that musicians are highly prone to hearing problems during their lifetime. In one study (Kahari, Zachau, Eklof, Sandsjo, & Moller, 2003), manifestations of one or more of these disorders were found in 74% of the 139 rock/jazz musicians studied.
Musician's shearing necessities, as related to their livelihoods, are much greater than those of other professions, and their hearing-related injuries can become severe or possibly career-ending disabilities (Sataloff, 1991).

Some of the major disorders arising from NIOD (noise induced otologic damage) are:

Auditory disturbances
- Noise induced hearing loss
- Tinnitus
- Hyperacusis
- Diplacusis
- Recruitment

Vestibular dysfunction
- Vertigo
- Disequilibrium

Musicians are routinely exposed to potentially hazardous sound pressure ranges, extending up to 120 to 130 dBA only 3 feet from the speaker in amplified rock/pop bands (Hart et al., 1987), 83 to 112 dBA on stage in various orchestras (Sataloff, 1991), and 80 to 101 dBA on stage in jazz, blues, and country and western bands (Chasin, 1996). Furthermore, for rock/jazz/pop music performances, there is not much variation in the sound levels during the performance as compared to classical music (Hart et al., 1987). Therefore, on the average, rock music is louder than classical music because there are not as many quiet passages in the arrangements (Gunderson, Moline, & Catalano, 1997).

Chasin (2009)

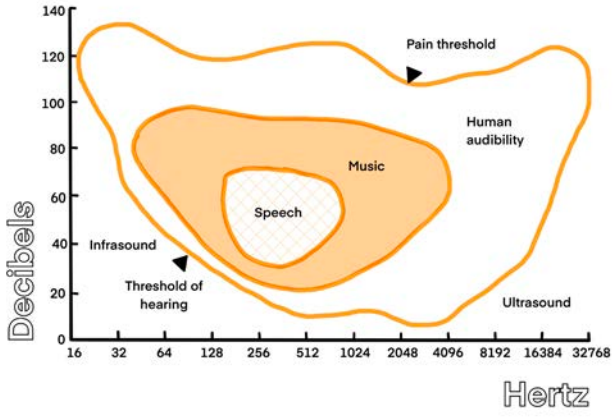
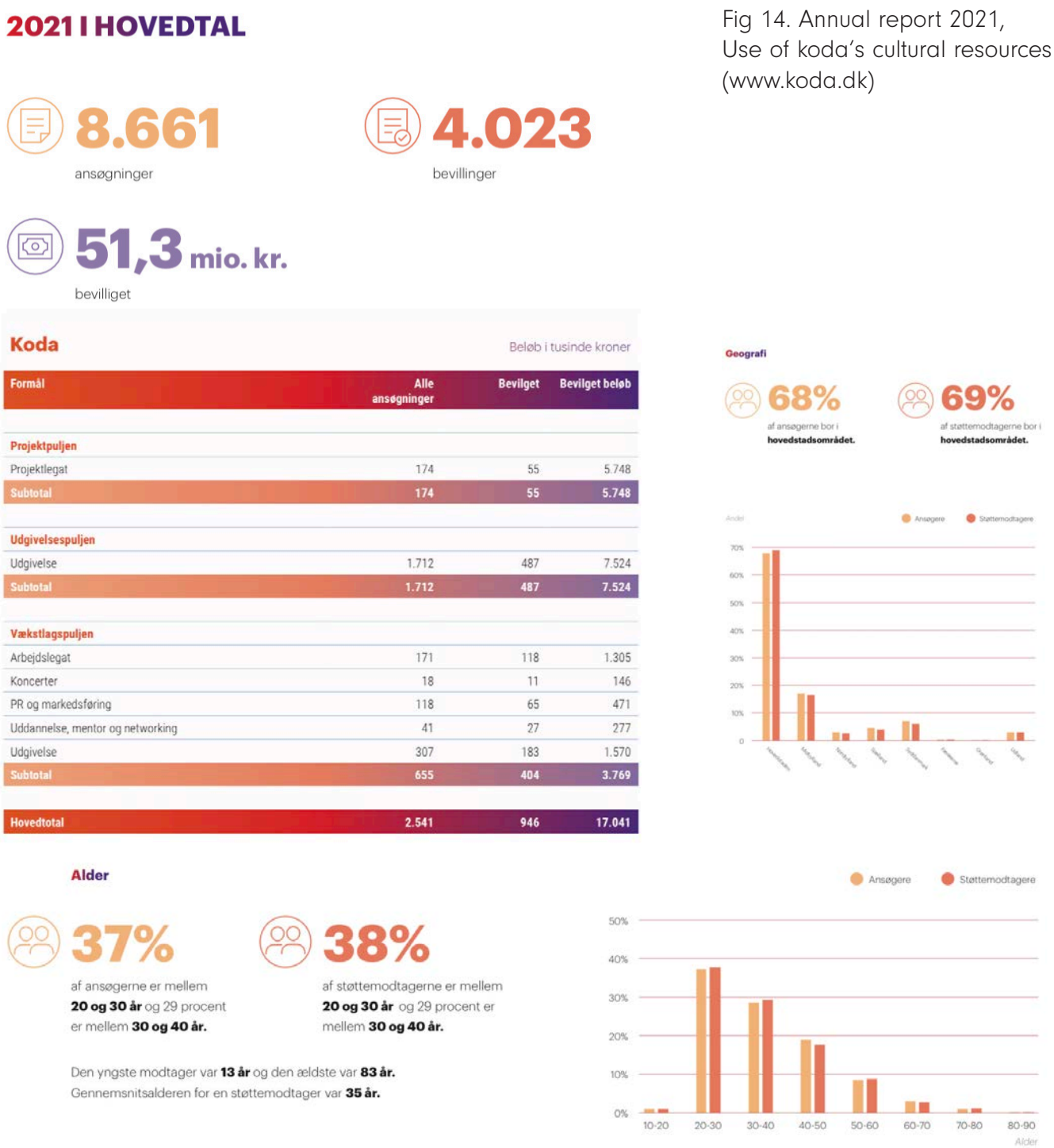


Fig 13. Human hearing range

statistics from koda

Koda is the collecting society for songwriters, composers and music publishers of Denmark. They are continuously invested in establishing a strong and sustainable music life for musicians. Every year, they allocates up to ten percent of their net earnings to cultural funds, which, among other things, stimulate and support the creation of new music in Denmark. They offer support in the form of work grants, production support, songwriter camps, teaching courses, network initiatives and possibilities for international collaborations.



2021 I HOVEDTAL

8.661 ansøgninger

4.023 bevillinger

51,3 mio. kr. bevilliget

Koda — Beløb i tusinde kroner

Formål	Alle ansøgninger	Bevilget	Bevilget beløb
Projektpuljen			
Projektlegat	174	55	5.748
Subtotal	**174**	**55**	**5.748**
Udgivelsespuljen			
Udgivelse	1.712	487	7.524
Subtotal	**1.712**	**487**	**7.524**
Vækstlagspuljen			
Arbejdslegat	171	118	1.305
Koncerter	18	11	146
PR og markedsføring	118	65	471
Uddannelse, mentor og networking	41	27	277
Udgivelse	307	183	1.570
Subtotal	**655**	**404**	**3.769**
Hovedtotal	**2.541**	**946**	**17.041**

Geografi

68% af ansøgerne bor i **hovedstadsområdet.**

69% af støttemodtagerne bor i **hovedstadsområdet.**

Ansøgere · Støttemodtagere

70% 60% 50% 40% 30% 20% 10% 0

Alder

37% af ansøgerne er mellem **20 og 30 år** og 29 procent er mellem **30 og 40 år.**

38% af støttemodtagerne er mellem **20 og 30 år** og 29 procent er mellem **30 og 40 år.**

Den yngste modtager var **13 år** og den ældste var **83 år.**
Gennemsnitsalderen for en støttemodtager var **35 år.**

Ansøgere · Støttemodtagere

50% 40% 30% 20% 10% 0%

10-20 · 20-30 · 30-40 · 40-50 · 50-60 · 60-70 · 70-80 · 80-90

Alder

Fig 14. Annual report 2021, Use of koda's cultural resources (www.koda.dk)

interview with koda

To explore the potential clients for the proposed project, an interview with Koda is being arranged. The project idea is well acknowledged and the problem of the missing link, as discussed before is well agreed upon. If not being the main owners, willingness to be the shareholders for such an facility is positively shown. Musicians getting their project grants can further go to such an facility and realize their projects.

One of their project grants deals with teaching courses and mentorship. Thus, a small aspect of it has the potential of also being integrated into the facility. This can be achieved by providing a teaching space for the musicians. These are some basic functions discussed in the interview and the idea of integrating the facility with their project grant system ended on a positive note.

takeaways

- There is a need for nurturing and further development of the user activity.
- There are concerns of health and well being of the users, that needs attention.
- Koda statistics gives an idea of the massive user demand for support, demographics and shows that Copenhageners are in need of it the most.
- Koda is already invested in providing support to the users, but only at the monetary level. The potential of them being the future clients have been discussed and the idea of providing a facility support to the user group is being welcomed.

focus

The project offers integrated design solutions based on fields of social sustainability, architecture and engineering. For that, the project focuses on the following 3 aspects:

- Co-working
- Acoustics
- Aural Architecture

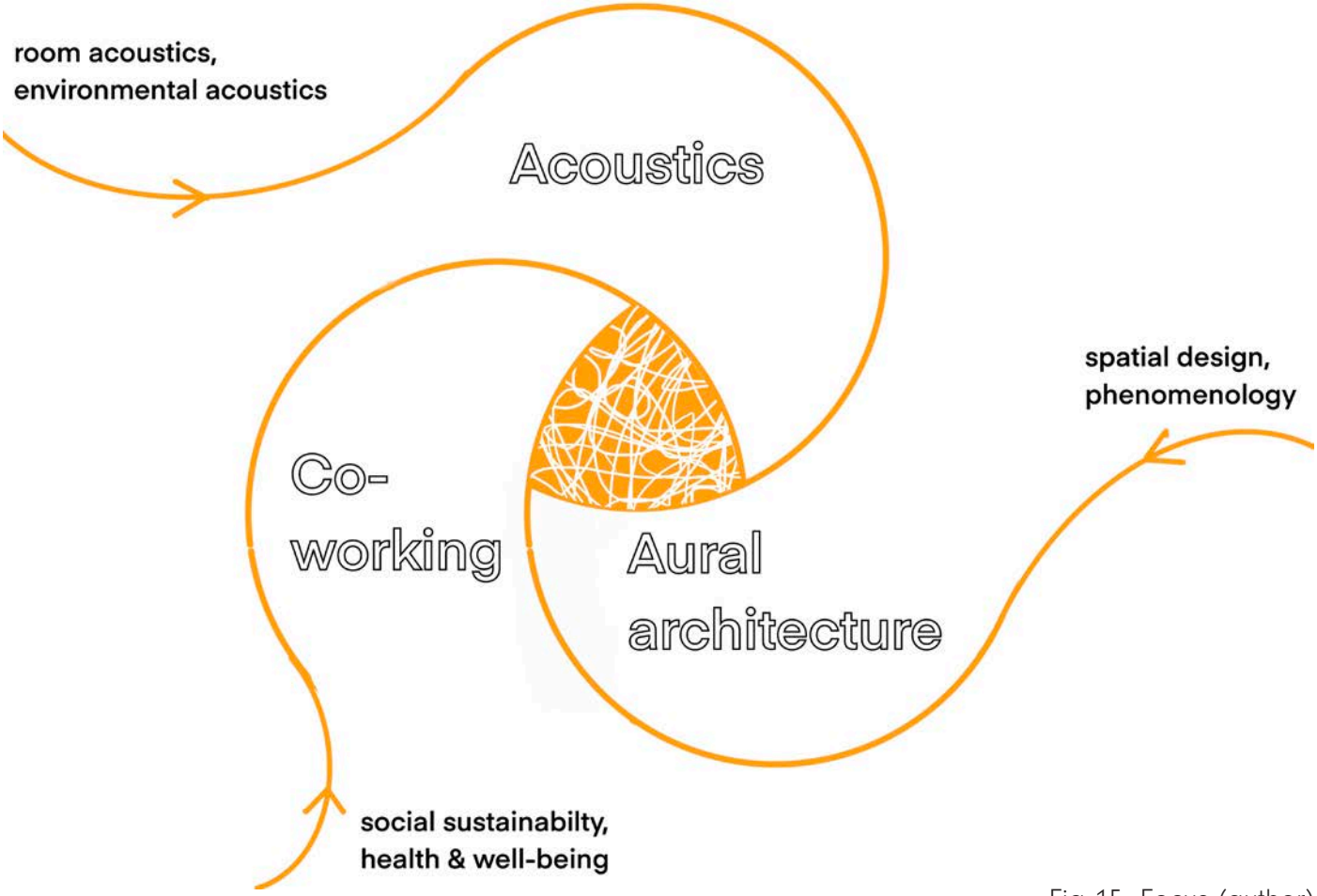


Fig 15. Focus (author)

methodology

co-evolution of problem - solution

"the problem and solution space are interwoven, solution conjectures are helpful to explore and understand the problem space"

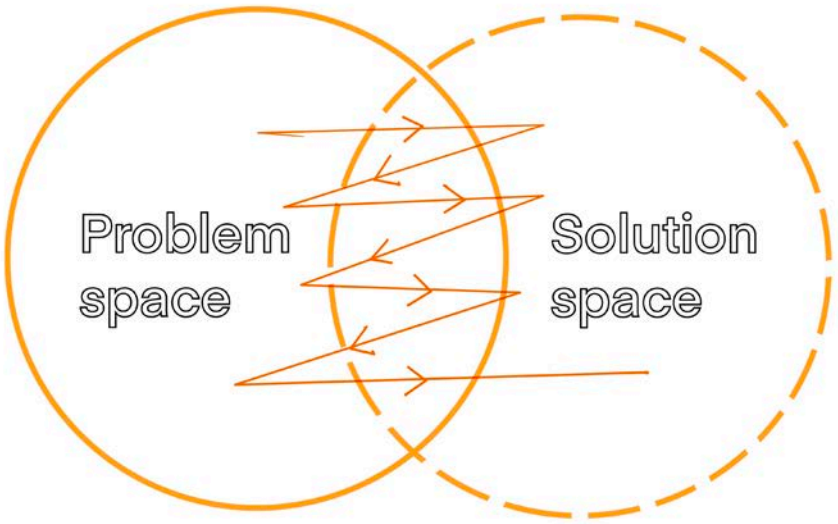


Fig 16. Co-evolution of problem-solution

design problems

- Design problems cannot be comprehensively stated.
- Design problems require subjective interpretation.
- Design problems tend to be organised hierarchically.

design solutions

- There are an inexhaustible number of different solutions.
- There are no optimal solutions to design problems.
- Design solutions are often holistic responses.
- Design solutions are a contribution to knowledge.
- Design solutions are parts of other design problems.

design process

- The process is endless
- There is no infallibly correct process.
- The process involves finding as well as solving problems.
- Design inevitably involves subjective value judgement.
- Design is a prescriptive activity.
- Designers work in the context of a need for action.

Lawson (1997), Dorst and Cross (2001)

integrated design process

This method is being used as a blueprint for the organization of different processes involved and to give an overview. The methodology is divided into five different phases: Problem, Analysis, Sketching, Synthesis and Presentation. In this model, the traditional architecture and engineering components are split into different components, and some of the components from engineering are combined with the architecture components. The method addresses the integration of these by going back and forth between the different phases.

This method is further arranged into three categories: Explorative, Generative and Evaluative. These are used within the iterative process to impart structure and a targeted approach towards a well evaluated result.

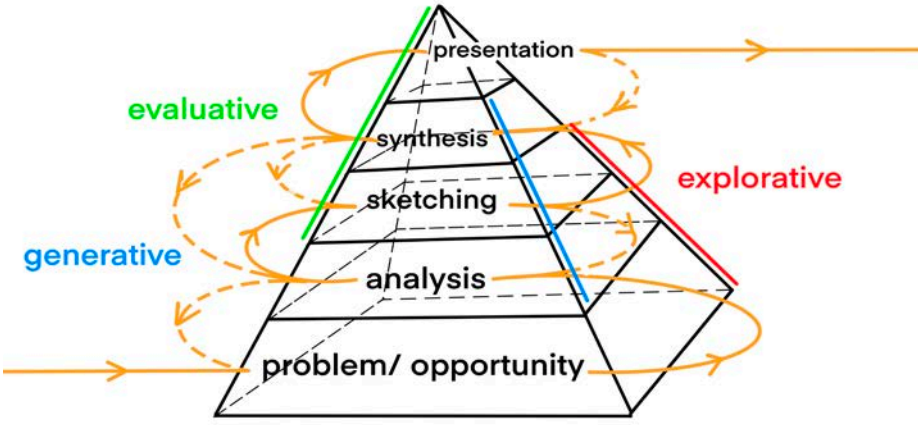


Fig 17. Integrated Design Process

Knudstrup (2004)

research data

Research data in the form of papers, publication and books has been used as a launch pad for conducting further investigations in the design research process. Furthermore, they have been used as a reference point to move around, when it comes to exploring different topics of interest.

theory

The project, being an academic project makes the most of different theories relating to the subject. Theories are being used as a tool for finding facts and basing further hypothesis and evaluating them.

case studies

State-of-the-art projects in the areas of interest have been studied by arranging for guided tours and interviews at the facilities itself. The project being one of its kind does not correspond directly to the case studies undertaken, but it encompasses the same focus areas, which acts as a common denominator between them.

field studies

Multiple site visits during different seasons, different times of the day and using different modes of transportation has been made. Field sound recordings have been conducted to understand the soundscape and identify the site atmosphere. Stress has being laid in capturing the first impressions, in terms of user experience and site accessibility.

interviews

Interviews with stakeholders, experts and users have been conducted, whereby user's needs, project functionality and technical aspects of the project are being followed through. Agencies have been contacted to be hypothetical clients for the project, so as to have sparring sessions to understand its different aspects from their point of view.

tools

Different tools for the qualitative and quantitative assessment during the design process are being used. These are as follows:

Sketching
Story boarding
3D Modelling
Acoustic simulations
Auralization simulations

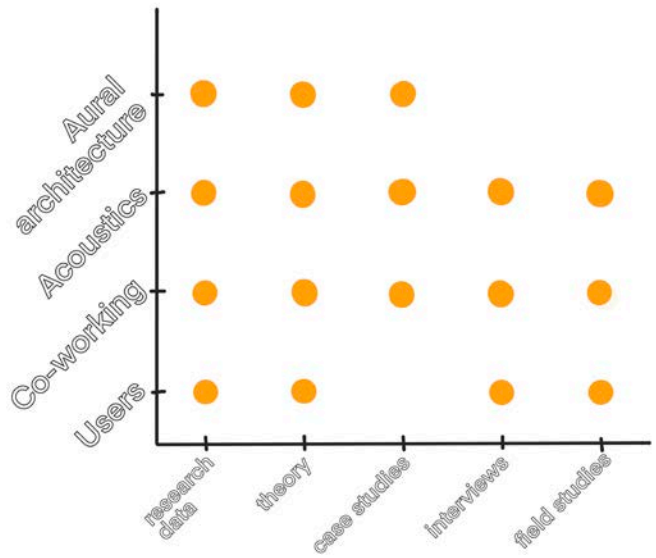
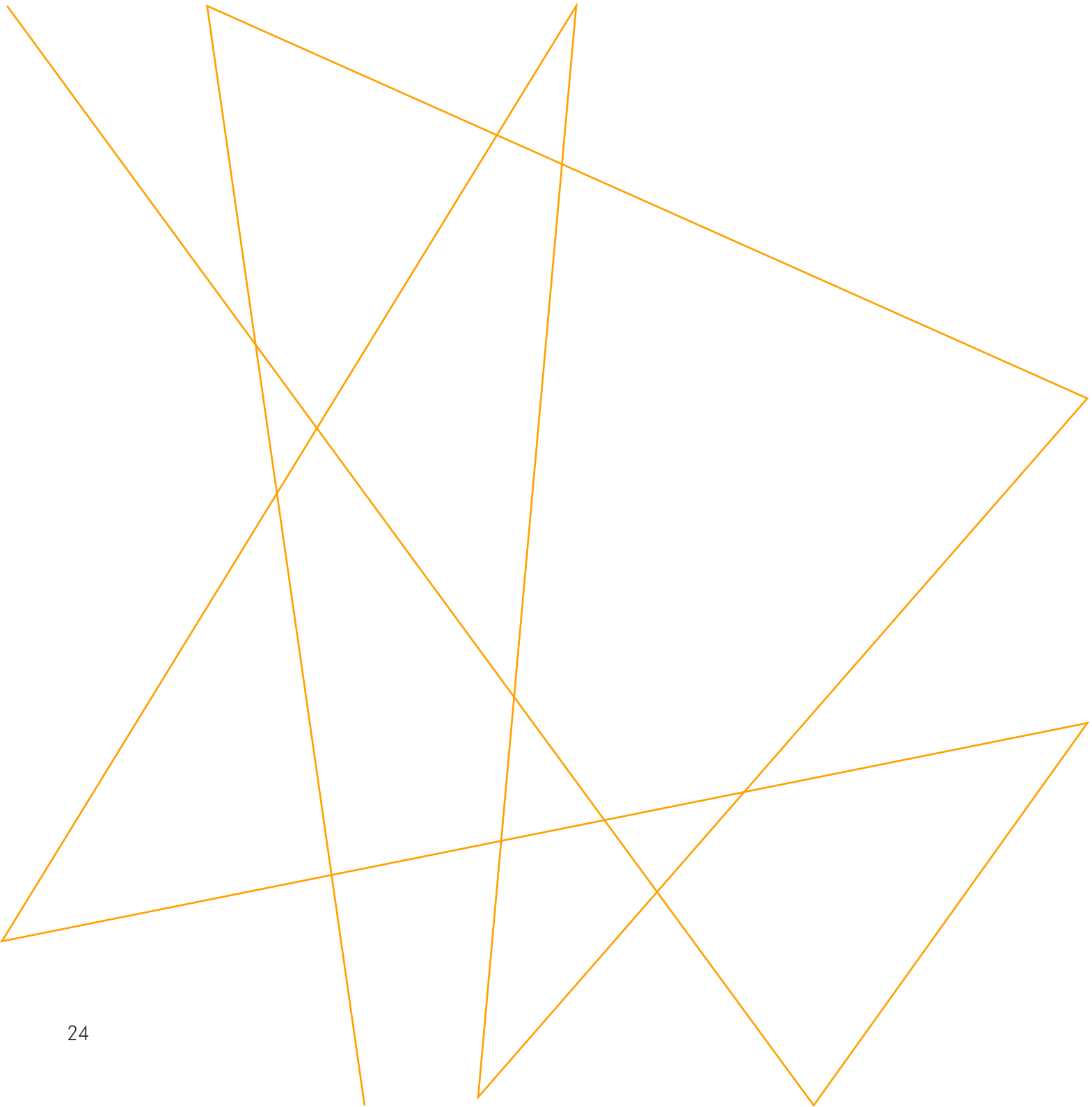


Fig 18. Methods

co-working



what is co-working?

Co-working refers to any office or workspace that is either wholly or partially shared between three or more individuals or companies. Most co-working spaces are owned and managed by a landlord and operate on a rental or membership basis, but they can also be cooperatively owned.

sharing systems

Sharing can manifest in different forms, whereby the shared elements might be physical, in the form of spaces or objects or shared organizational structures and services. It depends a lot on the nature of the project and its user's demands and needs. There are four categories that sharing systems can fall under:

spaces

Shared physical space is of course fundamental to the design of co-working environments. Any shared working space must include some portion of space (large or small) which is communal without being open to the general public. This can include spaces that are bookable, such as meeting rooms etc.

services

Shared services like cleaning and maintenance are most often included in the co- working setup. Some places also offer their occupants access to events, classes or subscription based services. Not all services are included; some come in the form of paid-for extras, with convenience in mind.

resources

All objects and consumables fall under the category of shared resources, so naturally most co-working spaces will include a number of them. Typical shared objects include kitchen appliances, tools and electronic devices, along with forms of transport like pool cars and bicycles. Food and drink can also be shared, in the form of communal meals. Sharing of resources has obvious implications for physical space requirements – the more you share, the less personal space you are likely to need.

contracts

Ownership and management are highly important to the way a co-working model operates. Some setups work under democratic systems, while others have a centralised approach with opportunities for feedback built in. With the introduction of sophisticated digital networks and platforms, these management systems can become incredibly complex, linking people across wider networks of spaces.

Cleaver, Frearson (2021)

why co-working?

Co-working and co- working spaces have emerged as a practice of self- help and self-organisation out of a lack of supportive structures for independent workers (Merkel, 2018).

Co-working as a practice of self- organisation for freelance workers is increasingly subsumed into the promotion of entrepreneurship and an 'entrepreneurial, self- regulated, motivated and individualized work-force' (McRobbie, 2016: 67).

As creative workers have been celebrated in creative city strategies (Pratt, 2008) for their self- entrepreneurial attitude, co-working and co-working spaces are now increasingly embraced and supported by city governments as new intermediaries in entrepreneurial growth agendas (GLA, 2014).

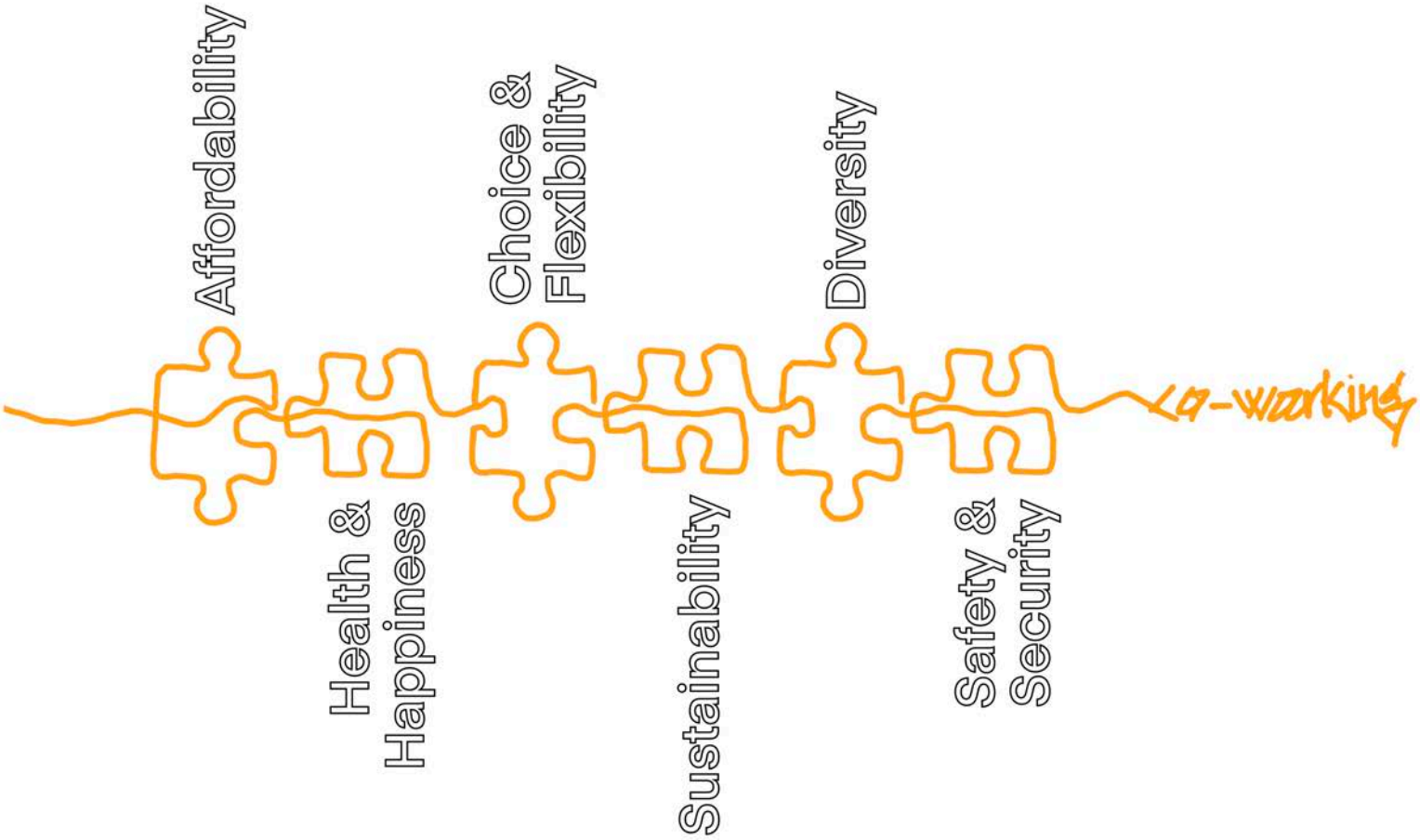


Fig 19. Why co-working? (author)

interview with SVFK (Statens Værksteder for Kunst)

An interview with the director of SVFK has been conducted to understand a real life working example of a shared facility for artists. The three focal points of SVFK are: Artistic production, artist development and shared knowledge.

Artists:

There are about 20 simultaneous projects taking place at the facility, which involves about 40-60 artists at a time. In total, there are about 200 projects per year and the projects are being shortlisted through a selection process which takes place four times a year.

Facility:

It consists of about 9 shared workshops with multiple projects taking place in a single time. For instance, at the time of the interview, there were 8 projects taking place at the wood and metal workshop each and 3 projects in the graphic photo workshop. Besides, there is also availability of private studios which is more directed towards big and special projects.

Secondary activities:

These workshops are also used to conduct related talks and courses every once in while. Conferences are being organised and exhibitions of the finished projects takes place every year.

Operations and management:

There is a sense of ownership for the artists as they have 24x7 access to the facilities. A very limited staff is engaged in the operations and management of the facility:

- The director and a communication person, working full time.
- Two workshop managers, which are also full time but are available only when needed.
- An administrator, who works 3 days a week.
- A janitor, who cleans up and is also the care taker of the facility.
- Two consultants, who are available every time when new artists start at the facility.
- IT support and finance are taken care of by the government.

Wishes:

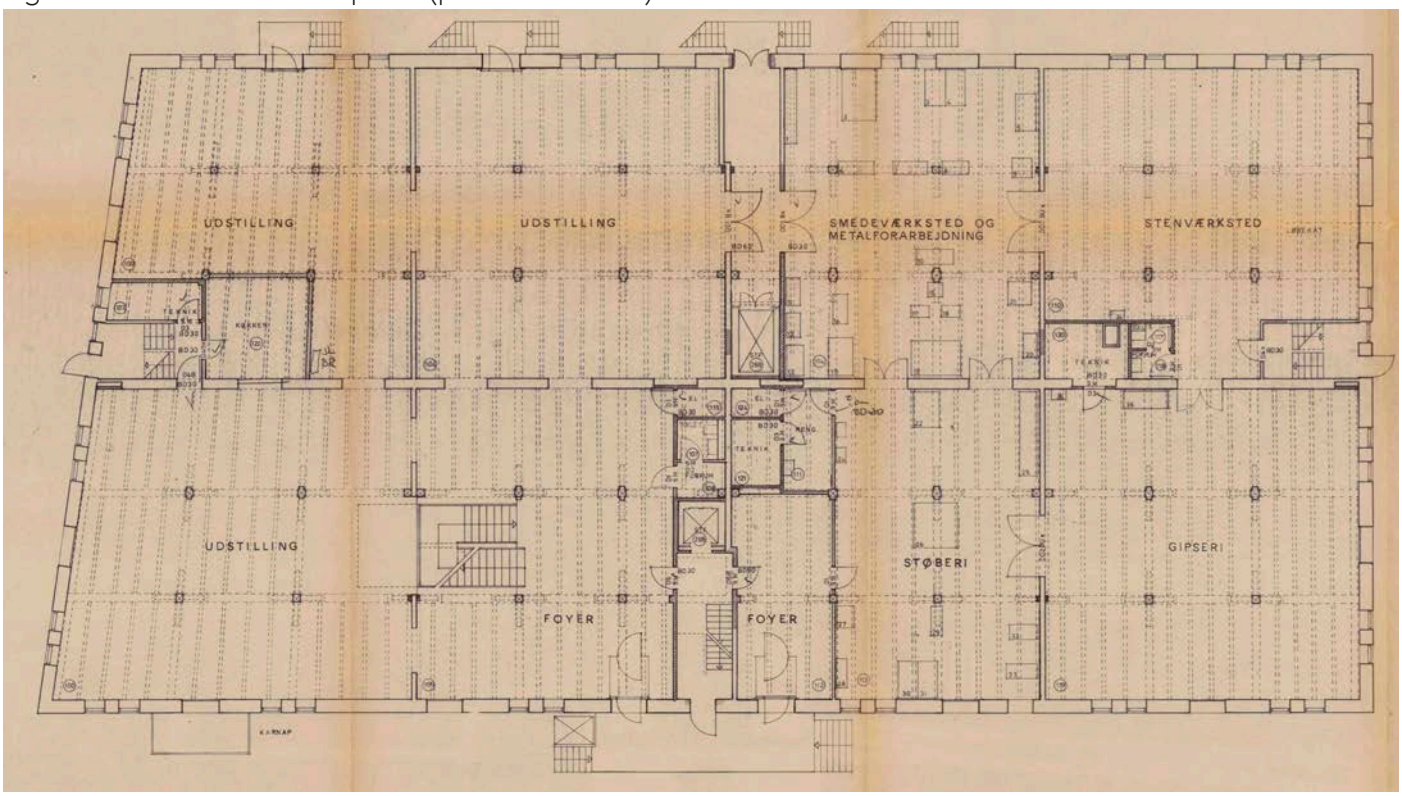
They wished to have more elaborate and lively shared spaces for example a lounge space or a cafe, for artists to take breaks and socialise more actively.

Fig 20. SVFK entrance

takeaways

- SVFK is open for collaboration to accommodate other facilities working with art. For instance, they send all the shortlisted sound artists to Sound Art Lab in Struer, which is a dedicated facility for sound artists. Likewise, there is a big potential of adding music artists in the selection criteria and then send them to a similar dedicated facility to actualize their music projects.
- Giving users a sense of ownership and having a very dynamic staff is the key to operations and management of such a facility.

Fig 21. SVFK Ground floor plan (public.filarkiv.dk)



Exhibition → Shared

foyer ← workshops

Every session ends with a public exhibition, where completed art projects are exhibited in the exhibition foyer, and new projects are introduced after that.

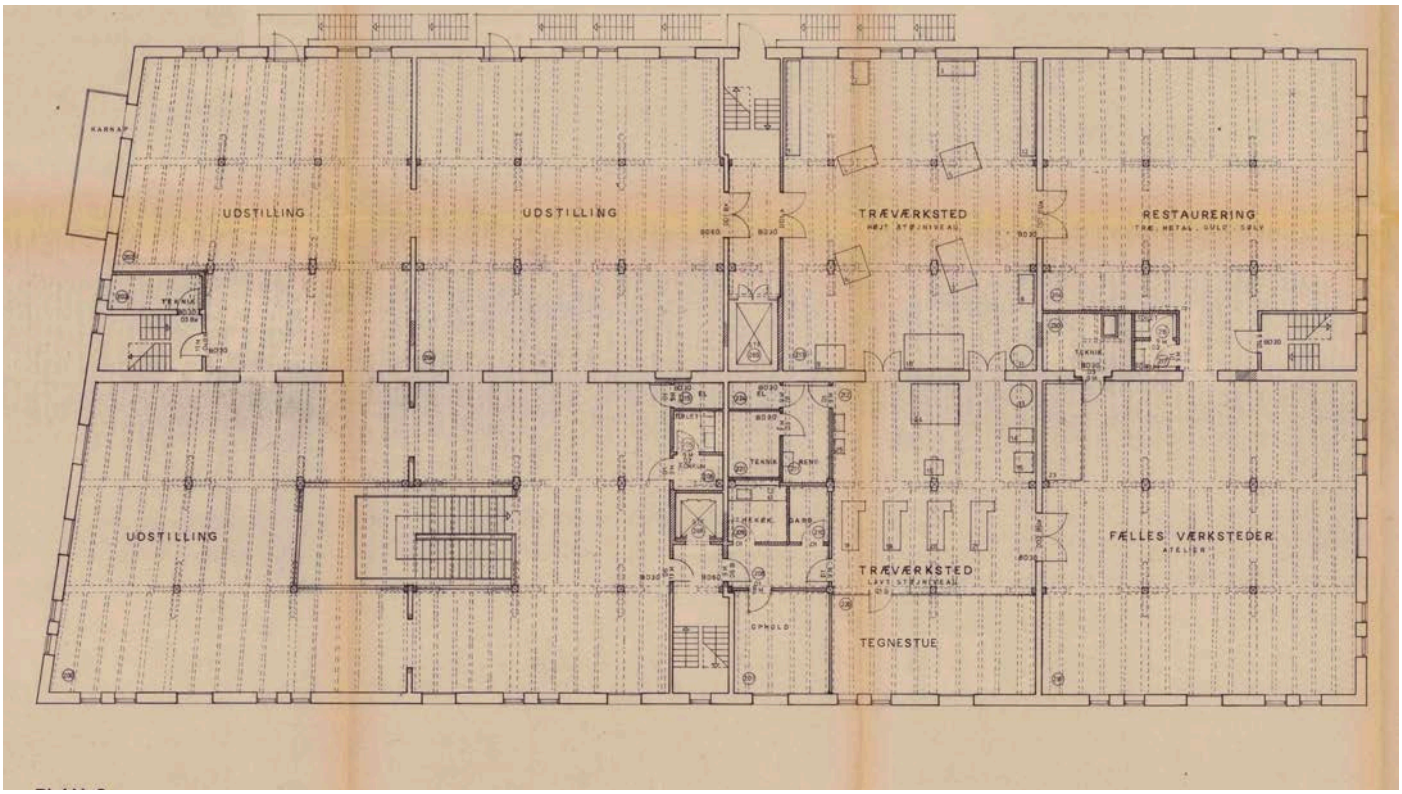
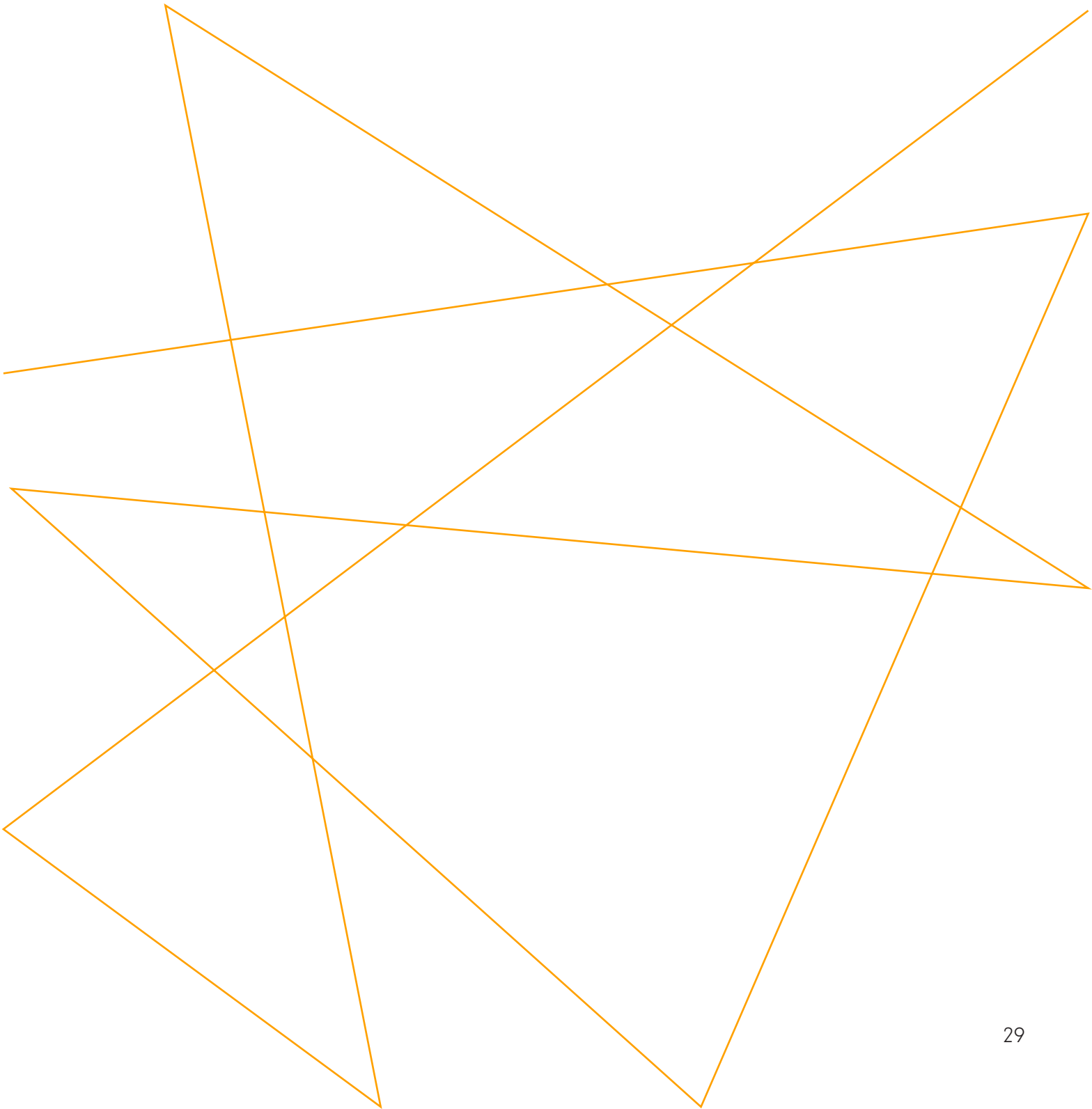


Fig 22. SVFK First floor plan (public.filarkiv.dk)

aural architecture



aural is a parallel to visual and refers exclusively to the human experience of sonic processes. Hearing refers to the detection of sound; and listening to active attention or reaction to the meaning, emotions, and symbolism contained within sound.

acoustics is derived from the Greek word akoustikos, meaning that which pertains to hearing. It refers mostly to the behavior of sound waves (vibrations) in different mediums like solids, liquids, or gasses. Listening is not required but when expected, acoustic architecture uses the language of physics to describe sonic processes as phenomenon that can be measured.

"aural architecture refers to the properties of a space that can be experienced by listening."

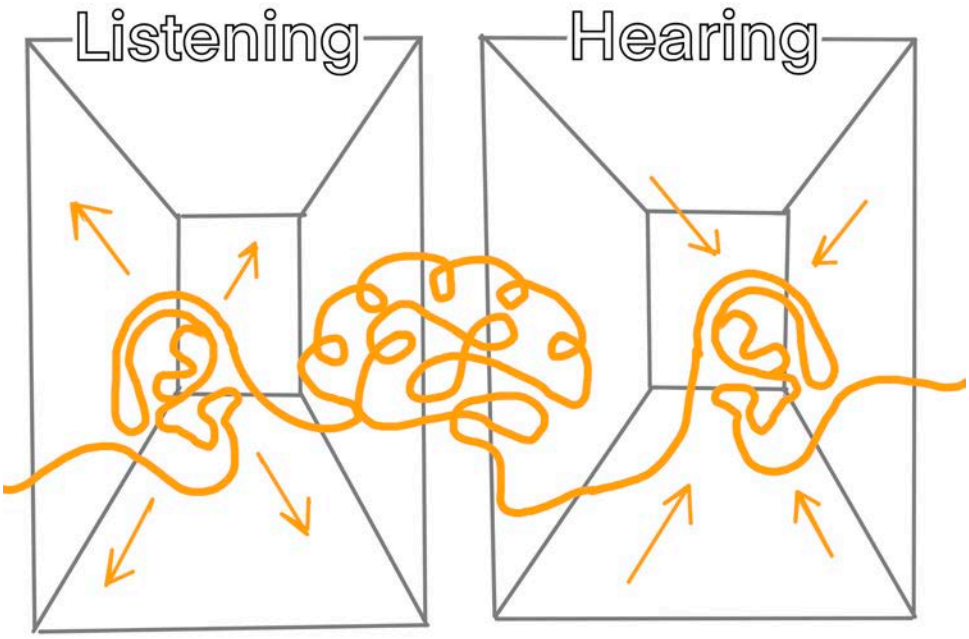
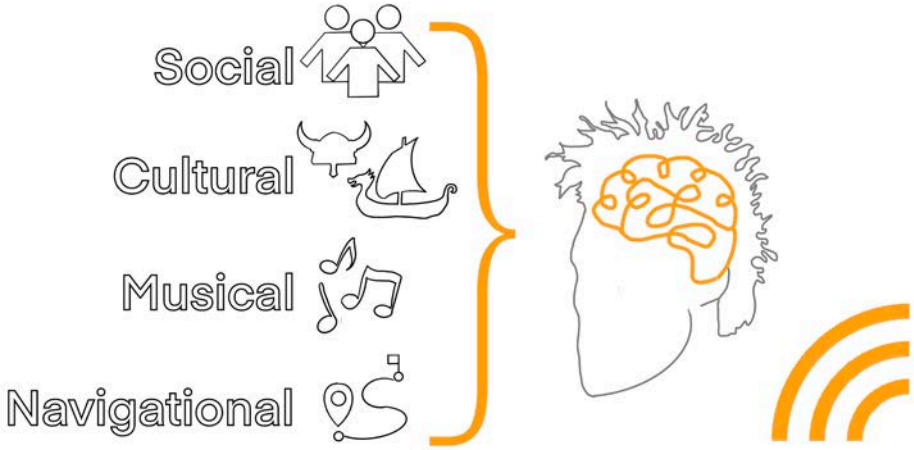


Fig 23. Hearing/ Listening (author)

"because of difference in their perspectives, acoustic architects focus on the way that the space changes the physical properties of sound waves (spatial acoustics), whereas aural architects focus on the way that listeners experience the space (cultural acoustics)."

Fig 24.
Different aspects of
aural architecture (author)



"depending on the physical design and the cultural context, aural architecture can stimulate anxiety, tranquility, socialization, isolation, frustration, fear, boredom, aesthetic pleasure, and so on."

different aspects of aural architecture

There are four aspects of aural architecture: social, navigational, aesthetic, and musical spatiality.
To some degree, every space manifests all four, even though only one or two aspects typically dominate the design or selection criteria. A space designed for music can be examined for its aesthetic or navigational attributes, and a space design for navigation can be evaluated for its musical and social attributes.

A complex amalgam of spatial attributes, auditory perception, personal history, and cultural values, auditory spatial awareness manifests itself in these four aspects. First, it influences our social behavior. Some spaces emphasize aural privacy or aggravate loneliness; others reinforce social cohesion. Second, it allows us to orient in, and navigate through, a space. Hearing acoustic objects and surfaces supplements vision or, in the case of darkness or visual disability, replaces vision. Third, it affects our aesthetic sense of a space. Devoid of acoustic features, a space is as sterile as barren, gray walls. Just as visual embellishments can make a space aesthetically pleasing to the eye, so aural embellishments can do so for the ear, by adding aural richness to the space. Fourth, auditory spatial awareness enhances our experience of music and voice. The physical acoustics of a musical space merge with sound sources to create a unified aural experience.
Space then becomes an extension of the musical or vocal art performed within it.

Blesser (2007)

takeaways

- How to create a transition from hearing to listening?
- How to translate different aspects of aural architecture, parallel to the visual ones?
- How to communicate the aristic, social and emotional aspects of the project through aural architecture?

soniferous garden

Fig 25. Soniferous garden (author)

"with good reason then do we insist on the necessity today to throw the emphasis back to the acoustically designed park, or what we might more poetically call the soniferous garden. There is but one principle to guide us in this purpose: always to let nature speak for itself. Water, wind, birds. wood and stone, these are the natural materials which like the trees and shrubs must be organically moulded and shaped to bring forth their most characteristic harmonies."

A garden is a place where nature is cultivated. It is a humanized treatment of landscape. Trees, fruit, flowers, grass are sculpted organically from the wilderness by art and science.

A park is a public garden into which various community recreations are introduced. Theater, music, athletic events, picnics, all or any of these may be possible in the well-designed park. But parks today are not well designed and that is the problem. In modern cities parks are too often leftover pieces of real estate, belted by what is euphemistically called a parkway, which spits its smell and noise over a site chosen by sight. This can be seen clearly on Isobel maps made for three Viennese parks:
Burggarten, Stadtpark and Belvedere Garten. All are today situated beside busy streets. In none does the ambient level drop below 48 dBA and the average is closer to 55 dBA, which is several decibels above the established Speech Interference Level for normal conversation at four meters.

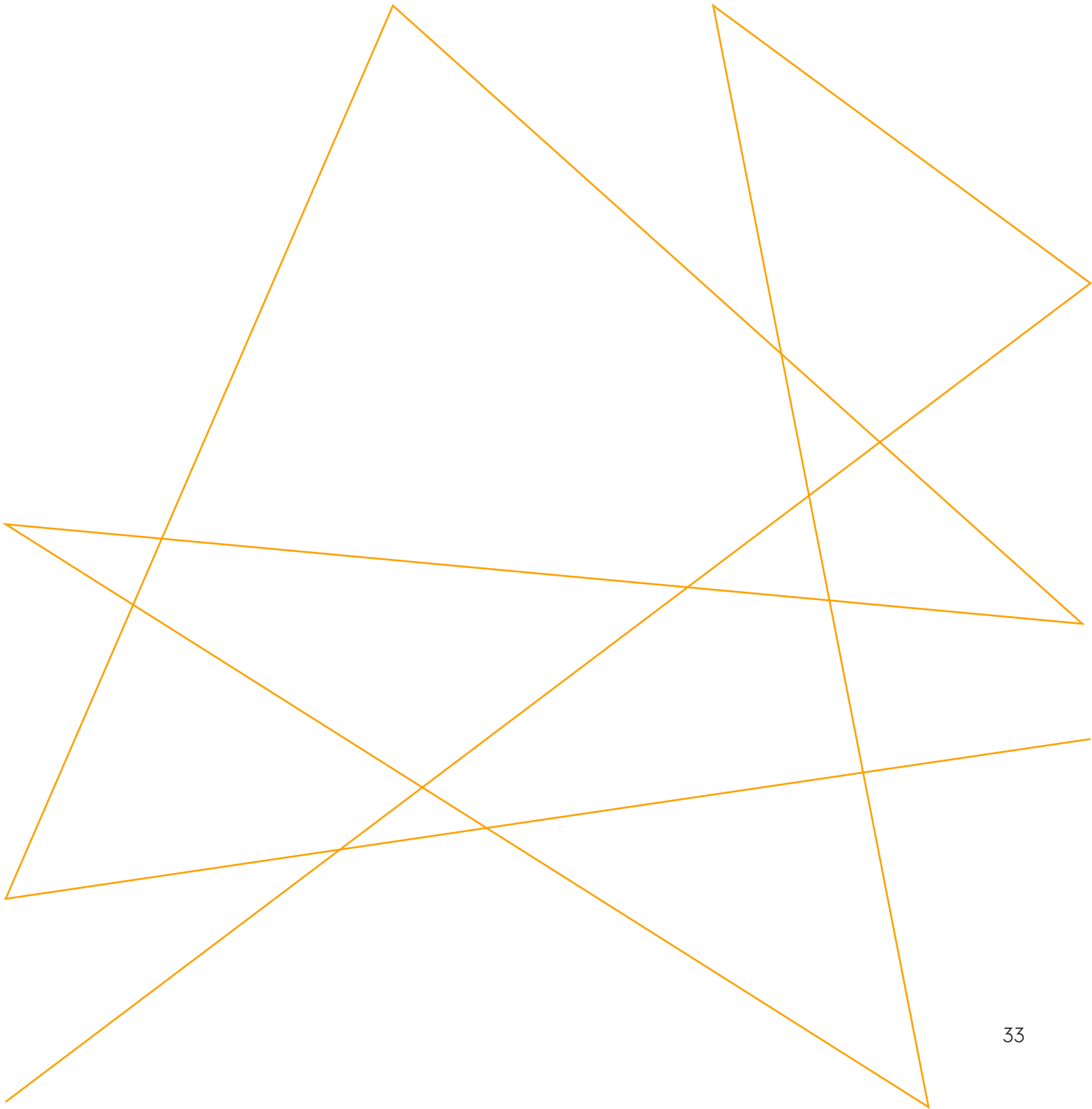
Thus, if synthetic sounds are introduced into the soniferous garden, they should be sympathetic vibrations of the garden's original notes. Let nature speak with its own authentic voices. That is the grand and simple theme of the acoustic designer.

Schafer (1977, 1994)

takeaways

- How to design a acoustically sound premises, while doing the site development of the project?
- How to desiign a building, that reponds to its surrounding soundscape?

acoustics



sound related phenomena

Sound waves interact with media in different ways. When a sound wave strikes a wall, there is usually more than one phenomenon occurring to it. This means the energy is distributed in different ways: part of the energy might bounce back (reflection), part of it might go through (transmission), and part of the energy yet might be lost inside the material and converted to heat (absorption)

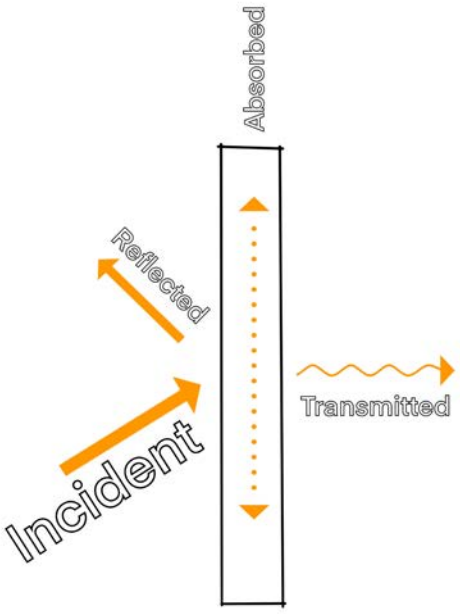


Fig 26. Interaction of sound wave and medium

reflection

Reflection occurs when a sound wave striking an obstacle is redirected back to the space it came from in a specular manner, which is the way mirrors reflect light. The angle of incidence is the same as the angle of reflection.

In order for a wall to reflect sound, it needs to be dense, smooth, flat, and large. If the obstacle in the path of the wave needs to be dense in order to avoid the transmission of energy through it; it needs to be smooth in order to avoid the diffusion of energy in all directions; and it needs to be flat so the energy won't be either diffused or focalized and it needs to be large in order to avoid diffraction of the wave. This last characteristic is relative to frequency, which means the obstacle should be larger than the wavelength of the frequency it intends to reflect.

focalization

It is a specific case of reflection of sound, whereby a convex surface will diffuse the sound energy in multiple directions and a concave surface will concentrate them to a focal point. The use of concave walls is not necessarily something that needs to be avoided as long as this phenomenon is taken into account. It could be used to define different acoustic arenas by using it to place the focal point inside or outside the listening space.

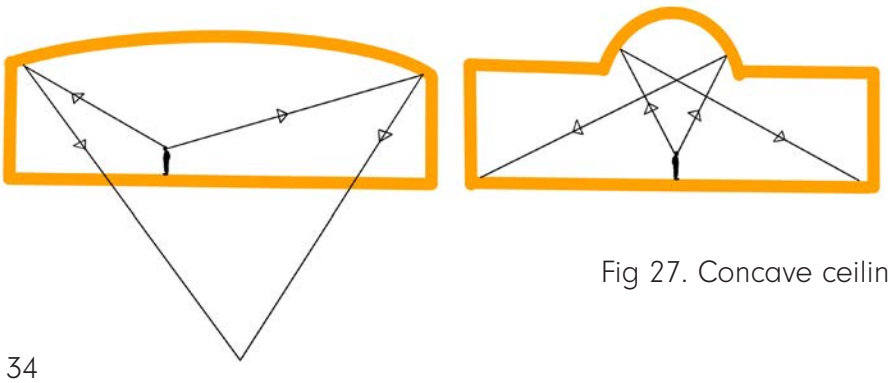
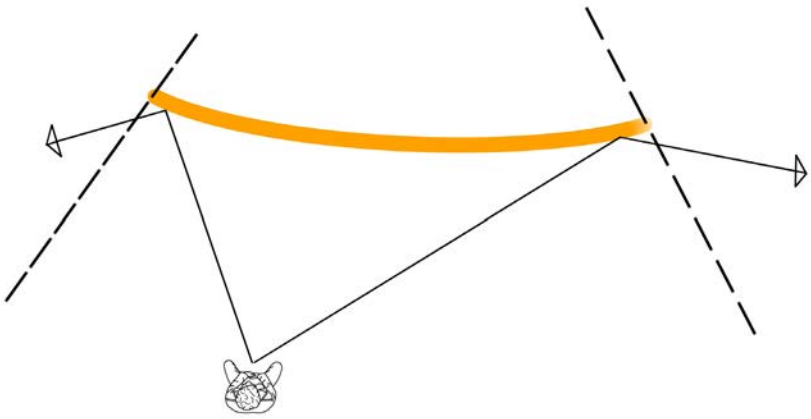


Fig 27. Concave ceilings

Fig 28. Scattering using convex surfaces



scattering

When a sound wave strikes a wall that is not smooth or flat, then the incident energy won't be reflected specularly. This means that the energy will instead be scattered in multiple directions. Scattering can occur on a very specific diffusion pattern if the surface is convex or mathematically designed, or randomly if the surface has a texture has a texture in its material or construction

differaction

Diffraction occurs when a sound wave changes direction due to a change in medium, or an obstacle of a similar size to the wavelength. This phenomenon is very important in the design of noise barriers.

transmission

Sound transmission through a structure is the passage of the sound pressure wave from the air, into the structure, through the structure and then out the other side. During this process some of the sound pressure is reflected back into the room while some is lost within the structure of the wall. Transmission can occur through various ways in the structure for example, low frequency noise pushes the whole structure causing the sound pressure wave to be transmitted by the surface of the wall or floor. At higher frequencies, sound can also find transmission paths through structural connections or by causing components or sections of the partition to resonate or vibrate. Finally, sound will also transmit through small gaps or voids within the structure or through weaker flanking elements such as adjoining walls or service runs.

A.M. Jaramillo, C.Steel (2015)

basic mechanisms for controlling sound transmission

There are seven key factors in the reduction of sound through a building structure:

stiffness

The stiffness of a partition particularly affects sound transmission at low frequencies. Stiff materials will naturally resist any force against it, such as a sound wave, and the greater the stiffness or rigidity, the better a material will be at reducing the transmission of lower frequency sound.
Cast in-situ concrete walls and floors can provide very high levels of acoustic insulation despite the apparently slim sectional profiles.

resonance

One of the first limiting factors of all materials is that they all have a natural resonance frequency. A frequency at which a material or structure stops acting like a stiff element and starts to naturally vibrate. As the sound wave pushes against the surface of a material, there are frequencies at which it is easier for the sound wave to excite the surface of the material.

There is a considerable resonance dip from a double thick brick wall to a twin leaf thick brick wall because of the mass-spring-mass effect created by the isolation. The cavity acts like a spring layer dampening the forced transmission of sound from one leaf to the next. This construction method also benefits physical isolation.

isolation of a structure

Isolation is the primary means by which twin-leaf partitions, suspended ceiling systems, and floating floors improve the acoustic performance of a wall or floor. It is particularly important for the acoustic insulation of floors against impact sound. Impact resistant mats, isolated floor battens, and floating floor systems all help in isolating the structure from impact sound. The more materials sound has to transmit through, the more energy is lost and so isolation helps with this process by adding different materials and creating cavities in a floor or wall structure.

mass of structure

The more mass a material or structure has, the more difficult the sound pressure wave has in forcing it into vibration. For most materials mass is the defining factor in acoustic transmission performance. For every doubling of mass in the structure or material, a 6dB improvement in acoustic insulation is being seen. However, this will only be seen in mass controlled frequencies (generally the mid-range).

absorption within a structure

Within a structure, absorption occurs (to some extent) within the materials, but also within the cavity. Adding absorptive materials on the cavities within a partition, we can improve the effects of absorption within the cavity by placing a material that is more efficient at absorbing sound than just air.

completeness of a structure

Without a complete structure, sound can leak through any gaps or holes. Besides that, incompleteness of a structure or weakness in a structure will also have a similar effect. Common reasons for poor sound insulation from incomplete structures are:

- Lack of architectural detailing for wall heads or service penetrations.
- Failing to instruct which contractor is responsible for detailing of wall heads and service penetrations.
- Missing materials within a wall or floor structure, such as failing to place absorptive layers within cavities or the coring of screeds and mass elements for services.
- Poor workmanship.

A.M. Jaramillo, C.Steel (2015)

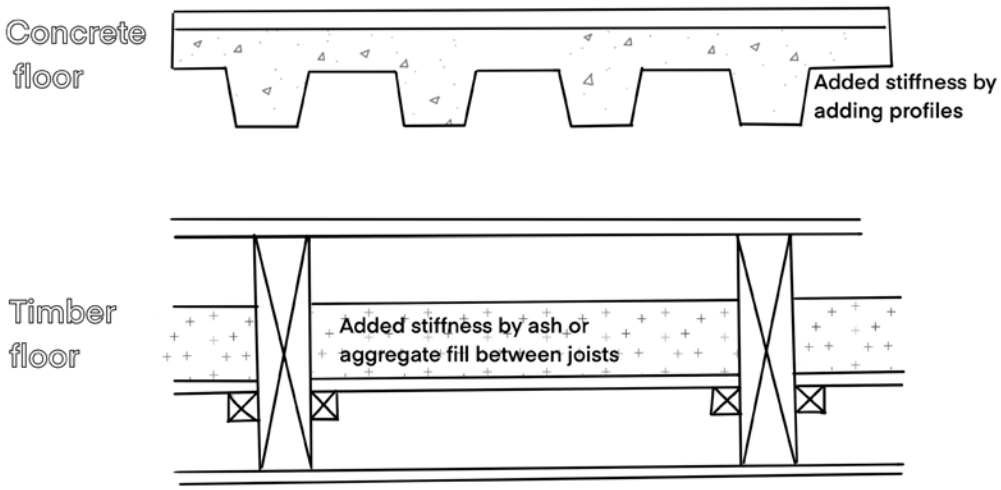


Fig 29. Profiles in concrete decks or heavy mass materials between joists improve stiffness

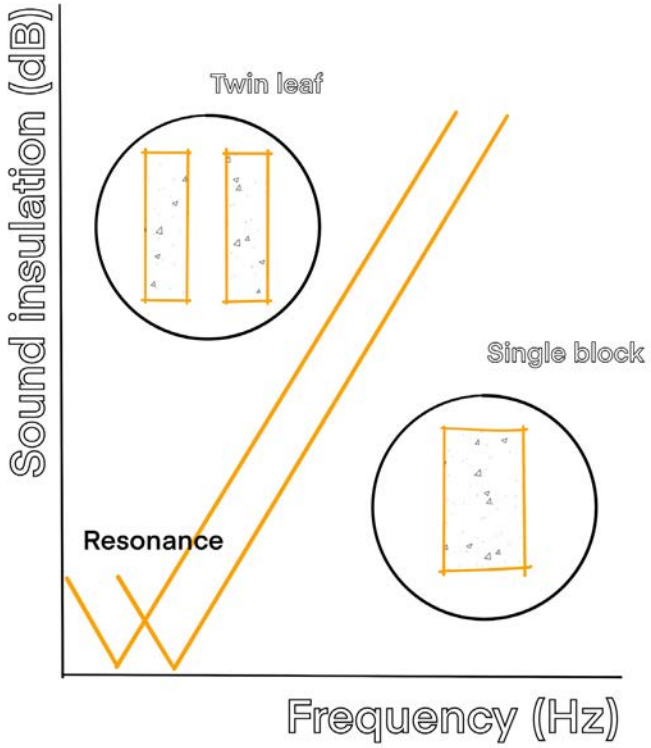


Fig 30. Resonance dip of two walls with the same mass but different constructions

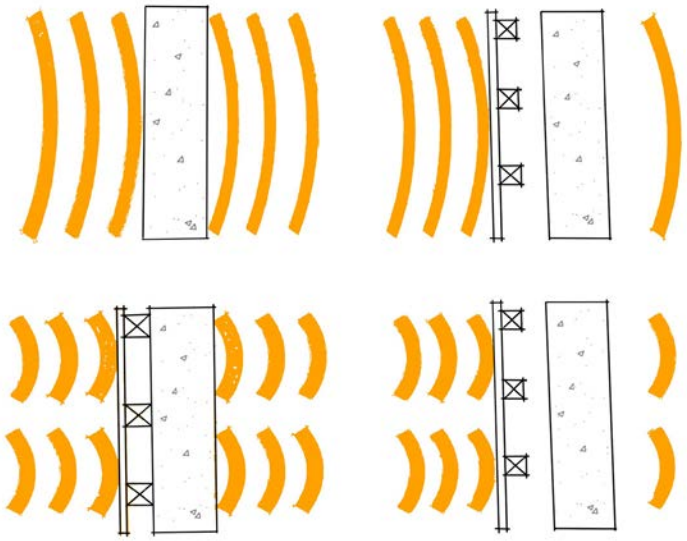


Fig 31. Isolation

absorption

All materials will absorb some sound that comes into contact with it. It's just some of them do it more and some less. Acoustically absorptive materials commonly used in architecture fall into three main categories:

porous absorbers

These are materials such as mineral fibre ceiling tiles, carpets, curtains or open cell foam panels. Here sound waves come into contact with the material an the energy in the sound is transferred into the porous material. The sound wave causes friction within the porous or fibrous structure of the material thereby changing the sound wave energy into heat. Acoustic energy is list and the sound wave being reflected is weaker. These are commonly good at absorbing sound across a wide range of frequencies.

panel absorbers

These are made of a thin panel that is set off a wall or ceiling surface and the depth of the cavity behind the panel, along with the overall mass of the panel, determines the frequency at which sound is absorbed. As sound hits the panel, some is transmitted through the cavity and this sound is then reflected off the wall or ceiling and back towards the panel. The sound wave passing through the panel causes it to vibrate, and by setting the panels at a particular distance from the wall, it is possible to have the panel vibrate with the sound wave being reflected from the walls. Two wave fronts which are out of phase, but vibrating at the same speed will cancel each other and produce the desired result. These are more effective around a narrow band of frequencies.

composite absorbers

These are a mix of the previous two categories. This panel absorber is enhanced by introducing an acoustically porous material in the cavity created by the panel and the wall. The panel is usually given perforation or slots which allow sound waves to be better absorbed by the fill aterial as well as having a Helmholtz effect where the perforations or slots allow for absorption. The greater the number of slots or holes, the better the panel will work at higher frequencies. These can provide good performance across a range of frequencies.

A.M. Jaramillo, C.Steel (2015)

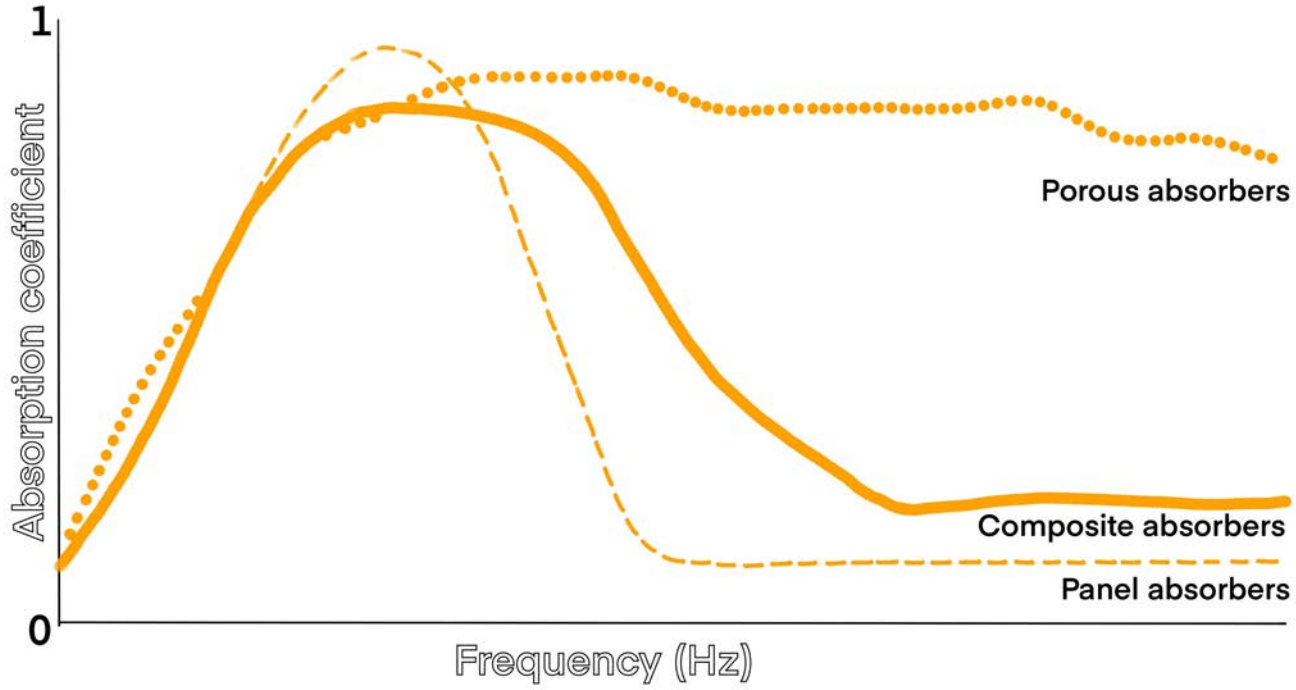


Fig 32. Acoustic absorbers and their frequency performance

acoustic parameters

reverberation time (RT, T30, T20, T10)

It is defined as the time it takes a sound to decay 60dB after the source has stopped emitting it. When measuring reverberation times in a room it is not always possible to obtain a 60dB decay. For this reason, its measurement is usually extrapolated. A 30dB decay is measured from -5dB to -35dB below the starting level. This is called T30 and it is equivalent to the calculated RT, RT20 and RT10.

When a room is too much reverberant, speech loses intelligibility as the important details as consonants are masked by louder, lingering vowels. However in spaces for music, higher reverberation can have a positive impact, as it imparts fullness to sounds by binding adjacent notes and blending sounds from different instruments in ensemble.

early decay time (EDT)

It is a similar acoustic parameter to reverberation time. It is defined as six times the time it takes sound to decay by 10dB after the source has stopped emitting. EDT has been commonly considered as having a closer relation to our perception of reverberation than reverberation time itself.

clarity (C50, C80)

C80, or musical clarity is the equivalent of C50 from theaters. It defines a ratio between early energy (before 80ms) and late energy (after 80m/s). Music clarity is measured with a limit of 80ms as opposed to 50ms for speech clarity, because as mentioned before, music needs less separation of individual sounds, and this means some reverberation is accepted as a positive quality.

A.M. Jaramillo, C.Steel (2015)

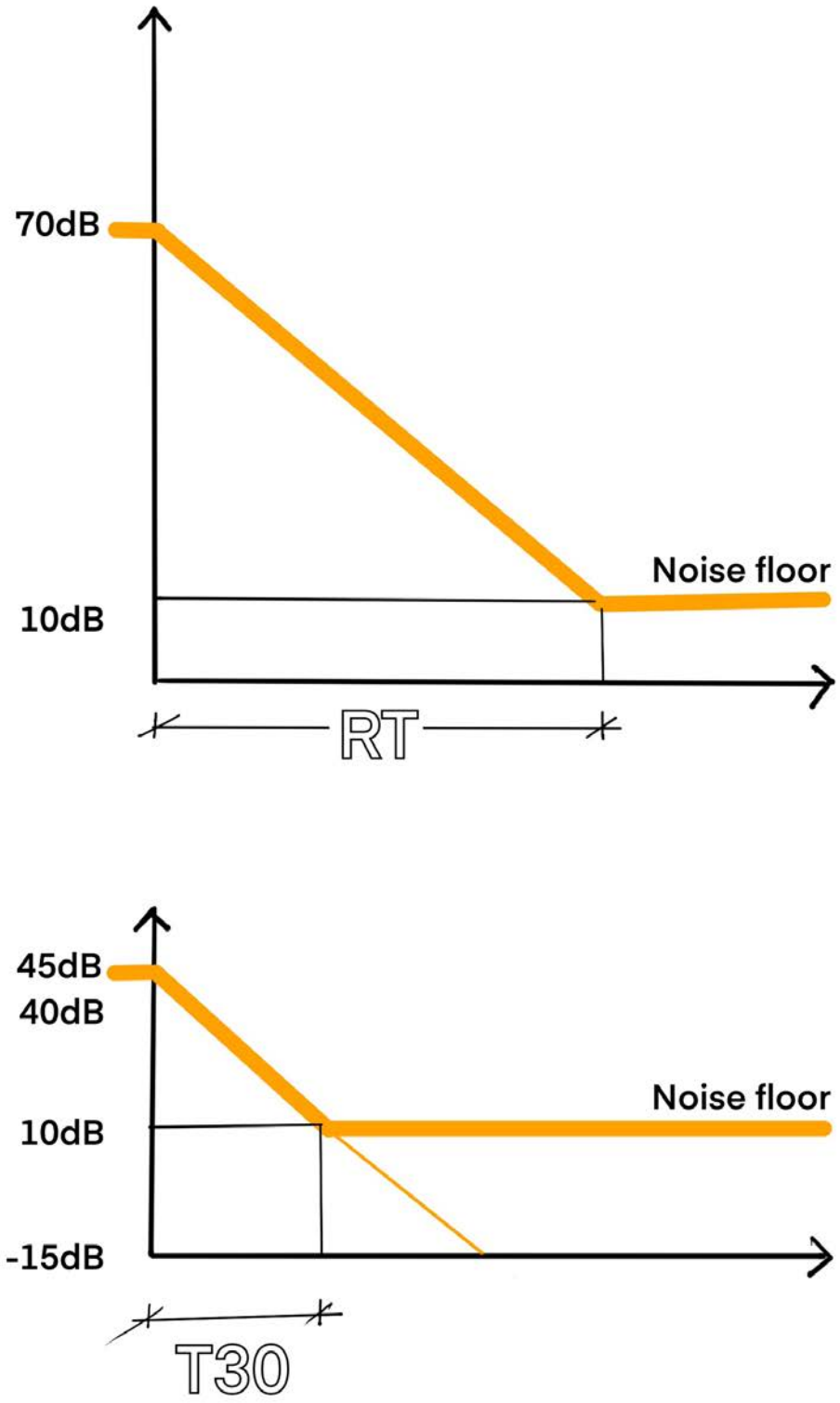


Fig 33. Reverberation time

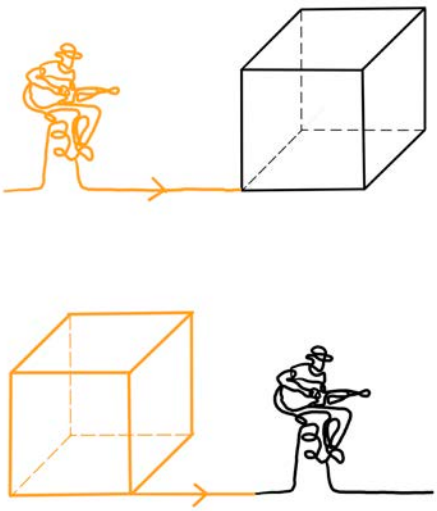


Fig 34. Music for rooms and rooms for music (author)

music for rooms and rooms for music: two different points of view

From the musical perspective, the relation between music and performance practice operates on the following levels:
1. The performance of a specific piece of music (for instance, a polychoral symphonia sacra by Giovanni Gabrieli).
2. The performance practice of a specific musical genre that demands certain acoustic conditions, as does polychoral church music in general which, for acoustic reasons, needs a full choir with bass for each group, if the choirs are placed apart.
3. the most general level, that is, church music in general with its particularities related to the liturgical function, which in itself may have developed partly as a result of acoustic conditions of performance.

In acoustics-related architectural elements the following levels must be distinguished:
1. The analysis of a specific space, its specific shape, special decoration, arrangement of platforms and seats for a specific event and number of attendants at the moment of a certain performance, as, in this case, the church of San Marco in Venice with its organ lofts and special palchetti.
2. The type of architectural space with its typical construction properties according to style and function, as in this case, a Byzantine-style church in the form of a Greek cross with side nerves and several domes.
3. The category of space, that is, the church in general, which elicits in the listener the expectation of a long reverberation, regardless of its directions, construction and acoustics. The church then becomes as acoustic topos closely related to the symbol of the dome as domus dei (house of God), even though churches of different shapes and dimensions, with various ceilings (flat and vaulted), ground plans and, therefore, very different acoustic properties, have been built throughout history.

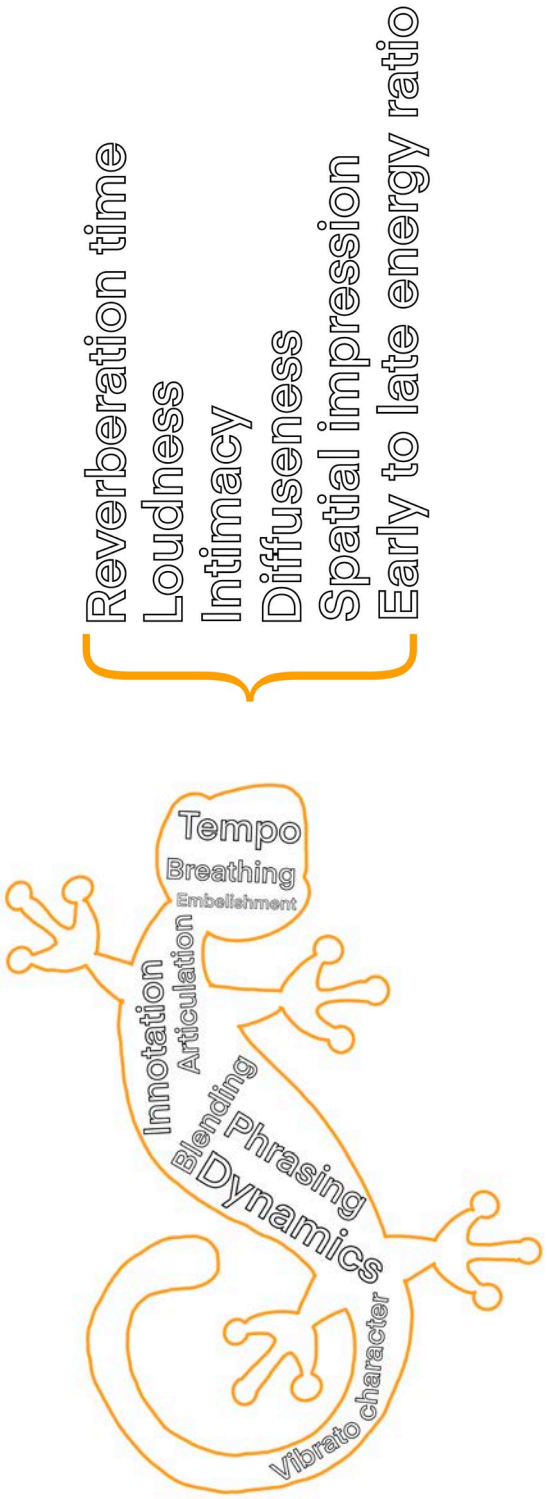


Fig 35. Musician's space adaptive factors (author)

musicians are adaptive to the space they perform in

This has been explored and documented by Dorothea Baumann, where the performance rooms of selected English performers from the eighteenth to the twentieth century and their influence on the change of performance practice are investigated through a comparison with Händel's own performance practice of Messiah, one of the most important Baroque compositions of the 19th century. The following observations were made out of it:

1. Sensitive musicians adapt dynamics, articulation, phrasing, embellishment, breathing, and even intonation and vibrato character to the hall's reverberation. The slower the decrease of reverberation and the longer it lasts, the shorter are tones cut and the more "air" has to be left between the tones in order to produce a non-legato. With very long reverberation a non-legato is impossible because tones are bound together or even blurred by one or several following notes.

2. The effect depends on the directivity and frequency spectrum of each instrument. Room acoustics may be excellent for oboes, good for the soprano but problematic for the bass due to different frequency characteristics of the reverberation. The amount of the reverberation can depend also on the position of the sound source in the room.

3. To avoid blurring, a slower tempo may be necessary, or the musicians may be forced to avoid breaks, play loud enough and drag the music forward. On the other hand, in dry acoustics musicians have to produce volume and sound power in order to achieve enough blending.

4. The average playing volume and playing dynamics, too, must be adapted to the desired blending. This element is crucial for room acoustics, as in good halls the musicians sense the other instruments of the ensemble, whose total sound and sound blending they can control. The poorer the acoustics, the more difficult the blending and its control. A larger orchestra makes this process more difficult.

5. All these factors affect also the tempo. There is a clear difference among experienced tempo, measured tempo and intended expression. The correct assessment of these elements is easily lost if a section s taken out of its context within the work. On the other hand, the direct confrontation with other recordings makes the creation of "virtual space" audible as an element of the holistic perception process.

Baumann (2011)

music rehearsal spaces

Music rehearsal and teaching spaces require sufficient physical volume to avoid excessive acoustical volume and the potential for hearing loss. Additional absorptive treatments can be helpful but result in a dry acoustic, and volume levels could still be excessive. ANSI S12.60-2002, Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, suggests for a large core learning area a midband (500 Hz) RT of 0.7s to 1.1s (ANSI, 2002). This is to ensure good speech intelligibility between the teacher and students. Beranek (2004) indicates that music rehearsal spaces should have RTs on the order of 0.3 to 0.4 seconds less than considered optimal for a performance space, again to enhance intermusician audibility and blend.

Following are the different reverberation times that are recommended for different instrument in an orchestra:

0.2-0.4s for drums, low-frequency bass
0.4-0.6s for brass, woodwind
0.6s for flute, guitar, trumpet, cello
0.7s for piano
0.8s for clarinet and violin
1.1s for song

Kleiner, Mendel (2014)
Abelin, Å (1988)

takeaways

- How to design a rehealsal space, that can accommodate different preferences of different music instruments and music genres?

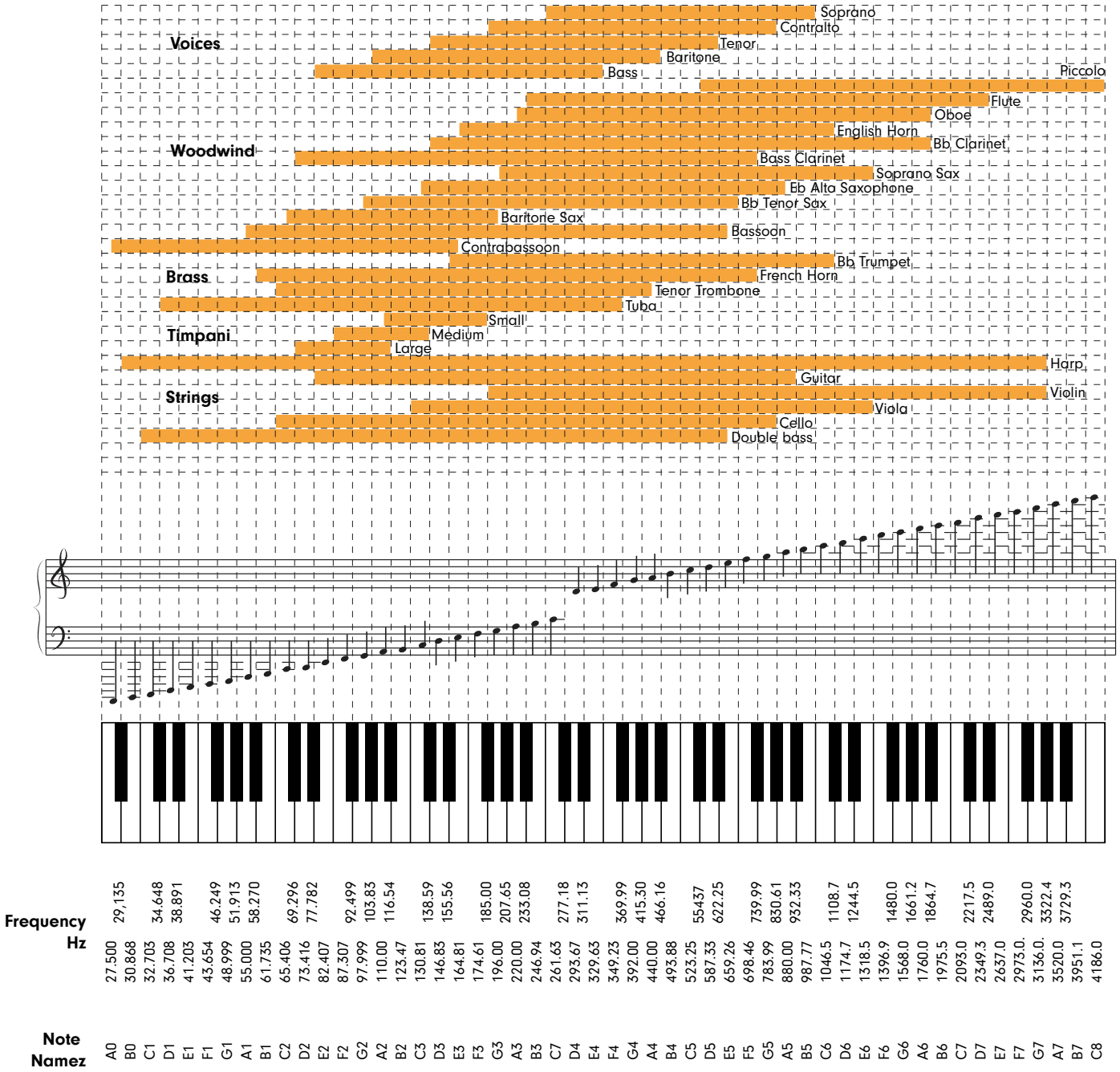
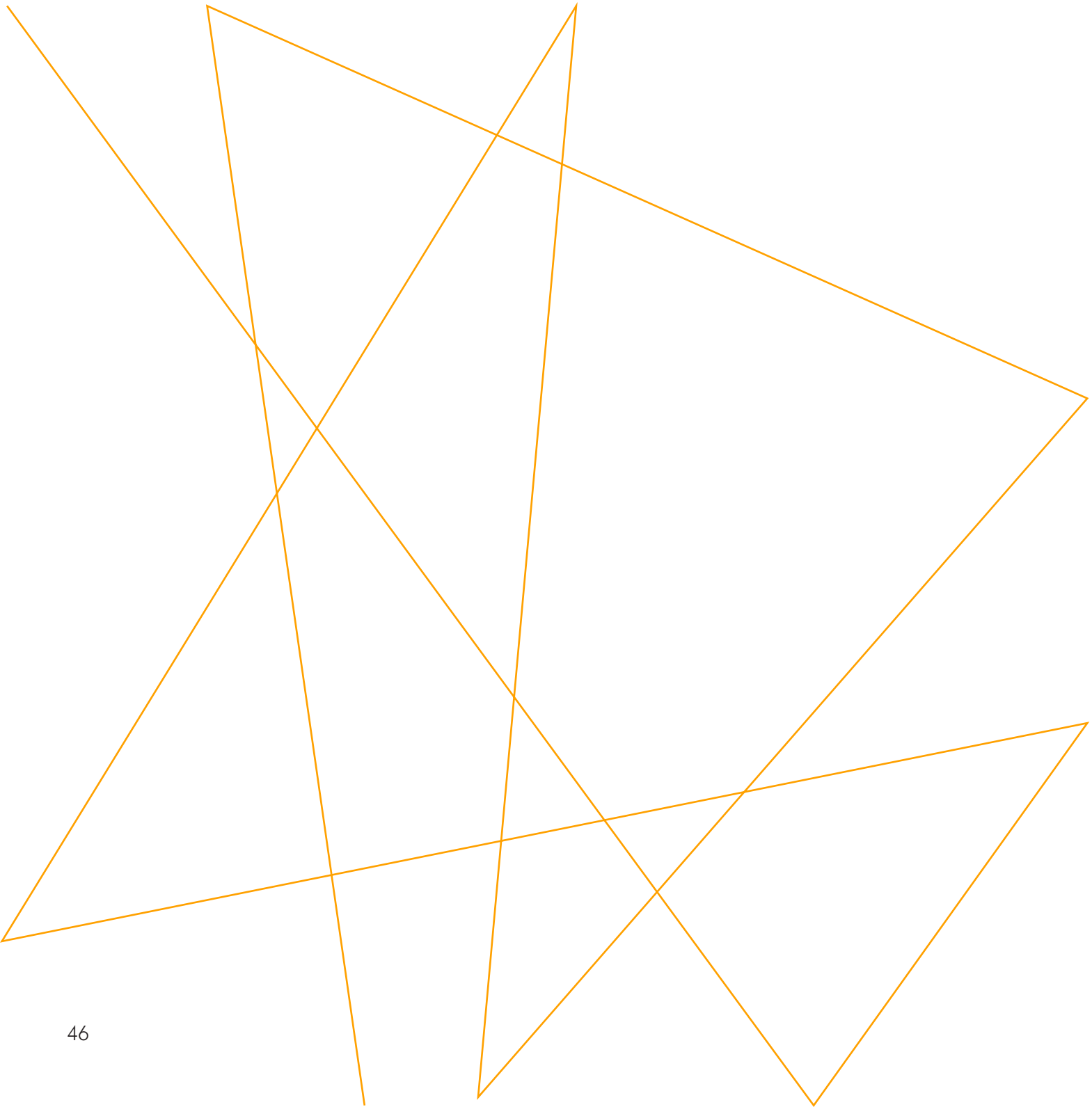


Fig 36. Frequency range of different musical instruments

case studies



DR koncerthuset

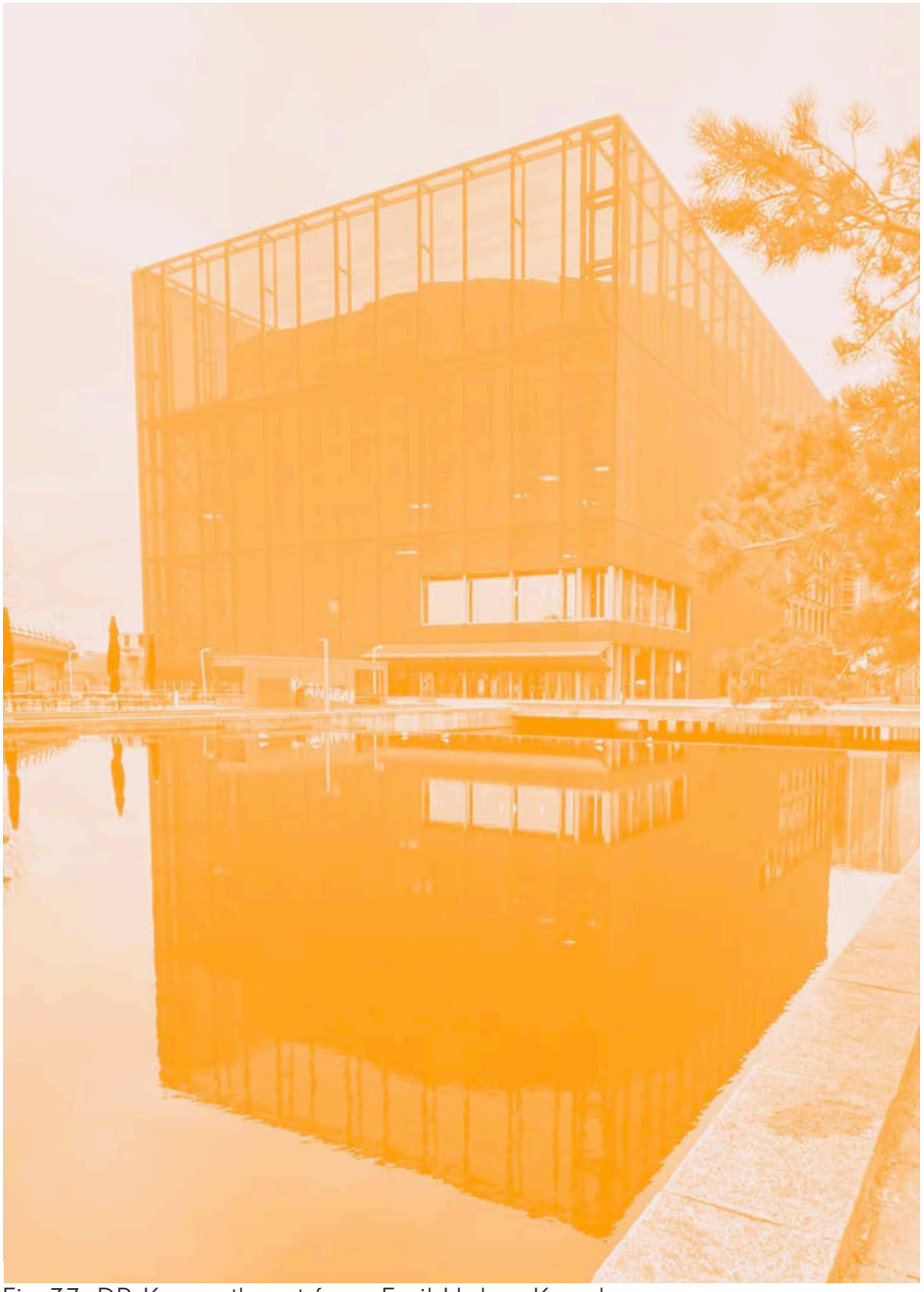


Fig 37. DR Koncerthuset from Emil Holms Kanal

Location
Copenhagen

Architect
Atelier Jean Nouvel

Acoustic design
Nagata Acoustics

Year of completion
2008

DR kocerthuset is one of the best state-of-the-art concert buildings in the world. Music events taking place over there range widely in terms of size and genre:

- Small-scale jazz concerts in the foyer
- Chamber music, choral, rock and pop concerts in the three smaller concert halls
- Symphony concerts, guest appearances and large scale rhythmic concerts in the large concert hall.

"the architecture asserts itself through details - doors, lighting, ceiling and staircases, a testimony of respect for the buildings's visitors, concertgoers and artists."

- Jean Nouvel (2002)

Fig 38. Box-in-box construction

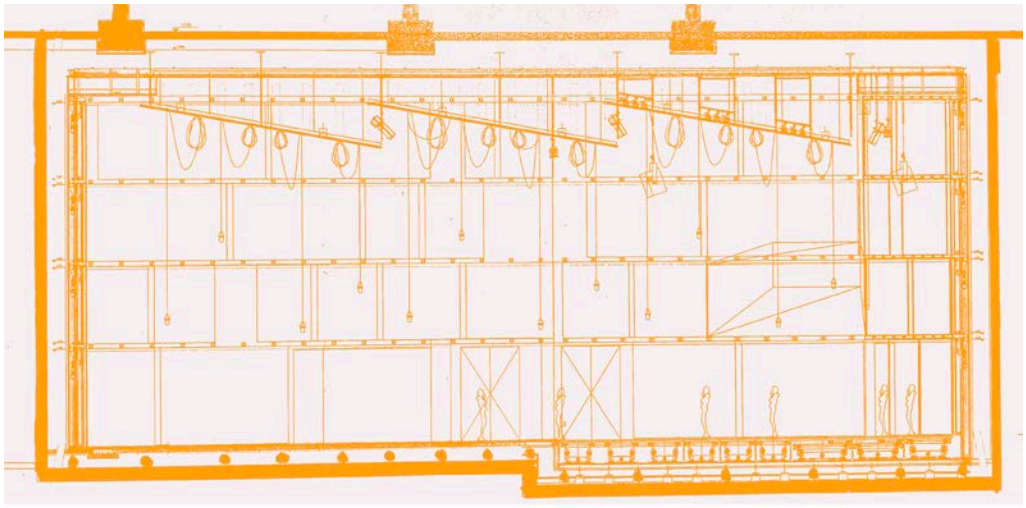


Fig 39. Section - Studio 2

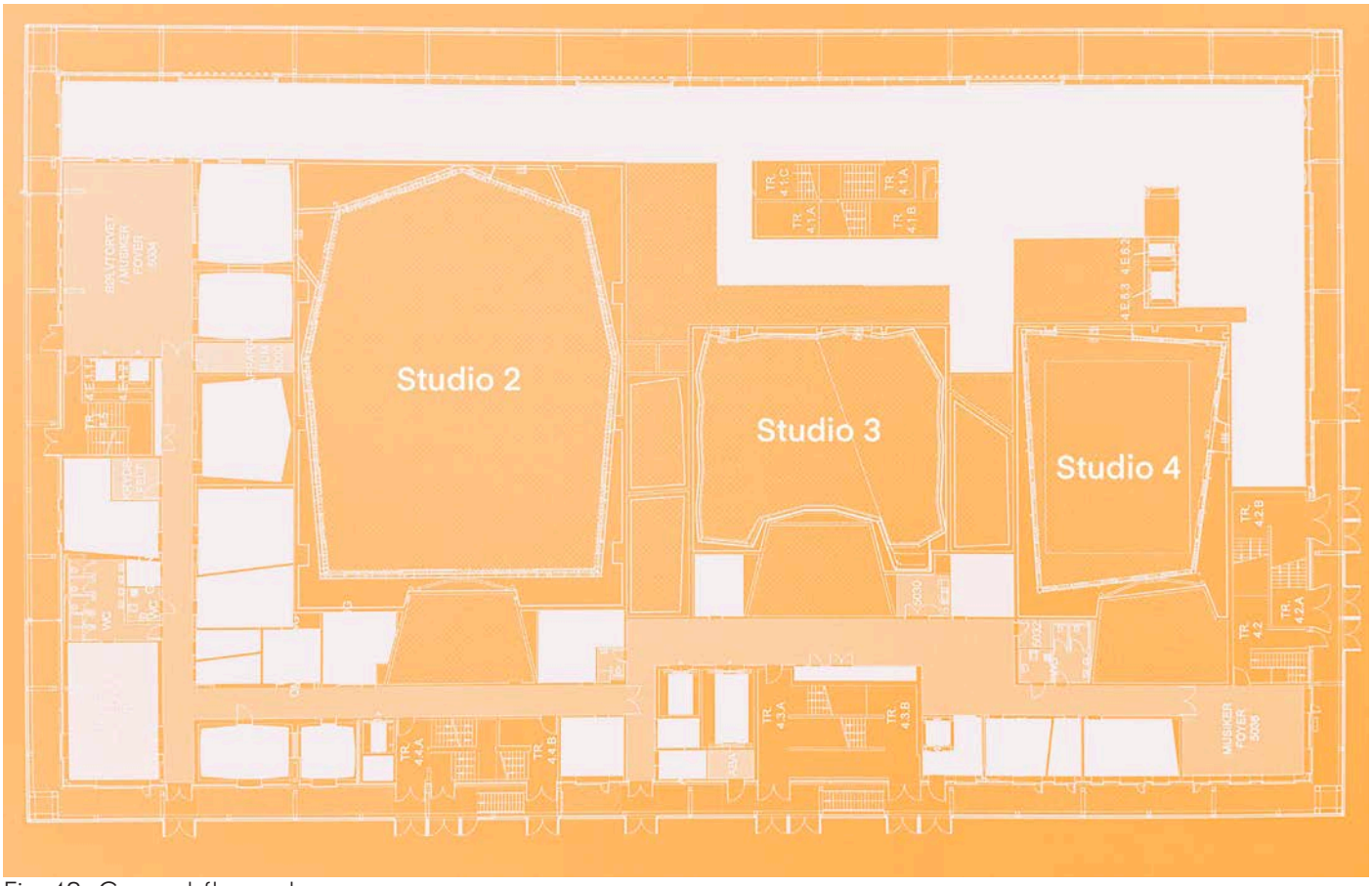


Fig 40. Ground floor plan

box-in-box construction

Box-in-box construction method is being used to prevent sound transmission through the outer shell of the music halls. Music performances can take place inside the halls without disturbing or without getting disturbed by the activities out side the halls. This has been acheived in following the layers of construction:

- Metal structure on the inside.
- Cladding with 6 layers of gypsum boards for sound absorbtion.
- Cavity for building services.
- 300mm thick outer concrete shell

variable acoustics

Fig 41. Studio 2

Studio 2

Area - 6600 sqm
Capacity - 560 guests

It is the largest of the three studio halls. It consists of numerous manually adjustible panels, sheathed with light birch wood. These acts as diffusers and are mounted on sliding rails on top of absorbant panels with fabric. In this manner, the sound quality of the hall can be adjusted as required.

1.1s < RT60 > 1.7s

Fig 42. Studio 3

Studio 3

Area - 1600 sqm
Capacity - 200 guests

It consists of no fixed stage and audience seating. The non-parallel wall surfaces consists of alternating polished and matte panels with numerous hatches that can be opened and closed for sound-regulating effects. The black finish is inspired from the lacquer on a Steinway piano.

0.3s < RT60 > 1.1s

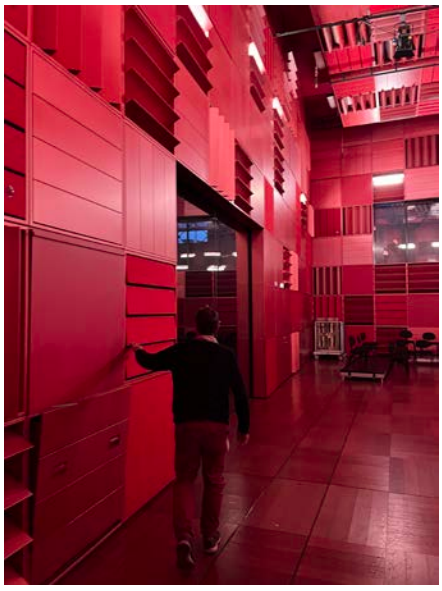


Fig 43. Studio 4

Studio 4

Area - 2000 sqm
Capacity - 185 guests

It is the hall furthest on the south, under the concert hall. It consists of modules of wall cassettes, which are machanised to be adjusted accordingly. The cassettes bear a matt as well as glossy finish and has pyramidical shapes, which can be rotated in different angles for the desired acoustic performance.

1.0s < RT60 > 1.4s

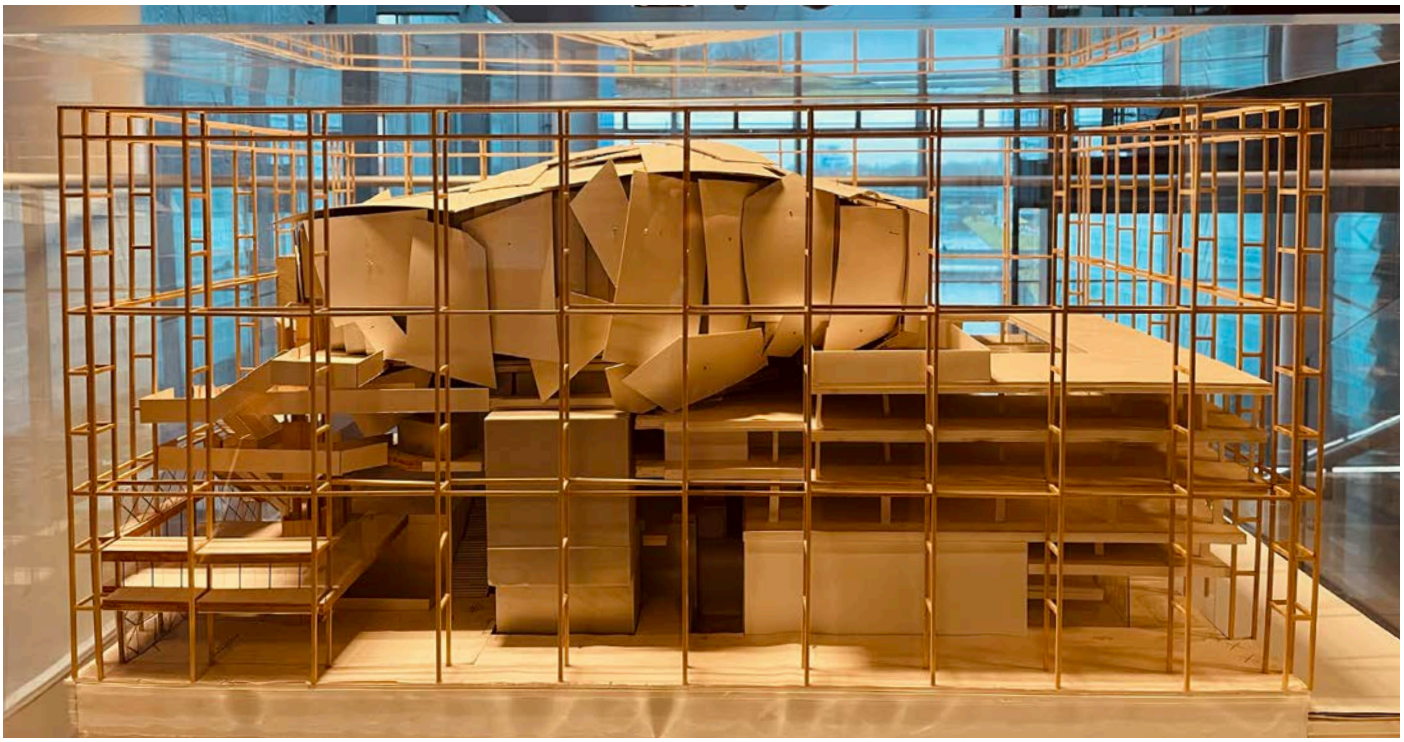


Fig 44. DR Koncerhuset - Model

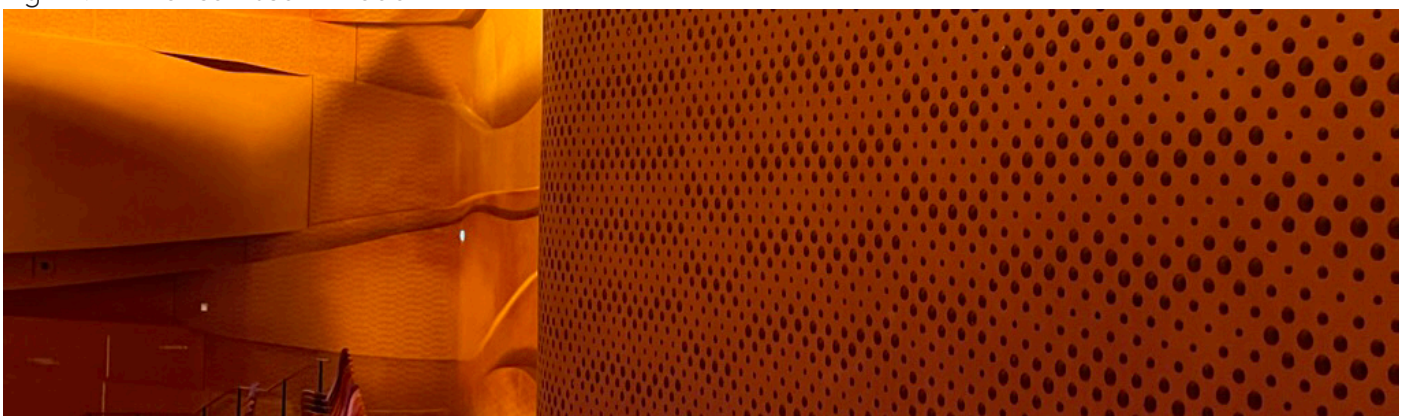


Fig 45. Concert Hall

takeaways

- Variable acoustics technology is the way to go to incorporate a wide variety of music genres in a single space.
- Based on the interview and the acoustic performance figures, Studio 2 is the most accommodating (music genre wise), and most convenient to use of all three halls.
- Box-in-box construction is an effective sound insulation technique. With the given scale of the proposed project, it would make sense to use it at the building level.
- The building MEP services should be allocated a sufficient and dedicated space, so that there is no conflict with the acoustics design and for ease of building operations and maintainance.

Musikkens hus

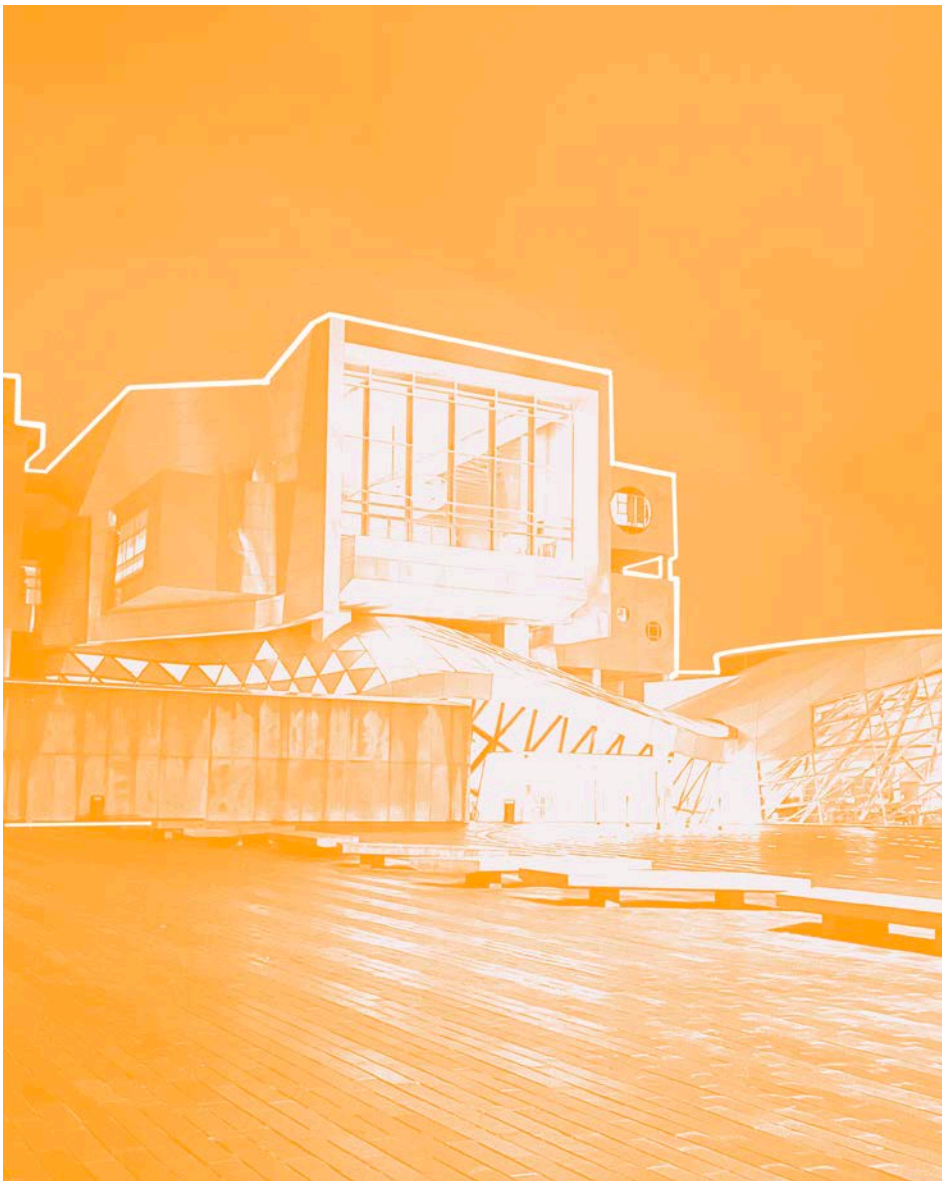


Fig 46. Musikkens hus from the harbour front

Location
Aalborg

Architect
Coop Himmelb(l)au

Acoustic design
Tateo Nakajima, Arup

Year of completion
2014

Musikkens hus consists of a myraid of flowing shapes and forms in contrast to a strict cubic outer shape. It is like a complex musical composition in itself. The layout is in a courtyard scheme with the concert hall as its center and other facilities surrounding it. The foyer acts as a important part of the building, where the public and performance spaces converge. It consists of spaces with observation balconies and large windows to frame the fjord and fetch sufficient daylight.

"music is the art of striking a chord in people directly. As the body of musical instruments, this architecture serves as a resonance body for creativity in the House of Music."

- Wolf D Prix

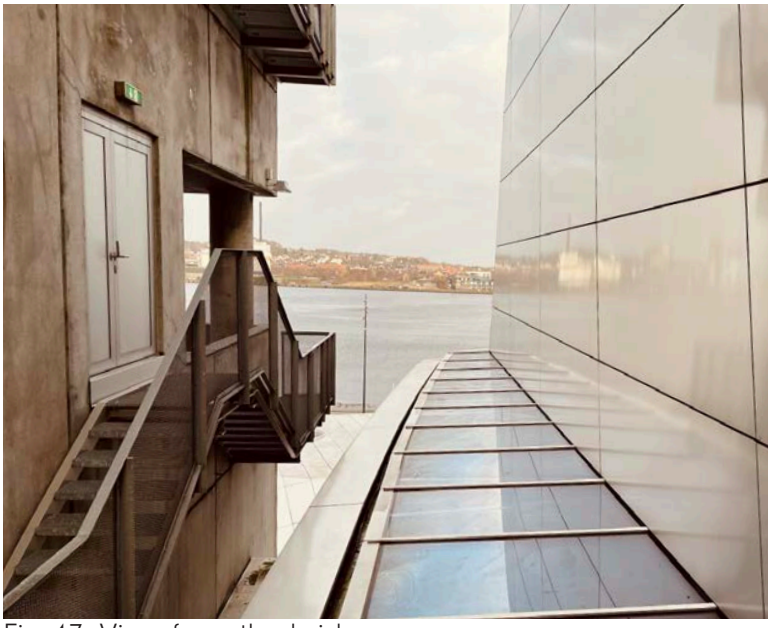


Fig 47. View from the bridge

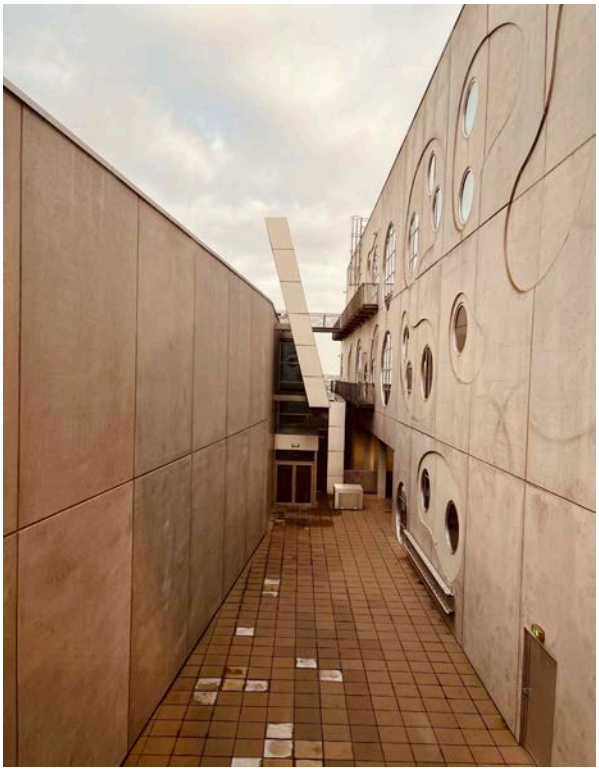


Fig 48. View from the corridor

detached construction

Sound transmission is controlled by organizing different functional zones of the building into different detached volumes. These volumes are then connected by small bridges and staircases for access. In this manner, different activities taking place in the building are well segregated and do not conflict with each other. For instance, the educational functions related to music are separate from the performance areas and the performance areas are seprate from the open public access areas.

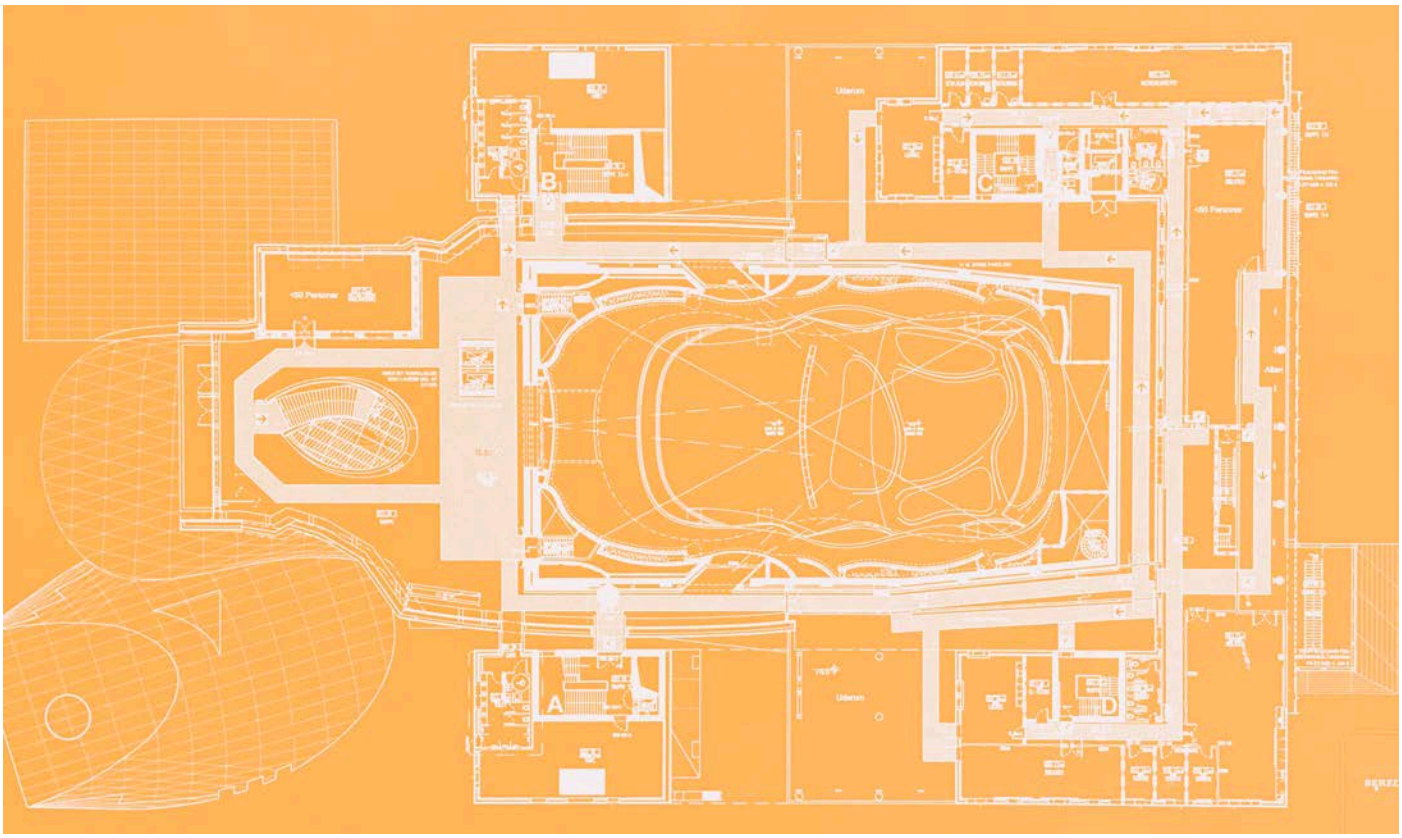


Fig 49. Third floor plan

music practice rooms

Fig 50. Band practice room

Fig 51. Ensemble practice room

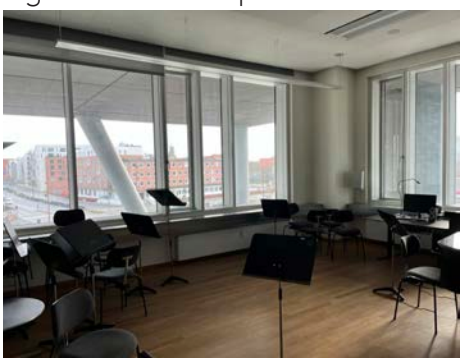


Fig 52. Individual practice room

Fig 53. Band practice room with control room

takeaways

- A building with multiple volumes can be beneficial for controlling sound transmission.
- Zoning is crucial for building fuctionality as well as acoustics.
- There is a big difference between the quality of music performance spaces as compared to that of music making/practicing spaces. How to improve the later in the proposed project?

MIRRORS Aalst

Fig. 54.
Parabolic
acoustic mirror

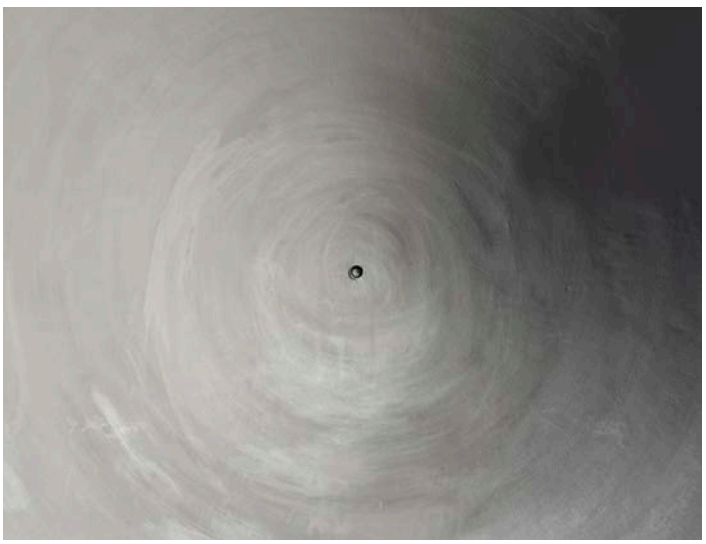


Fig. 55. Smooth concrete finish

Location
Gare de train Alost square,
Aalst, Belgium

Artist
Tim Bruniges

Year of completion
2017

MIRRORS Aalst is an aural installation, which was exhibited as part of the exhibition "Murmur", April 8 - July 2, 2017, of Netwerk center for contemporary art, Aalst, Belgium

"'MIRRORS Aalst' draws from the first generation acoustic early warning devices that were used at the English coastline during the interwar period to catch the sound of approaching airplanes. As an apparently functional eavesdropper, 'MIRRORS Aalst' samples and replays the sounds on the square while performing the status of an abstract "public" sculpture. Through a delay in the looping system, however, an element of alienation is brought in: what you hear has already vanished. As such, 'MIRRORS Aalst' mixes up perceptions in the here and now with stories from a recent past, generating a complex dialogue with the city and the life of Aalst."

(https://vimeo.com/219797162)

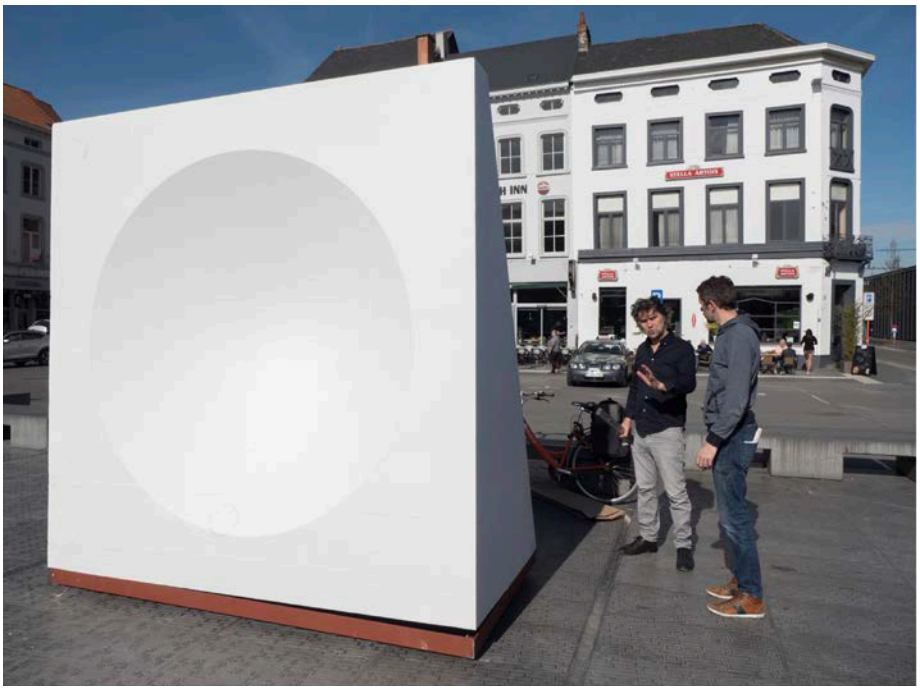


Fig. 56. Installation process

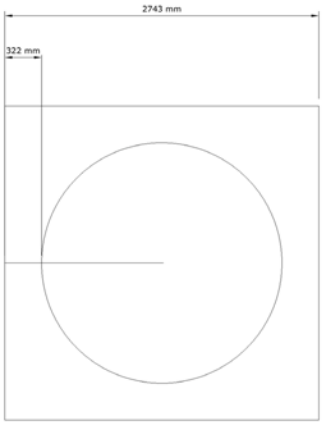


Fig. 57. Mirror elevation

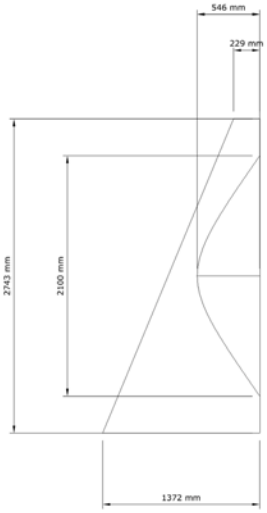


Fig. 58. Mirror section

Fig. 59. Public interaction

Fig. 60. Aalst Train Station and the mirrors

site analysis

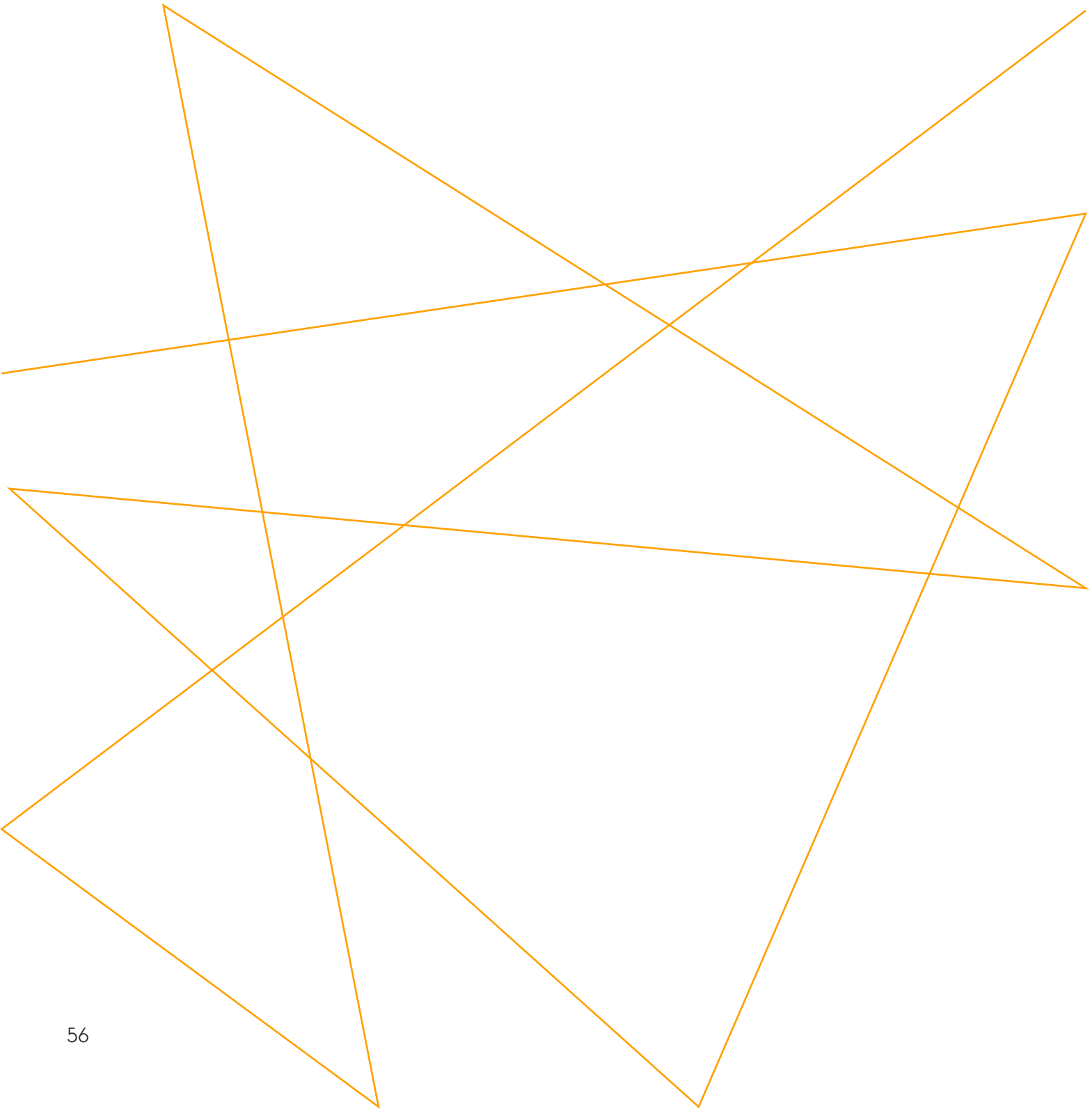
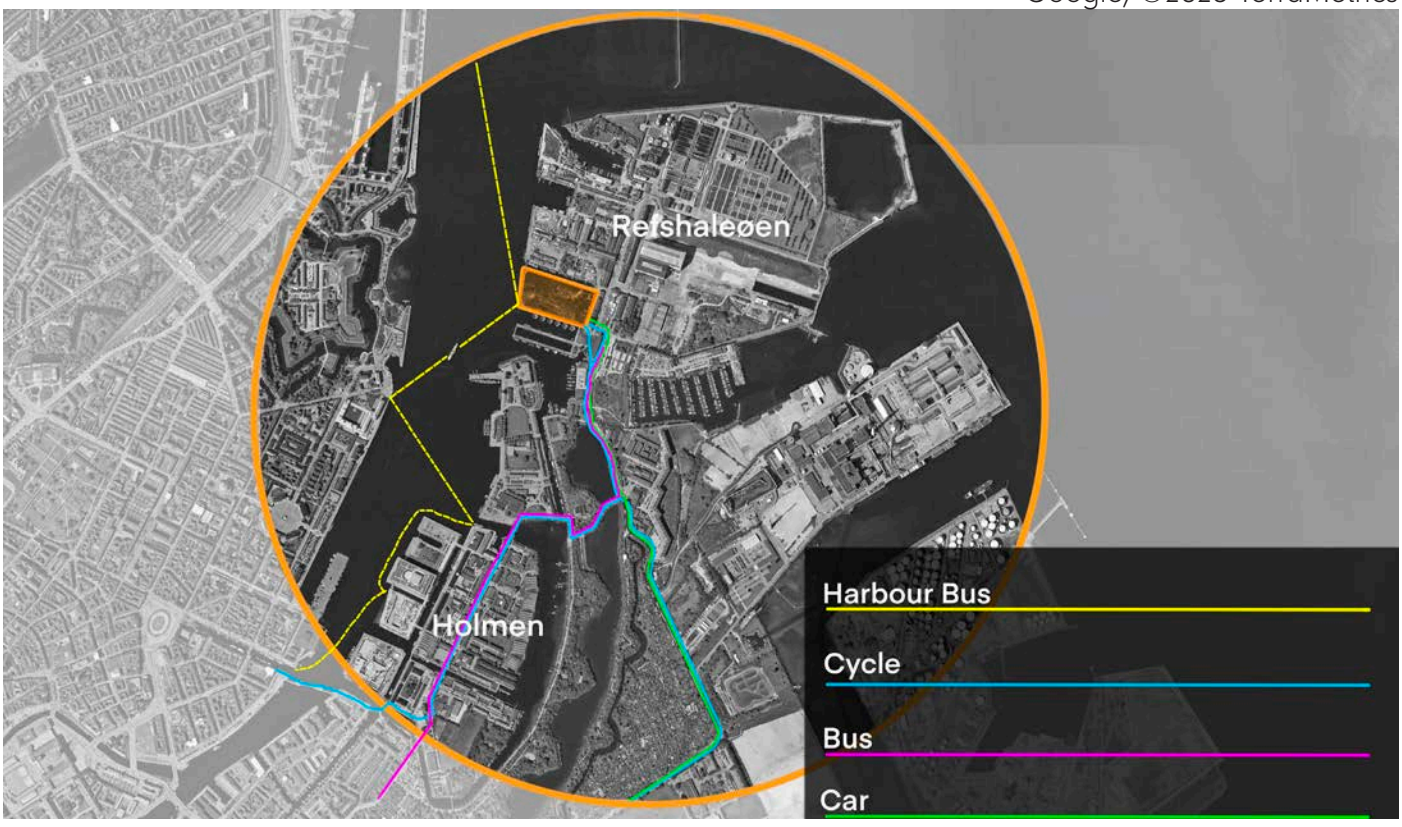


Fig 61. Surrounding music scene
Google, ©2023 TerraMetrics

surrounding music scene

means of transport

Fig 62. Means of transport
Google, ©2023 TerraMetrics



site context

Fig 63. Site context
Google, ©2023 TerraMetrics

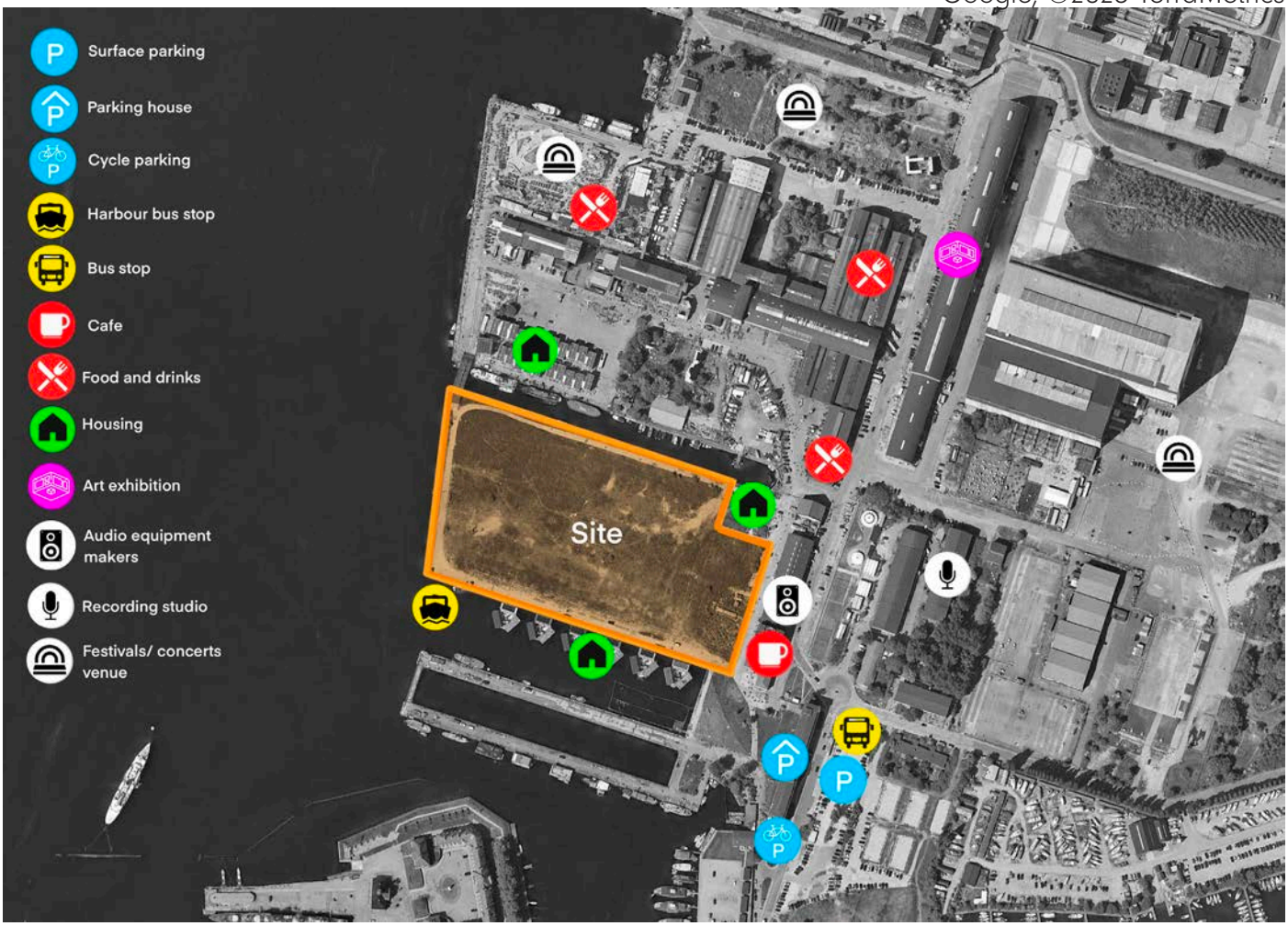


Fig 64. B&W halls from site

Fig 65. Copenhill from site

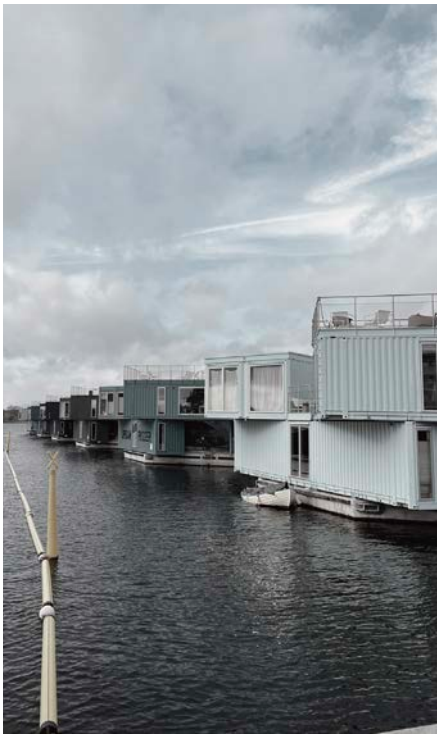


Fig 66. Urban Riggers

morphology

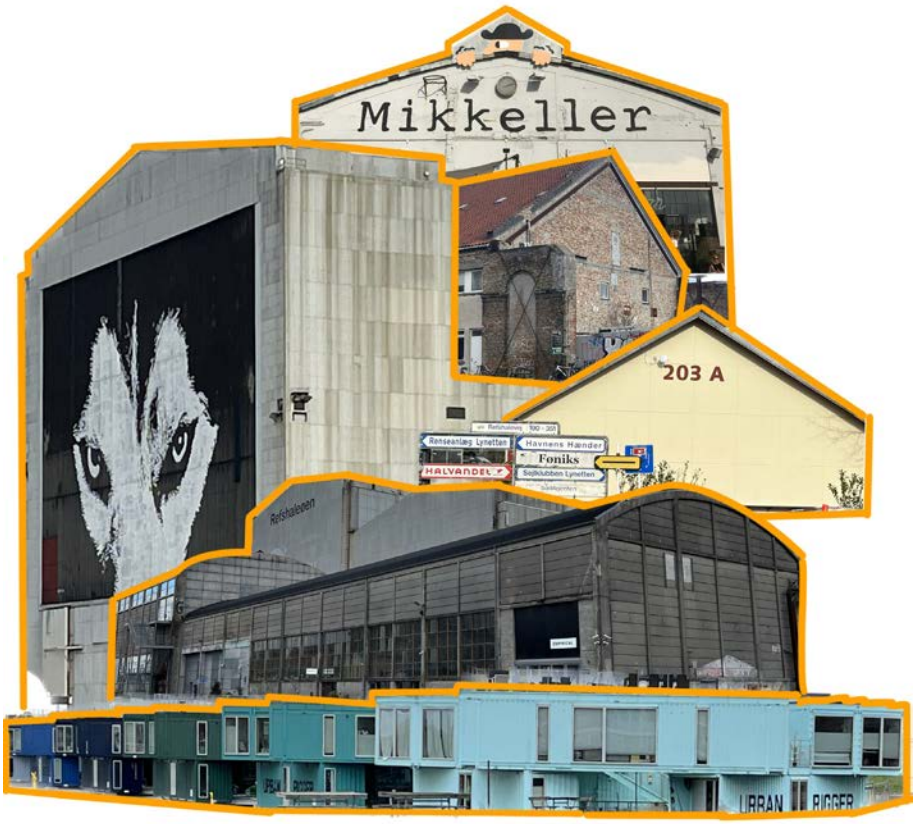


Fig 67. Morphological collage

Being an old industrial district, Refshaleøen bears a strong and peculiar built character. It is vital, how the design vocabulary and mannerism of the proposed project will relate to the site context. To understand that, a morphological analysis has been carried out by sorting out built forms on the basis of their basic shape and character.

The analysis shows that there are prdominantly 3 categories of built forms: buildings with pitched roof, buildings with rounded roof and buildings made out of shipping containers. Throughout the analysis, it was evident that there is a prevailing theme of gable walls. These walls are used for artwork, advertisement and at some places they are symbolic to the activities happening around them.

Buildings with pitched roof

Buildings with rounded roof

Buildings with shipping containers

Key plan

Gable elevation

Form

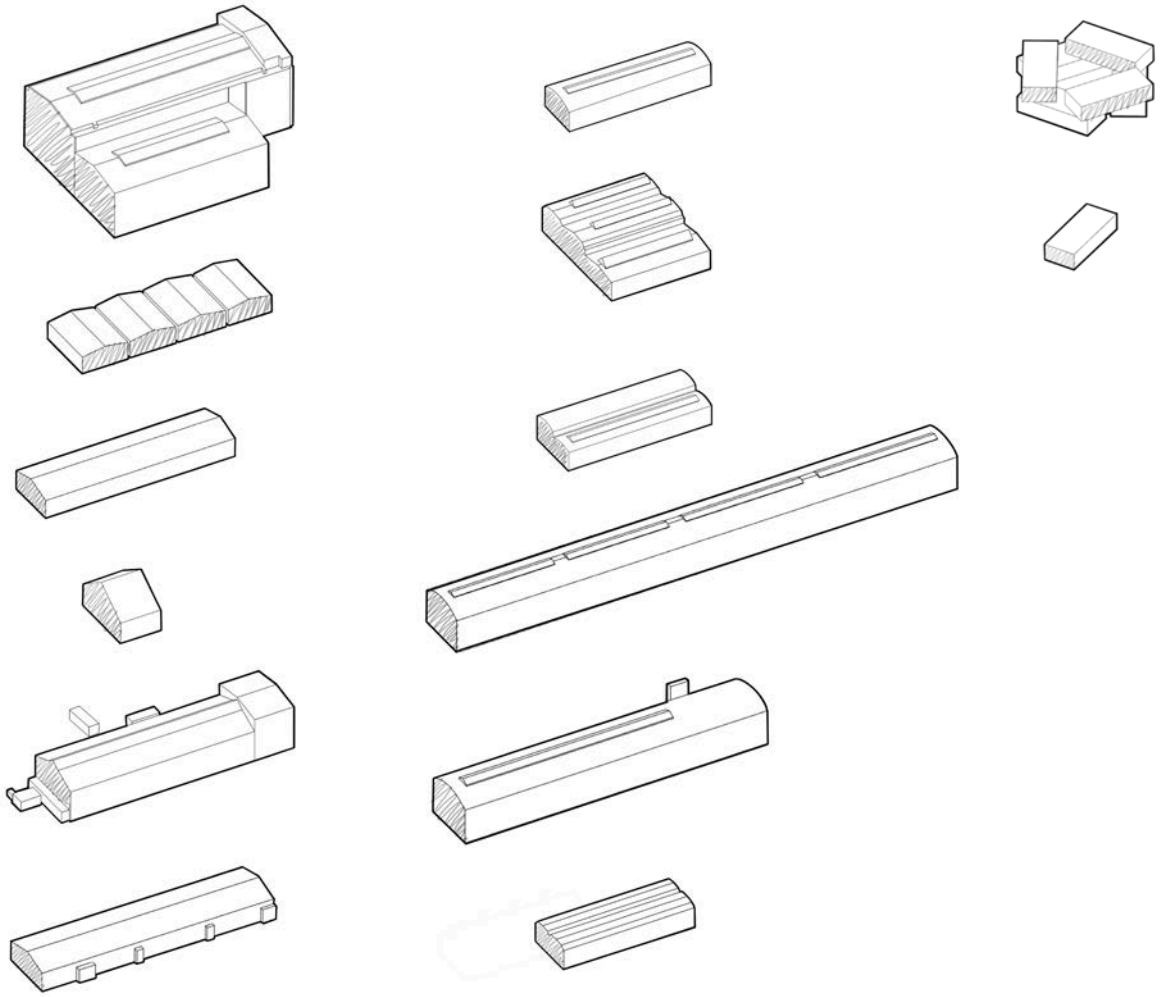


Fig 68. Morphology

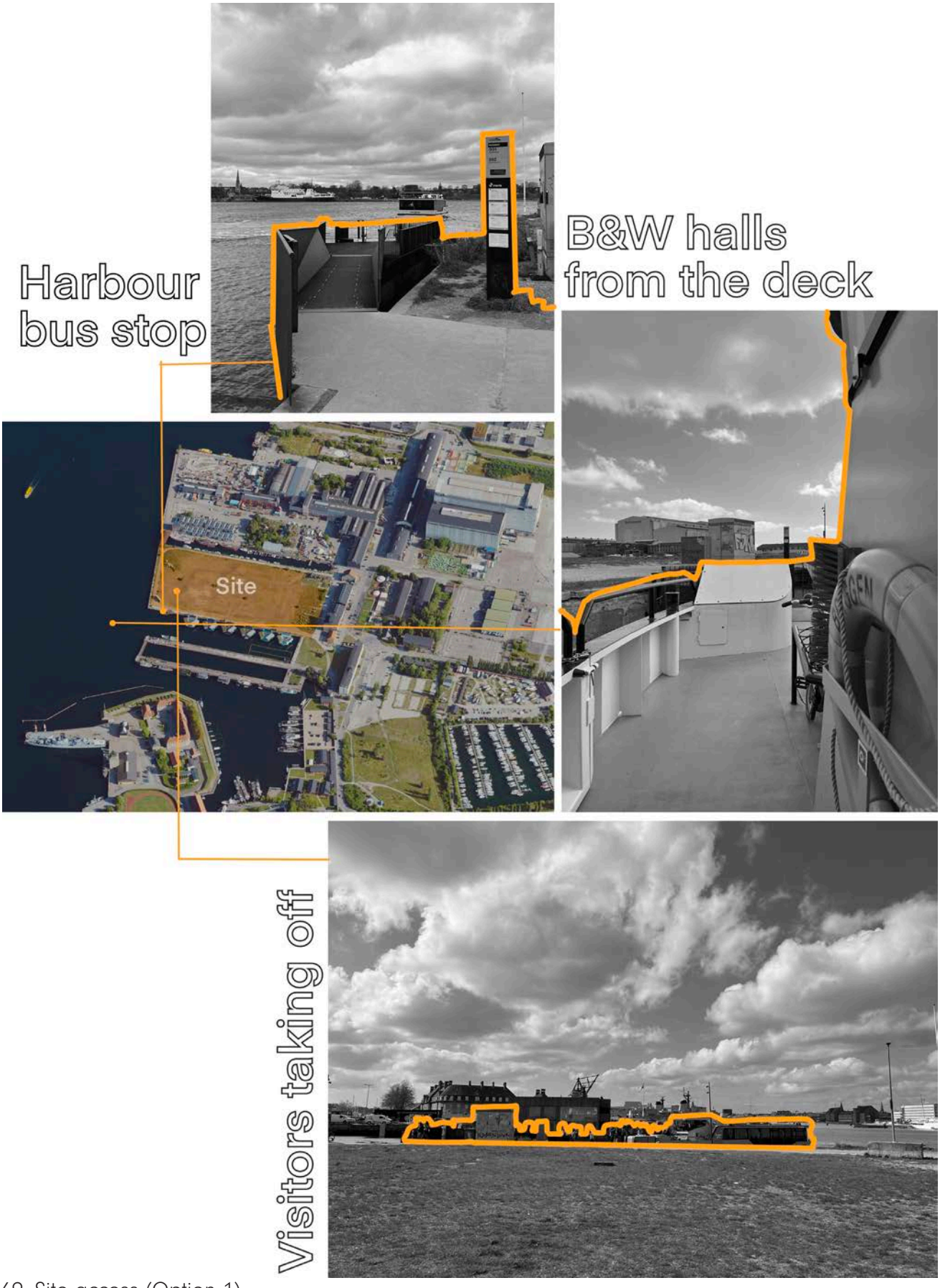


Fig 69. Site access (Option 1)

site access - vehicular

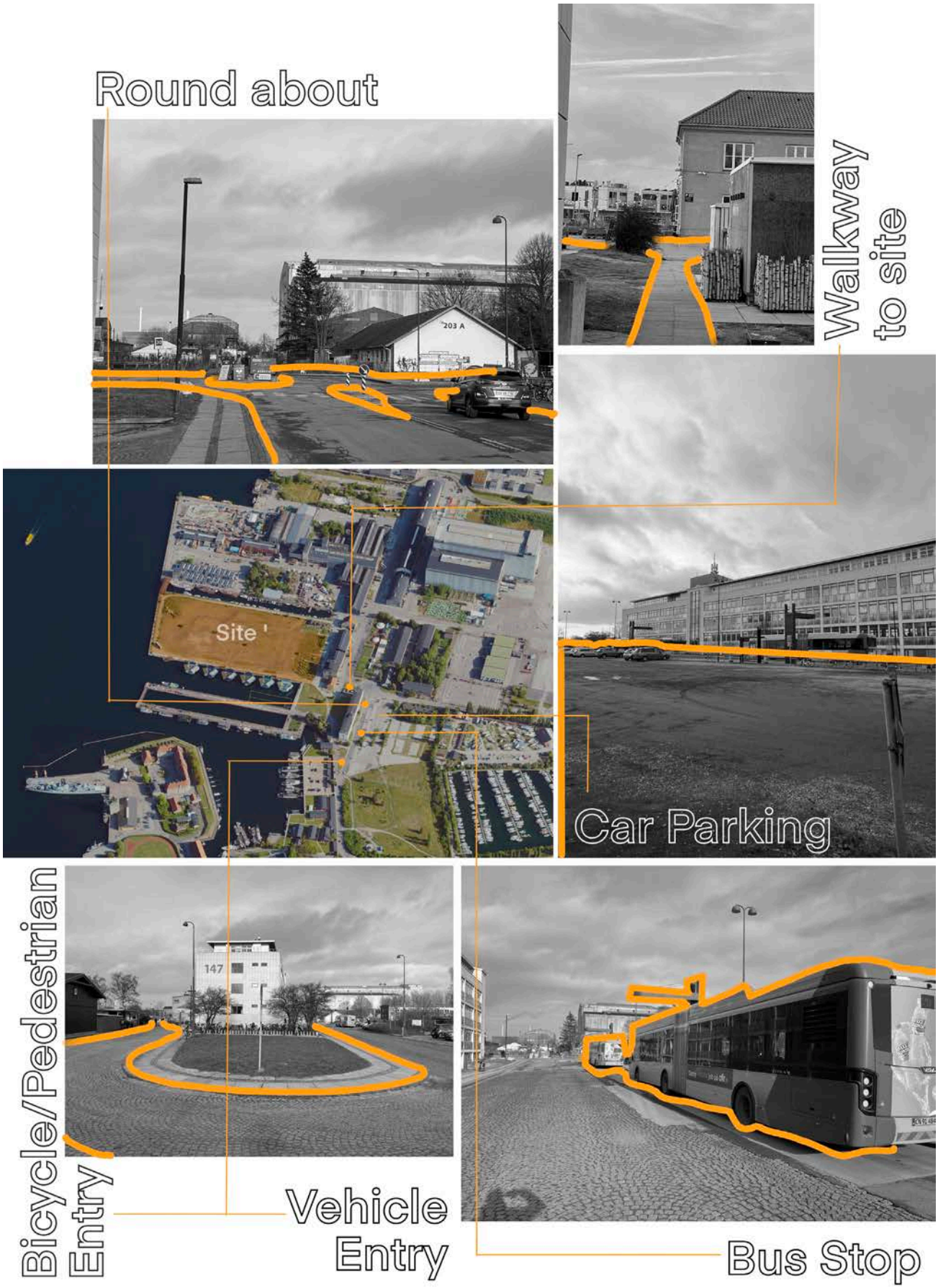
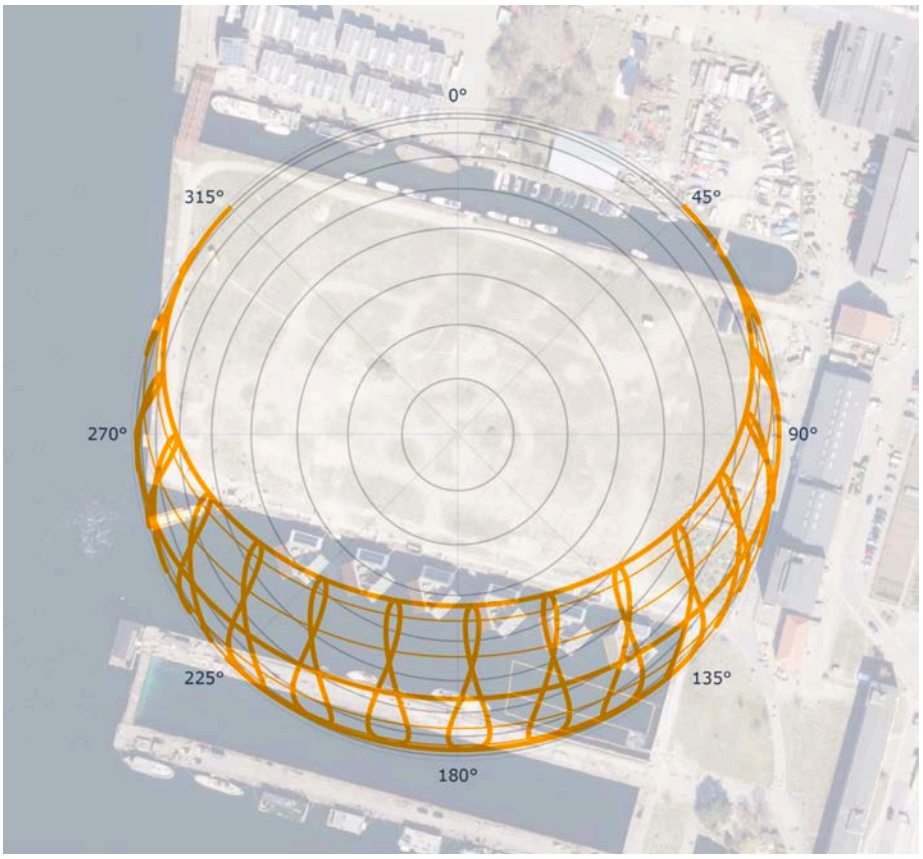


Fig 70. Site access (Option 2)

Fig 71. Site access (Option 3)

sun & wind

sun path chart



annual wind rose

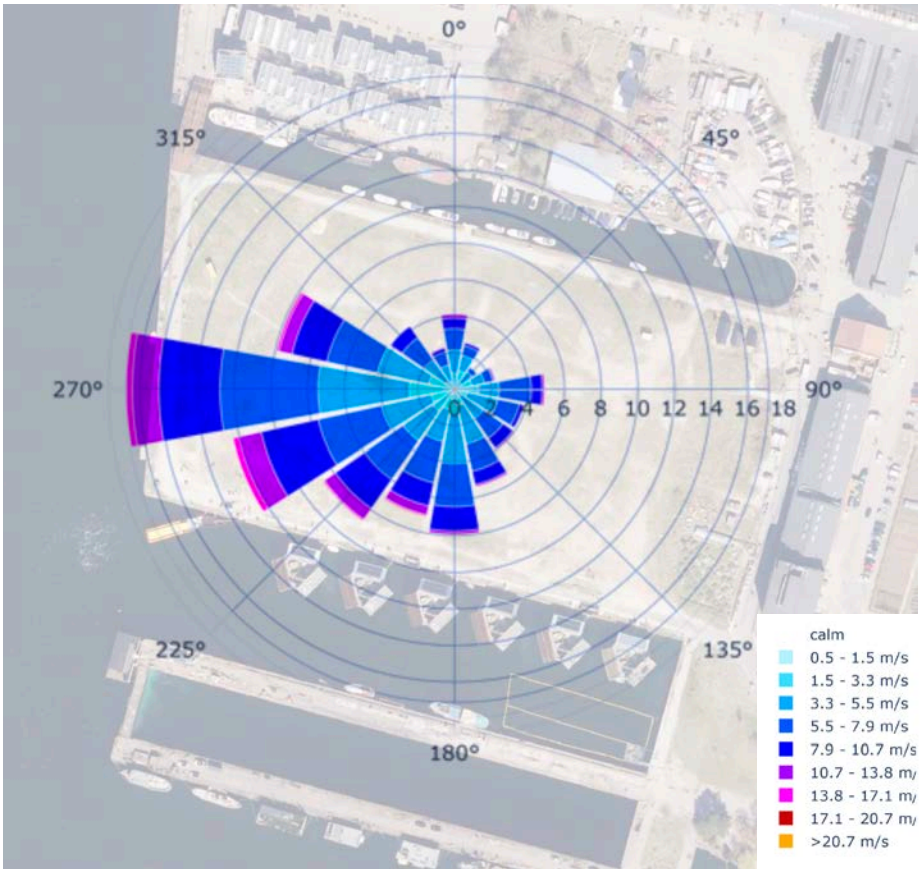
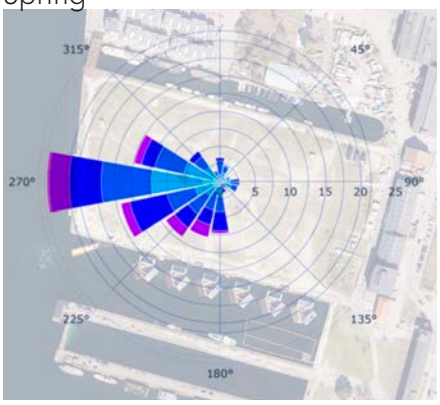


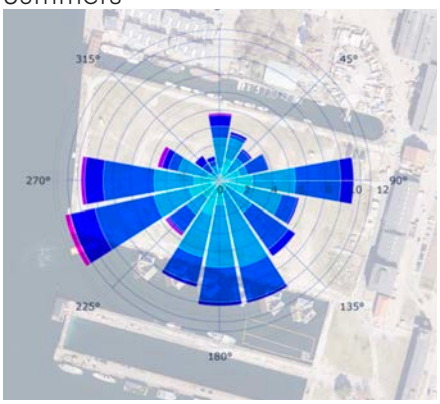
Fig 72. Sun and wind analysis (clima.cbe.berkeley.edu)

seasonal wind rose

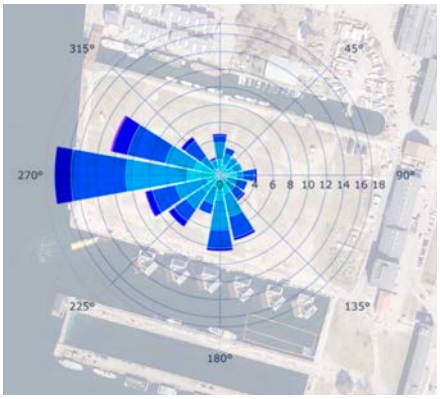
Spring



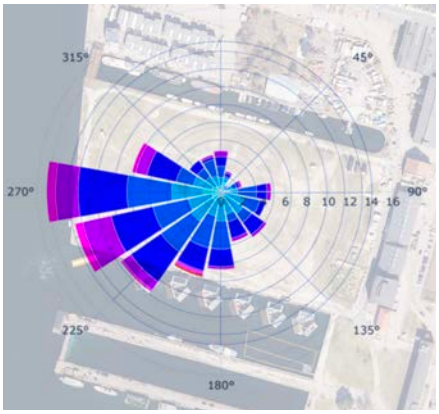
Summers



Autumn



Winters



noise

traffic noise

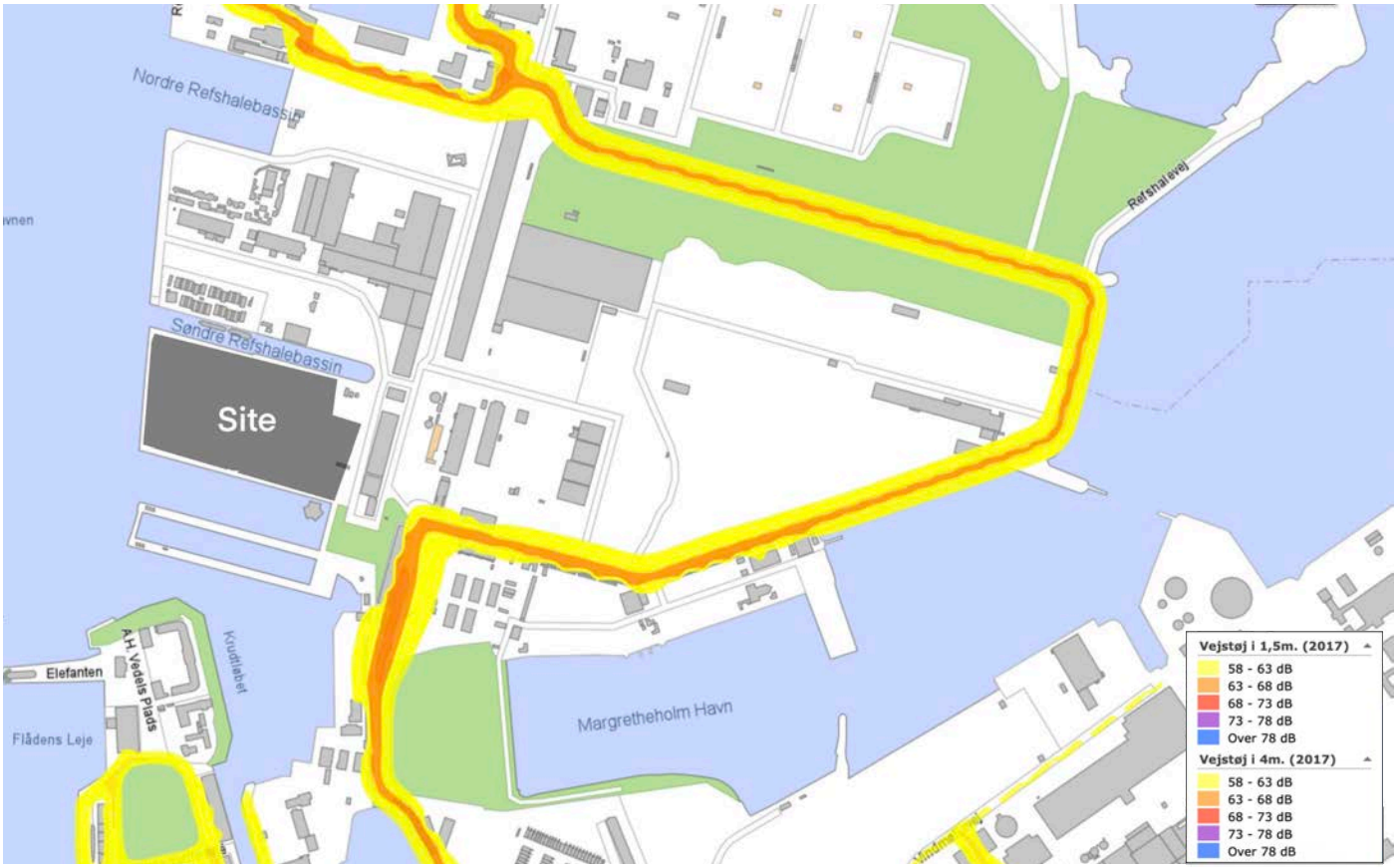


Fig 73. Noise map (ww.kkkort.dk)

Sound levels are under 58dB at the project site and there is no issues of noise from the road traffic either.

Though, music festivals and concerts are taking place at Refshaleøen on special occasions, any kind of amplified music is not allowed on normal days between 22:00 and 8:00.

Fig 74. Amplified music restriction signage

odour from cleaning plant

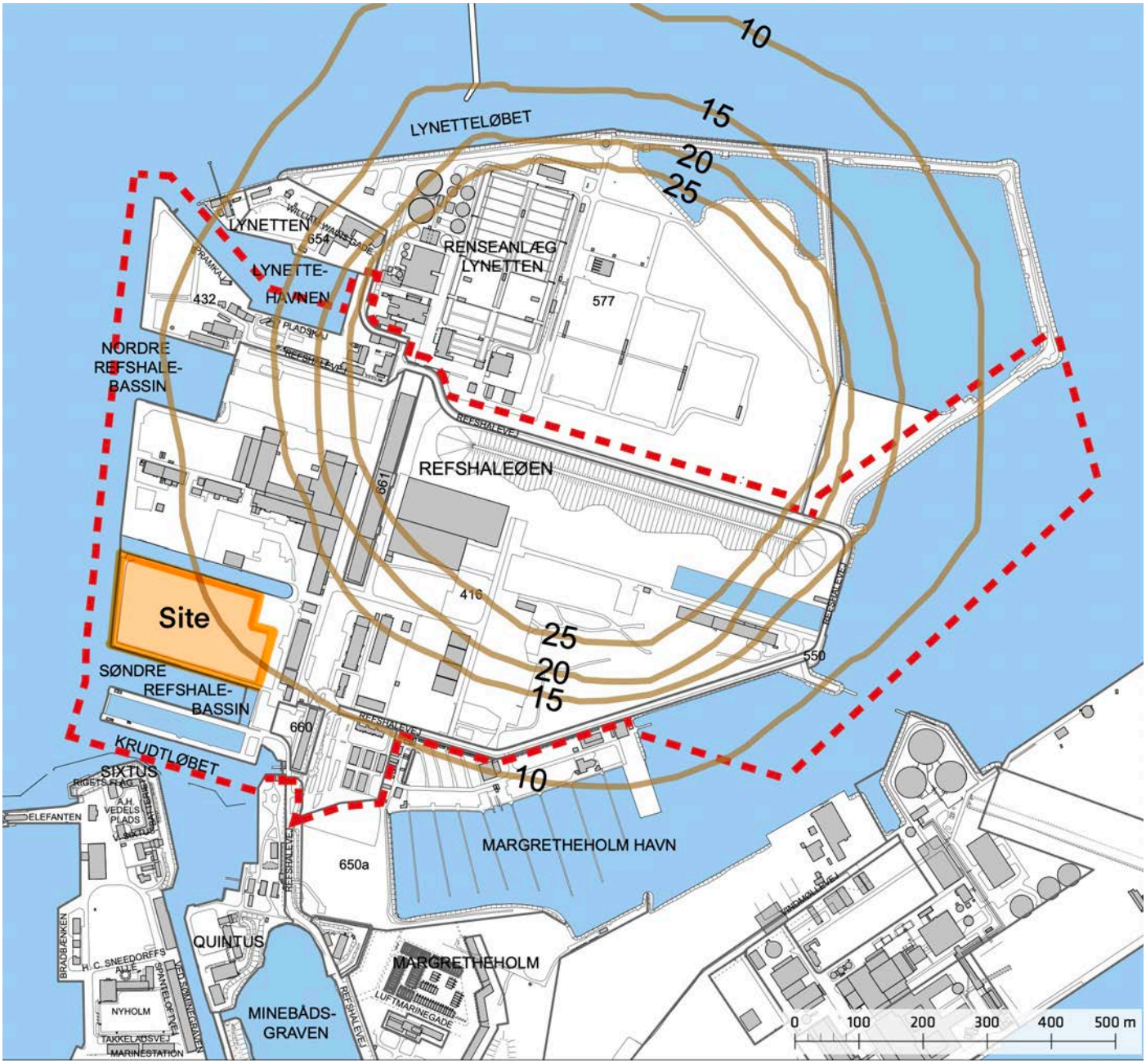
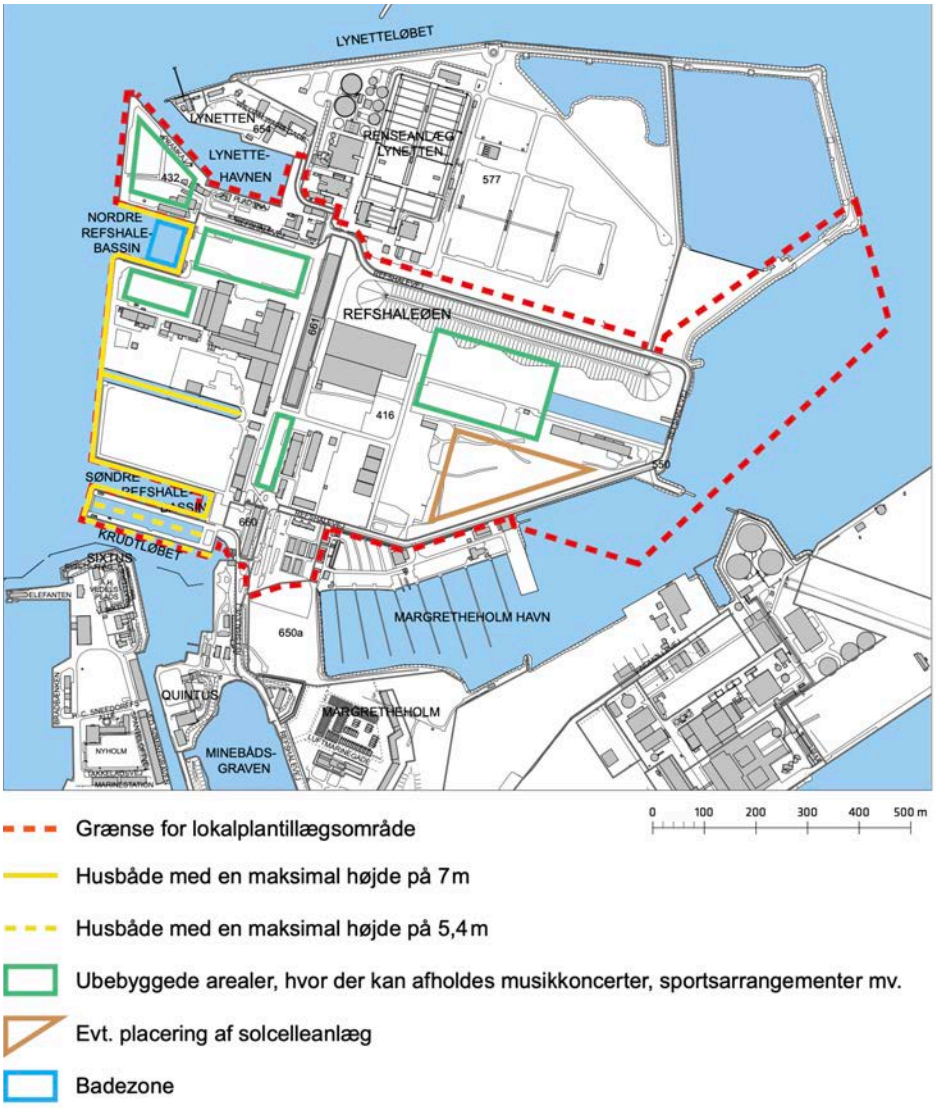


Fig 75. Map of odour from the cleaning plant,
Local plan nr. 209 "Refshaleøen med tillæg nr. 1" (www.kkkort.dk)

As per municipality directions, buildings and primary living areas must be used, placed, carried out and furnished in such a way that residents and users are protected against the bad odor from businesses in and outside the area. Dwellings in connection with businesses and houseboats as well as other sensitive uses can be located in areas with an odor level of up to 10 LE.
Recreational functions can be arranged in areas with an odor level of up to 15 LE and mixed business can be arranged in areas with an odor level of up to 20 LE.

municipality guidelines

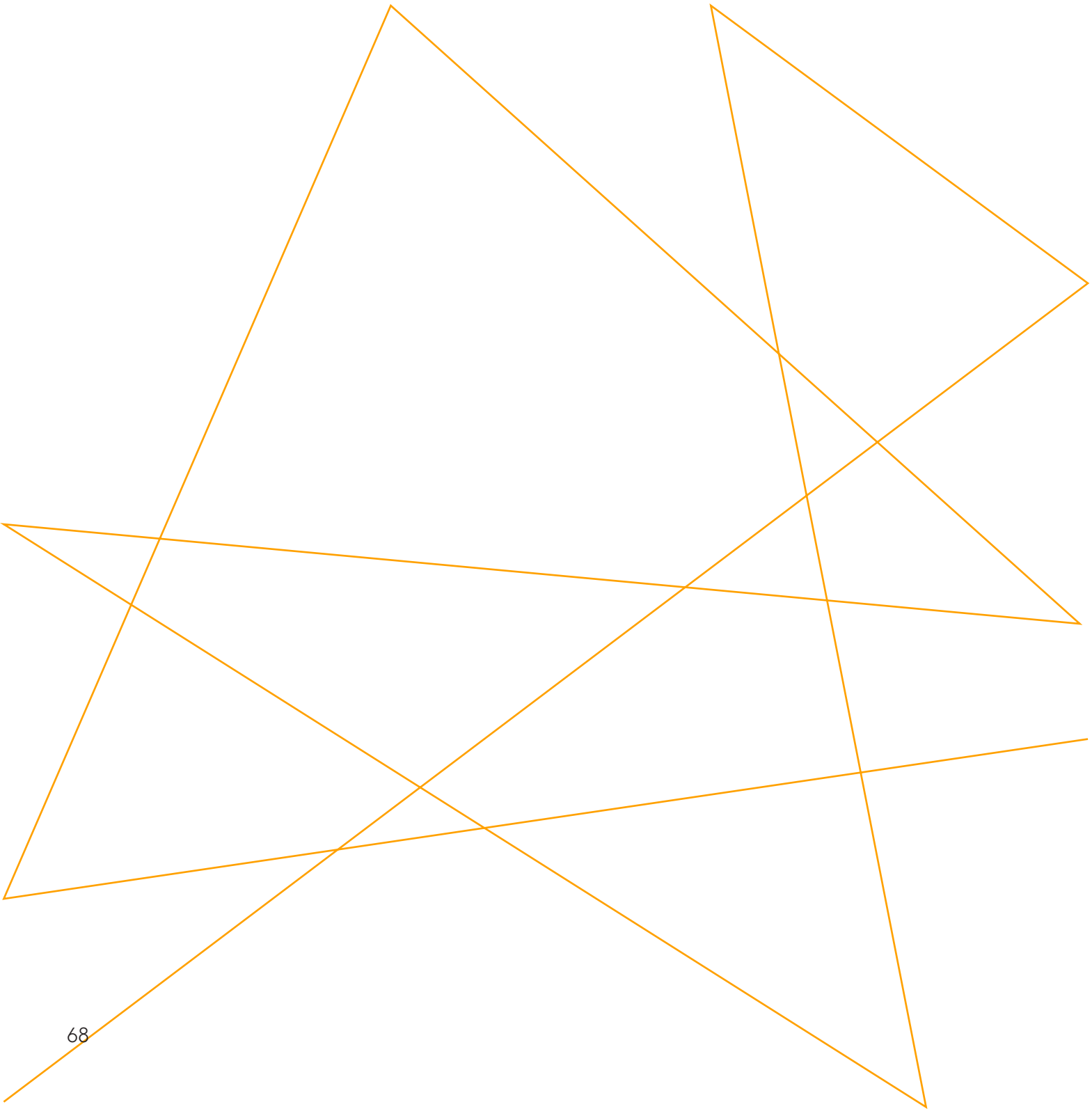


- Proposed project land use : Recreation, culture, gallery, teaching, exhibition
- Permissible built-up area : 5000sqm
- Maximum permissible height : 10m
- Parking :
  4 bicycle parking/100sqm
  1 car parking/100sqm

Fig 76. (above). Land use map (Anvendelse og husbåde),
Local plan nr. 209 "Refshaleøen med tillæg nr. 1" (www.kkkort.dk)

Fig 77. Planning map (Gældende rammer for området),
Local plan nr. 209 "Refshaleøen med tillæg nr. 1" (www.kkkort.dk)

initial design explorations



positioning

After the site analysis involving serial vision and flow, it made sense to postion the building close to the harbour, and leave off as much ground for the open air concerts. Three site circulation knots are also being identified, which are considered in the later stages.

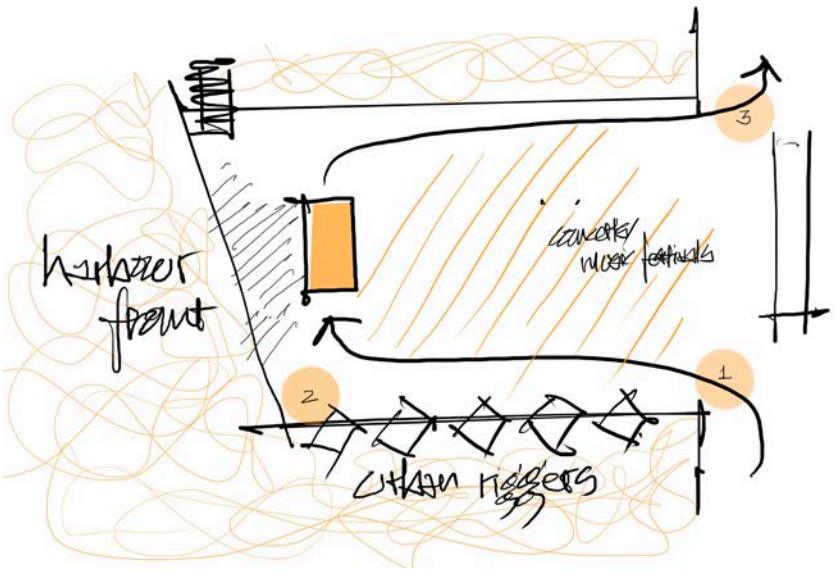


Fig 78. Positioning

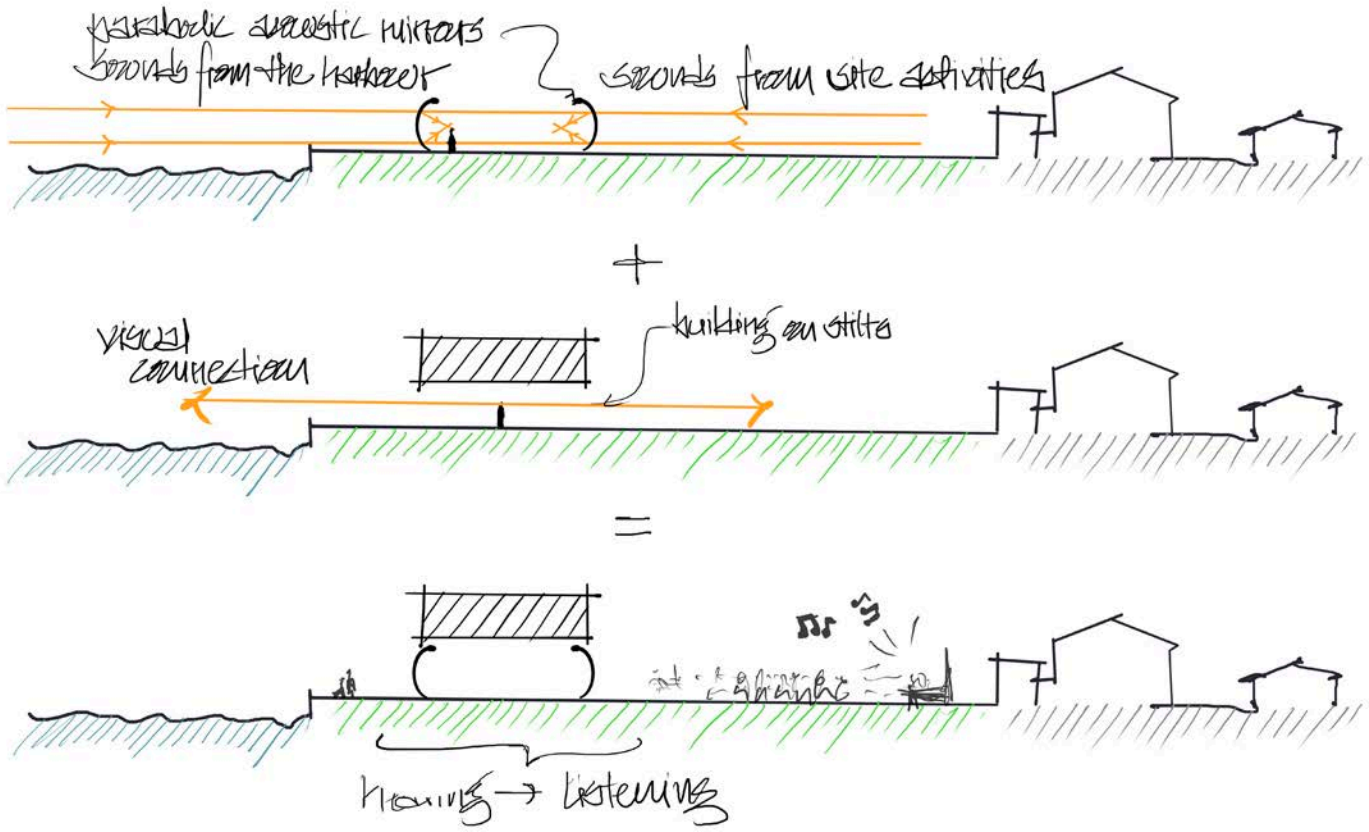
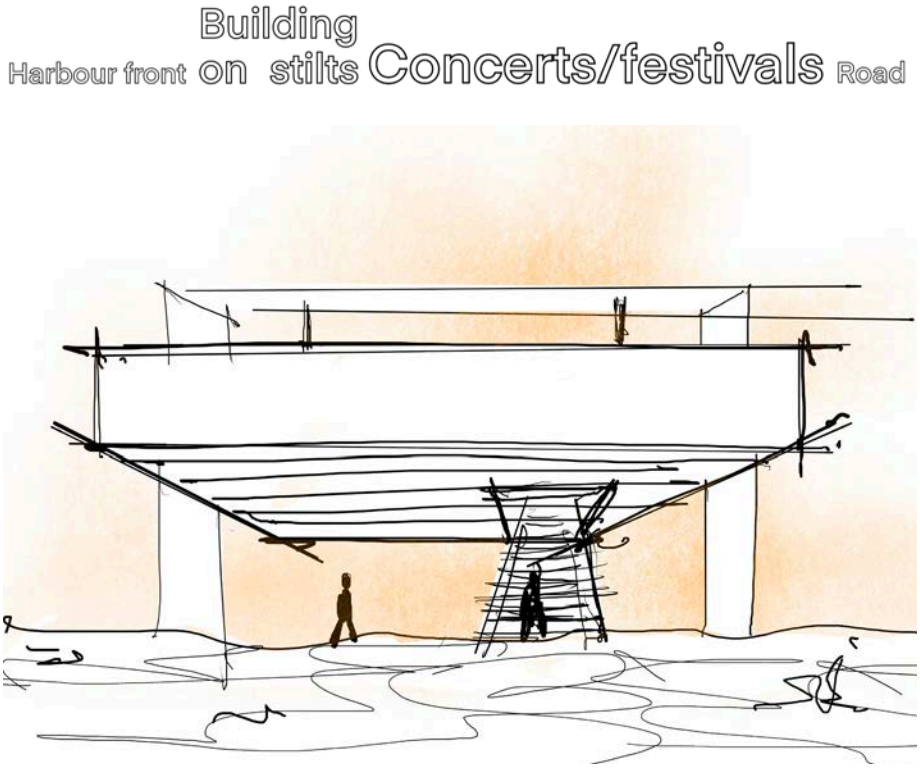


Fig 79. Conceptual site section



An initial design exploration, to achieve seamlessness at the site level; The concert ground flowing into a musicians/public plaza underneath the suspended building, which further flows into the harbour front.

This approach was met with issues of minimized building height availability and structural challanges.

Acoustically, there was also a big concern of handling sound vibrations in a suspended building structure

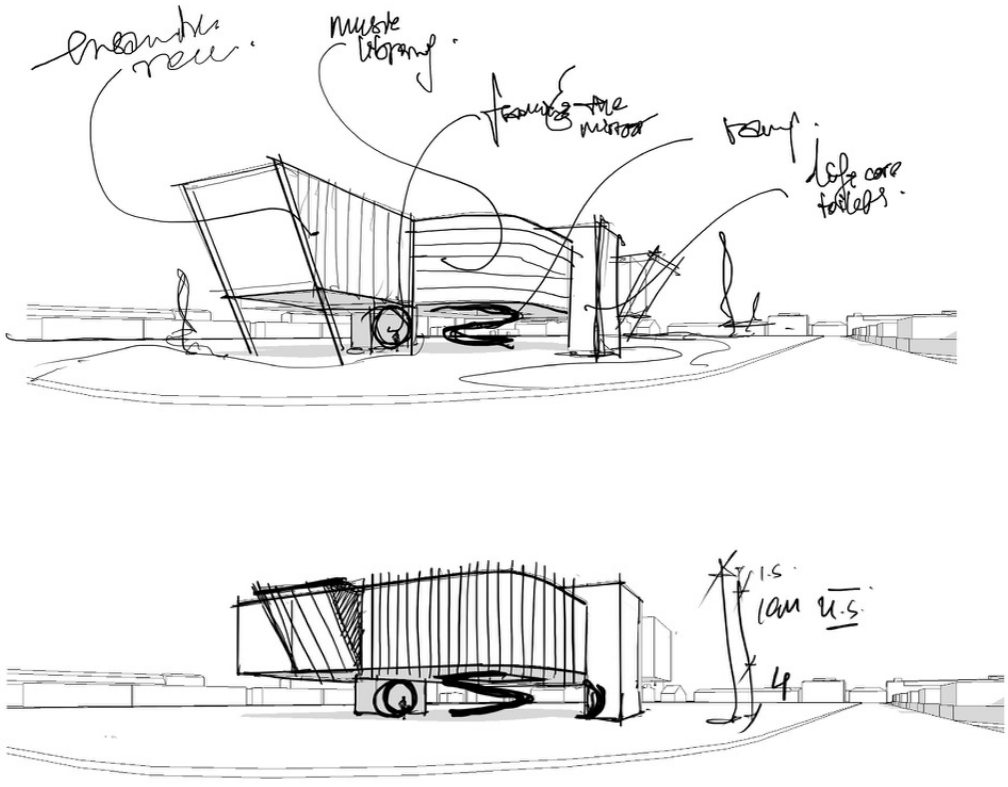


Fig 80. Exploring suspended building

contextual

Taking inspiration from the history of Refshaleøen, an option with upcycled shipping containers stacked on each other was explored. This approach proved to be spatially fragmented and it started competing with the neighbouring Urban riggers, which have a similar design approach.

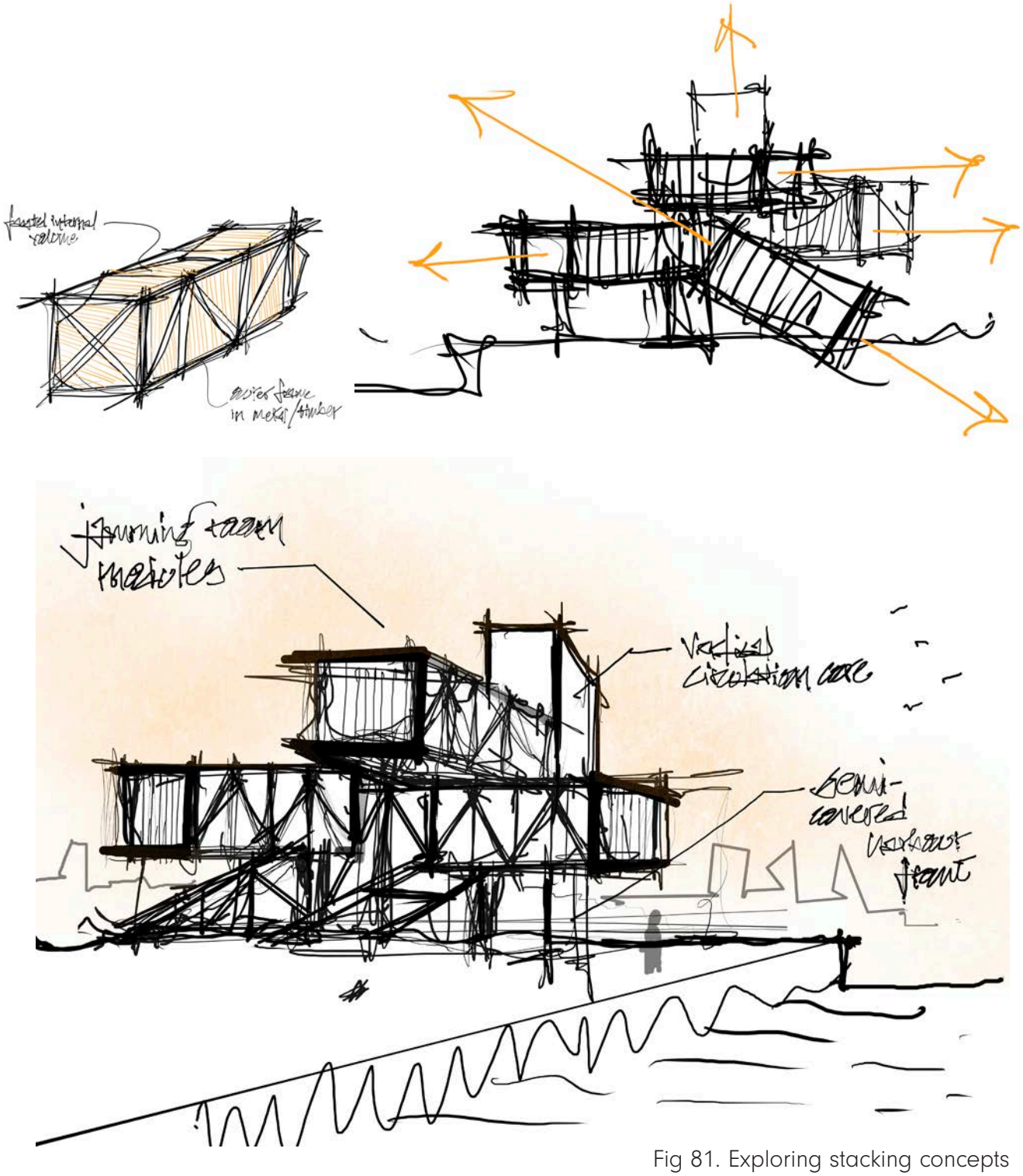


Fig 81. Exploring stacking concepts

juxtaposition

Something completely out of context and use the whole building as an acoustic mirror.

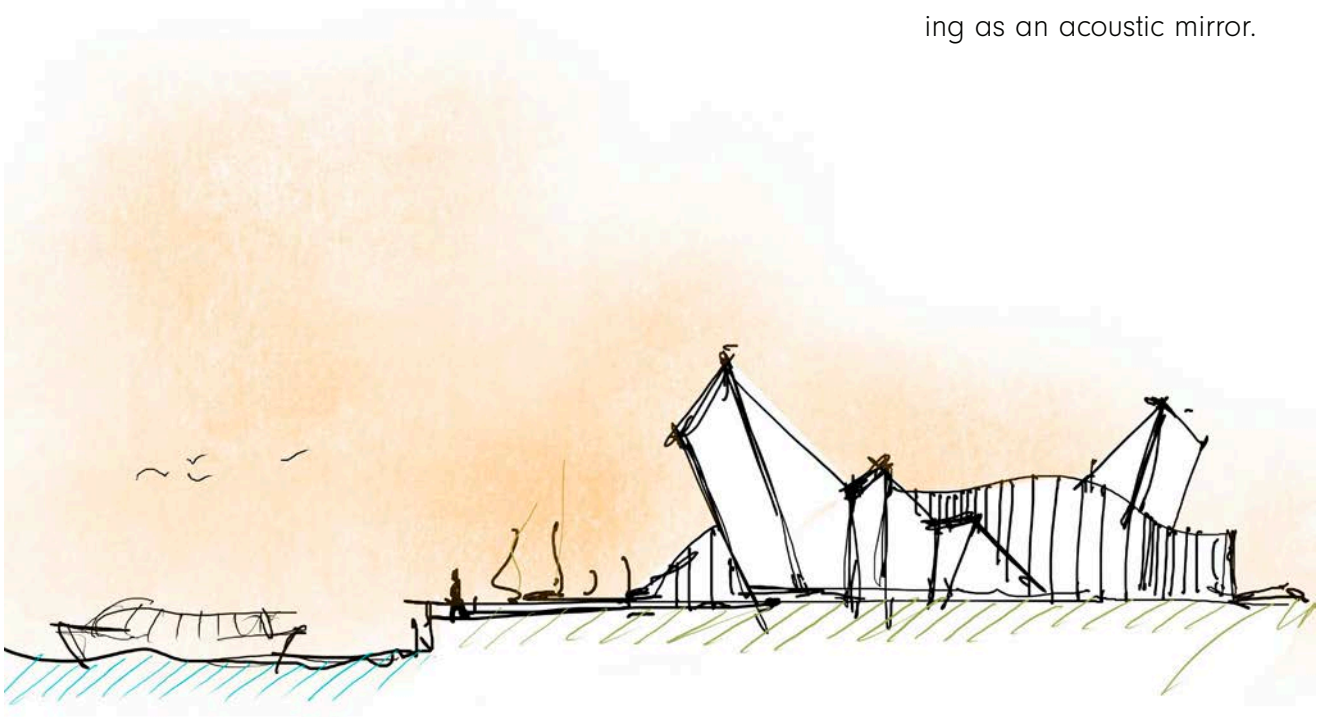


Fig 82. Explopring organic forms 1

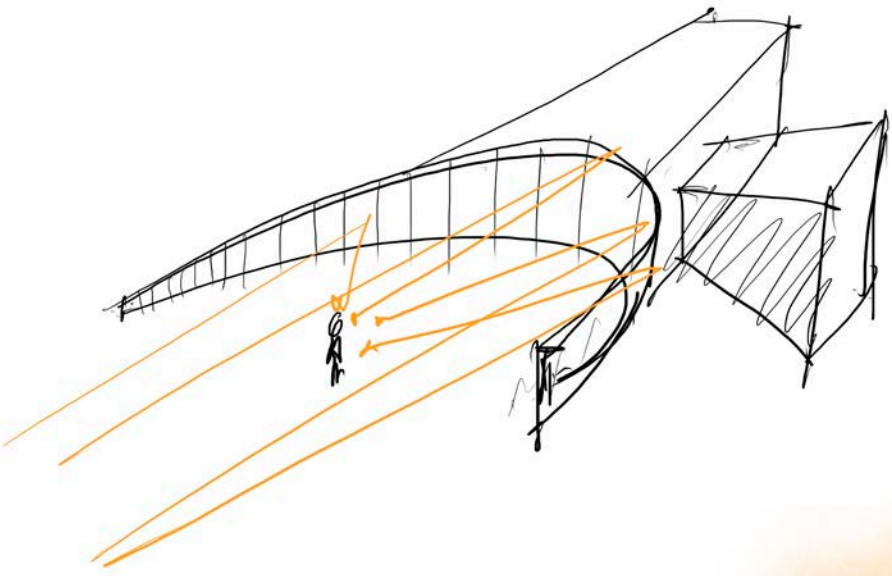


Fig 83. Building as an acoustic mirror

Fig 84. Explopring organic forms 2

acoustic mirrors

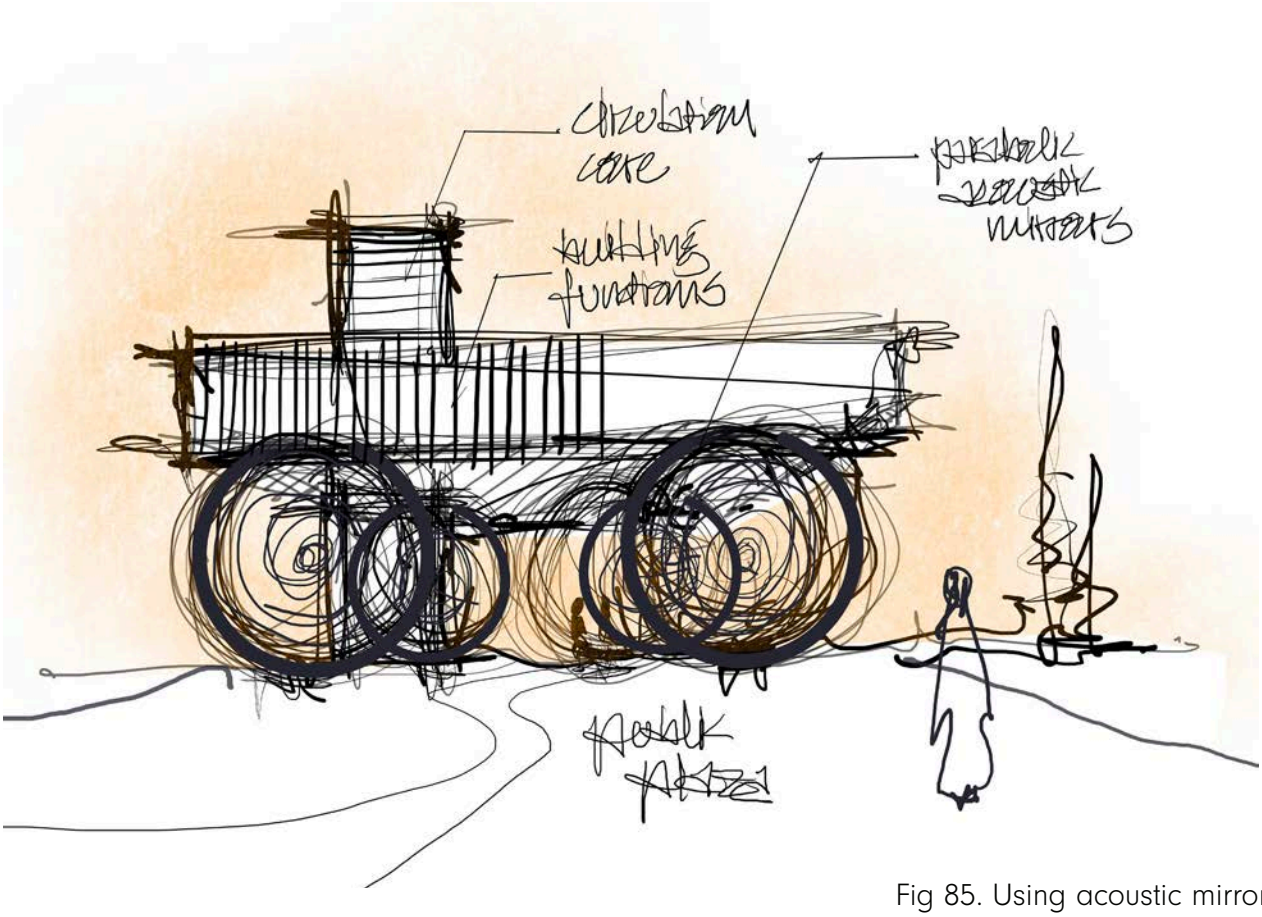


Fig 85. Using acoustic mirrors as a structural element.

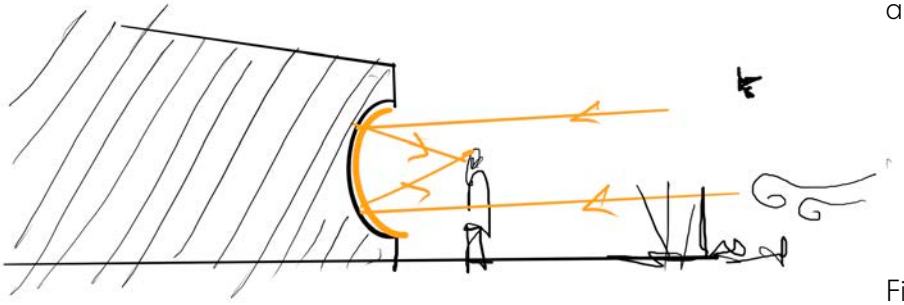
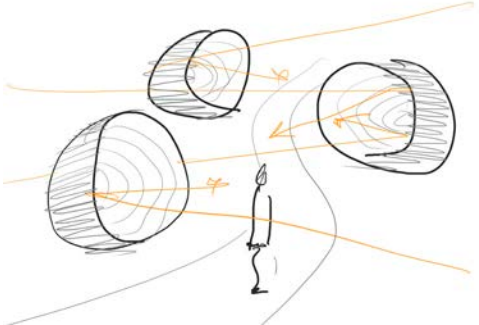
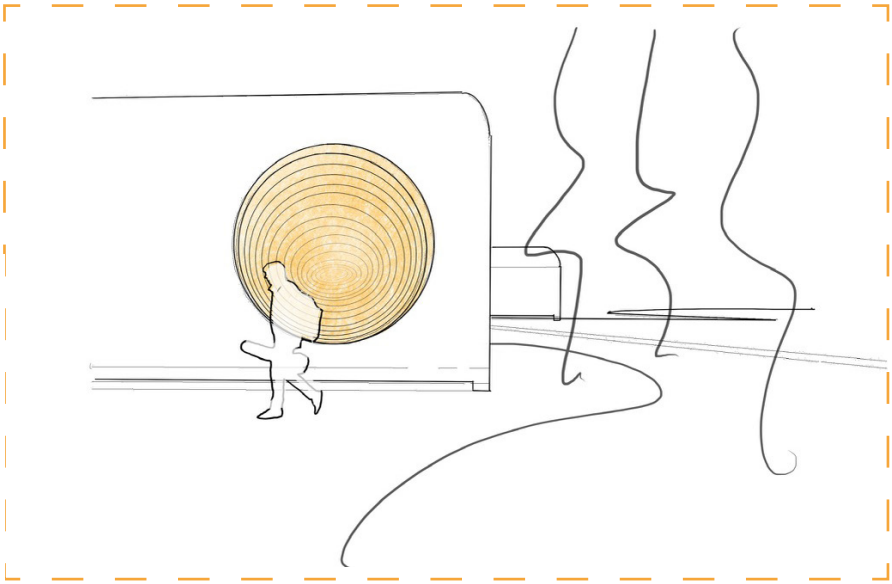


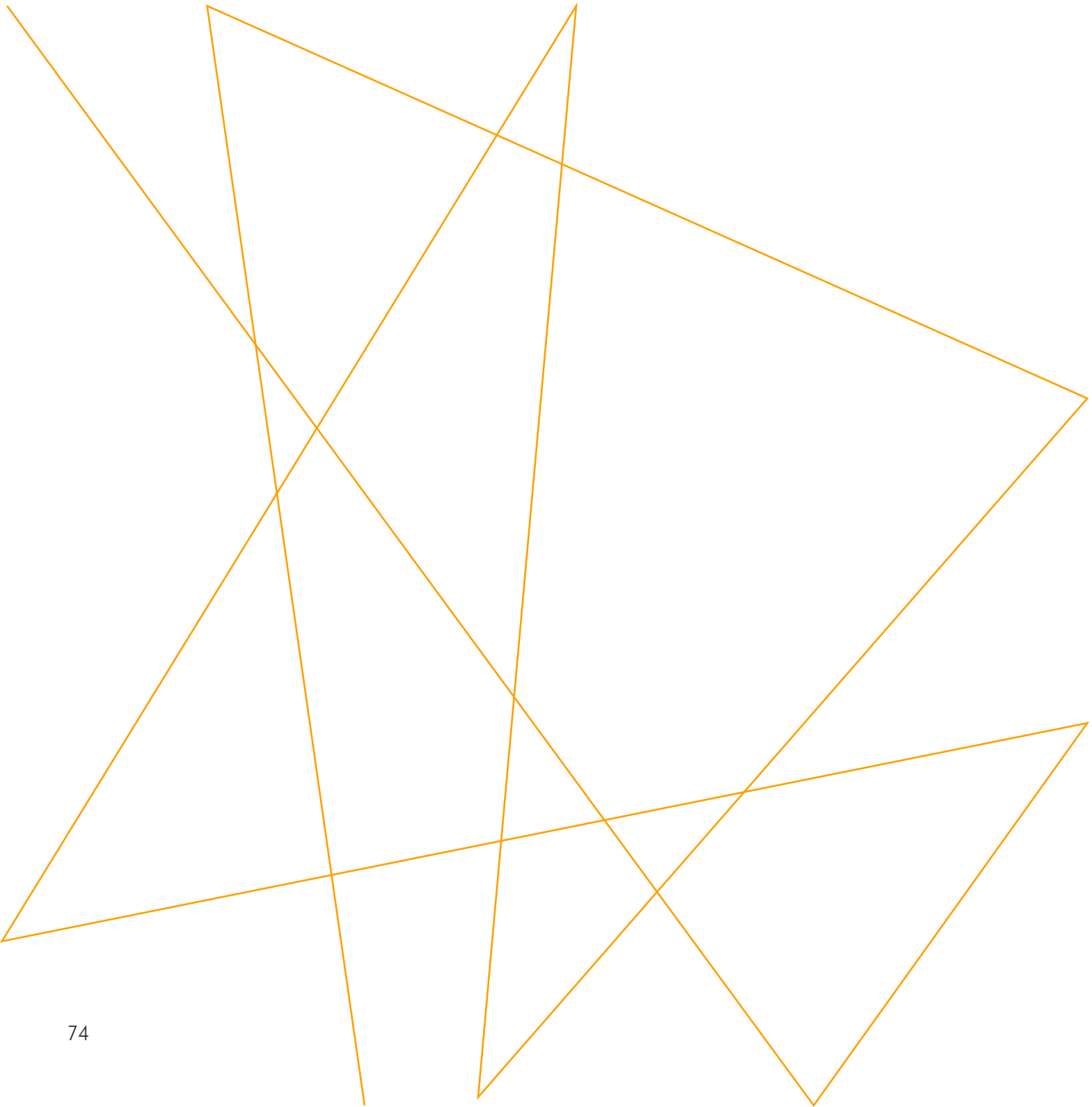
Fig 86. Using acoustic mirrors as an integral part of the facade.

Fig 87. Using acoustic mirrors to nevigate through space.





design process



conceptual zoning

Because of practical reasons and to boost the co-working agenda, shared facilities or common areas were placed at the centre of the two fuctional zones of a group oriented activity (ensemble rooms) and individual activity (small practice rooms).

This was based on the observation made at the SVFK facilities; Because of artists working on different floors and having a common room on the top floor, it was hard to encourage social connections between them.

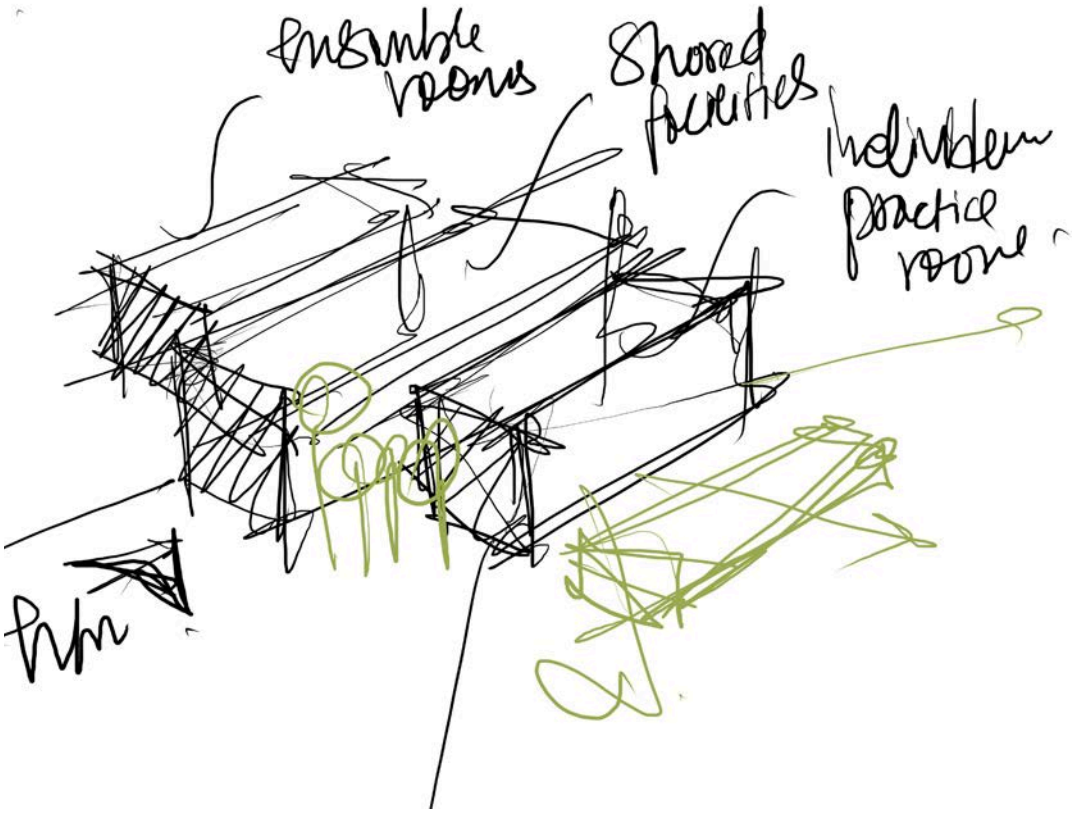


Fig 88. Conceptual zoning

plan evolution

During this process, the approach of creating very organic or almost musicial spaces inside of a strict geometry was undertaken.

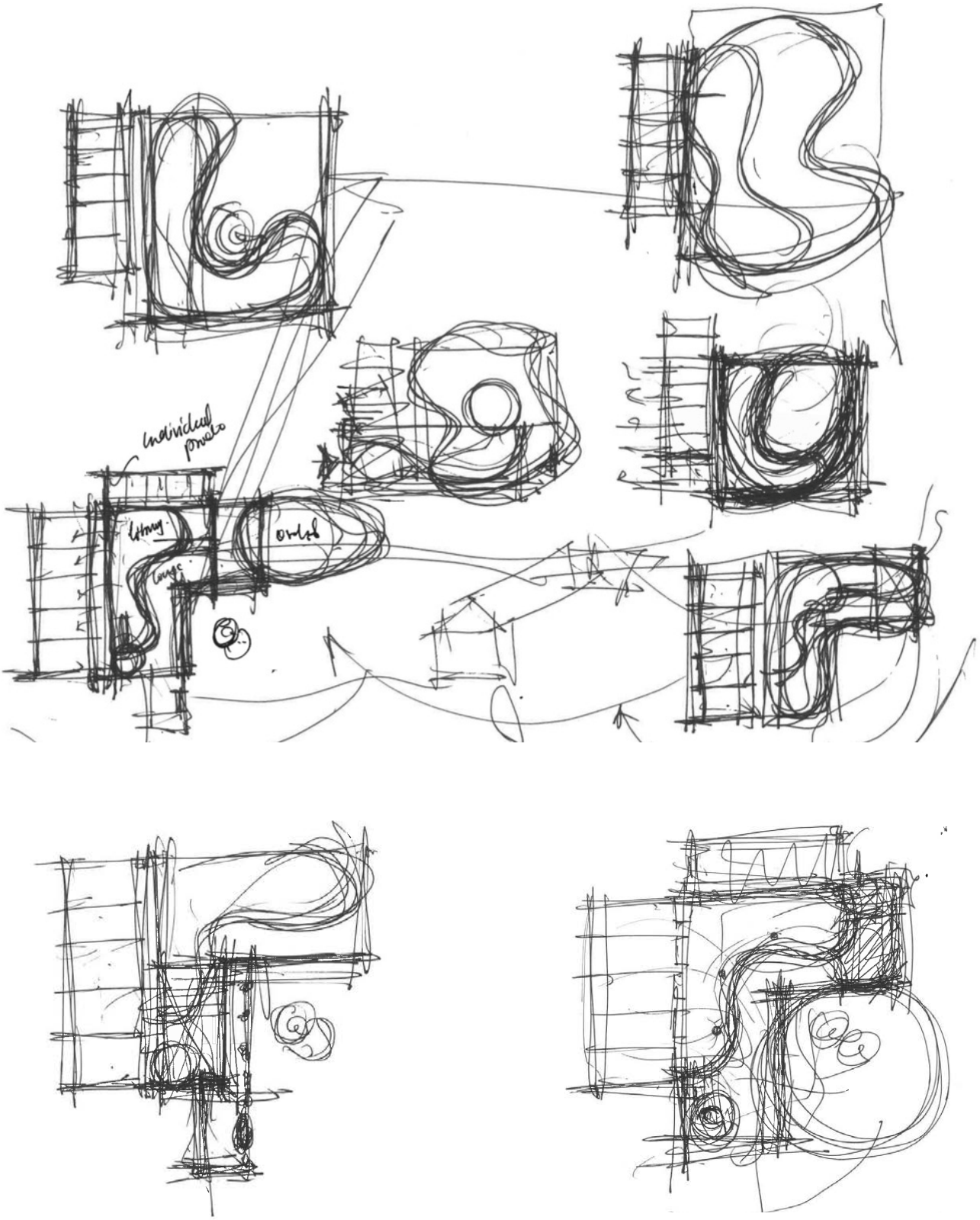
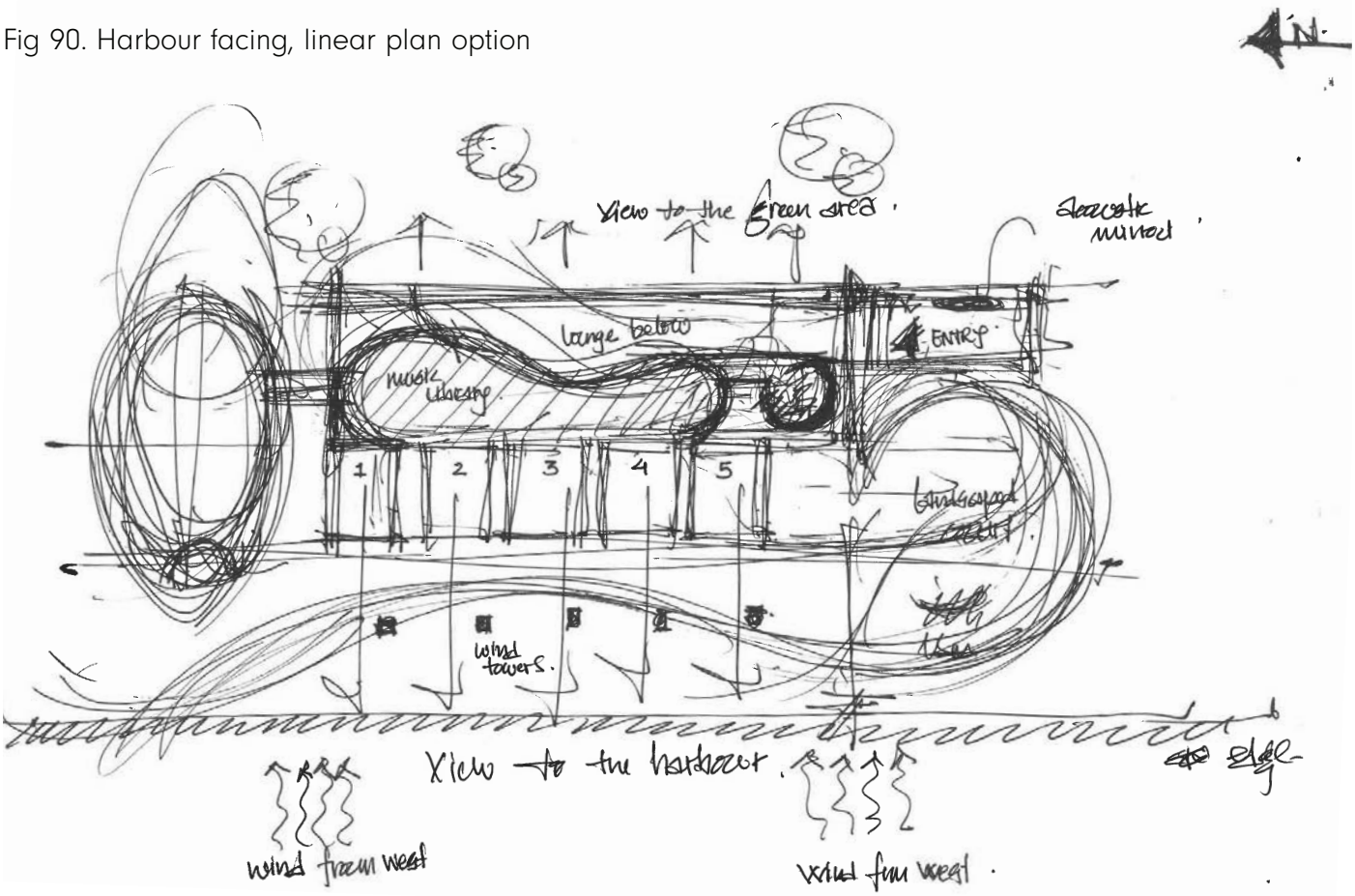


Fig 89. Plan evolution

Fig 90. Harbour facing, linear plan option



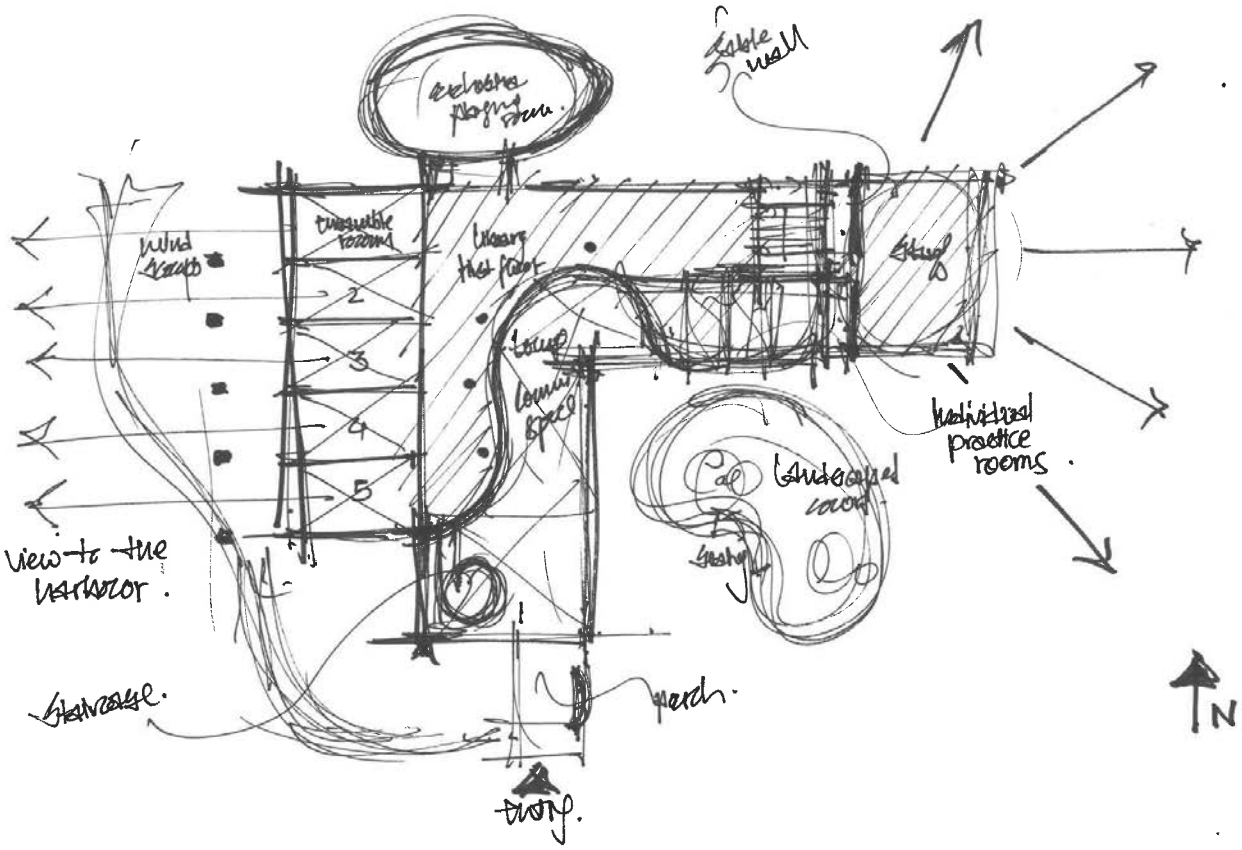


Fig 91. Last plan iteration

common spaces

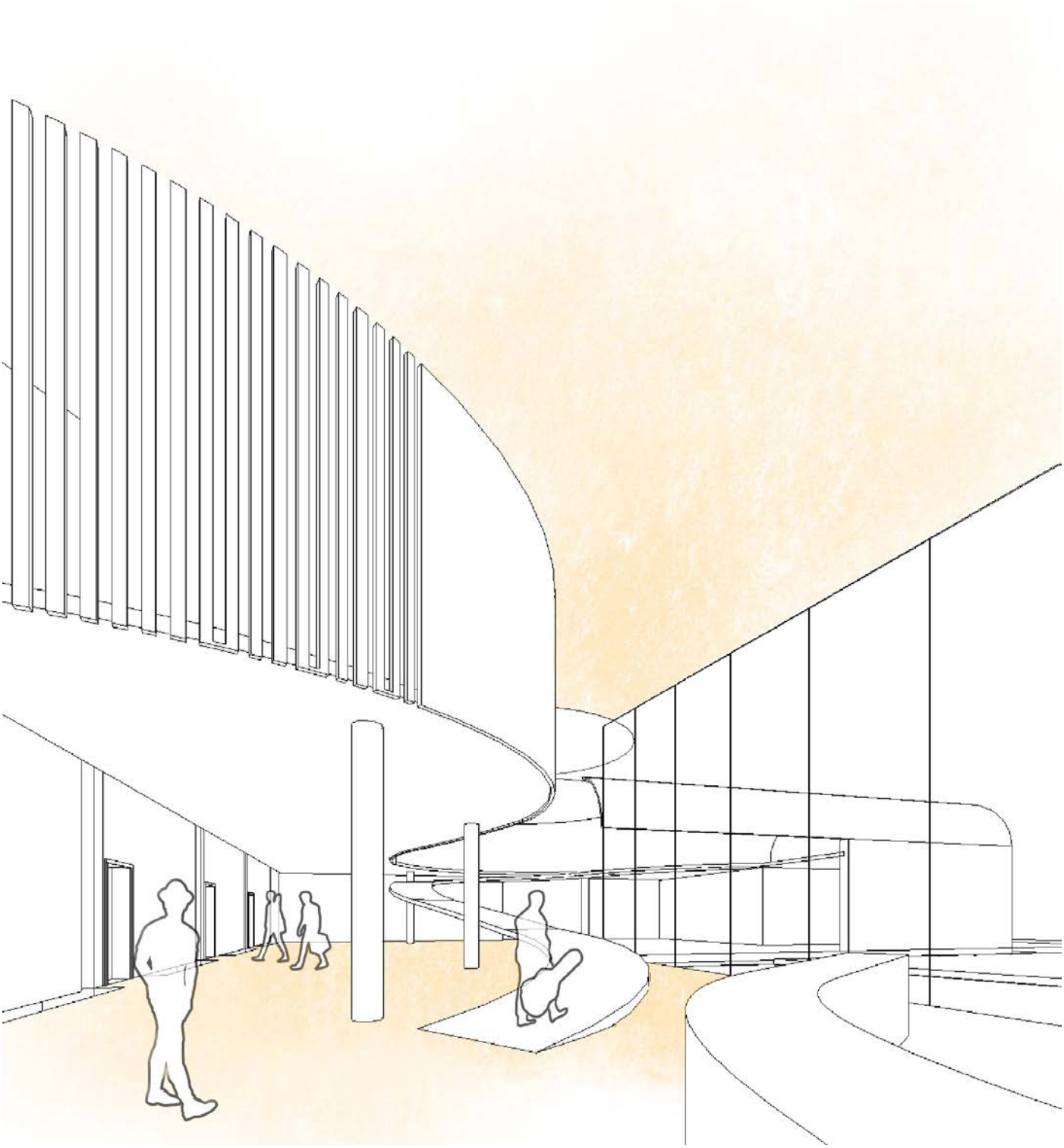


Fig 92. Common spaces (Conceptual view)

form evolution

The morphological analysis at the site was used to produce the final form. It was a derivative of 3 predominant building forms existing at the site.
The rounded edges and their affect on acoustics was later examined in the acoustics iterative process.

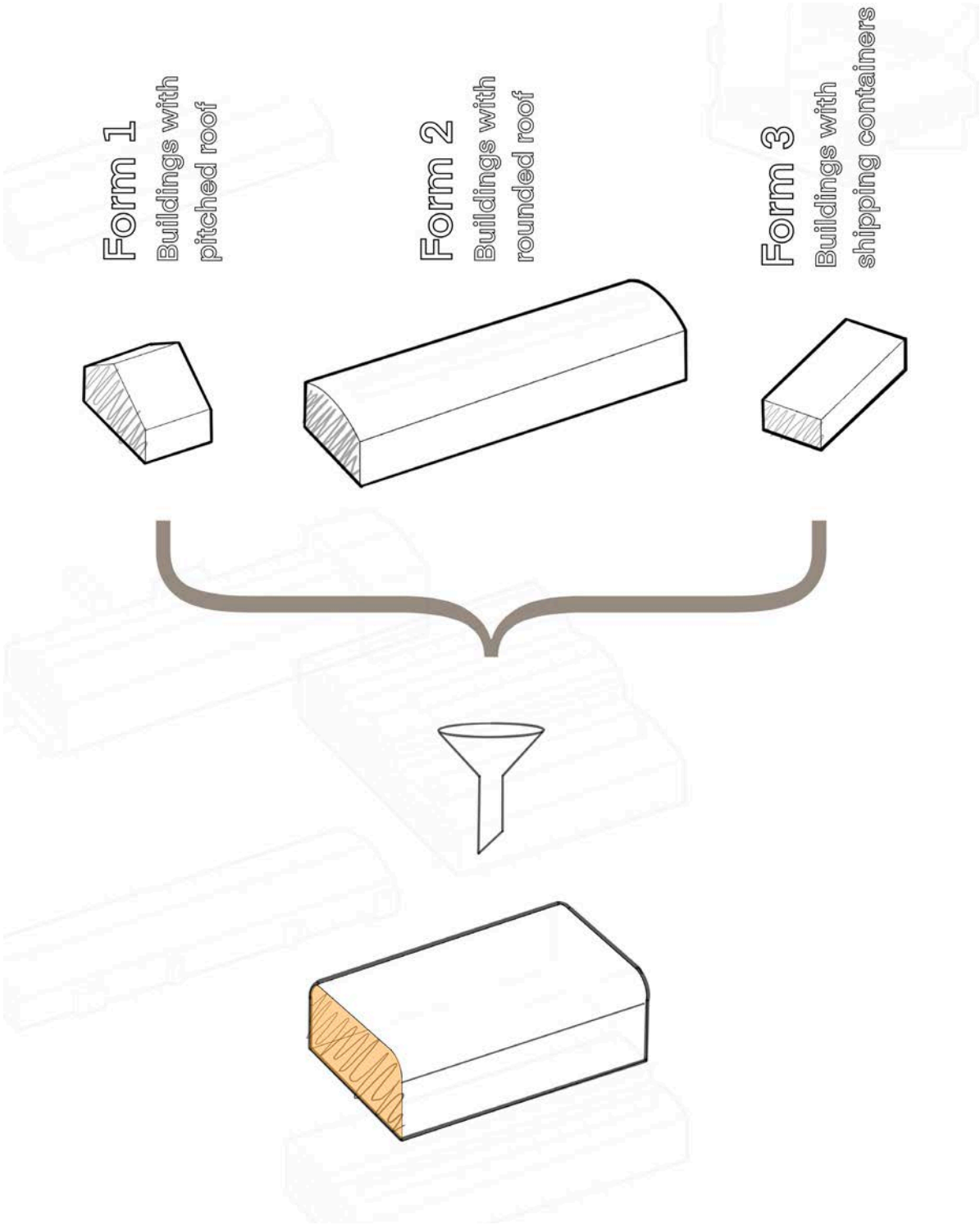


Fig 93. Form evolution

gable wall concept

It was being observed during the site visits and from the morphological analysis, that there is a theme of big gable walls going on at Rehshaleøen. These are sometimes empty, sometimes being used for branding or artwork and sometimes they act as an edifice or a symbol for different cultural activities taking place around them.

Taking inspiration from that, it was decided to mimic the expression by designing an empty gable wall facing the open concert ground. This will act as a backdrop for the future music concerts taking place over there. Just like the exhibition foyer at SVFK, musicians get the chance to share their art with public. On the other hand, it boosts the cultural agenda of Refshaleøen Ejendomselskab.

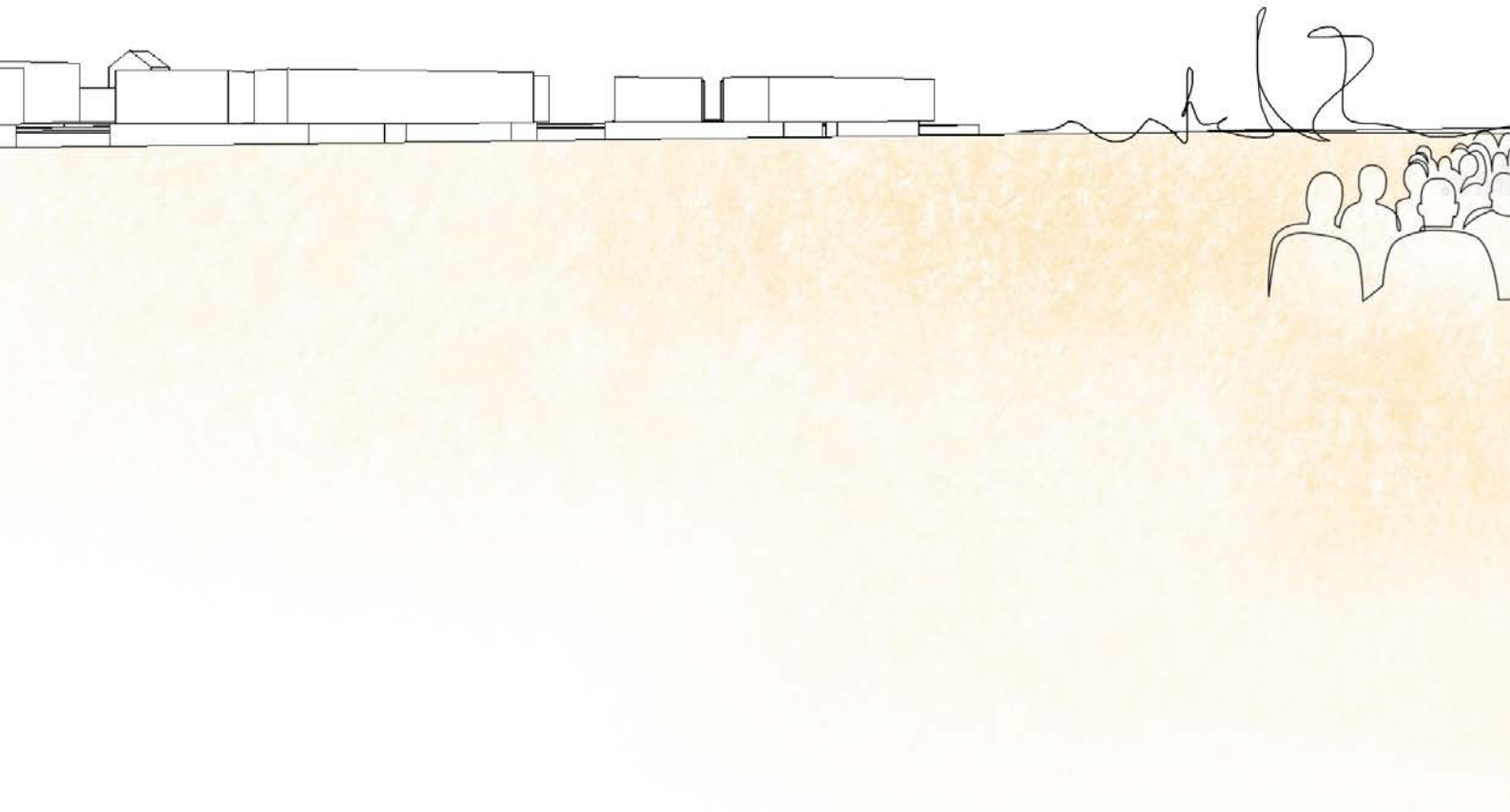
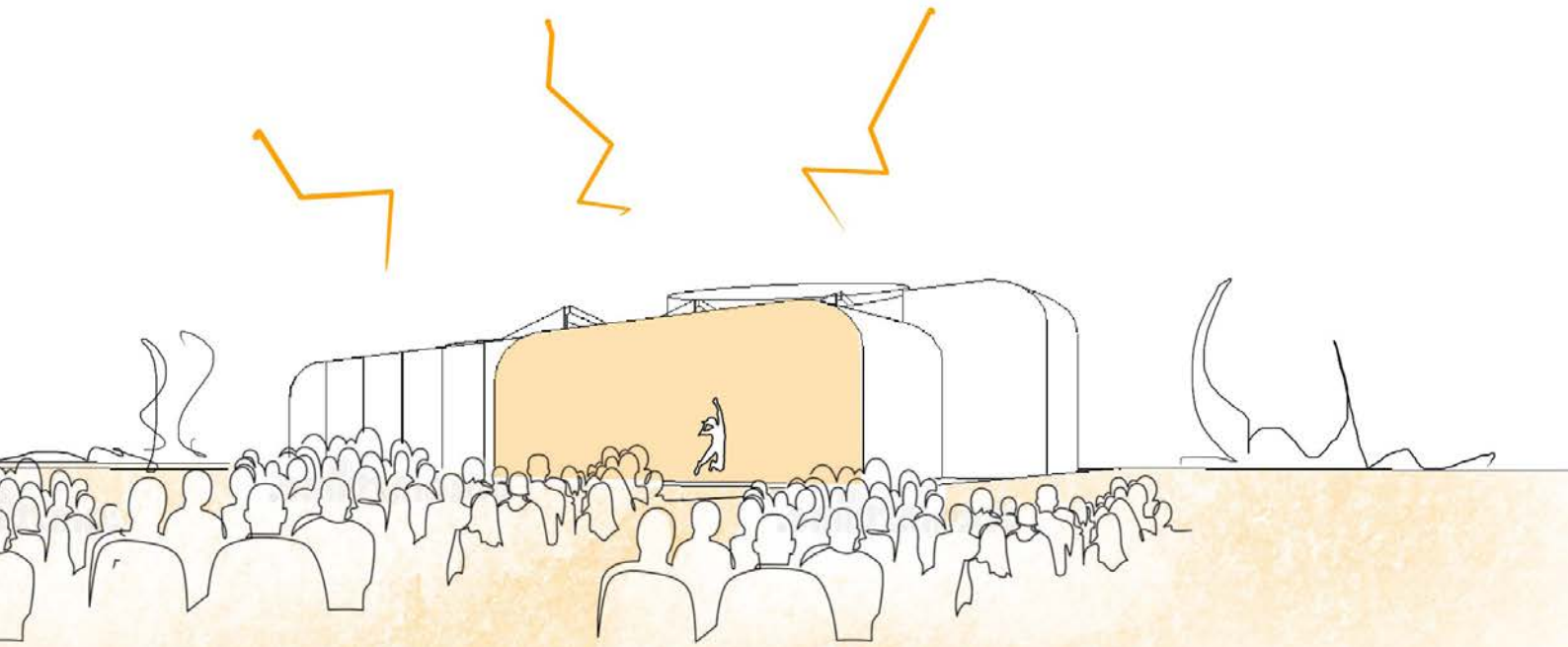


Fig 94. Gable wall concept



facade evolution

Different options of arranging building blocks was explored. Visual connections, diffused light, sunlight, ventilation and circulation patterns were also explored alongside this process.

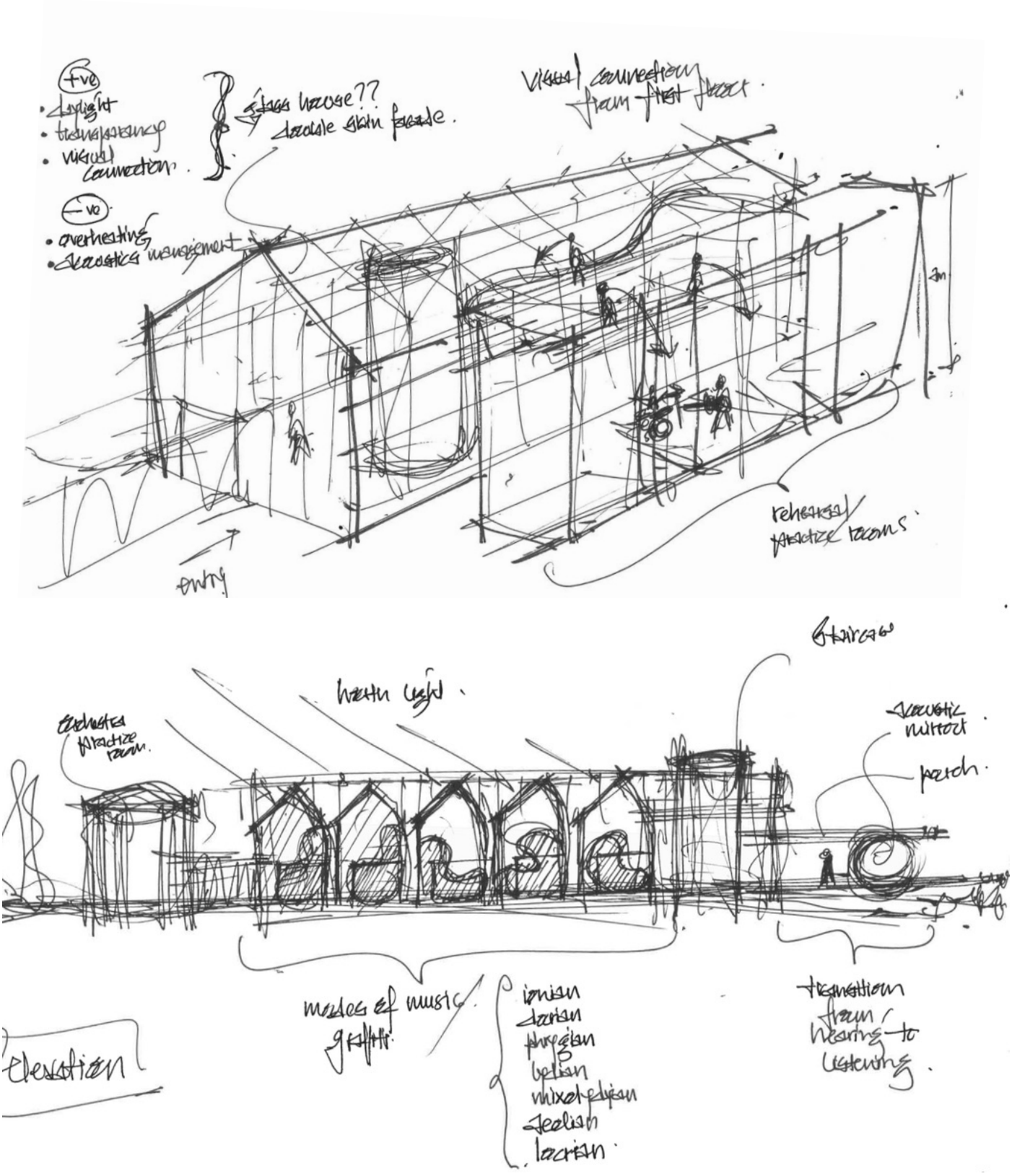
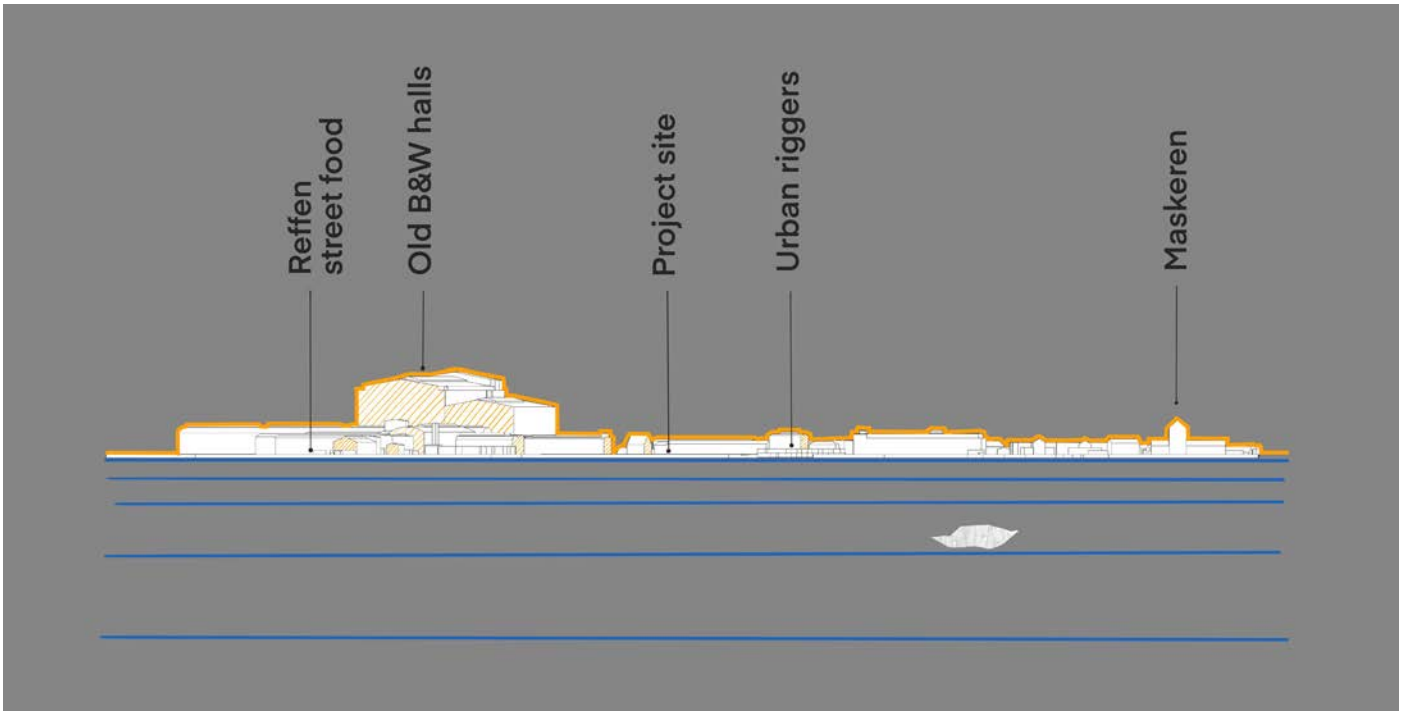
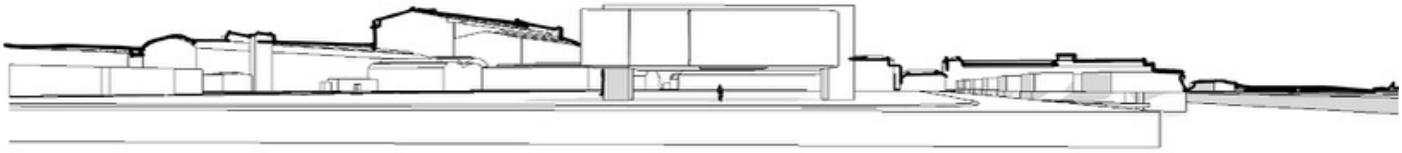


Fig 95. Facade evolution

skyline

Copenhagen municipality is quite critical about the view of building from the harbour, therefore it was important to study the skyline and make iterations based on that.





This exercise helped to understand the building height in relation to its contexts

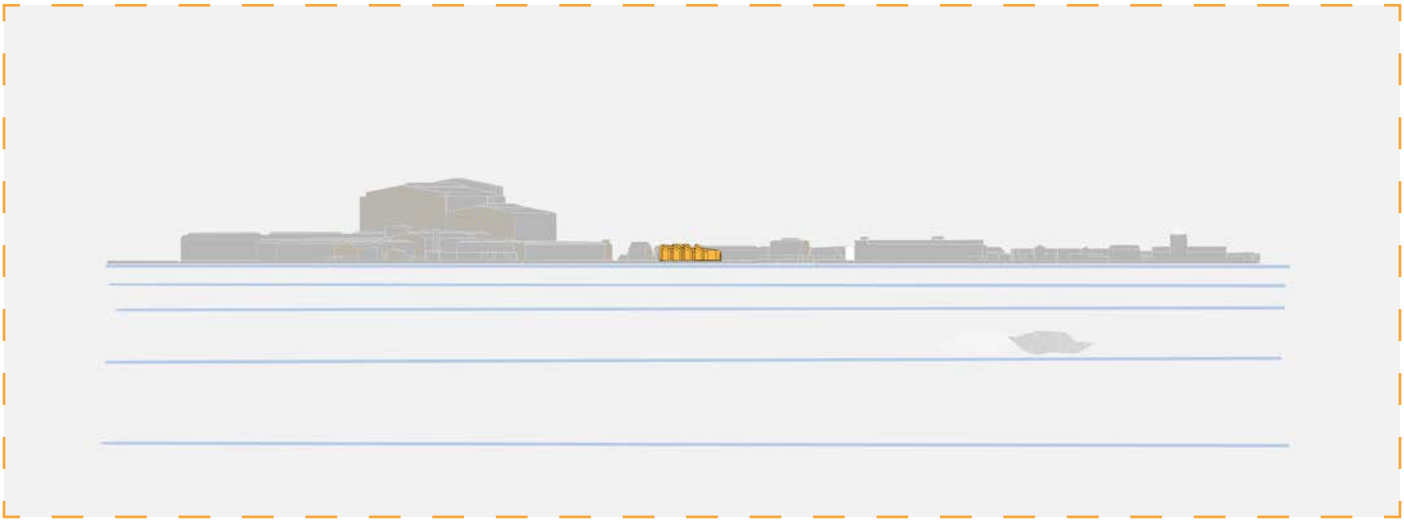


Fig 96. Skyline evolution

pre simulation ensemble room

Before running acoustic simulations, both single height and double height options were explored in sketches in terms of construction, visual qualities, daylight and natural ventilation.

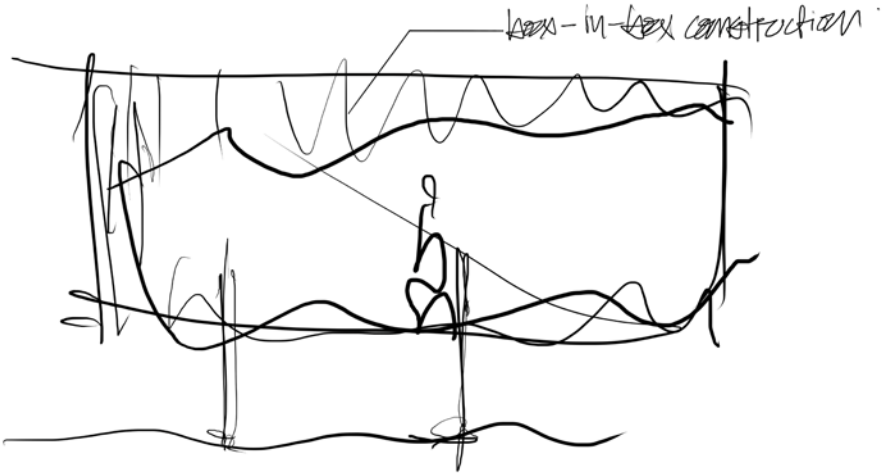


Fig 97. Box-in-box construction

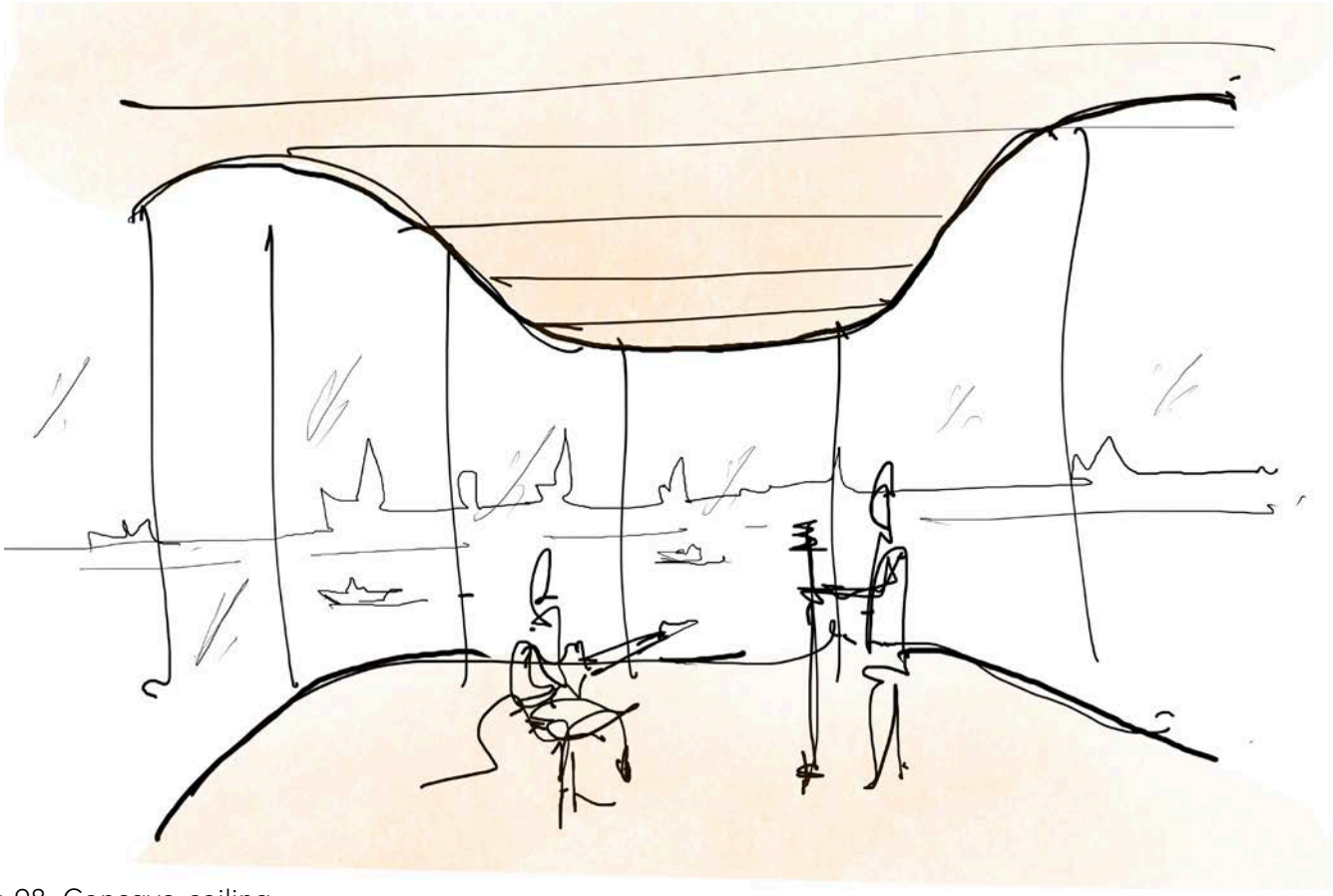


Fig 98. Concave ceiling

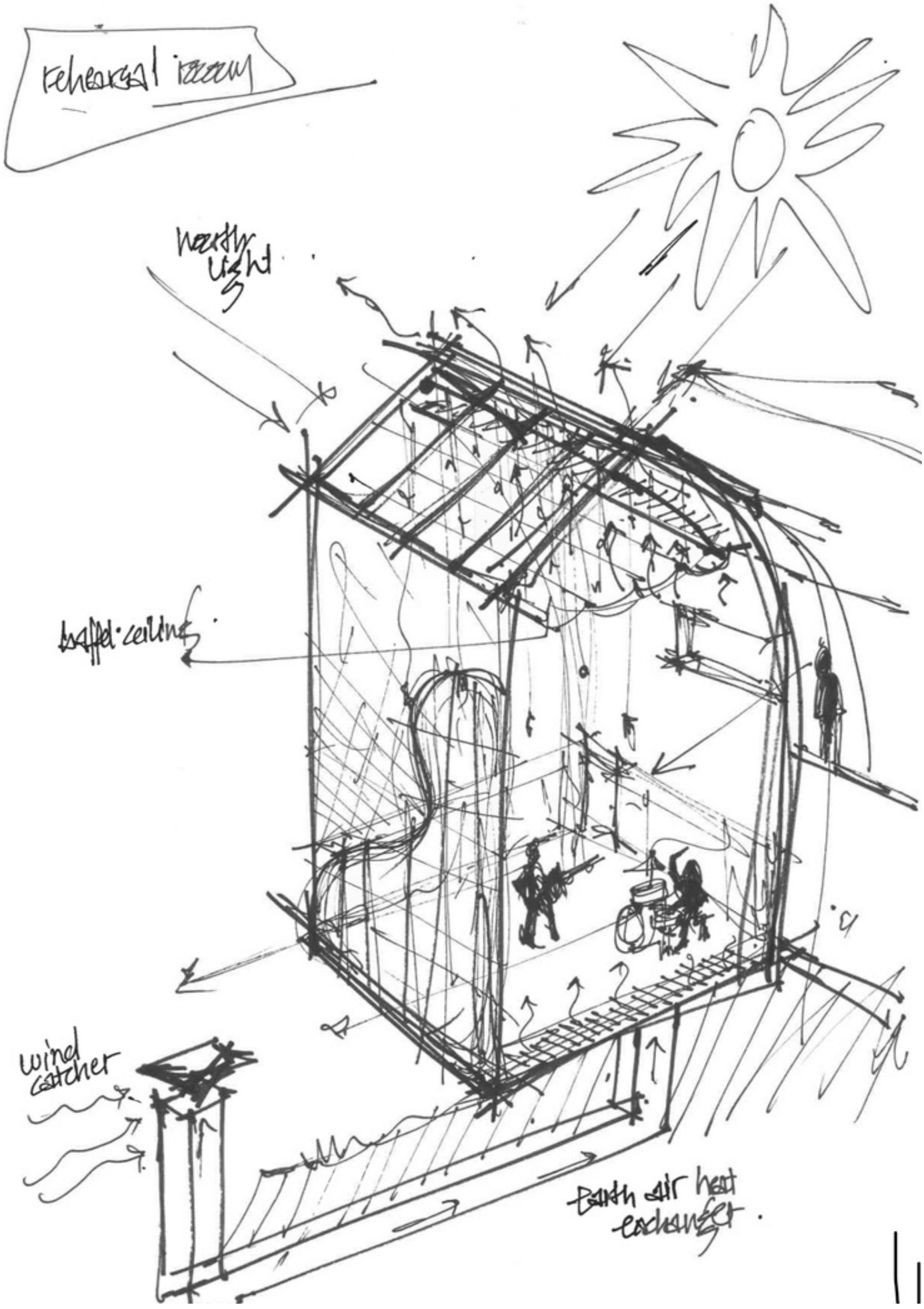
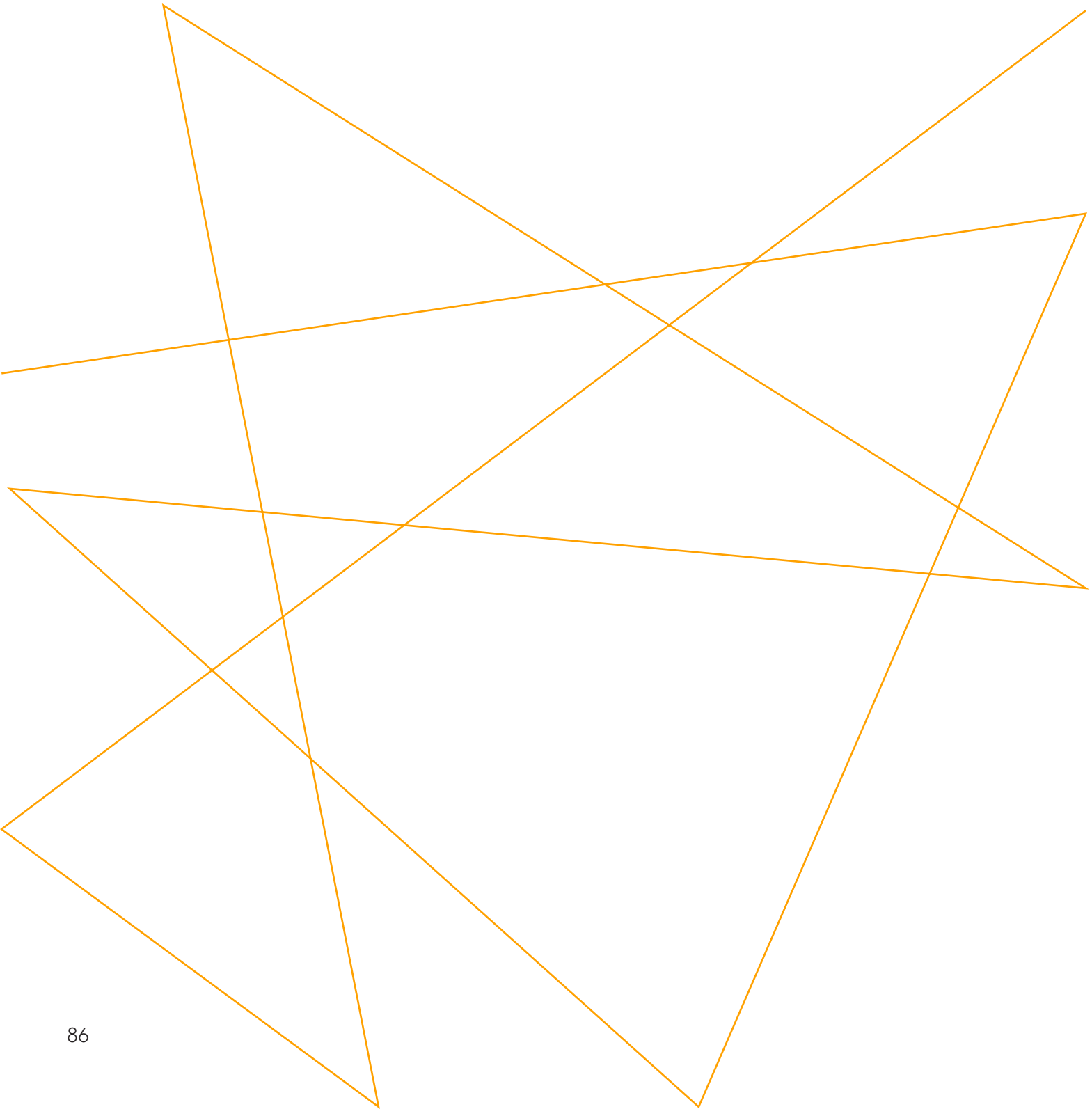
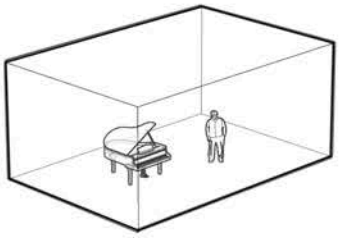


Fig 99. Double-height ensemble room concept

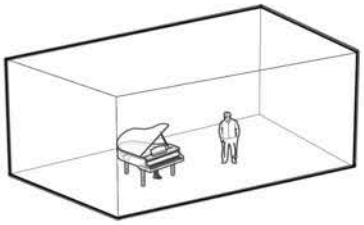
acoustic simulation iterations



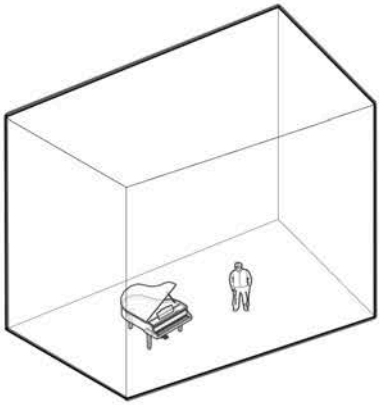
volumetric analysis



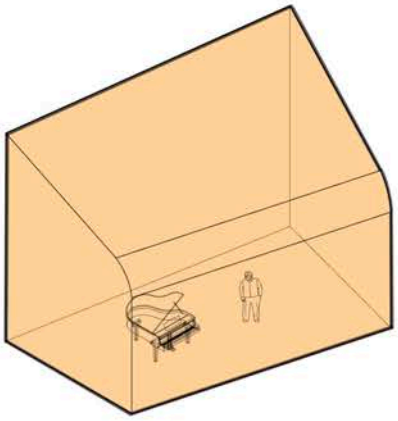
Volume 1
Single height
(Parallel walls)



Volume 2
Single height
(Non-parallel walls)



Volume 3
Double height
(Non-parallel walls)



Volume 4
Double height
(Non-parallel walls, curvilinear roof)

Acoustic simulation process was kickstarted on different room volumes, suitable for an ensemble room with a capacity of about 10 musicians (standing or sitting on stools).
Considering some of the bigger sized instruments like a grand piano, drum kit etc. 60sqm of floor area was taken as a starting point.

It was duly noted in different literary references and case studies, that an increased ceiling height is very benificial for such rooms. Therefore, both single and double heighted rooms were being tested.

Simulation considerations:

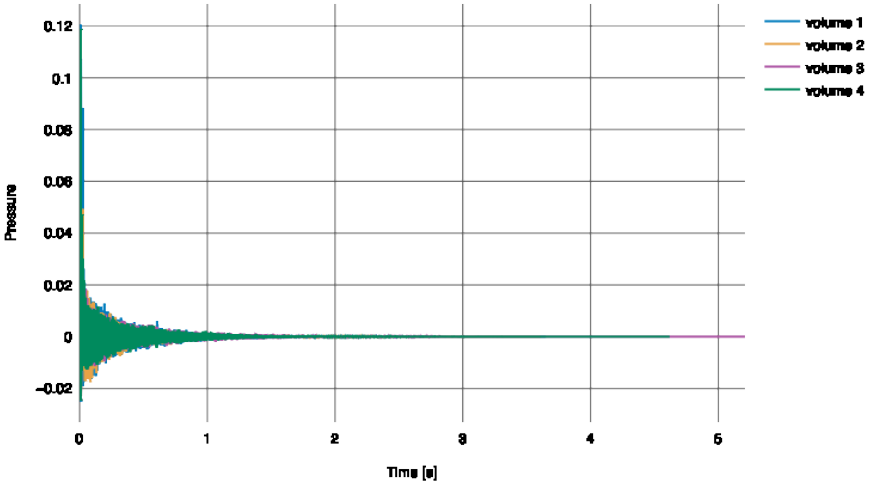
Walls: Rough concrete
Ceiling: Rough concrete
Floor: Wooden flooring

Number of sources: 1
Number of receivers: 1
Distance between source and receiver: 3m
Distance of source from the walls: 2m-3m from all sides.
Distance of receiver from the walls: 2m to 3m from all sides.
Height of source and receiver: 1.5m from floor level.

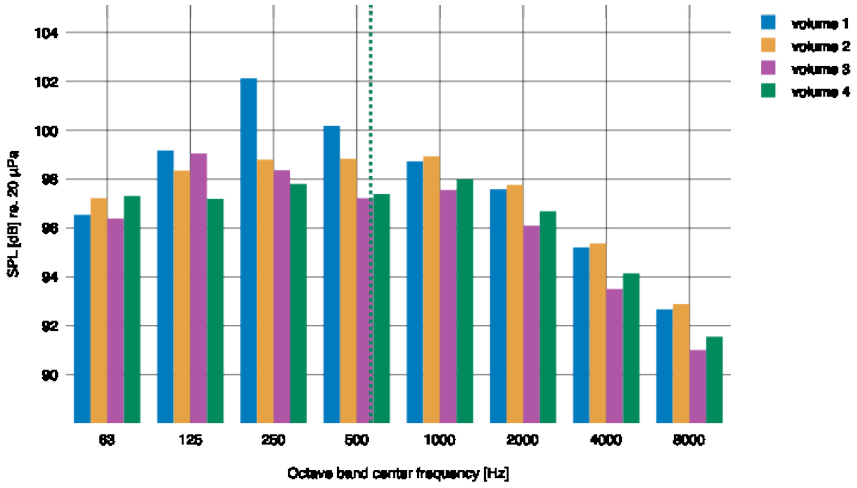
Simulation solver: Hybrid (using both Wave acoustics and Geometrical acoustics meathod)

Fig 100. Volumetric analysis

simulation results



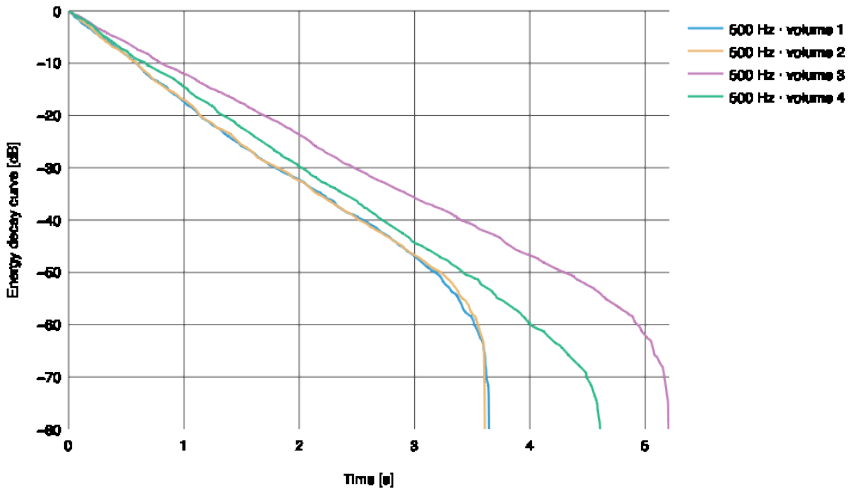
impulse response



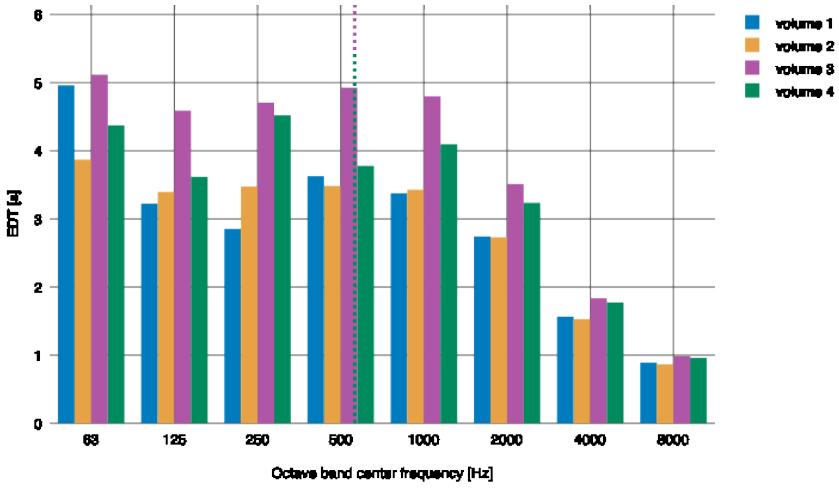
sound pressure levels (SPL)

It is evident that by increasing the ceiling height of the room, there is a drop in the sound pressure levels.
If we look in the mid frequency range of 500Hz, there is a drop of 3dB from volume 1 to volume 4.

Fig 101. Simulation results 1-4

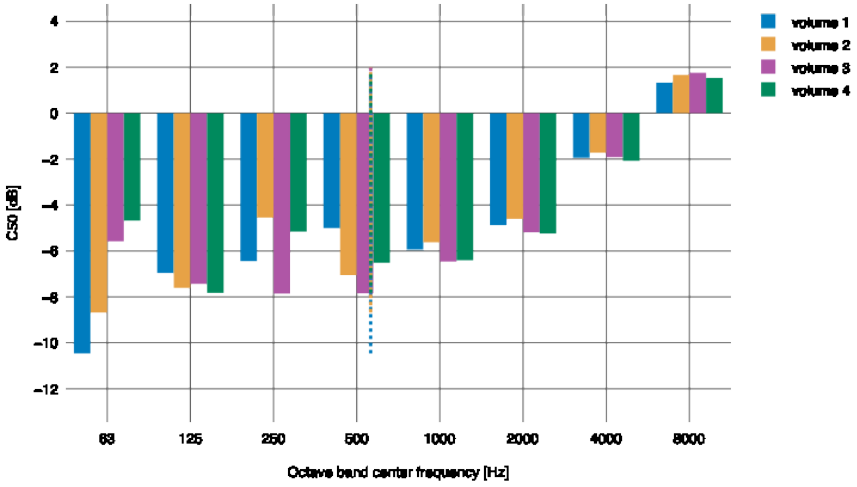


energy decay curve (EDC)

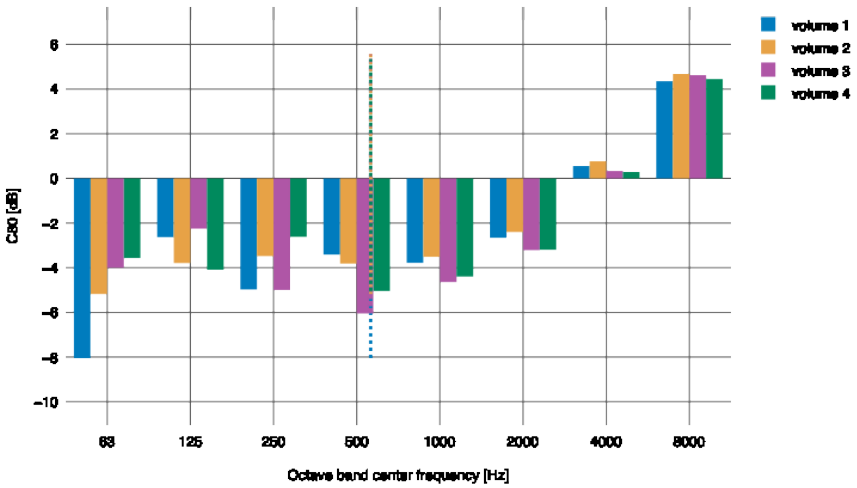


energy decay time (EDT)

Energy decay time of volume 4, especially in the 500Hz frequency range is very close to those of volume 1 and volume 2, despite of having a bigger volume.



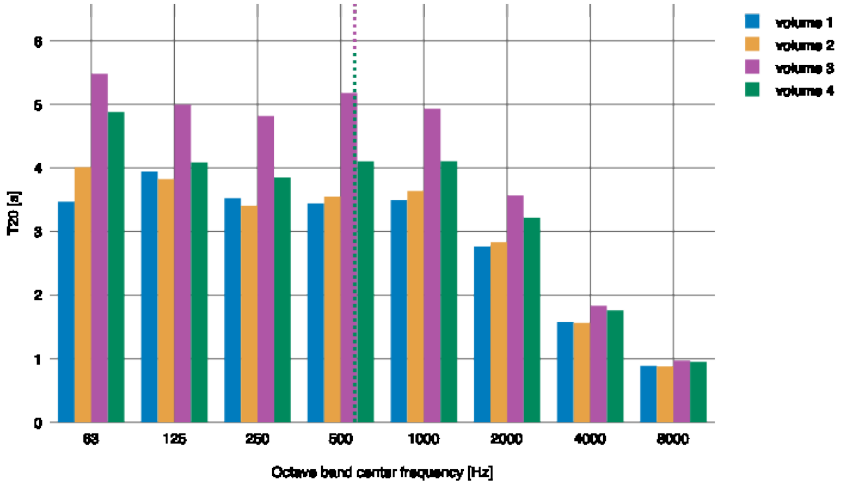
clarity (C50)



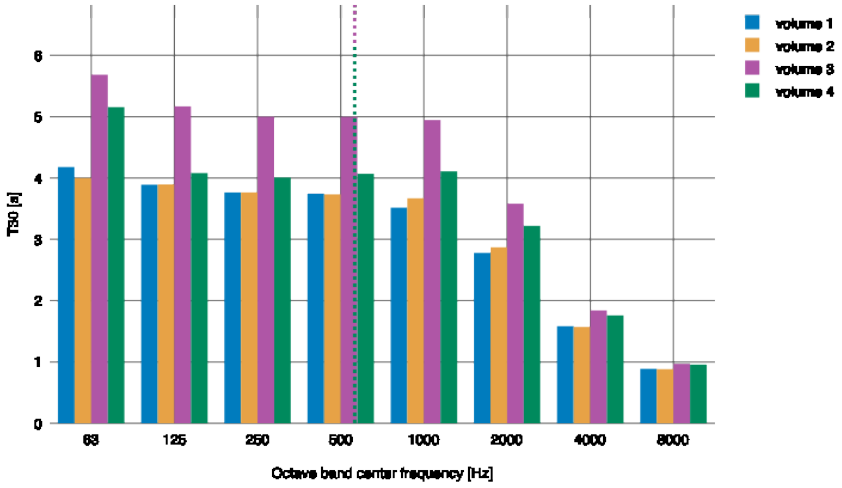
clarity (C80)

Clarity levels in all four volumes are mostly negative because of too much high reverberation times, which is due to untreated surfaces.

Fig 102. Simulation results 5-8



reverberation time (T20)



reverberation time (T30)

By deforming the volume 3 into volume 4, the reverberation time is reduced to about 1 second.

post simulation ensemble room

Based on both simulation results and literary data, volume 4 was chosen for further analysis. To optimise the high reverberation times and lower clarity values, suitable wall treatments were explored. The idea was to reinforce the early reflections from the surfaces and prevent the late reflections coming back to the receiver, which is making it sound cavernous.

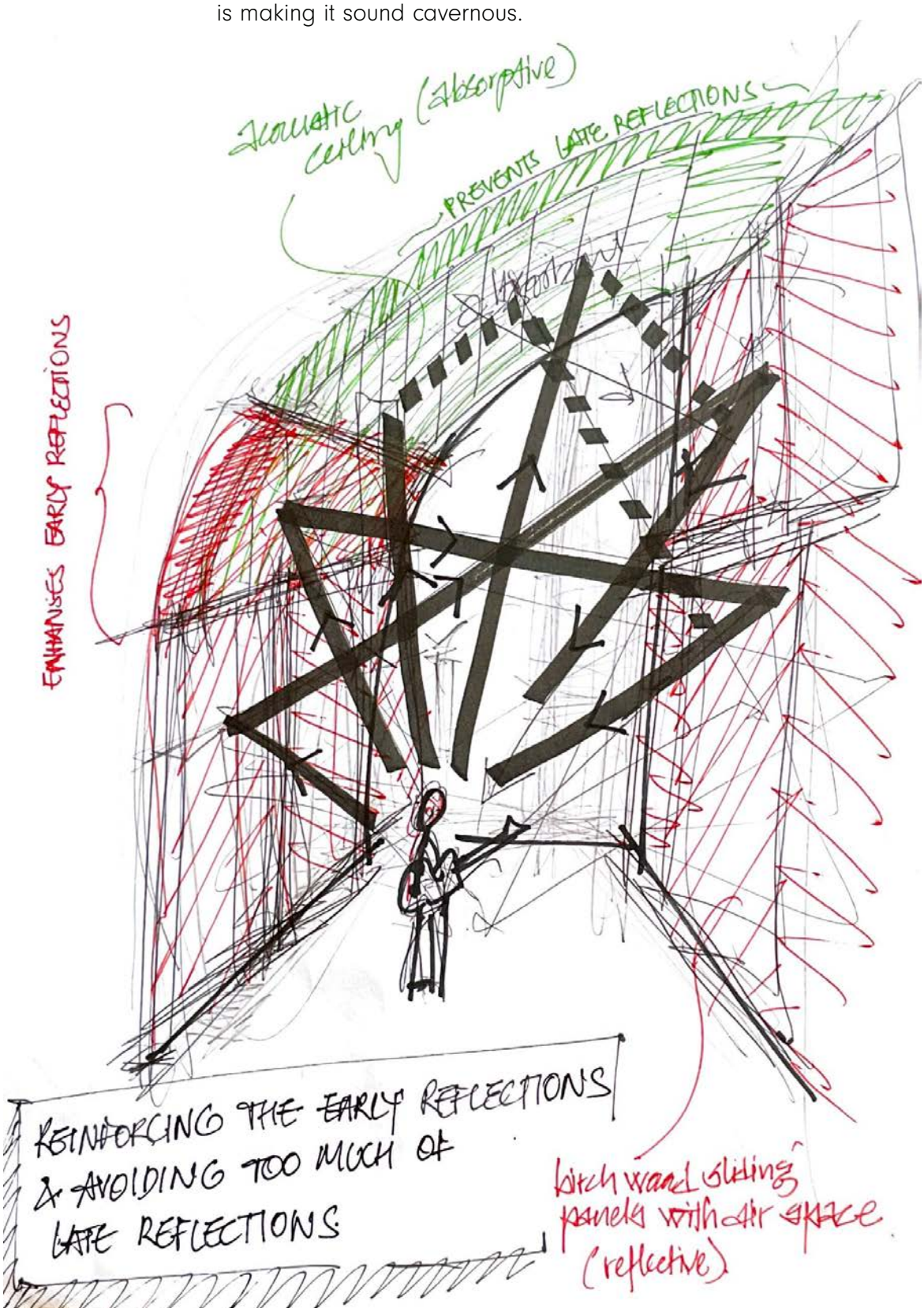


Fig 103. Post simulation conceptual sketch

Conceptual view of the ensemble room showing reflective material selection until 4m height and absorptive materials for the rest of the walls and ceiling. This was taken as starting point in running the consecutive acoustic simulations.

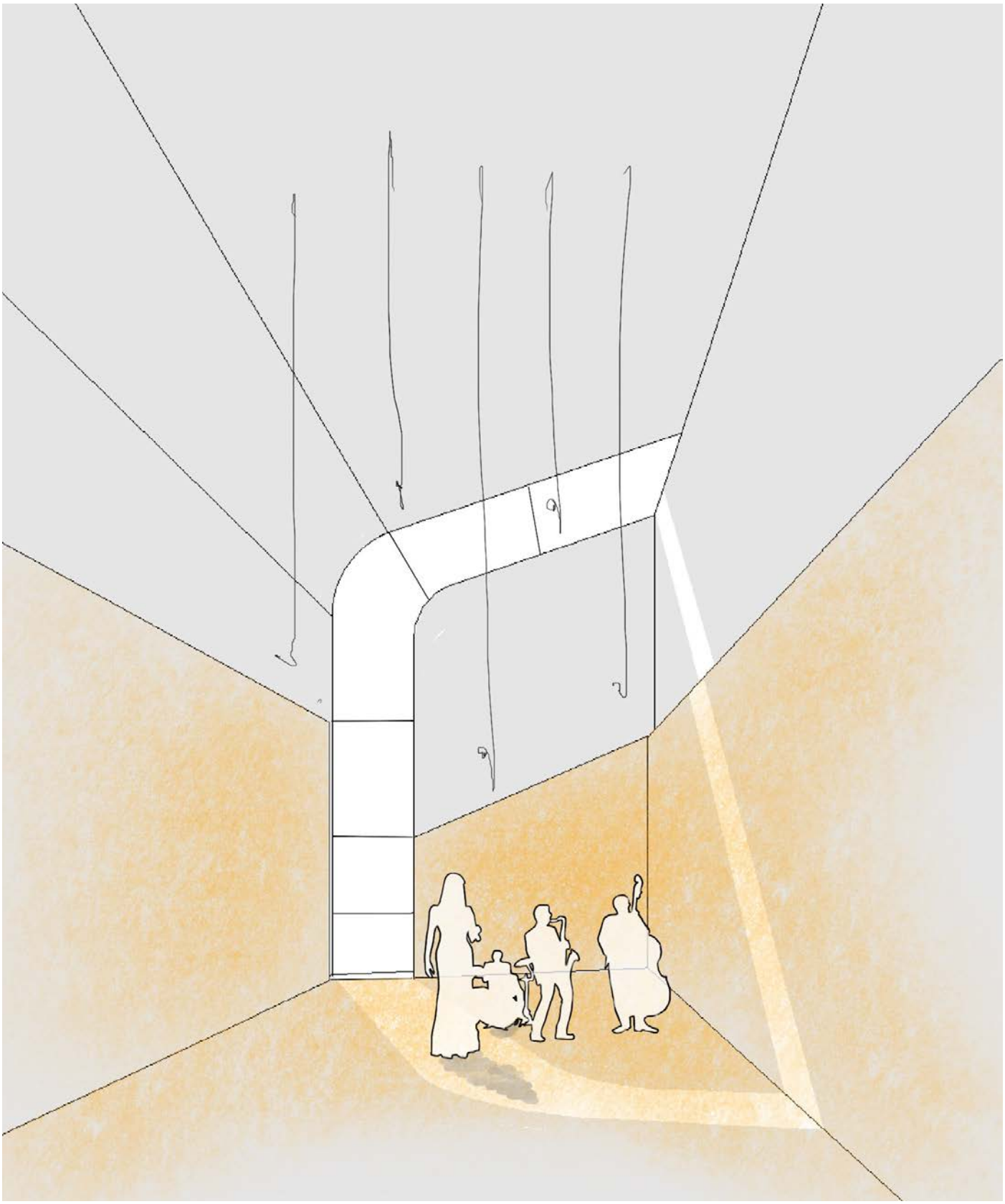
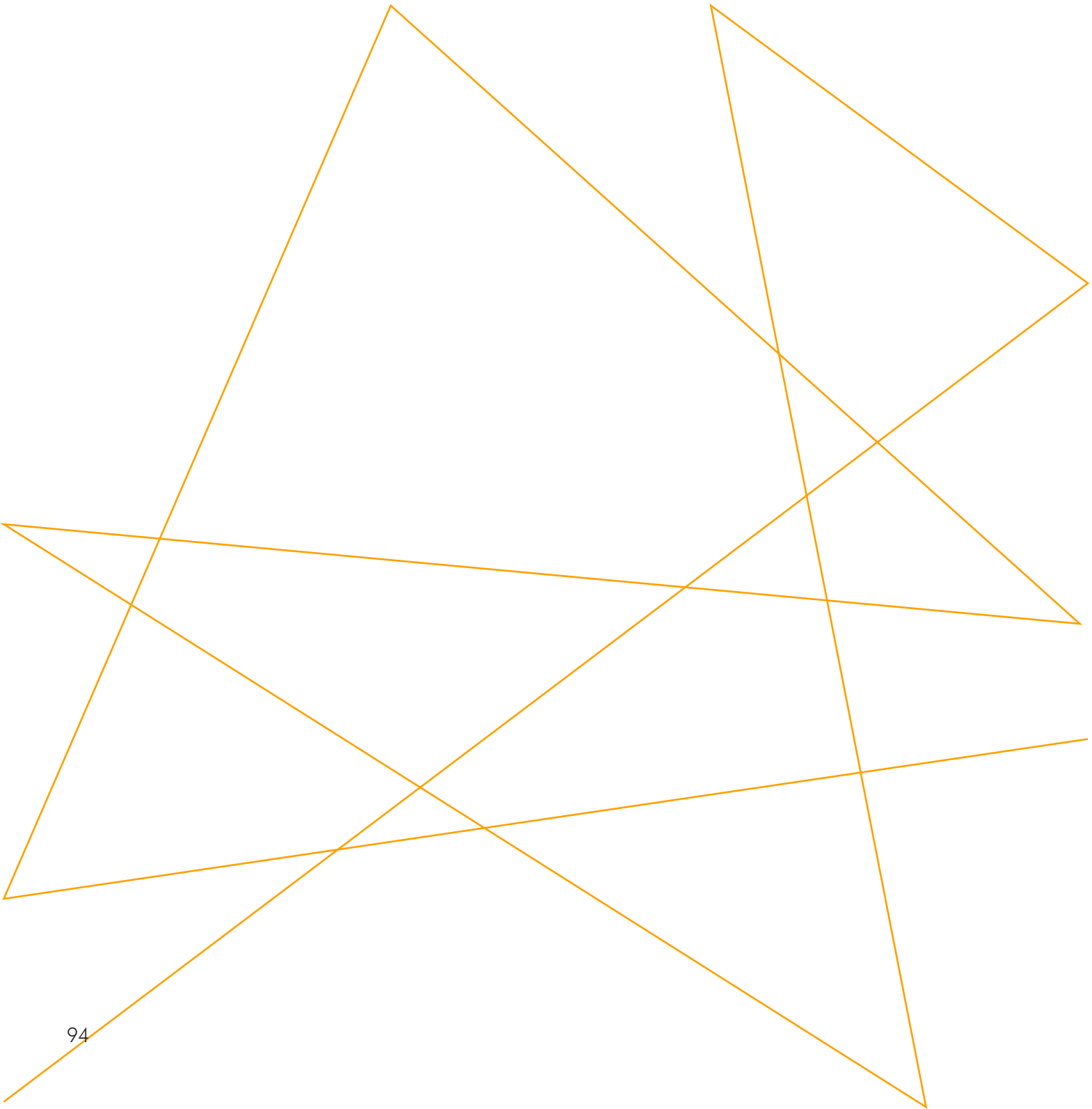


Fig 104. Post simulation conceptual view

synthesis



takeaways

Summing up all the takeaways from the analysis process

context

- Refshaleøen posseses a strong historical identity, which can be something to work with while designing.
- The stakeholders have a vision and are actively seeking ideas and projects for its further development.
- How to create a synergy between the existing functions and the proposed project?

experience

- How to create a transition from hearing to listening?
- How to translate different aspects of aural architecture, parallel to the visual ones?
- How to communicate the artistic, social and emotional aspects of the project through aural architecture?

acoustics

- How to design a music rehealsal space, that can accommodate different preferences of different music instruments and music genres.
- How to design a acoustically sound premises, while doing the site development of the project?

functionality

- SVFK is open for collaboration to accommodate other facilities working with art. For instance, they send all the shortlisted sound artists to Sound Art Lab in Struer, which is a dedicated facility for sound artists.
- Likewise, there is a big potential of adding music artists in the selection criteria and then send them to a similar dedicated facility to actualise their music projects.
- Giving users a sense of ownership and having a very dynamic staff is the key to operations and management of such a facility.

users

- The project has a well defined user group.
- There is a need for nurturing and further development of the user activity.
- There are concerns of health and well being of the users, that needs attention.
- Koda statistics gives an idea of the massive user demand for support, demographics and shows that Copenhageners are in need of it the most.
- Koda is already invested in providing support to the users, but only at the monetary level. The potential of them being the future clients have been discussed whereby, they also provide facility support to the user group.

design criteria

co-working

Spaces should offer privacy for work concentration but without creating isolation.

Spaces should encourage sociability by creating opportunities for engagement both inside and outside the building.

Circulation spaces should be designed in a way to create active as well as passive engagement within its users.

The project is situated in an harsh industrial setting, spaces should radiate with positivity and inspire users in their creative projects.

Spaces should make the best of the view of the harbour and the open green areas of the site.

aural architecture

The design should be the embodiment of different elements of music for example rhythm, harmony, pulse, tempo, texture, pitch etc.

The design should create a transition from hearing to listening in its users. The idea of active listening should be translated through the building design.

The design should work with at least two out of four aspects of aural architecture: social, cultural, navigational or musical.

acoustics

Music rehearsal spaces should offer "variable acoustics", so as to accomodate a wide spectrum of musical preferences.

Acoustic design for creating a difference between shared and private work space.

Design spaces with the right shape, volume and proportions for desired room acoustics.

Incorporation of suitable sound isolation techniques in the building tectonic design.

Natural ventilation strategies should be designed, keeping in mind the acoustic aspects of the spaces.

problem statement

—

“how to create an acoustically and aurally sound co-working space for young, amateur and professional musicians to come together and develop a culture of encourag-ing, creating and appreciating music.“

design approach

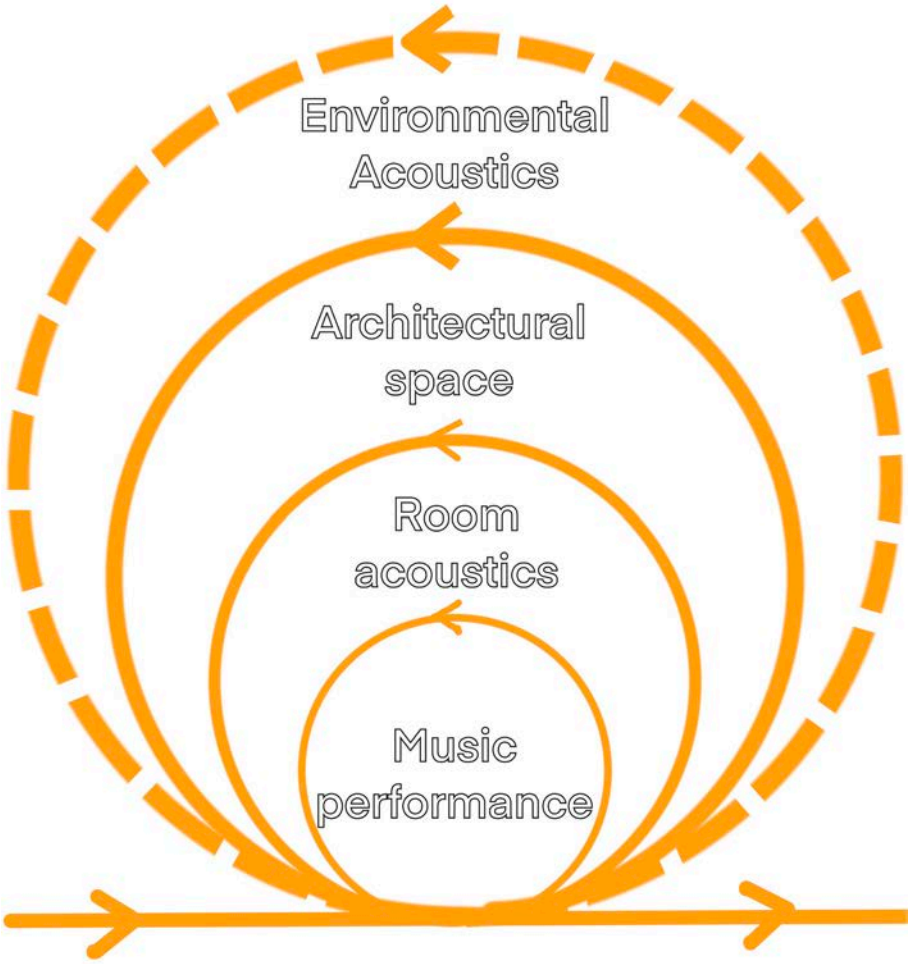


Fig 105. Design approach

The design approach for the project takes place in 4 consecutive steps as follow:

1. Music performance:
Understanding different space/ sound requirements for different music instruments.

2. Room acoustics:
Working with different parameters of acoustics like reverberation time, clarity, energy decay time etc., to accommodate the music performance in the best suitable manner.

3. Architectural space:
Spatial design and building tectonic design of the collective whole, to accommodate different spaces/ rooms.

4. Environmental acoustics:
Creating soundscapes and maintaining the sound quality at site level.

room program

Fig 106 . Room program

category	functions	area
Ensemble room (4 nos.)	Designed for about 10 musicians playing in an ensemble	240 sqm (60 sqm each)
Practice rooms (6 nos.)	Designed for one or two musicians	96 sqm (16 sqm each)
Breakout space	For taking breaks, informal meetings and socialising	Flexible
Jamming foyer	For impromptu jam session between musicians Foyer steps for musicians to sit and play or for people to sit and enjoy the jam sessions	81 sqm
Meeting room	For hosting band meetings, PR team meetings etc.	25 sqm
Teaching room	For educational purposes	23 sqm
Office	For the facility manger	24 sqm
Pantry	For preparing and heating food, drinks etc. Dining space along the windows	Flexible
Reception	Workstation for a receptionist/caretaker Built-in storage for music instrument cases, covers etc.	20 sqm
Music Library	Containing music literature, records and sheet music library Music pods for experiencing immersive audio	112 sqm
Equipment Room	Room for music gear and accessories like wires, cables, stands etc.	38 sqm
Storage Room	Room for furniture like stools, chairs etc. and stage equipment	16 sqm
Toilets	3 Unisex toilets, 1 Physically handicapped toilet	23 sqm
Soniferous garden	Ambient soundscape area for music experimentation Outdoor informal meeting space and garden	500 sqm
Outdoor stage	Stage for outdoor concert	Flexible
Ground floor area		**1142 sqm**
First floor area		**517 sqm**
Total built-up area		**1695 sqm**

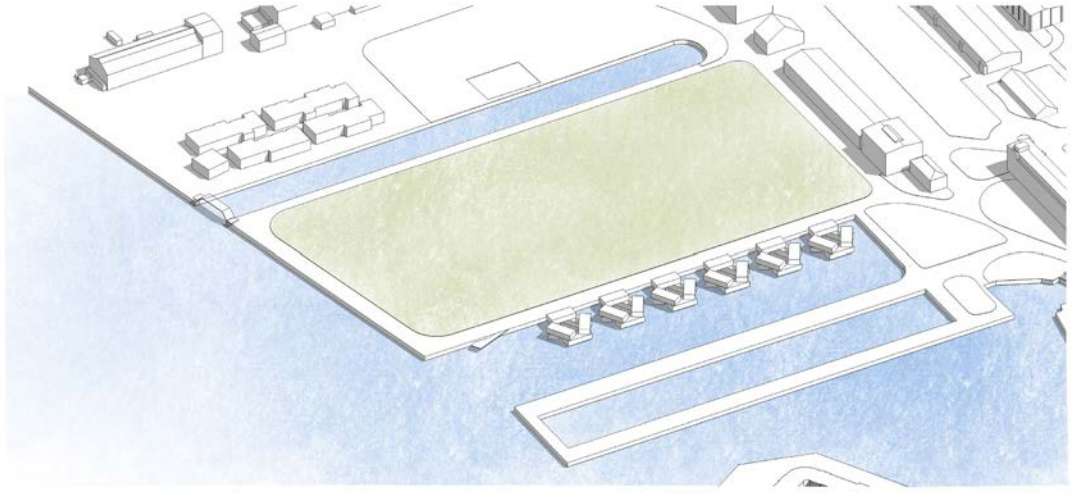
Room program is finalized based on the administrative setup at SVFK and rehearsal rooms setup at Musikkens Hus.

As observed at SVFK, a small office and a reception desk is sufficient, as half of the employees are present on appointment grounds, and the artists take care of the facility themselves. In terms of practice rooms, two types of activities were being identified; Ensemble rooms for a group of more than two musicians and small practice rooms for musicians working individually or with an another musician. The sizes are based on the general consideration of 17cum space per musician (Chasin, Marshall 2009), and additional considerations have been made to accommodate big sized instruments and easy manoeuvrability.

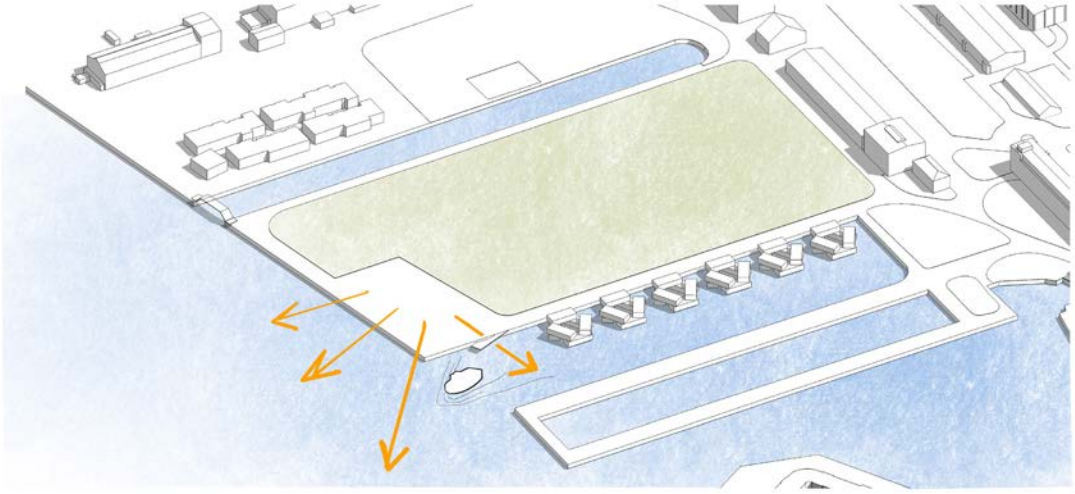
design process conclusion

To cut the long story short, the design process concludes into following stages, and the building in relation to its context is being generated.

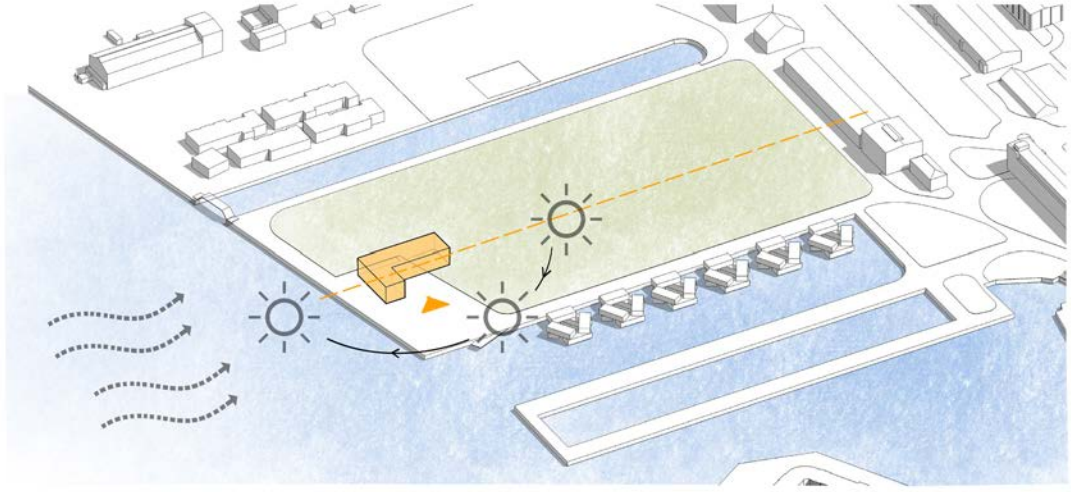
1.
project
site



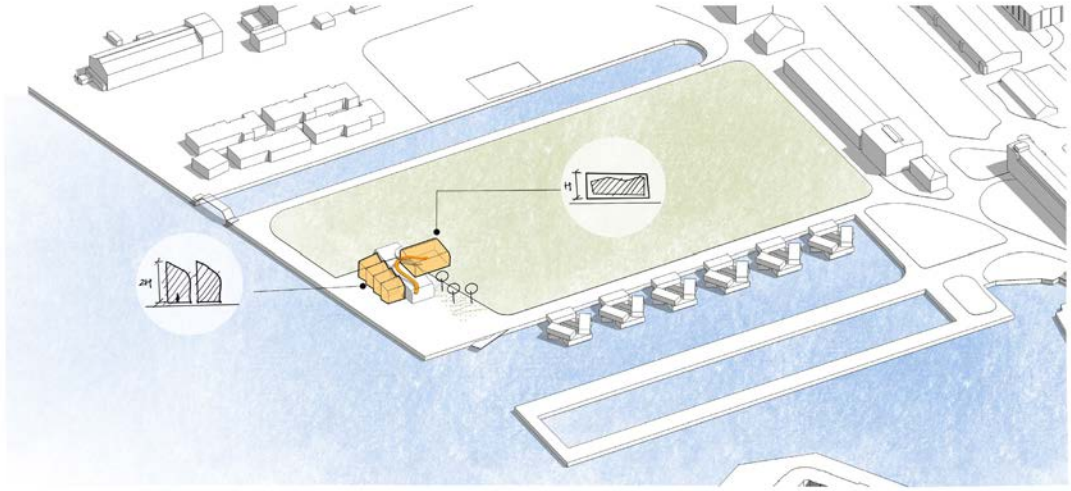
2.
opening
up the
corner



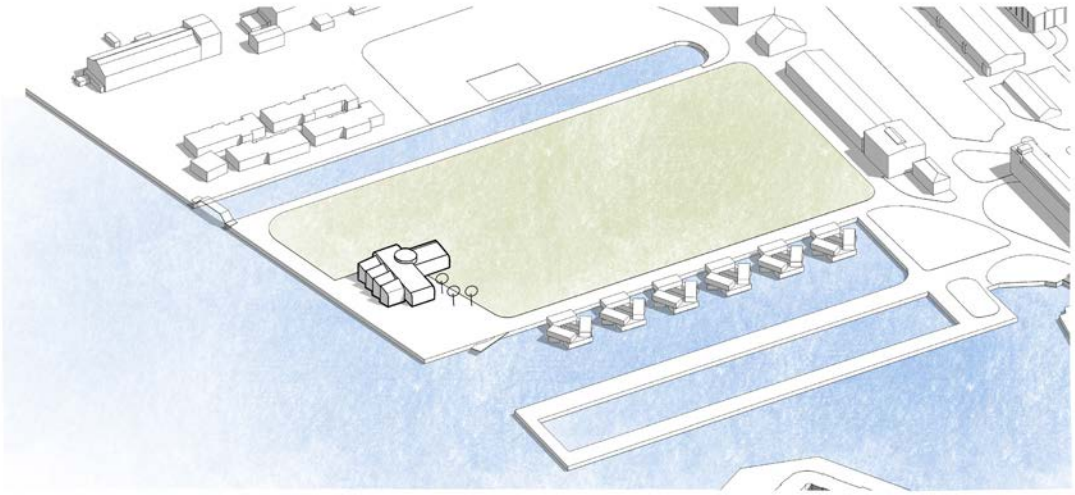
3.
interaction
with sun,
wind and
light



4.
functional
zones



5.
final form



6.
connec-
tion to site
activities

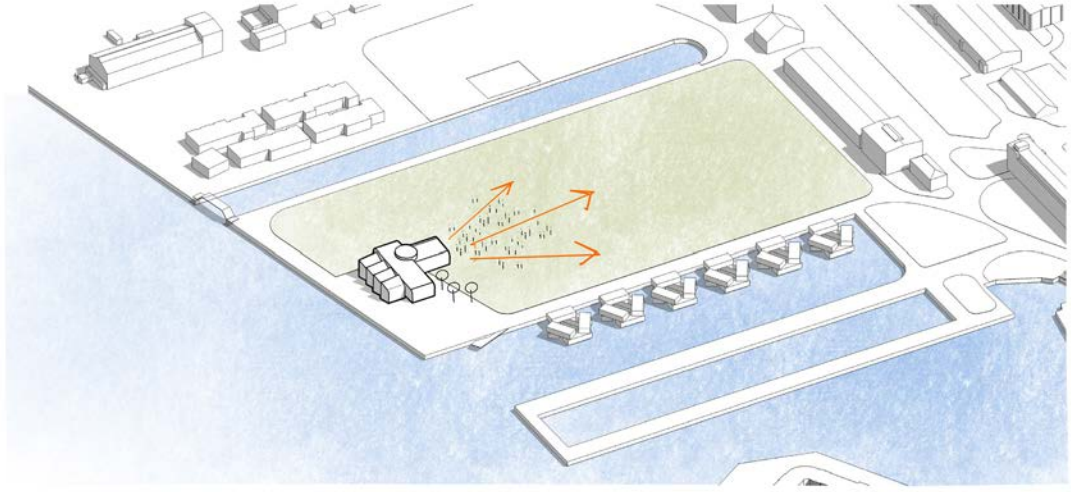
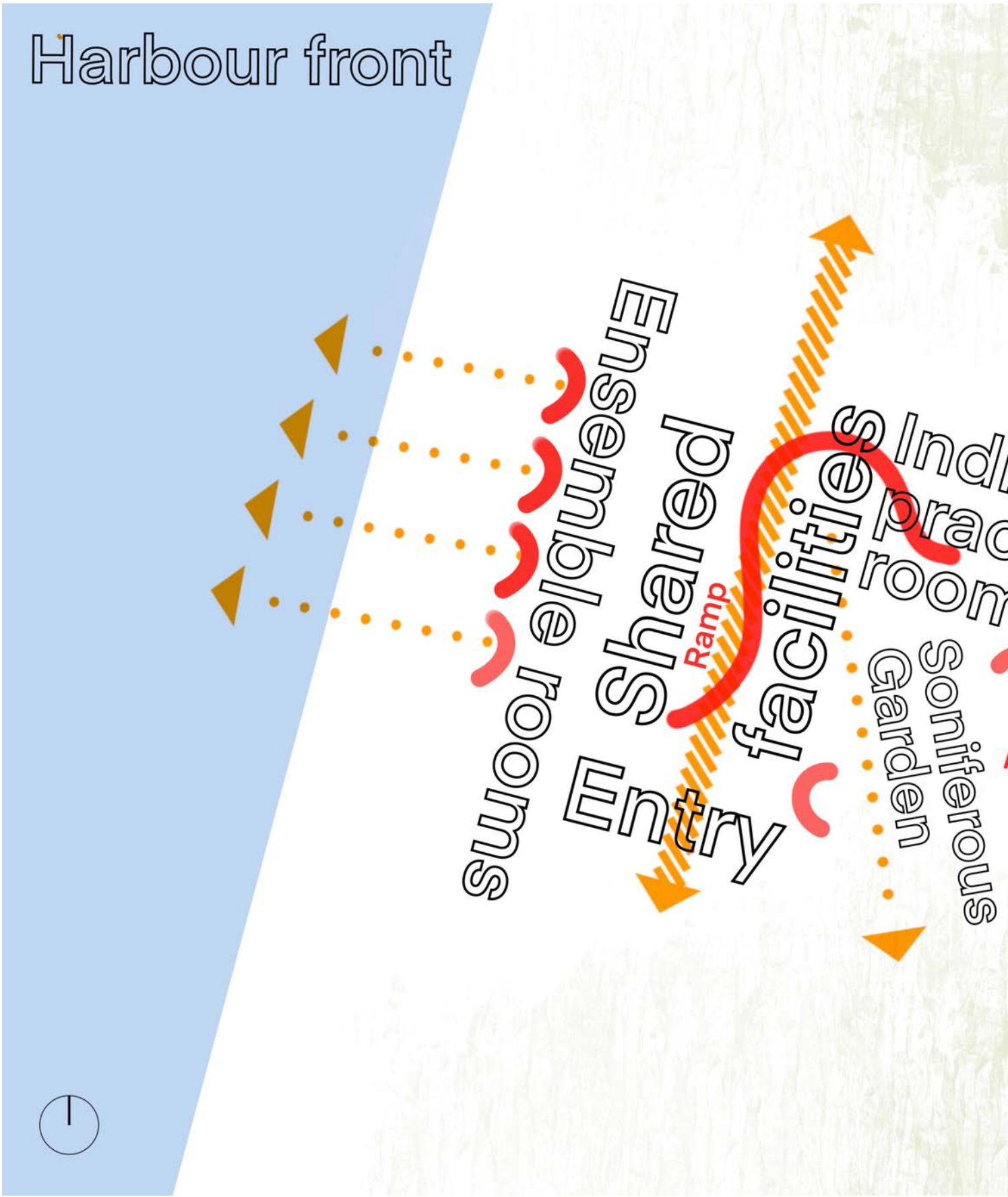


Fig 107 . Design process conclusion

function diagram



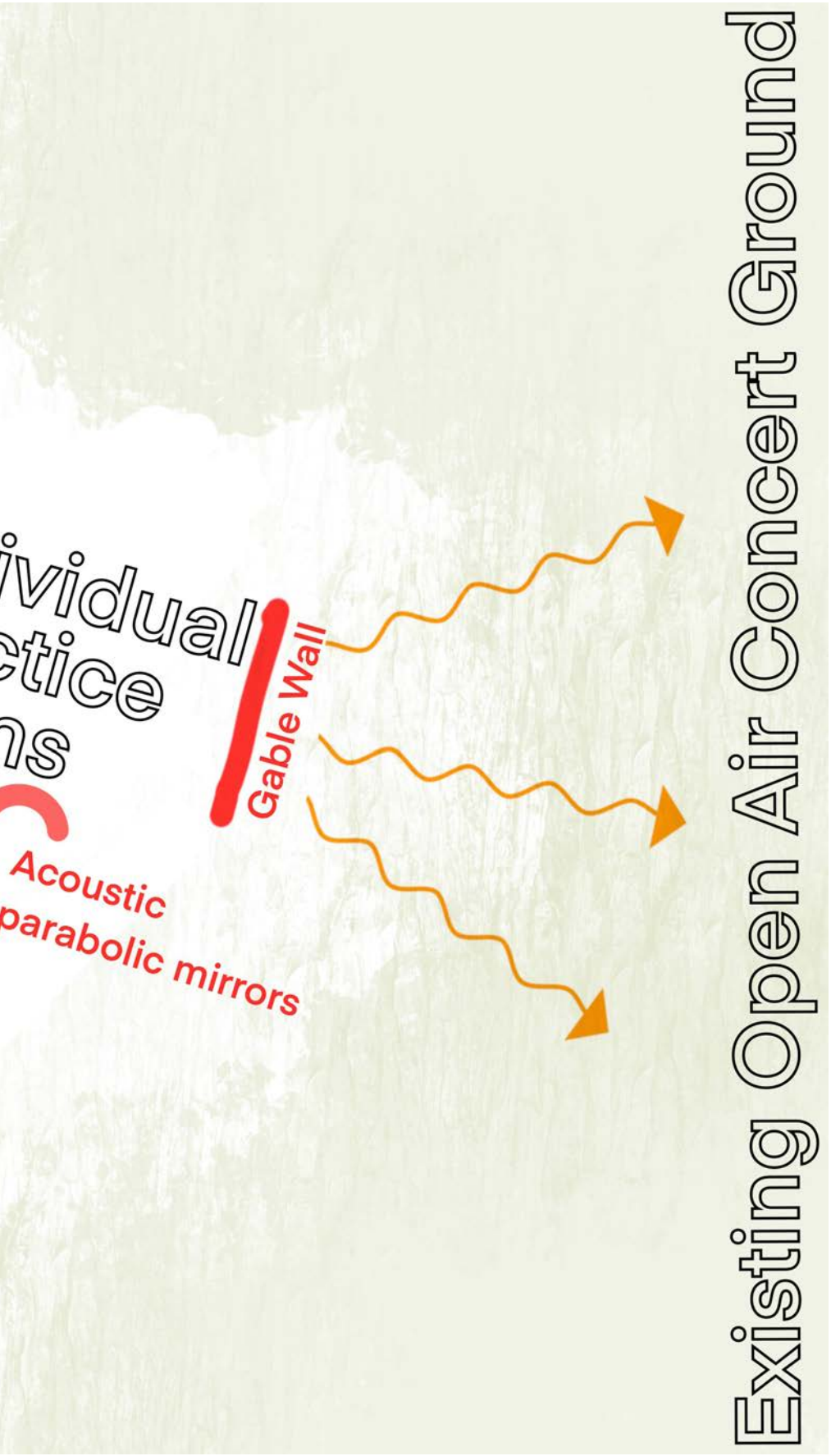
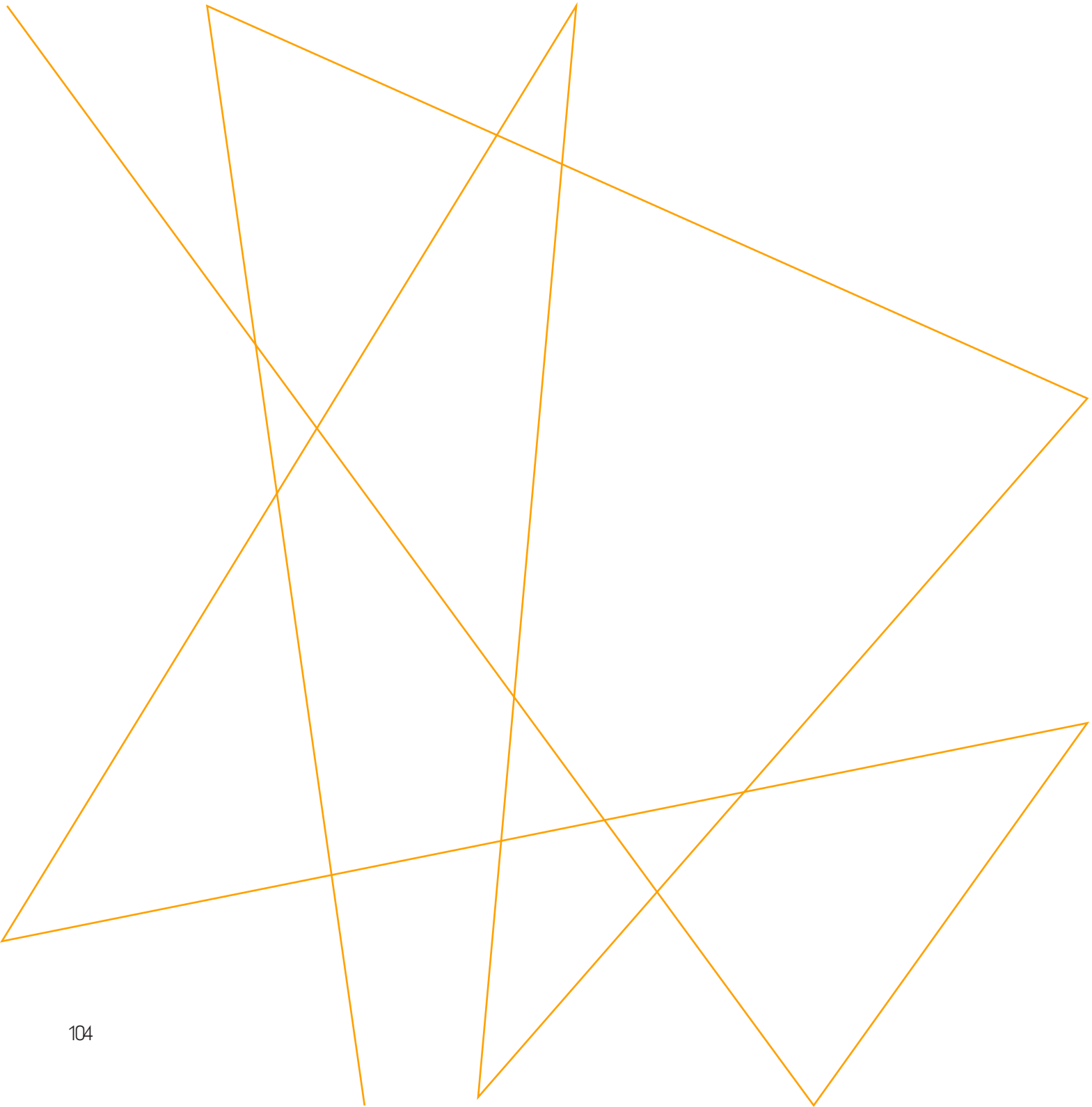


Fig 108. Function diagram

Function diagram acts as a simplified part of the conclusion of design process. It shows the shared/common facilities in the middle and music rehearsal spaces on its either sides. Because of acoustic and practical reasons, the ensemble rooms are detached from the main building, whereas the individual practice rooms are a part of it. The spiral ramp, acoustic parabolic mirrors and the gable wall are the main architectural elements and soniferous garden sits in-between the two flanks of the building.

presentation



“space is an extension to the music instrument and to its built environment“

The design of the building is inspired by the phenomena of sound. It is an extension to the dreams and aspirations of a musician, an extension to the music instrument and an extension to the cultural identity of Refshaleøen. It offers a elaborate, comprehensive and flexible platform to its users and acts as a catalyst for the activities taking place around the buiding site.

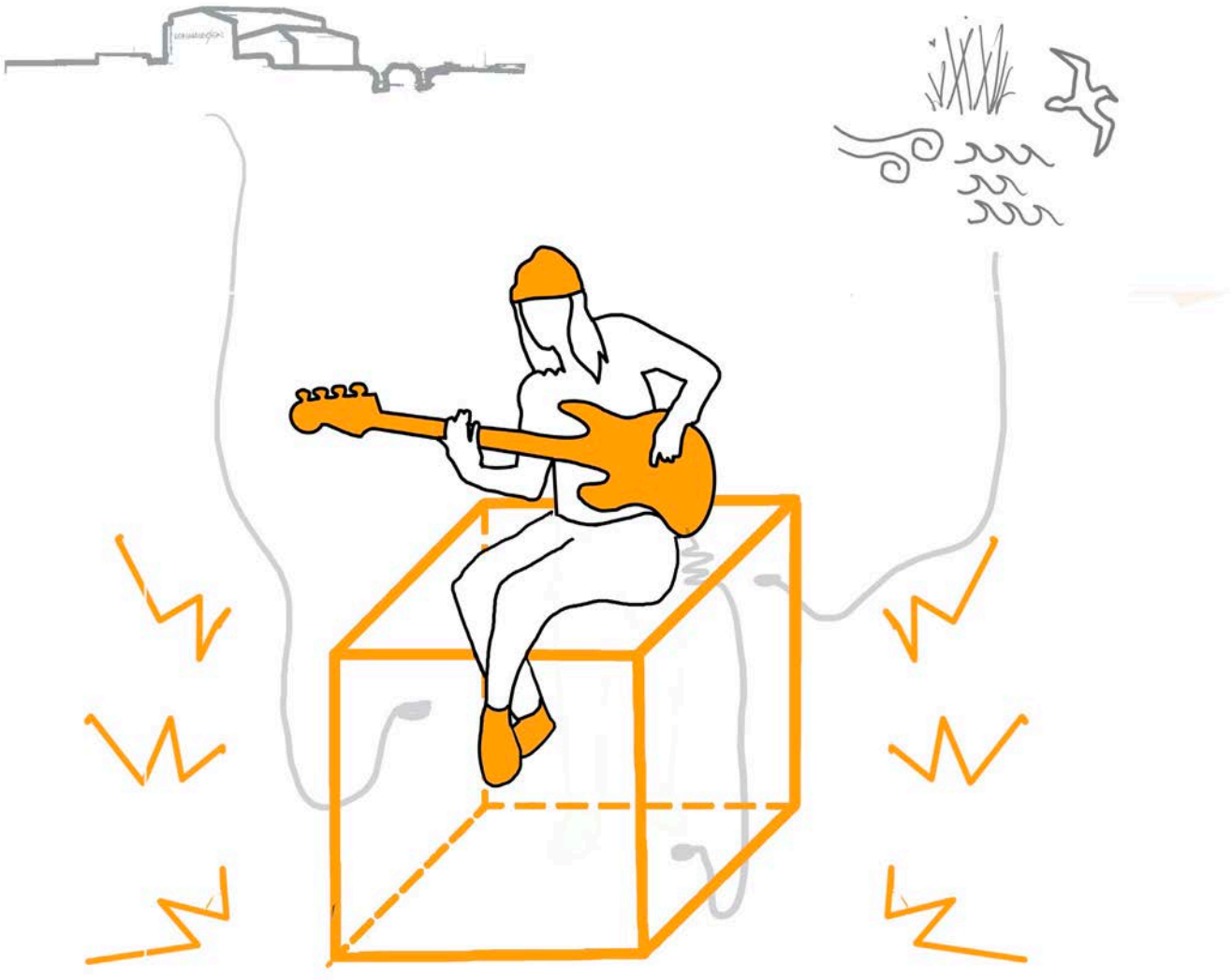


Fig 109. Design concept (author)

Fig 110. Arrival from Copenhagen Habour

Look yonder and the building sits delicately between the threshold of the water, land and sky. With the iconic B&W halls looming at its backdrop, it comes across as an integral part of its context. The western facade with four parabolic acoustic mirrors face the waters, accentuating the soundscape of the harbour to its passer-by.

QR 1
Harbour sound-scape recorded at the site on 03/05/23

site plan

The building opens up to one of the corners of the harbour front, inviting its users and people coming via harbour bus, vehicle, bi-cycle or on foot.

It is positioned in a way, so that the emply gable and an outdoor stage, lie along the centre line of the open concert ground. In that way, it acts as an edifice for the future events taking place over there.

Tha parking and service areas are hidden away, along the northern facade of the building.

1:1000

Fig 111. Siteplan

here

"Come on you raver, you seer of visions, come on you painter, you piper, you prisoner, and shine!"

- Pink Floyd (1975)

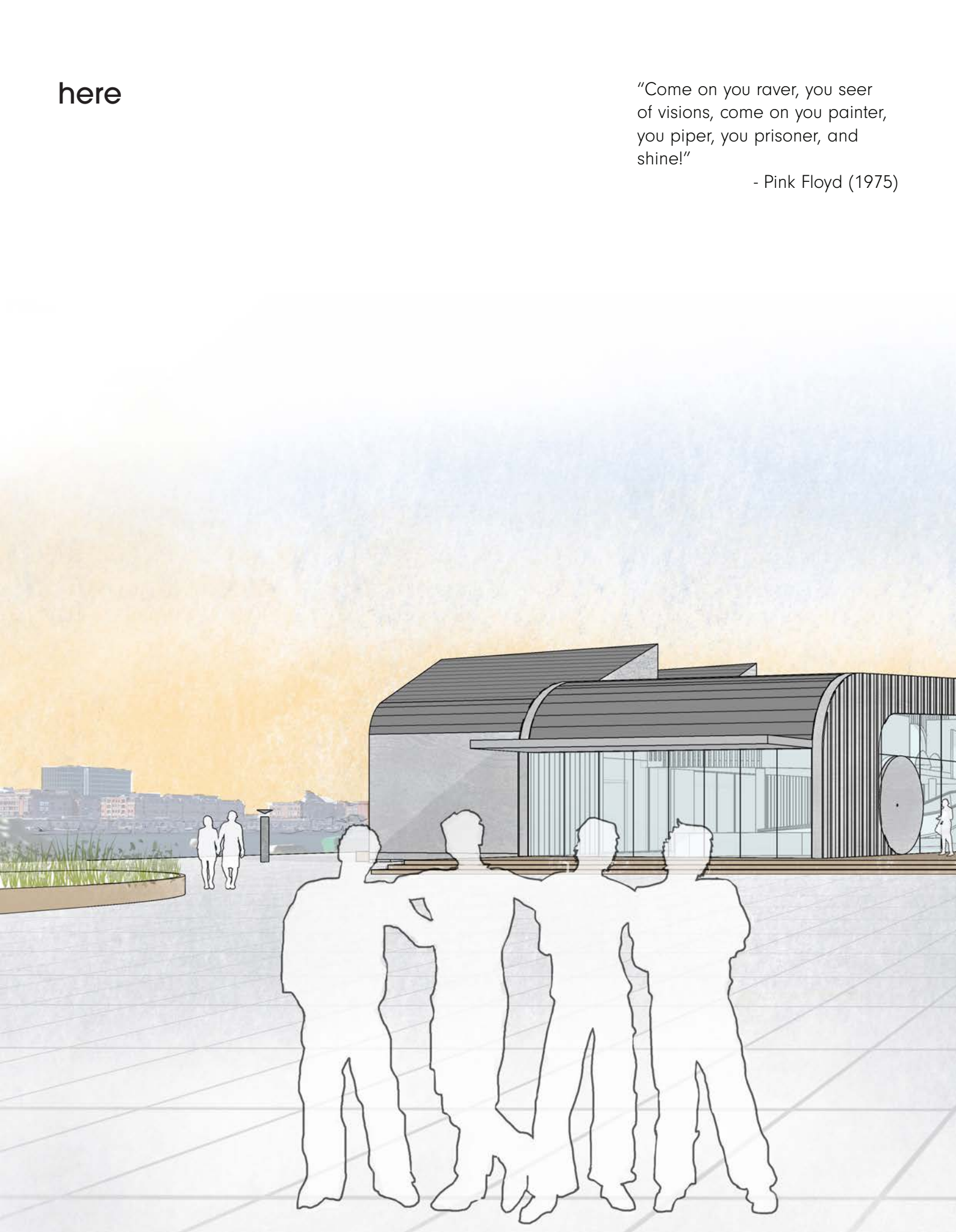
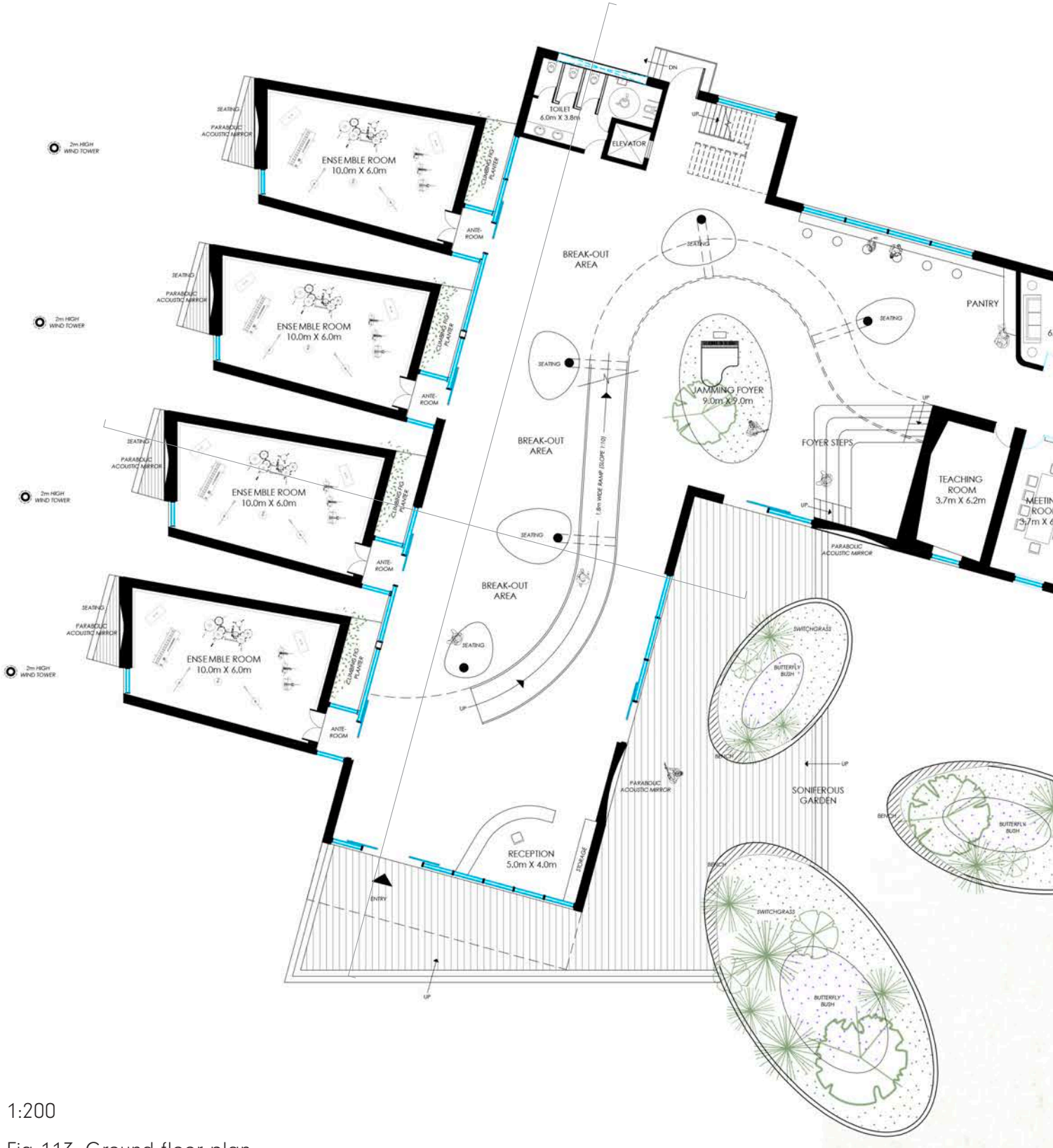


Fig 112. View from south

Apart from imparting a sense of identity and ownership to the musicians, the building also acts as a driver for a range of activities around it. Public engagement is encouraged to the extent, where it becomes an integral part of the musician's creative process and does not interfere with it. On the other hand, public gets inspired and culturally nourished while visiting Refshaleøen.

ground floor plan



1:200

Fig 113. Ground floor plan

An elaborate central common space acts as a driver for social interaction, relaxation and public engagement.

Musicians continuously mingle and hold impromptu jam sessions in the double height jamming foyer, exploring their tribe and developing high levels of musicianship.

Open air concerts are held next to the gable wall every once in a while, for musicians to share their art with public and hone their live performance skills at the same time.

first floor plan

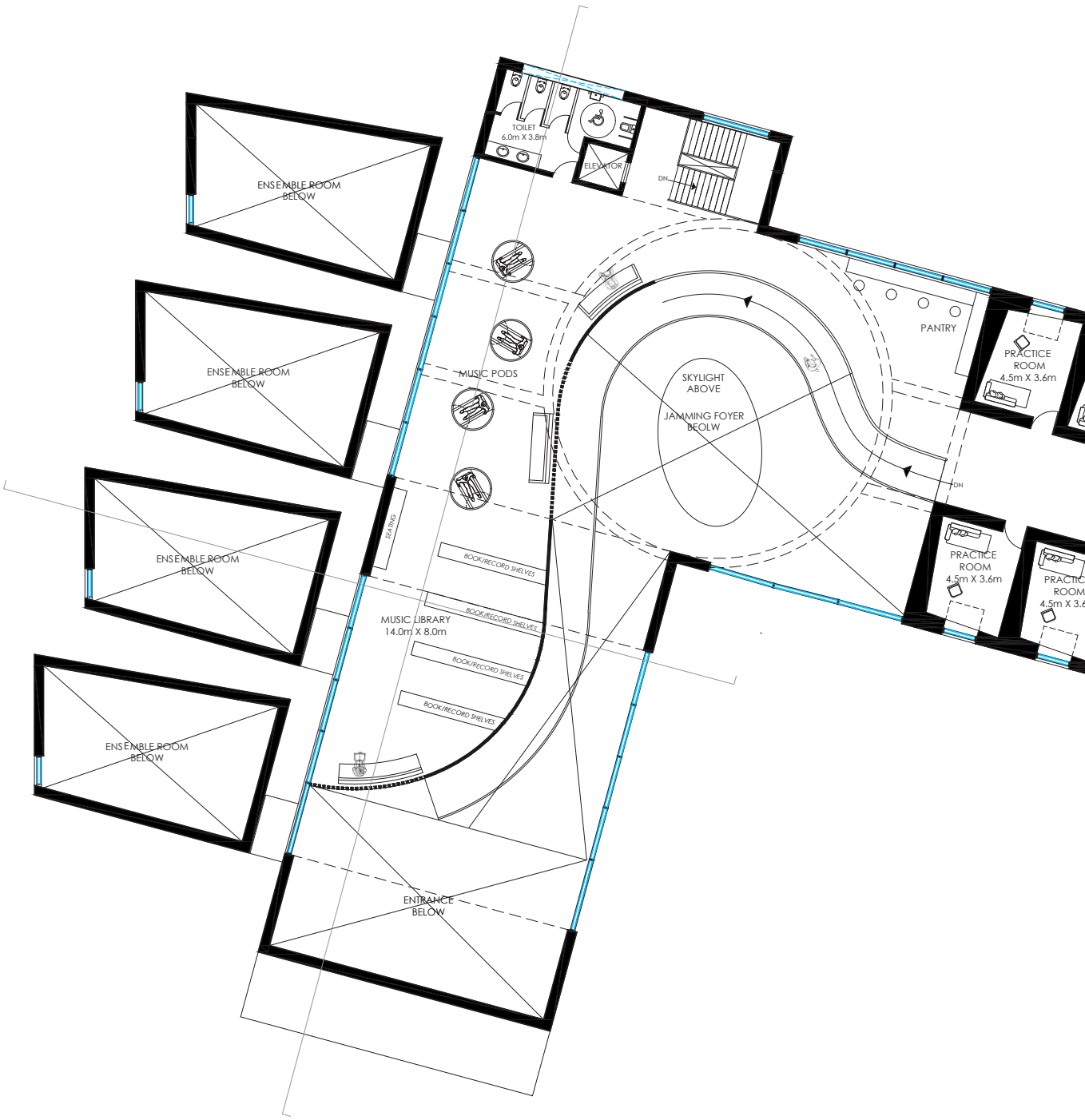


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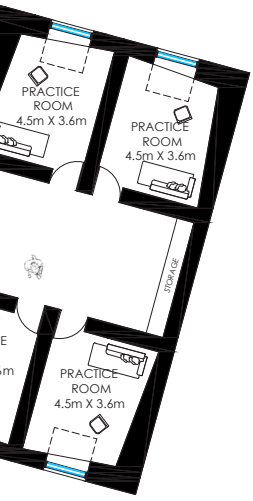
Fig 114. First floor plan



Small practice rooms are more of a private sanctury for individual musicians, to dig down deep into their craft and take breaks whenever necessary.

A music library consisting of literature, sheet music journals, records etc. is also open to public and overlooks partially to the common areas on the ground floor. Music pods offer music listening experience of the new audio format of "Immersive audio", the future of the music industry.

Fig 115. View from east

Neither here nor there, but somewhere in-between lies the soniferous garden, which acts a buffer between the building and the open concert ground. It consists of three elliptical planters consisting of benches, trees, shrubs and bushes. These are further overlooked by two parabolic acoustic mirrors on the southern and eastern facades of the building.

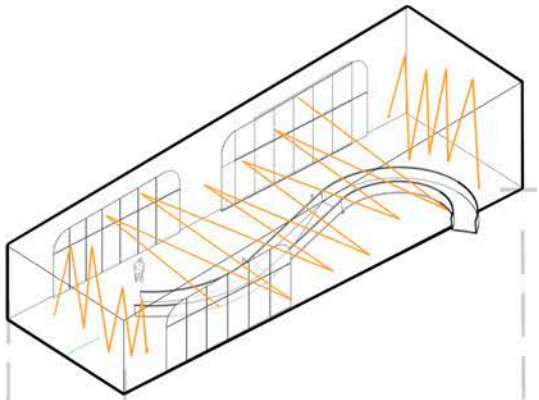
The idea is to first add to the ambient sounds of the garden and then use mirrors to reflect them back to listners and musicians at different locations. Thereby, enabling musicians to experiment with ambient sounds and offering a garden for listening to the passer-by.

QR 2
Soniferous garden conceptual soundscape (author)

acoustic considerations

Fig 116. Acoustic considerations

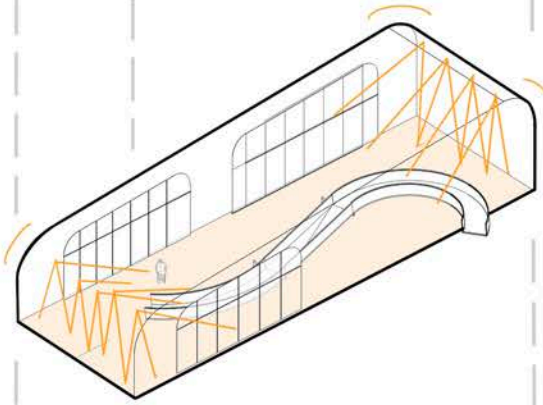
1



bare shell
Double height space with highly sound reflective surfaces

Issues:
Higher reverberation times
Lower Speech Intelligibility Index
Flutter echo

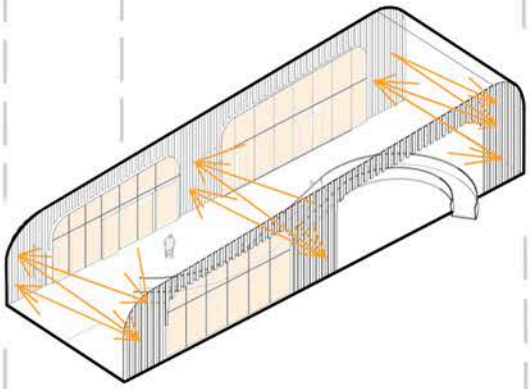
2



floor/ceiling
Rounding the corners.
Adding wooden flooring
Adding absorptive ceiling

Phenomenon:
Focalization
Absorption

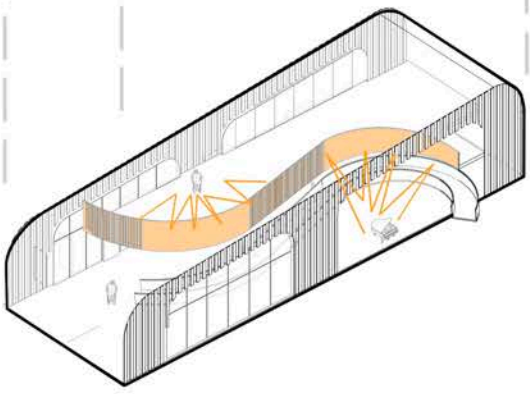
3



walls
Adding ribbed texture to the rough concrete walls

Phenomenon:
Scattering

4



additive element
Concave and convex surfaces in wood with periodic slits.

Phenomenon:
Absorption
Scattering
Focalization

within

Spaces flow in and out, encouraging active and passive engagement within its users. They further encourage musicians to take breaks and rejuvenate themselves during their creative process.

Fig 117. Entrance lobby view

elevations south and west

south

The curtain wall on the inner wall of the breakout areas offer view of the harbour, through apertures created by the disjointed construction of the ensemble rooms.

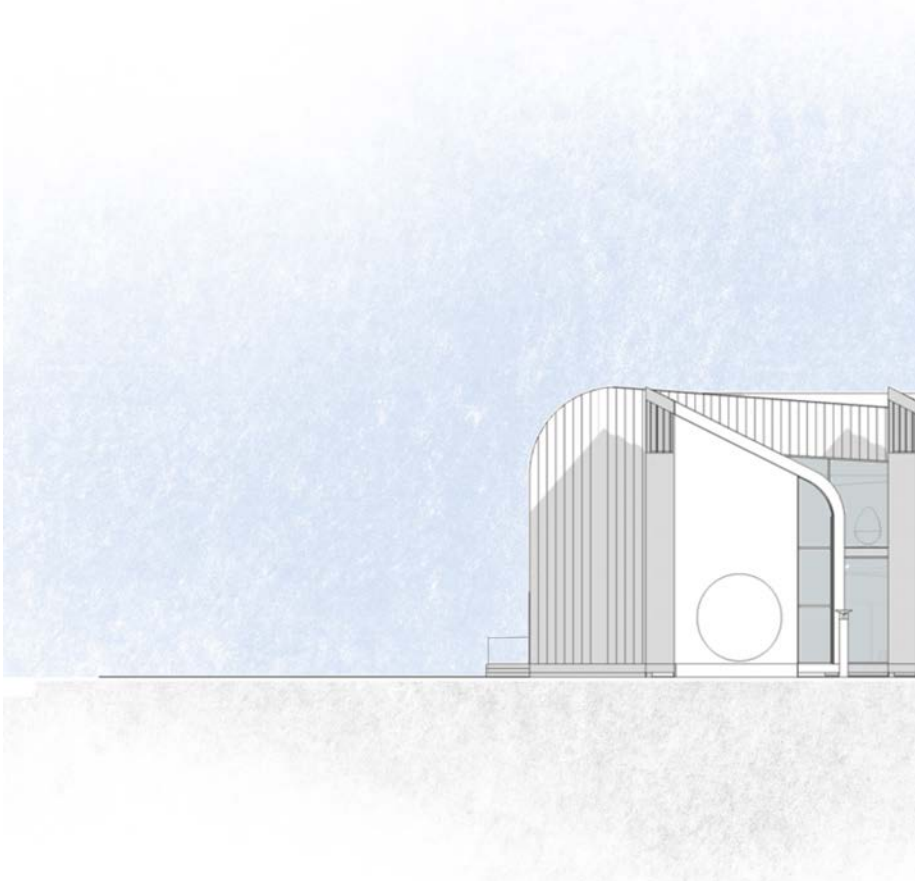


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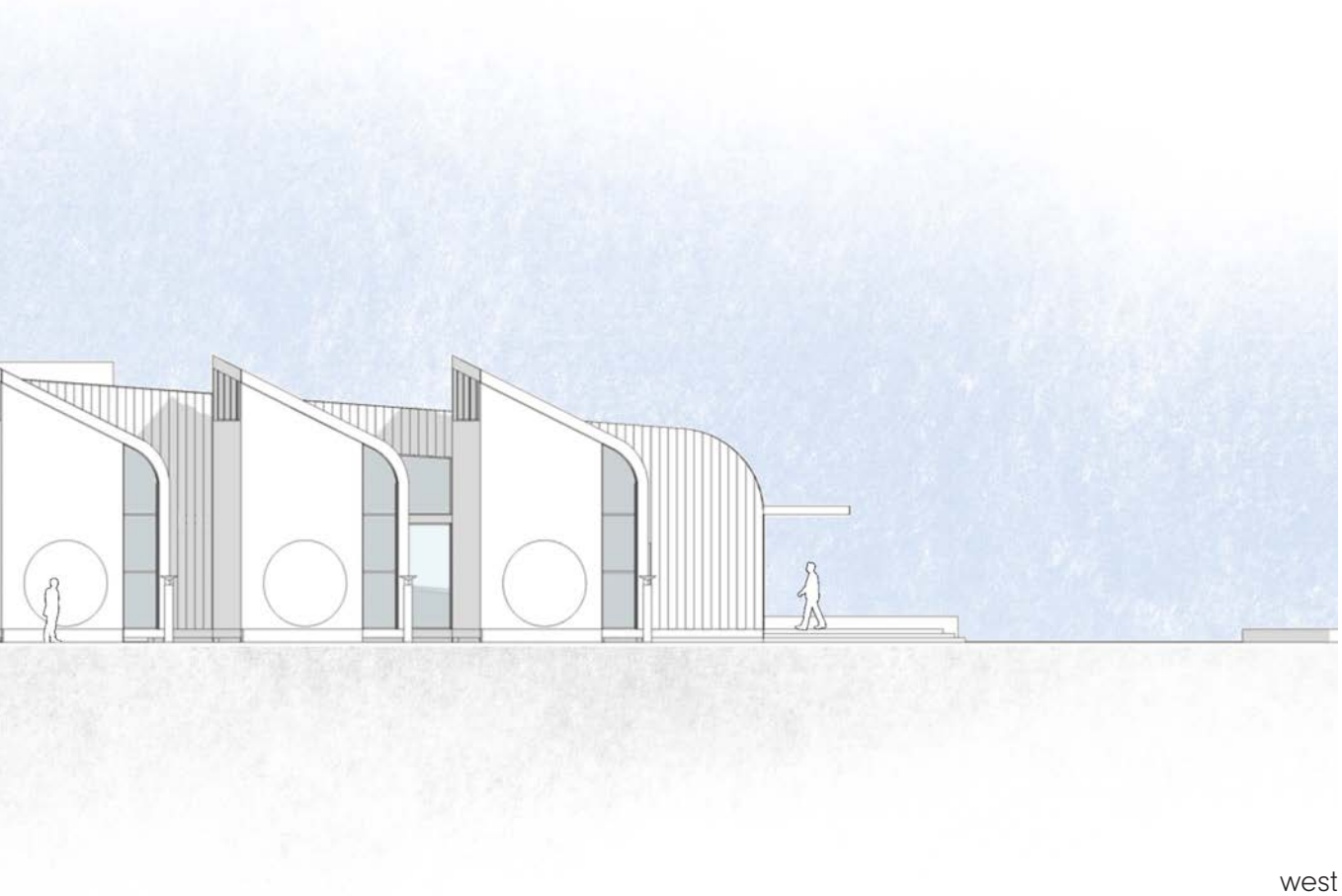
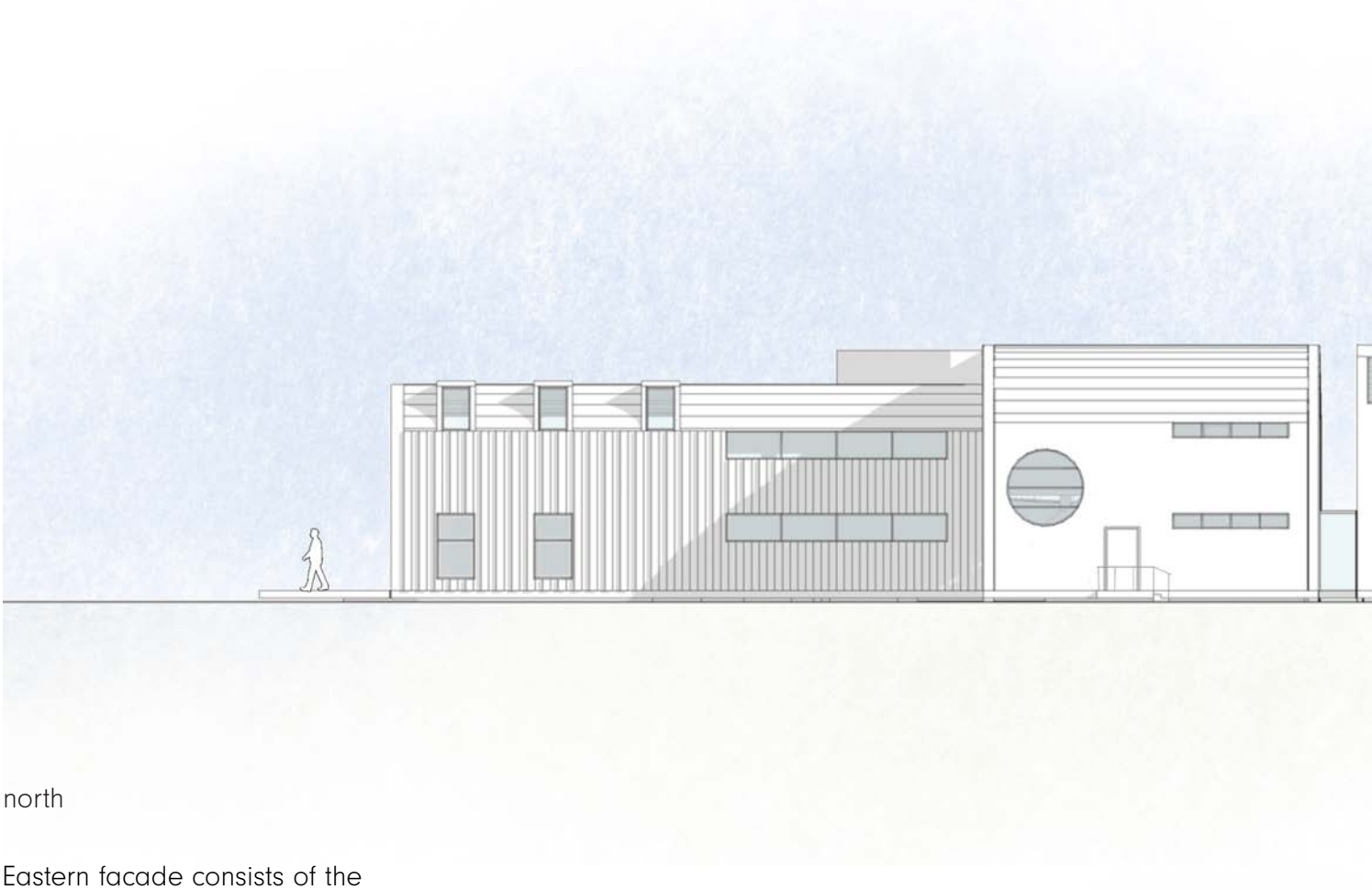
Fig 118. Elevations south and west

The main entrance is on the southern facade. Meeting room, teaching room and the small practice rooms on the first floor overlook the soniferous garden.



west

elevations north and east



north

Eastern facade consists of the empty gable wall, which acts as an edifice or a backdrop for the open air music concerts.

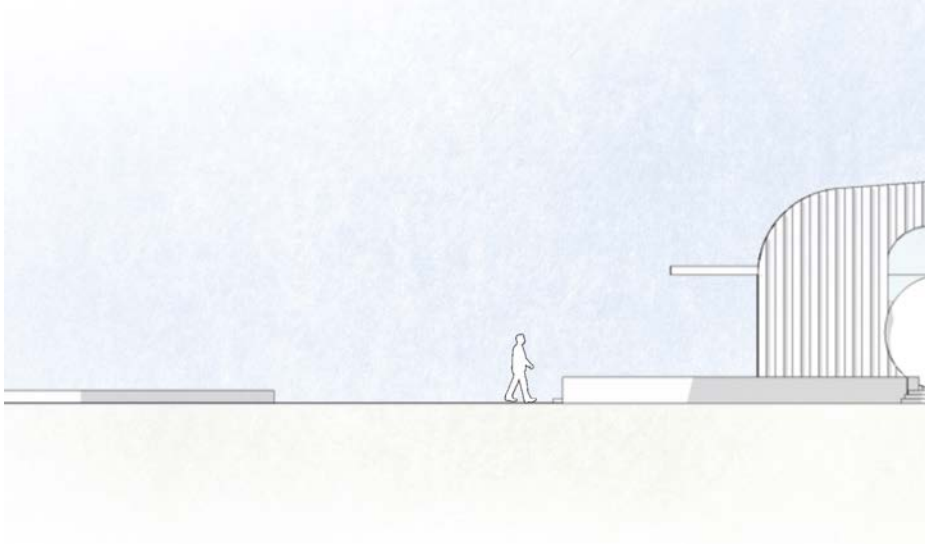


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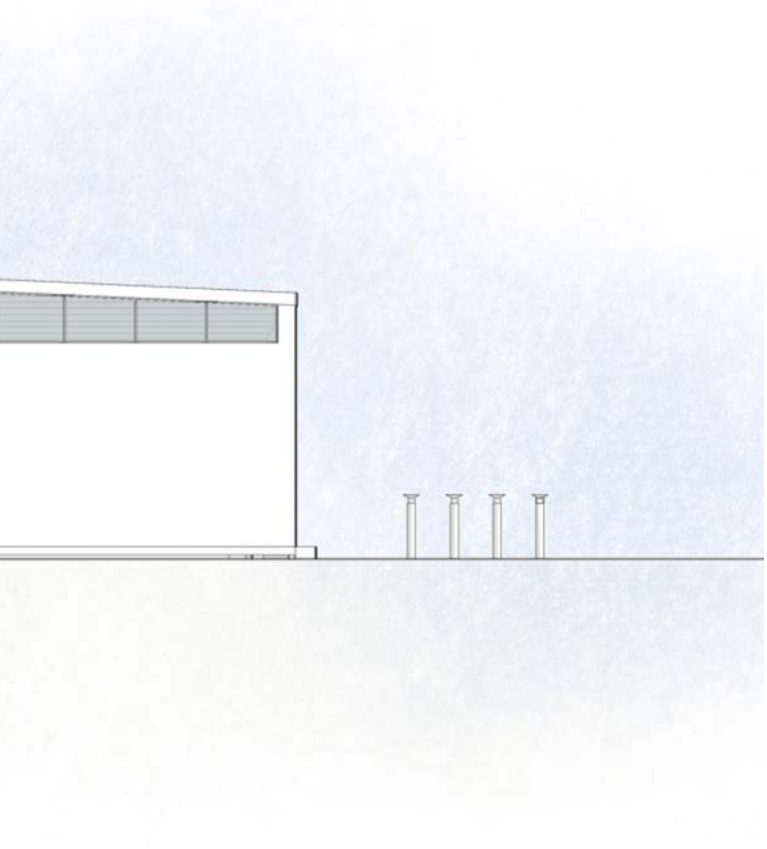
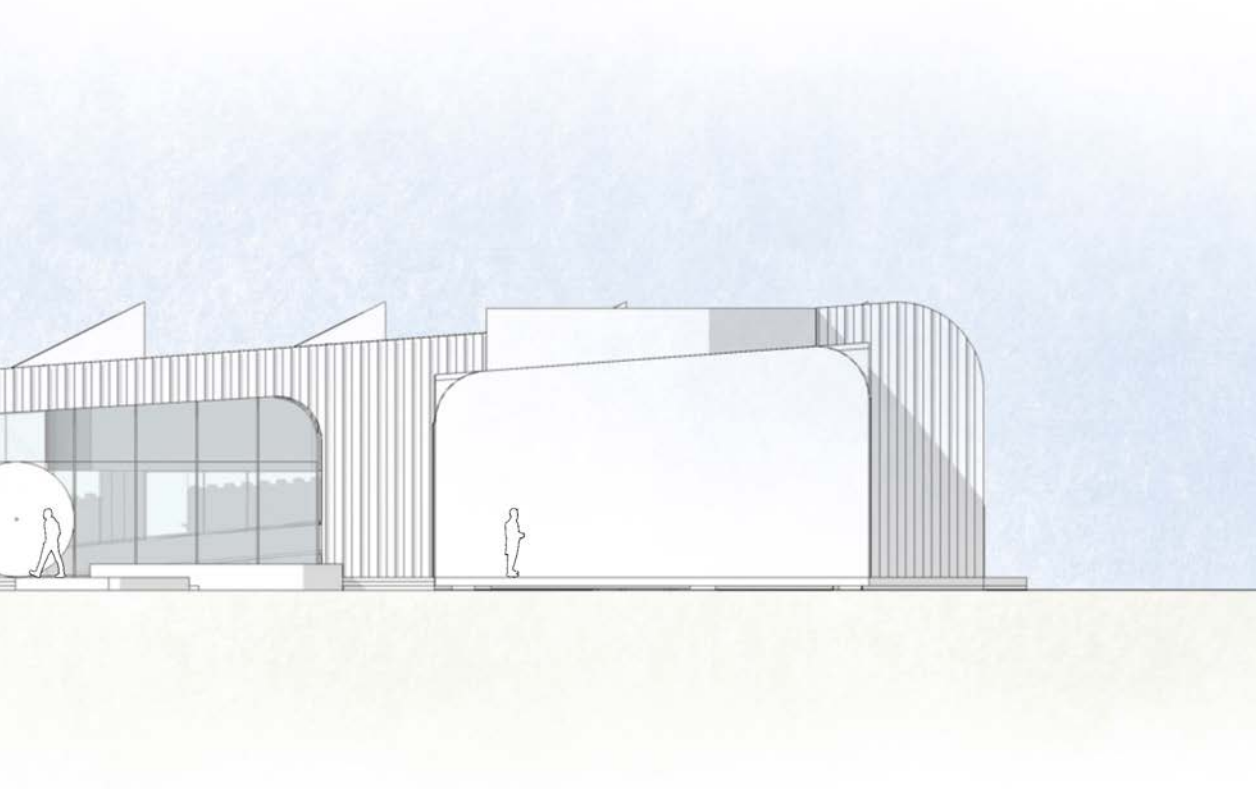
Fig 119. Elevations north and east

Northern facade consists of the fire escape staircase and toilets. The ensemble rooms have the clearstory windows at the top.





east

longitudinal section

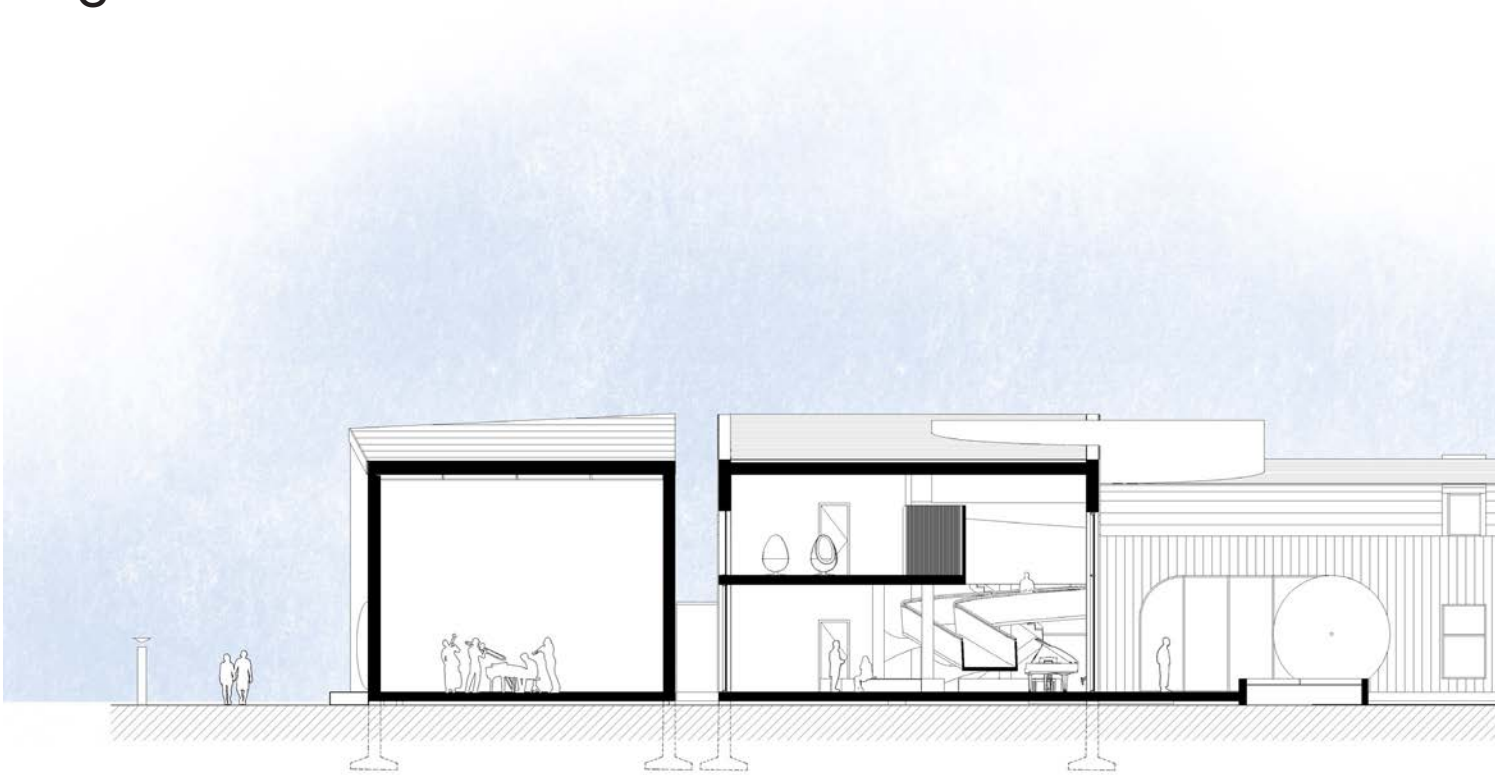


Fig 120. Longitudinal section

The building consists of concrete shear wall framing, which holds the structure and the roof deck. These are then anchored at 10 different points on the ground, acting as point foundations so as to have minimum contact with the ground.
On the other hand, the ensemble rooms are disjointed volumes having relatively smaller point foundations, also in concrete.

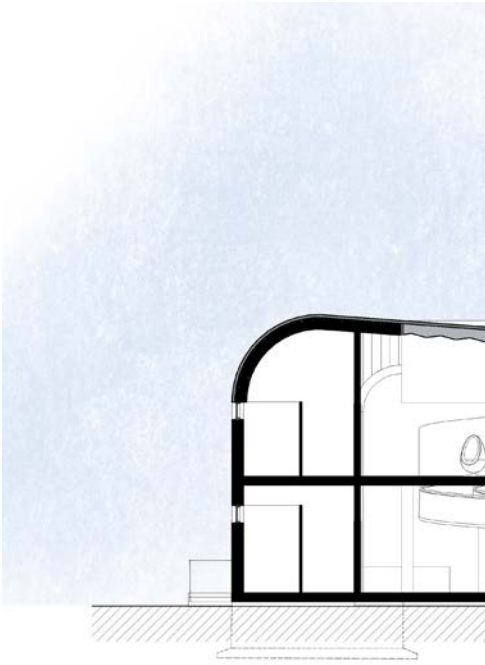


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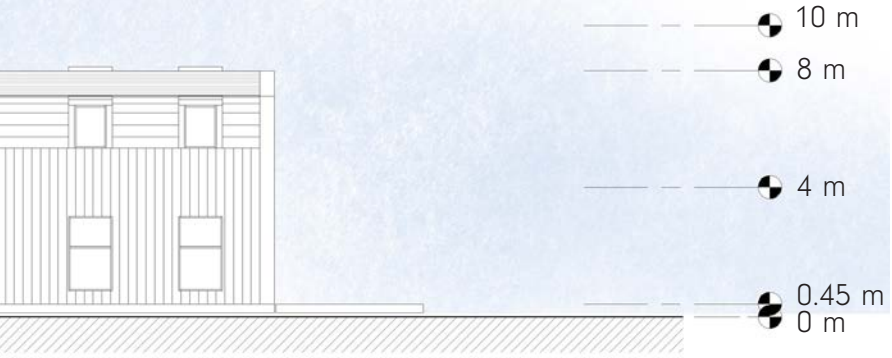
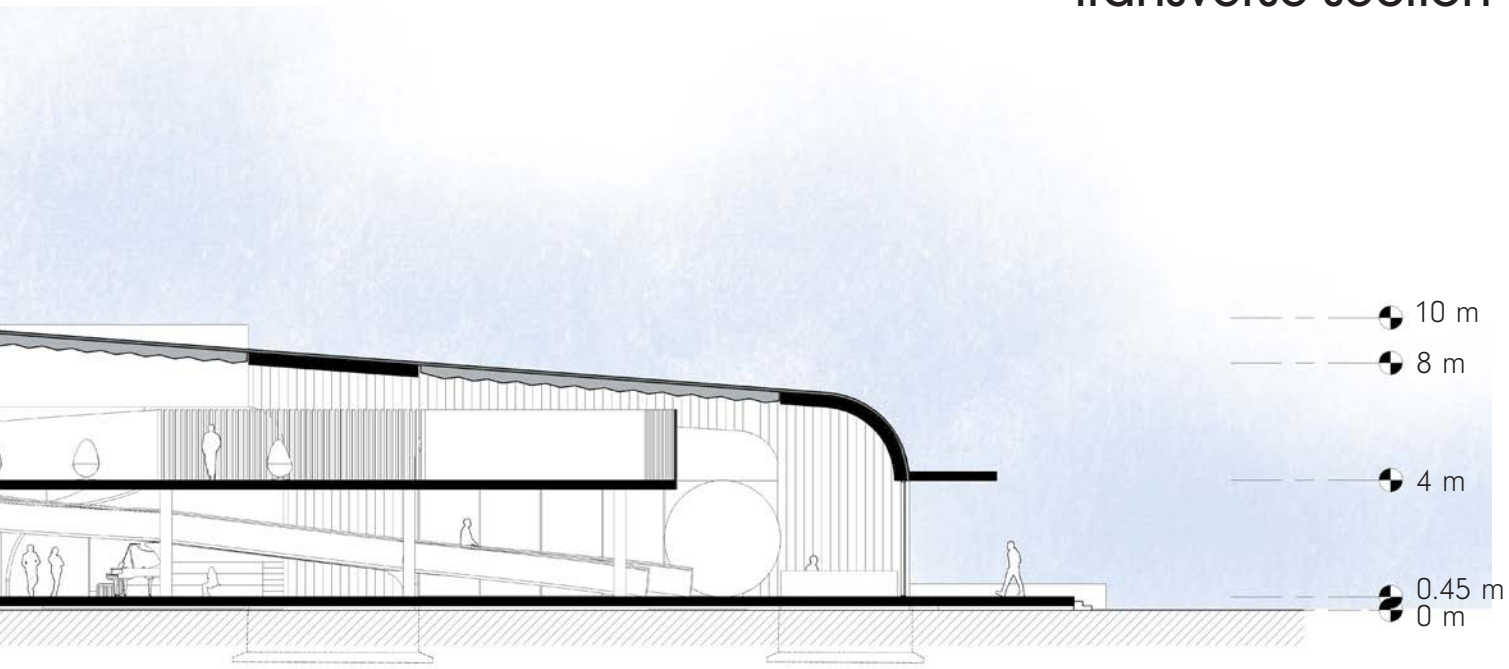
Fig 121. Transverse section

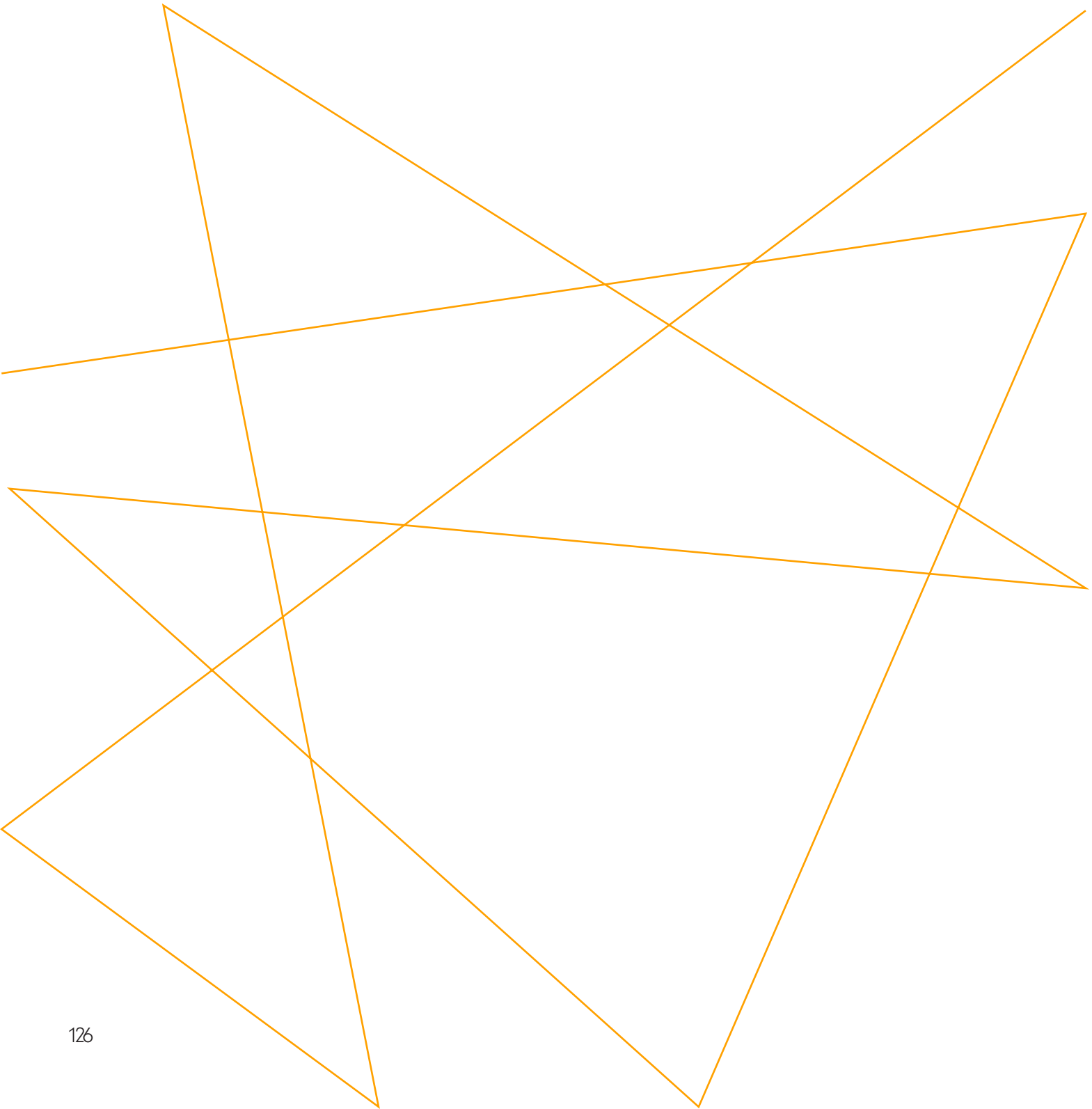


The spiral ramp is supported by concrete columns running along its length, which also hold the first floor level concrete slab. Interactive seatings are being created around these columns, which are used as an integral part of the breakout space.

transverse section



ensemble room



concept

"music for space and space for music; in synchrony"

As discussed earlier in the report, there has been two different approaches during the evolution of music; either music for rooms or rooms for music. The design of the ensemble room is driven by the idea of creating a synchrony between both these aspects. The musicians can adjust the space according to their music or make music suitable for the space.

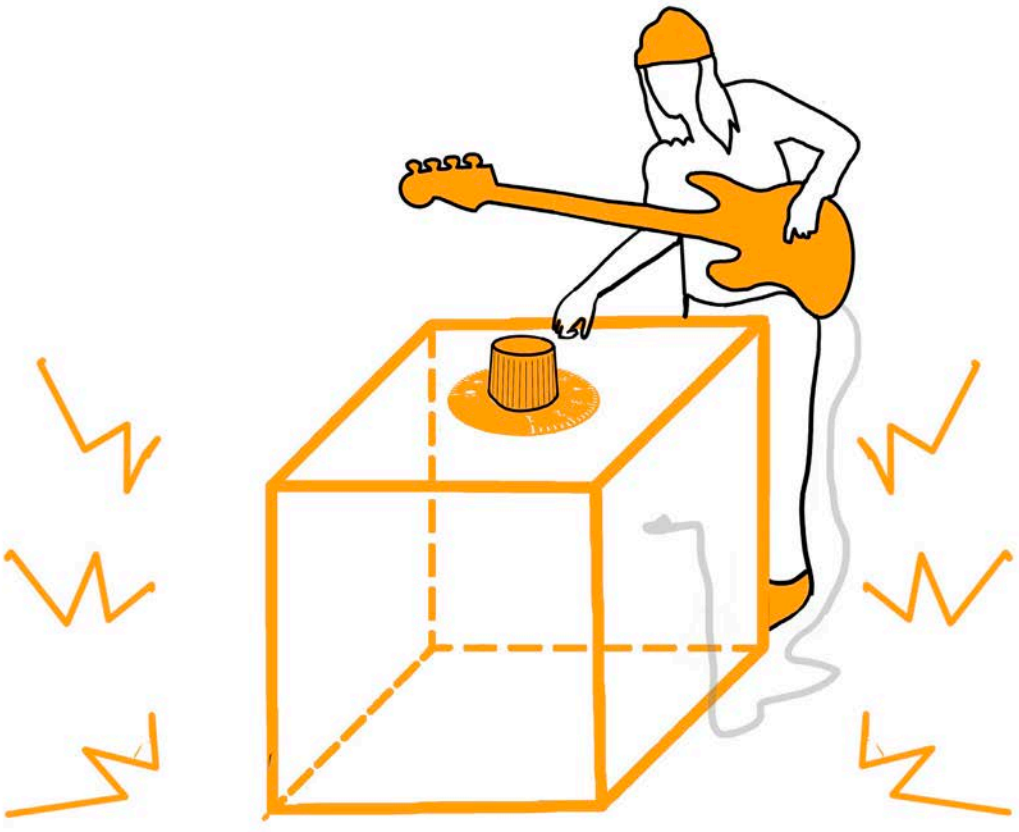


Fig 122. Design concept

floor plan

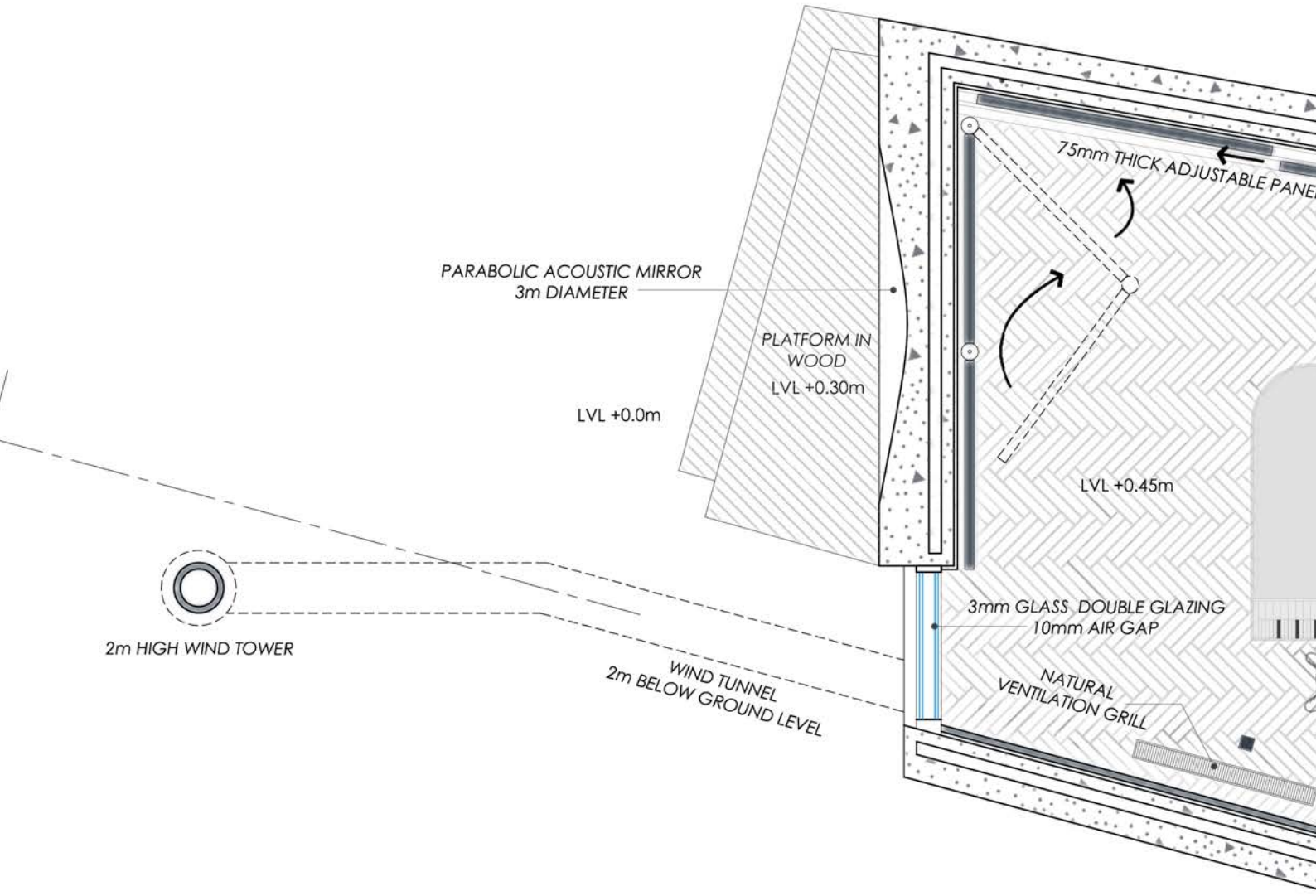


Fig 123. Ensemble room floor plan

A system of adjustable panels in birch wood can be moved around as per the desired acoustic response from the space.

1:50

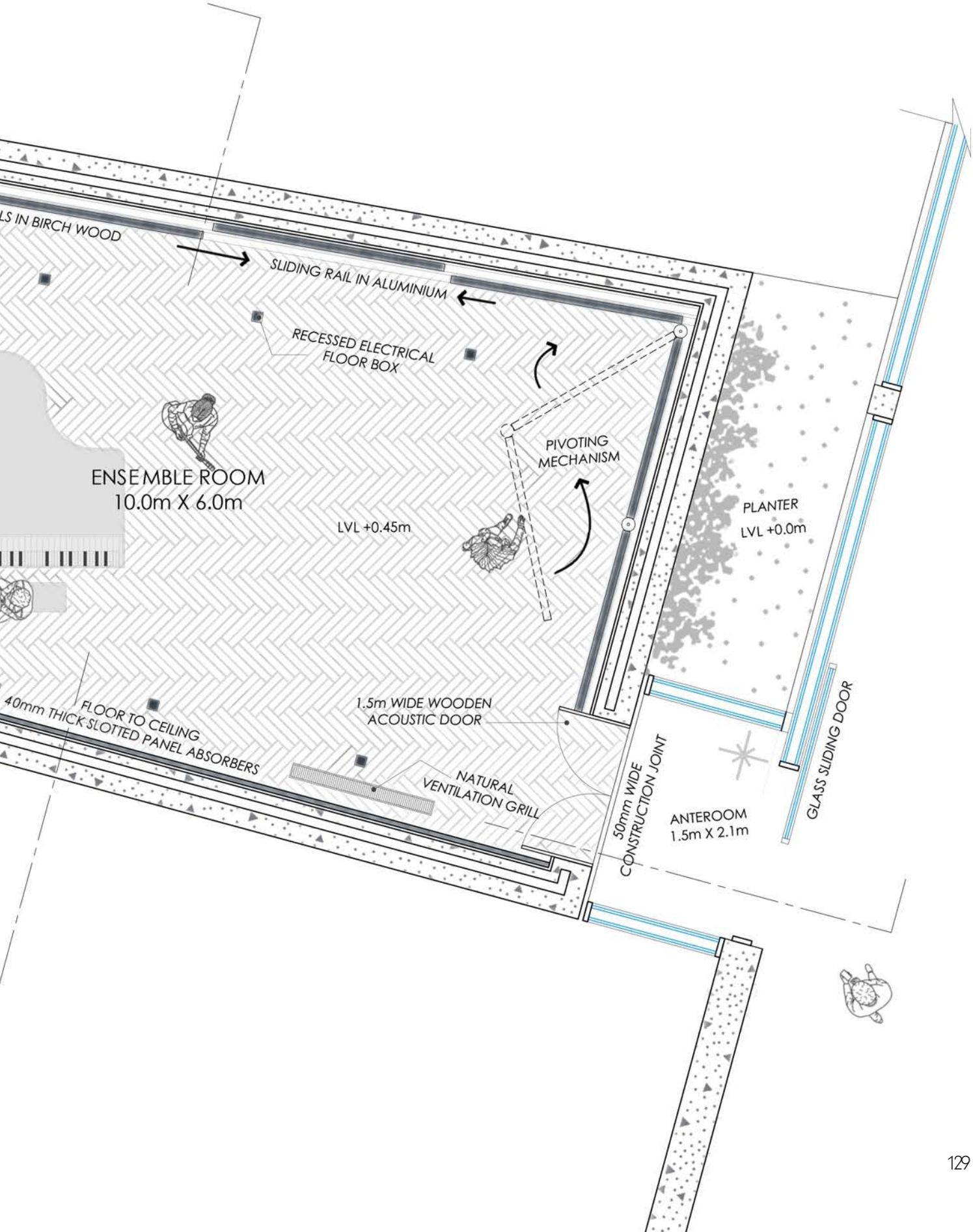
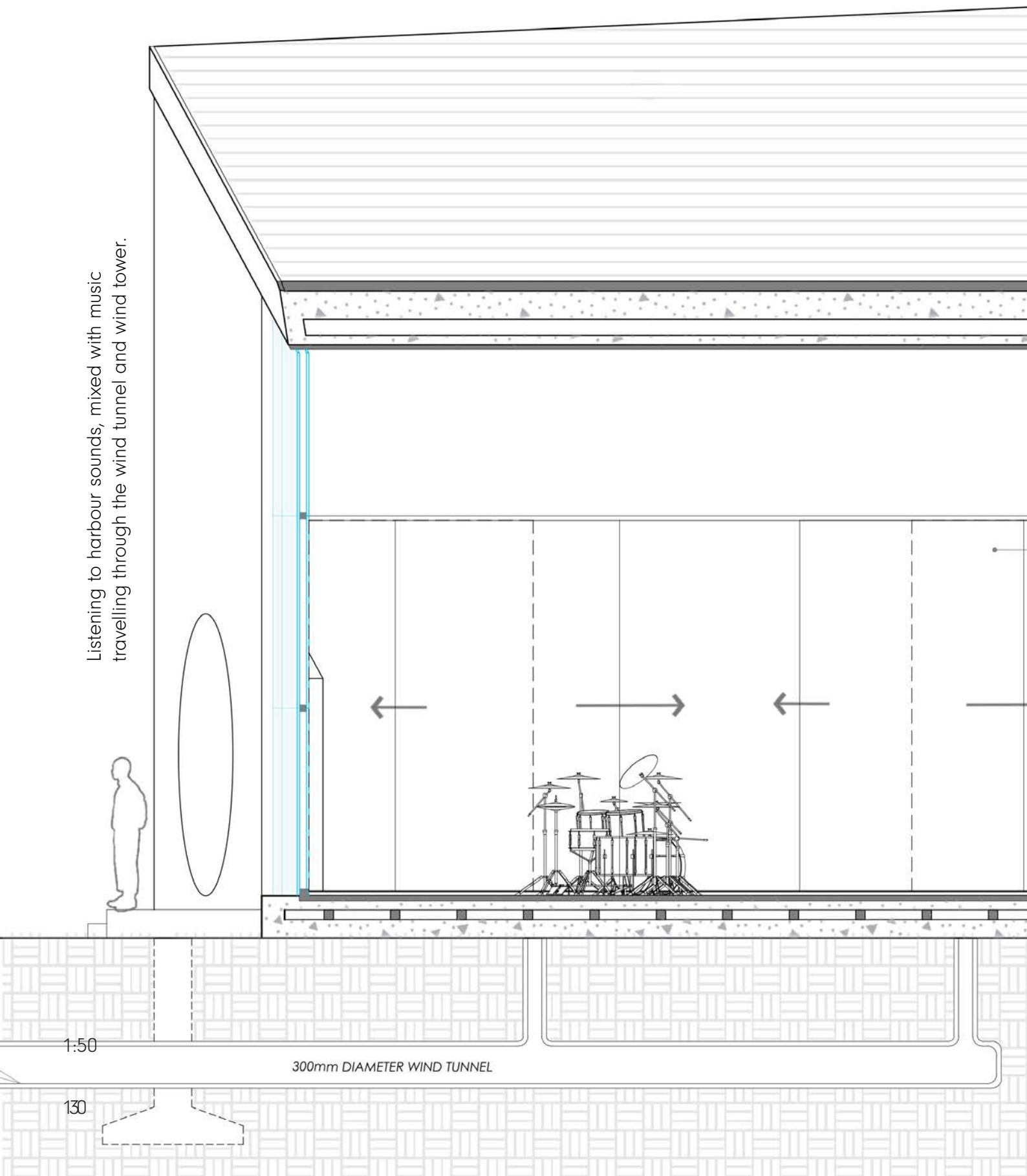
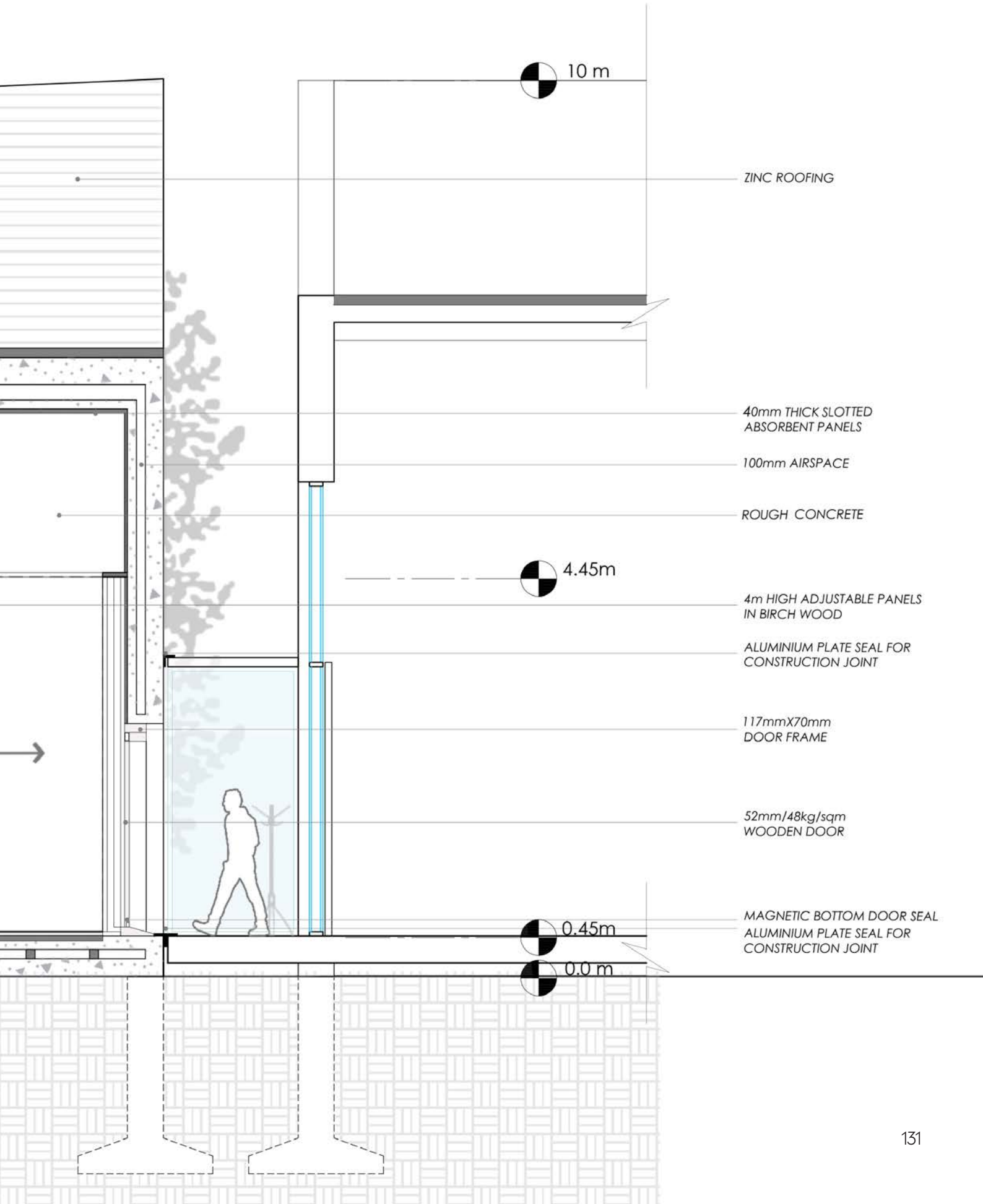

LS IN BIRCH WOOD
SLIDING RAIL IN ALUMINIUM
RECESSED ELECTRICAL FLOOR BOX
PIVOTING MECHANISM
ENSEMBLE ROOM
10.0m X 6.0m
LVL +0.45m
PLANTER
LVL +0.0m
FLOOR TO CEILING
40mm THICK SLOTTED PANEL ABSORBERS
1.5m WIDE WOODEN ACOUSTIC DOOR
NATURAL VENTILATION GRILL
50mm WIDE CONSTRUCTION JOINT
ANTEROOM
1.5m X 2.1m
GLASS SLIDING DOOR

Fig 125. Ensemble room longitudinal section

longitudinal section

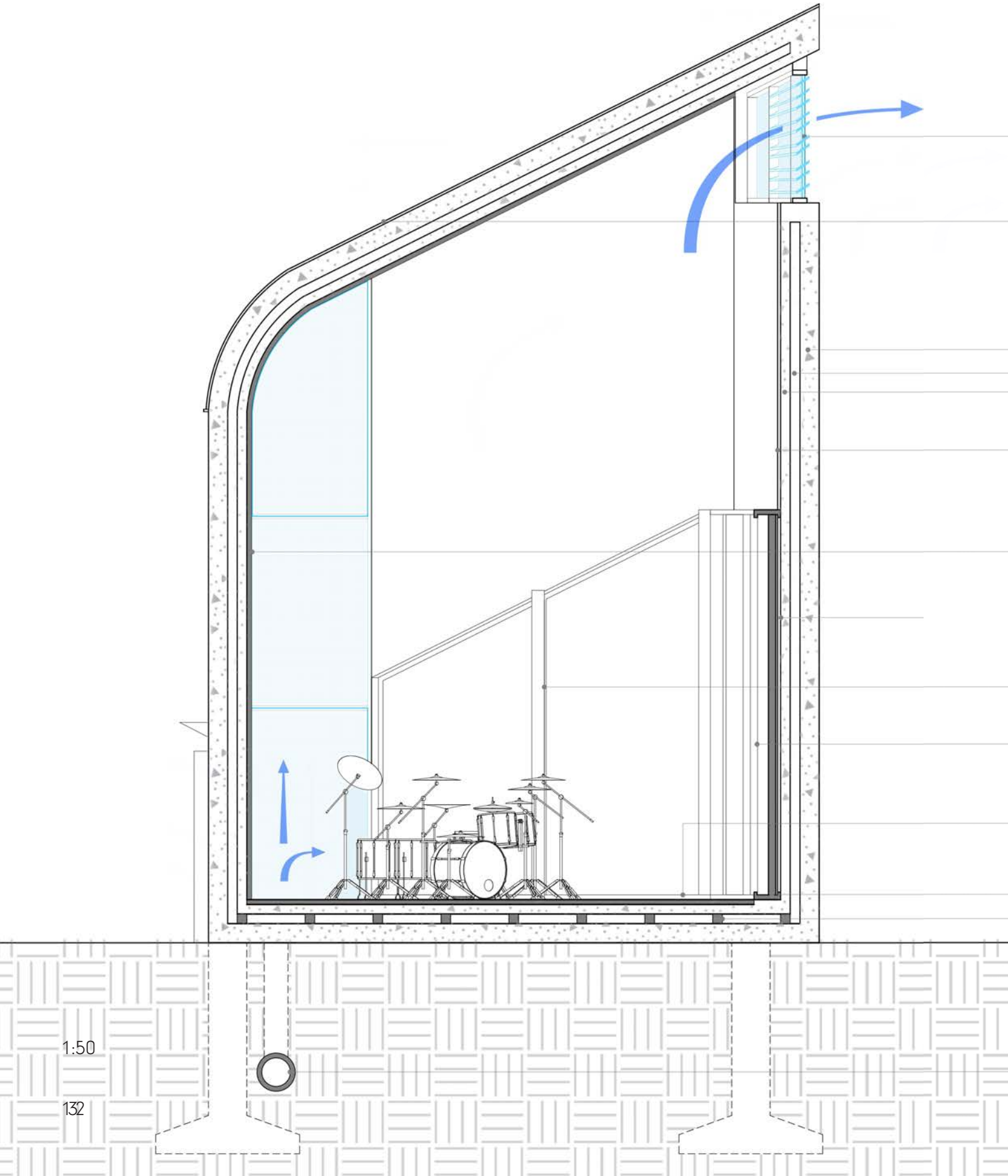


A disjointed construction, with a 50mm thick construction joint. The anteroom acts as a buffer between the ensemble room and the break-out lobby area.



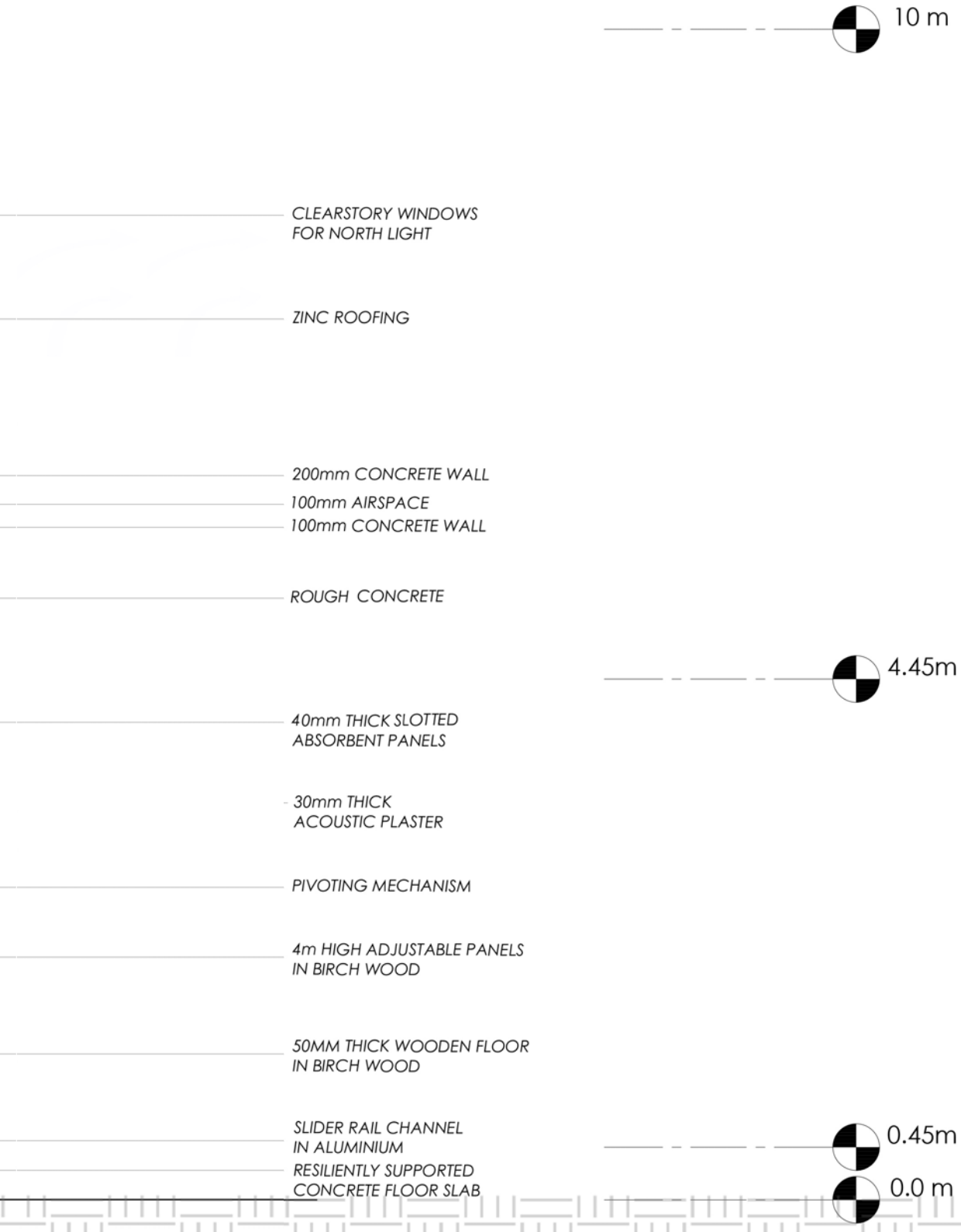
transverse section

Fig 124. Ensemble room transverse section



1:50

Earth air heat exchanger system is used as a natural ventilation strategy. It works on the principle of thermal buoyancy, where air is fed into the rooms via wind towers and wind tunnels and vented out through mechanized louvers on the clearstory windows.



room acoustics optimisation

The room volume chosen after the volumetric analysis, needed optimisation because of too high reverberation times and too low clarity levels. The idea was to achieve a neither too dead nor too live room through limited intervention. Thus, a floor to ceiling slotted absorbent panel was added to the southern wall to achieve the desired results.

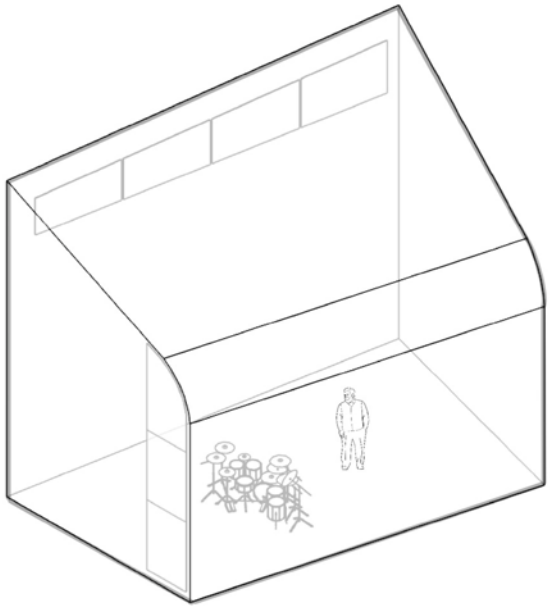


Fig 126. Bare shell

bare shell

Walls: Rough concrete
Floor: Wooden flooring
Ceiling: Rough concrete
Windows: Double 3mm glass, 10mm air gap

QR 3
Percussions

QR 4 Jazz ensemble

Percussions sound dull and boomy.
Jazz ensamble sounds muddy and has a poor blending between the musicians. The saxophone gets too much dominance over the other instrument sounds. Thereby, producing sound imbalance in the mix.

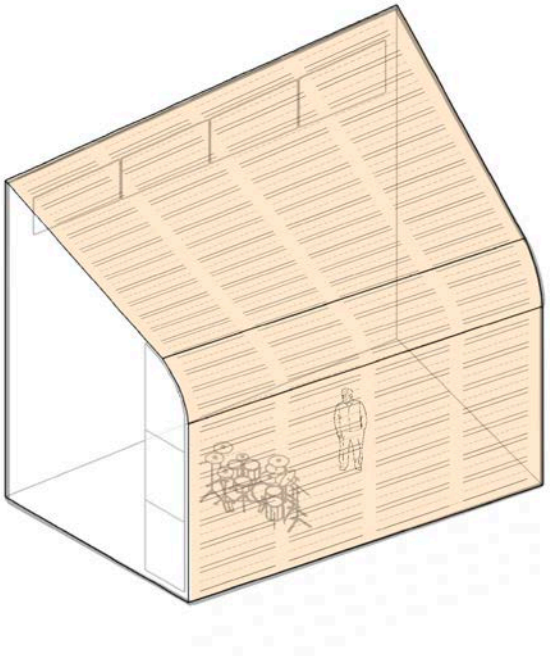


Fig 127. Optimisation

optimisation

Walls 1: Rough concete
Southern wall and ceiling:
Slotted panels, 30% open,
40mm 81kg/m3 absorber,
Windows: Double 3mm glass, 10mm air gap

QR 5
Percussions

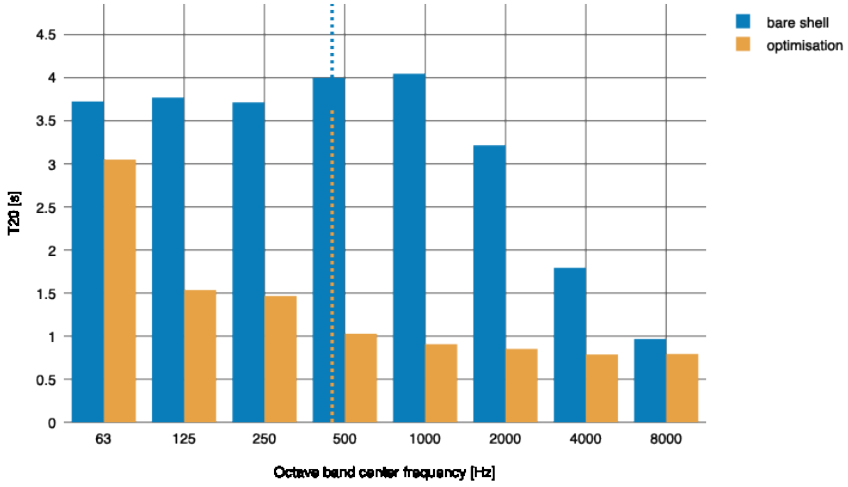
QR 6 Jazz ensemble

Percussions sound punchy with an added clarity in the cymbal accents.
Jazz ensamble sounds balaced with a decent blend. Also, there is much more clarity in the note articulation.

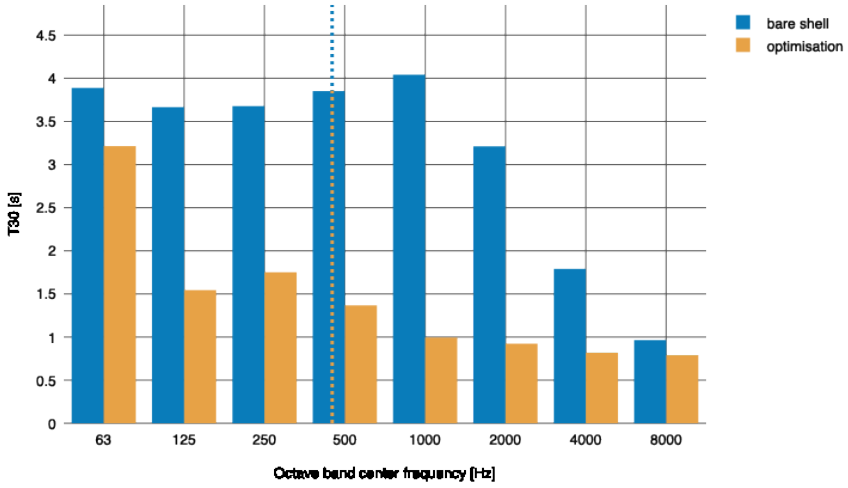
Fig 128. Ensemble room

comparative results

For the mid frequency range of 500Hz, T20 is reduced from 4 seconds to ! second, which is generally optimum for musicians to play in an ensemble.



reverberation time (T20)

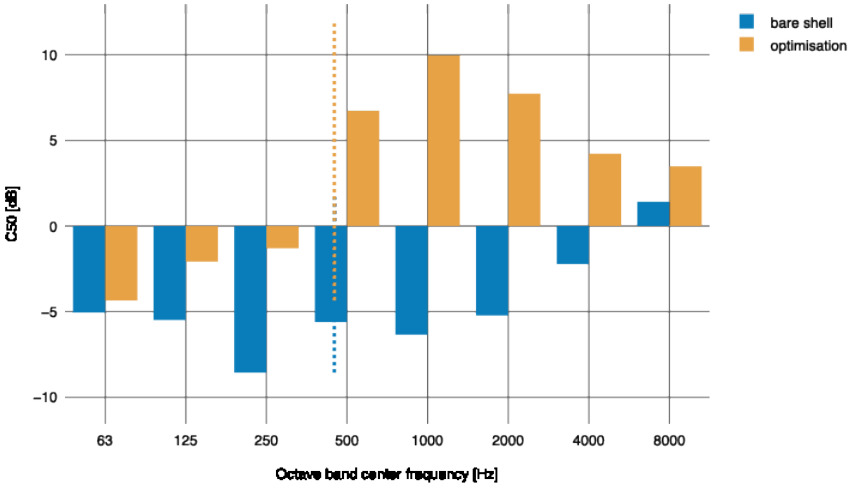


reverberation time (T30)

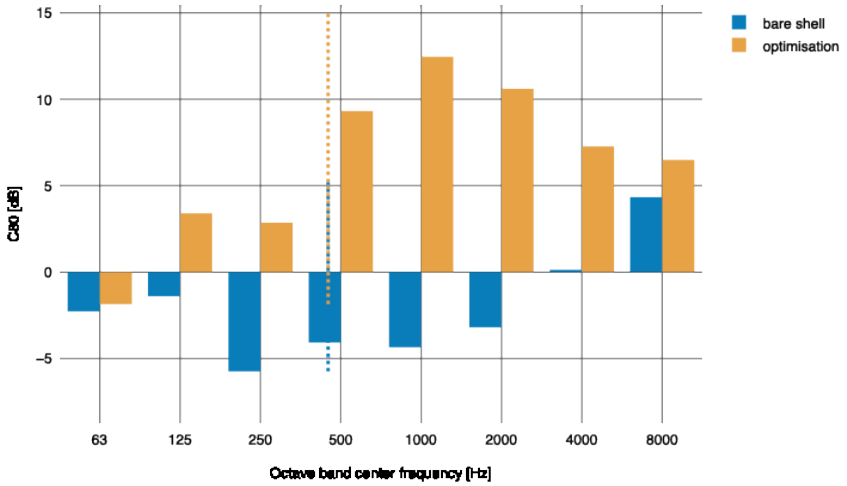
Fig 129. Comparative results 1-4

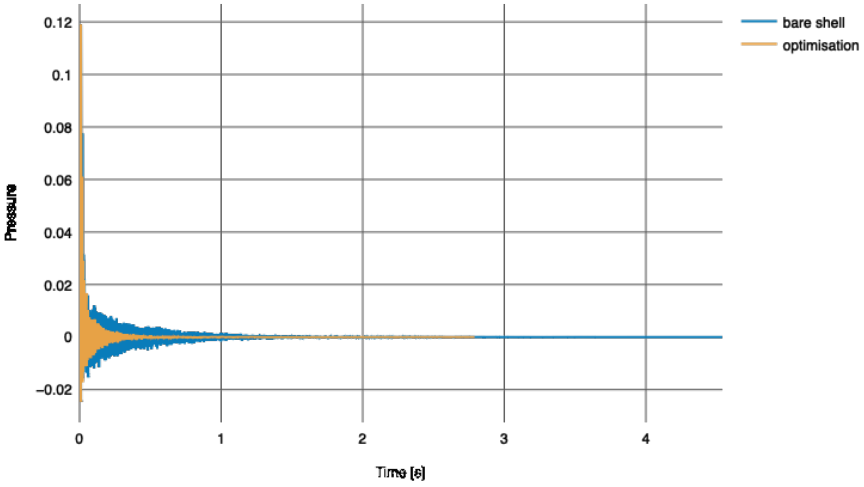
Both C50 and C80 levels are positive, with exception in the lower frequency ranges because of high reverberation times in the same frequencies.

clarity (C50)

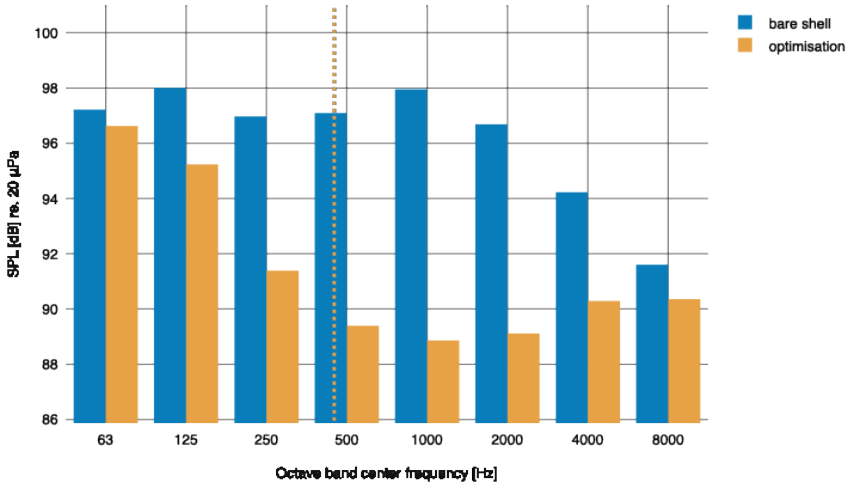


clarity (C80)





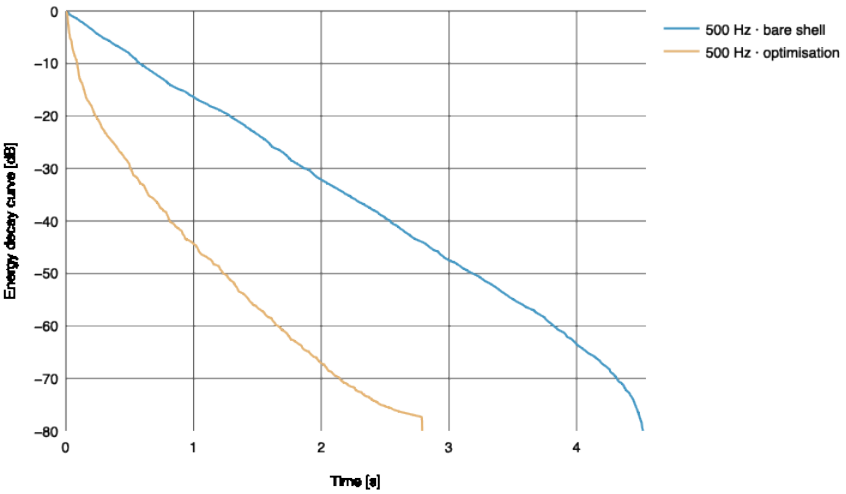
impulse response



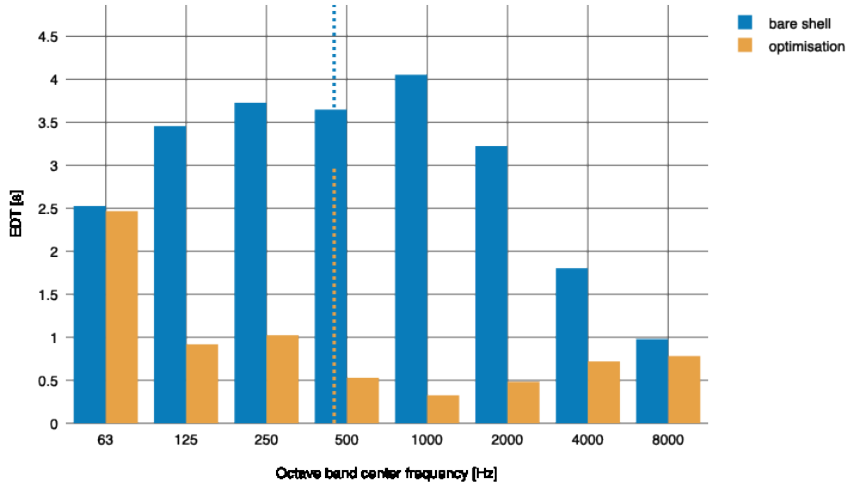
sound pressure levels (SPL)

The SPL levels are significantly reduced by 6dB to 8dB in different frequency ranges.

Fig 130. Comparative results 5-8



energy decay curve (EDC)



energy decay time (EDT)

variable acoustics

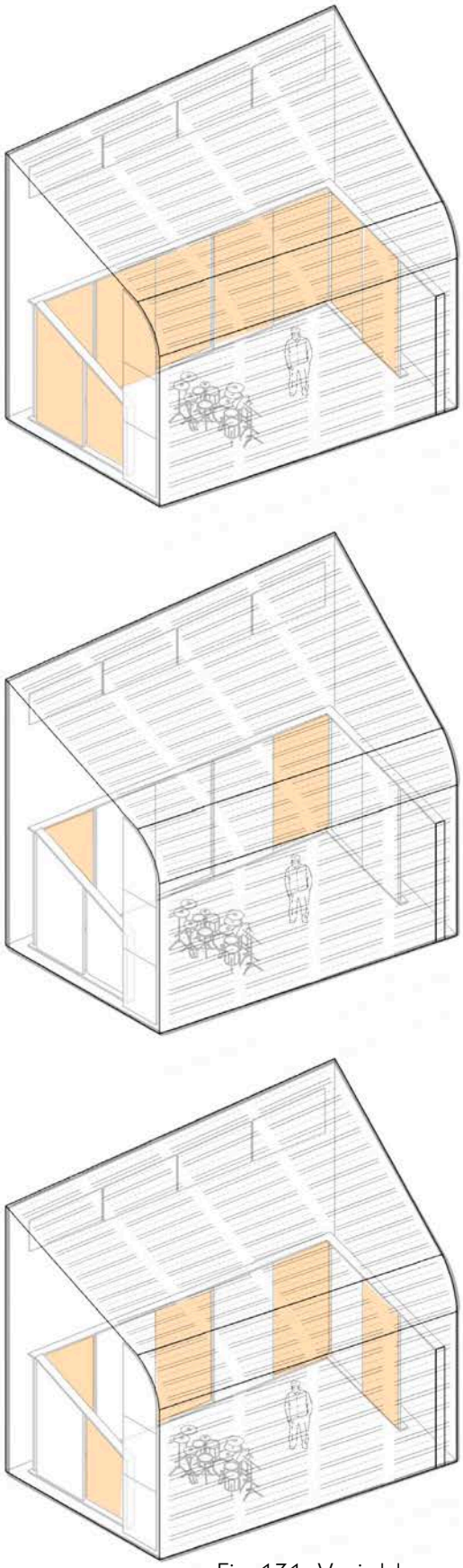


Fig 131. Variable acoustics

To accommodate different acoustic responses desired by different musical instruments, variable acoustics strategy is introduced after the optimisation process. It involves a system of adjustable panels in birch wood installed on top of acoustic plaster finish on the behind wall. Three scenarios of its setup are further analysed and discussed as follows:

open

Surface area: 70.5sqm

QR 7 Percussions

QR 8 Jazz ensemble

Kick drum of the percussions sounds fat and the snare drum rings
Phrasing and cadences of the saxophone in the Jazz ensemble sounds more smooth.

collapsed

Surface area: 20.5sqm

QR 9 Percussions

QR 10 Jazz ensemble

Kick drum of the percussions sounds more clicky than fat and the snare drum sounds tight.
Jazz ensemble sounds more upfront and dry.

semi-collapsed

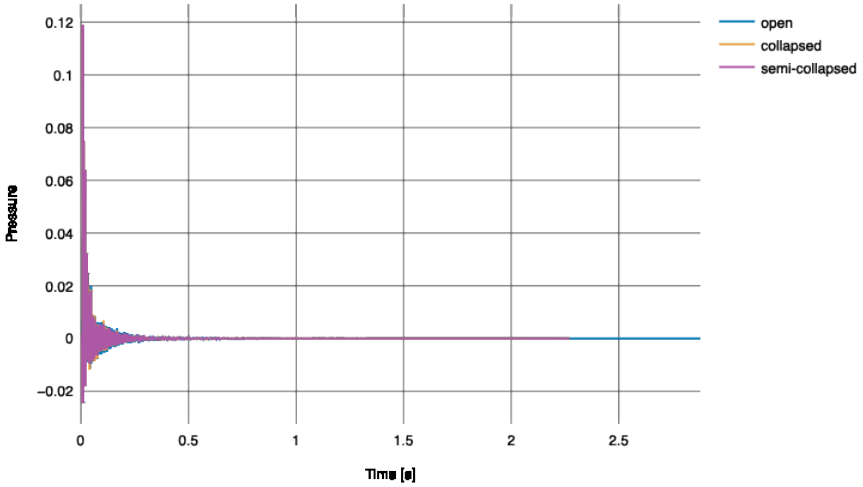
Surface area: 36.2sqm

QR 11 Percussions

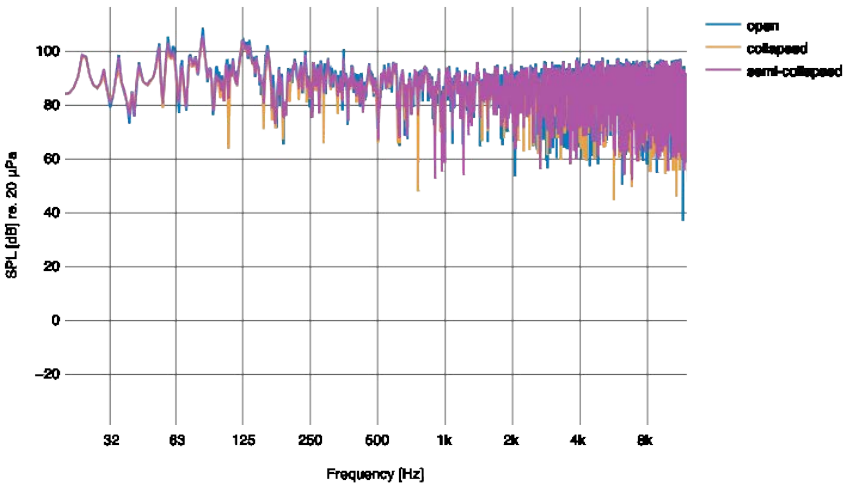
QR 12 Jazz ensemble

The percussion sound has more pronounced mids than bass and treble.
All 3 instruments of the Jazz ensemble sound well balanced and cohesive in the mix.

comparative results

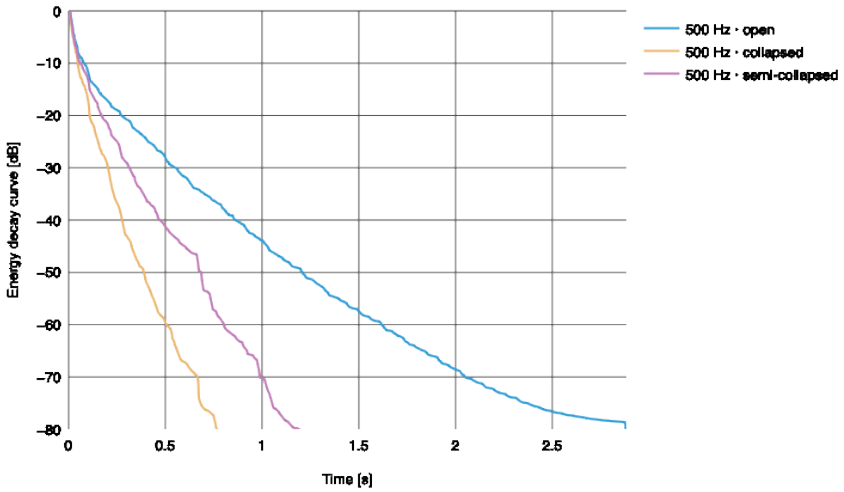


impulse response

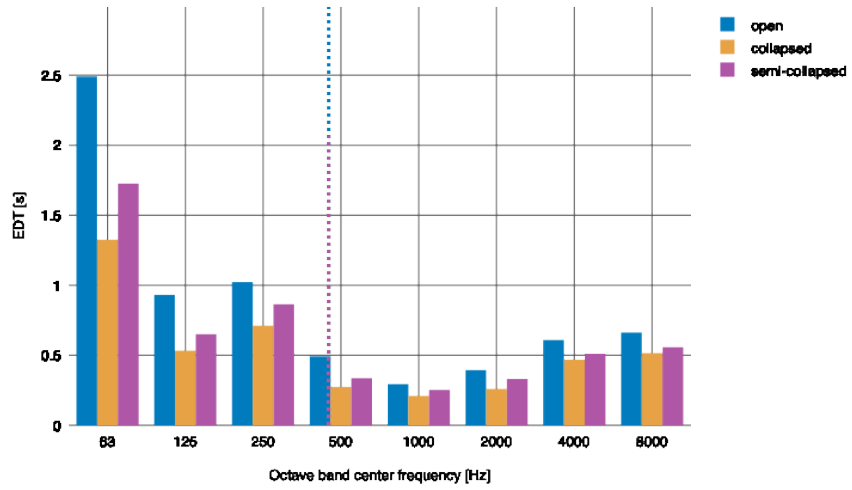


frequency response

Fig 132. Comparative results 1 and 2



energy decay curve (EDC)

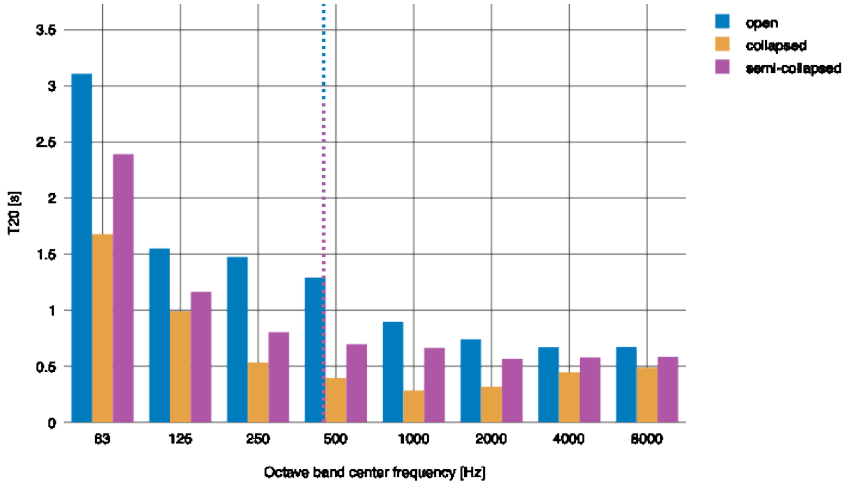


energy decay time (EDT)

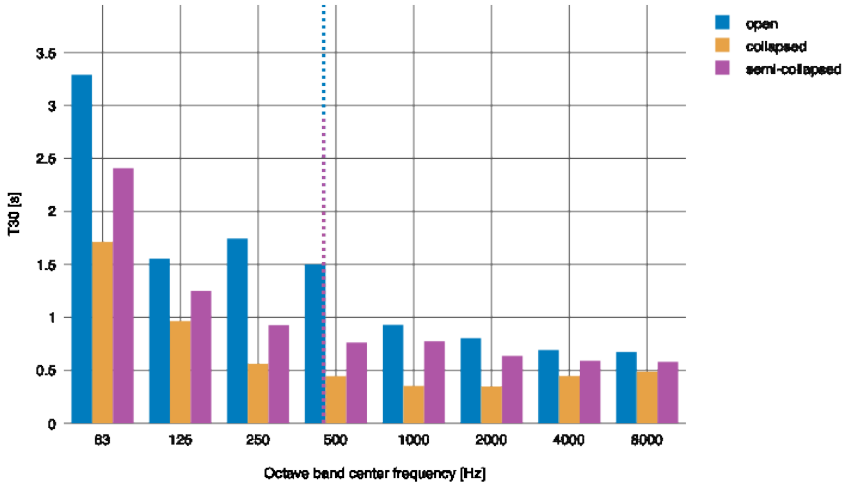
Fig 133. Comparative results 3-6

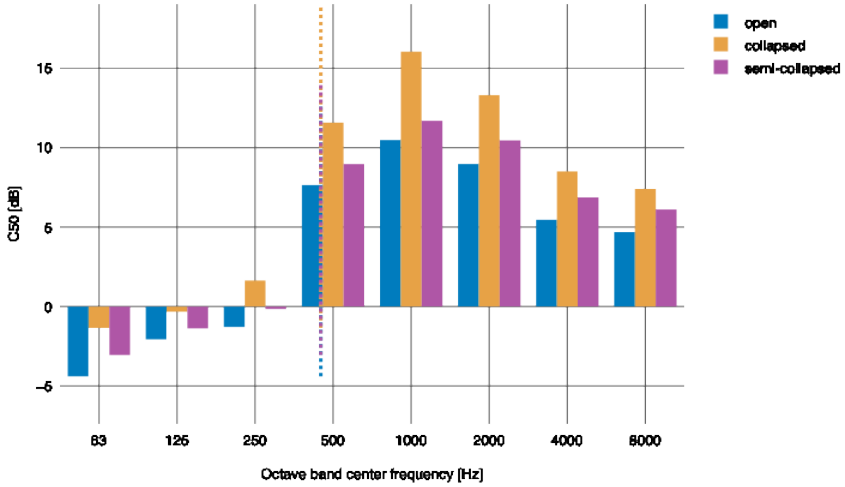
Reverberation time varying from 0.5s to 1.3s is achieved in the mid-range of 500Hz, which suffices quite a lot of the requirements and preferences, as discussed in the analysis part of the report. The resultant room is neither a dead nor a live room.

reverberation time (T20)



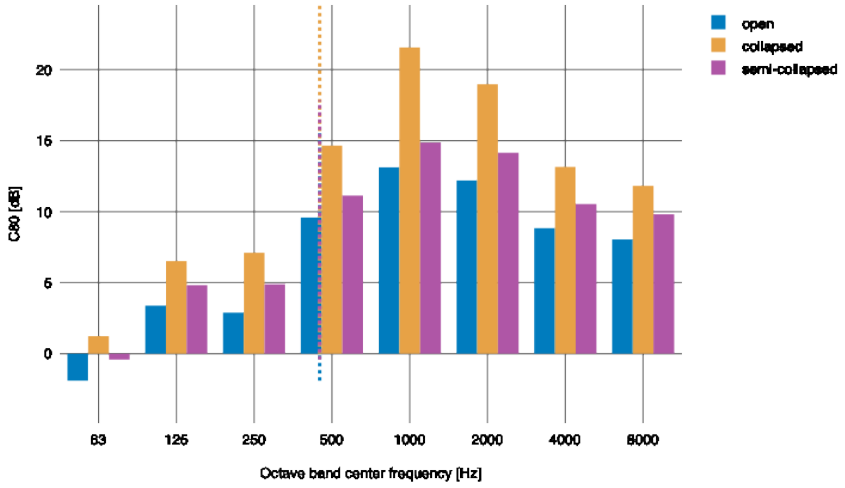
reverberation time (T30)





clarity (C50)

Musical clarity, C80 dips below 0 in the 63Hz frequency range. While it dips even more in the C50 graph. This is expected and not an issue, because of the sound enveloping and blending qualities offered by the reverberation time in those frequencies.

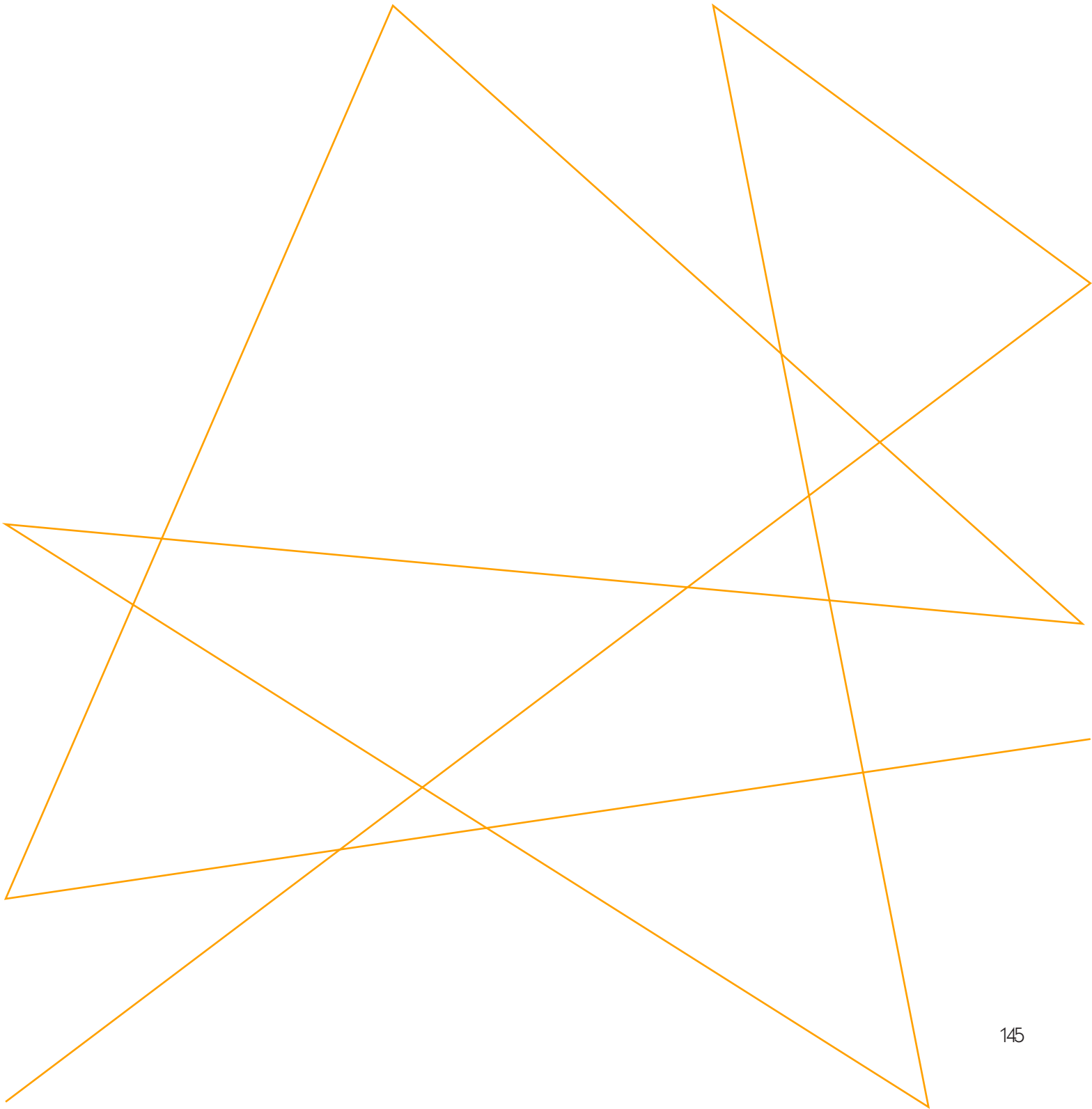


clarity (C80)

It would have been concerning, if the C50 and C80 numbers were dipping below 0, in the mid-range and higher frequency ranges.

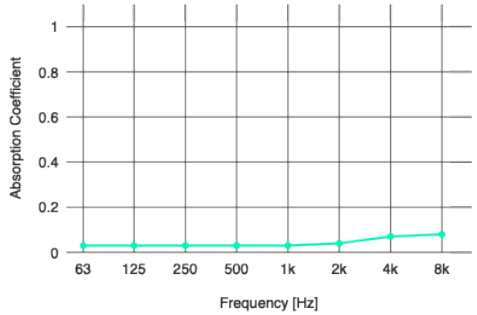
Fig 134. Comparative results 7 and 8

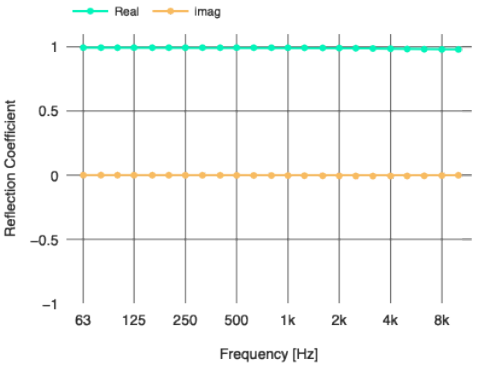
materials



rough concrete

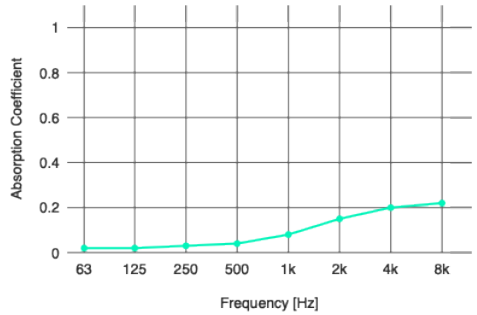
Fig 135. Rough concrete





birch wood panels
75mm thickness

Fig 136. Birch wood panel



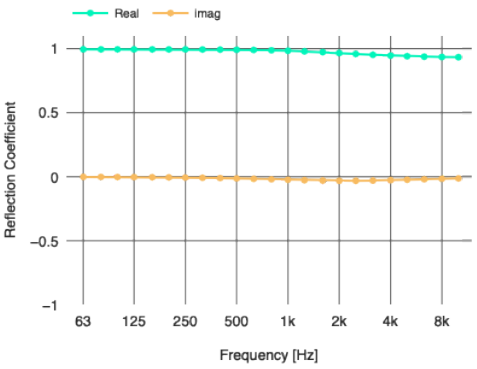


Fig 137. Material properties 1-4

slotted panel, 30% open absorber
40mm thickness

This material is built up of 3 layers. From the surface to the back:

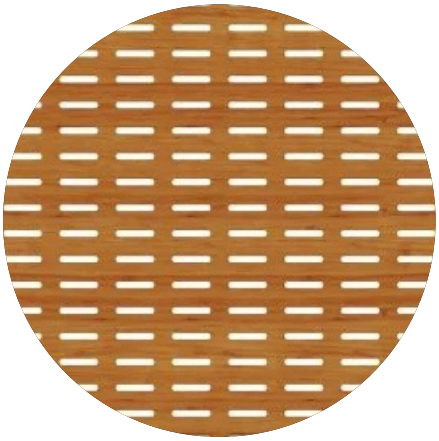
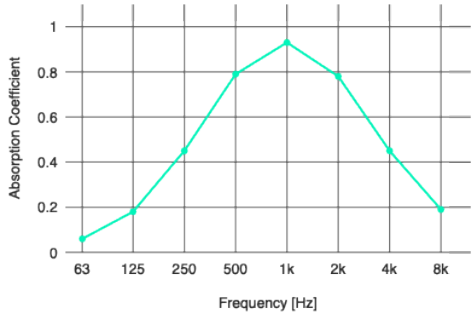


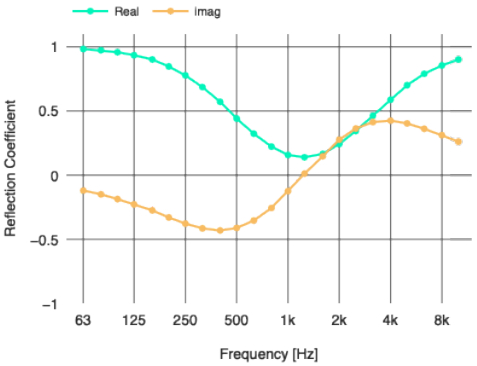
Fig 138. Slotted panel

1: Panel with slotted perforations with a thickness of 12 [mm], density of 700 [kg/m3], hole length in x direction of 5 [mm], hole to hole distance, × direction of 10 [mm], hole length in y direction of 30 [mm], hole to hole distance, y direction of 50 [mm], and the opening ratio is 30%.,

2: Porous absorber (rockwool) with a thickness of 40 [mm] and density of 81.2 [kg/m3].,

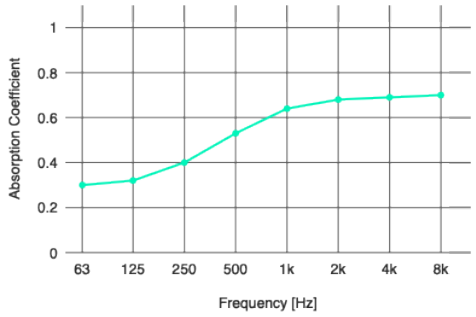
3: Rigid backing.





acoustic plaster
30mm thickness

Fig 139. Acoustic plaster



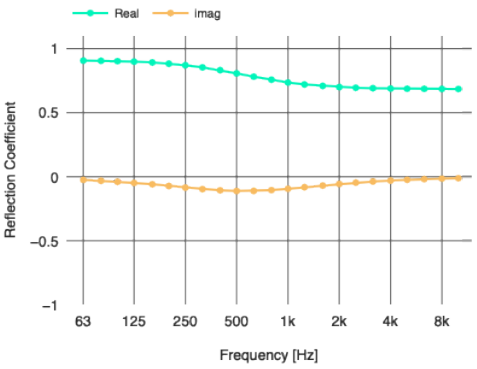
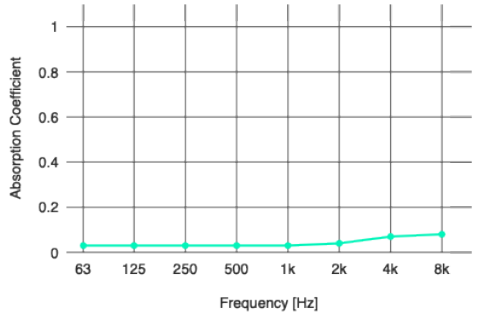
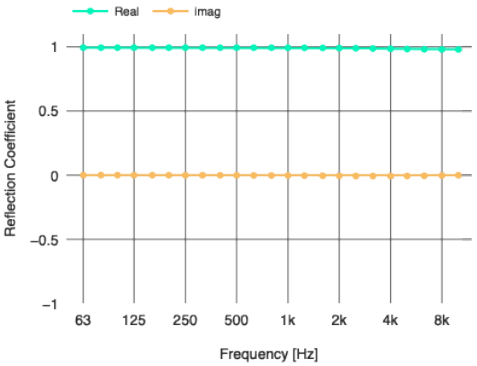


Fig 140. Material properties 5-8

double glazed unit
3mm thick glass, 10mm airspace

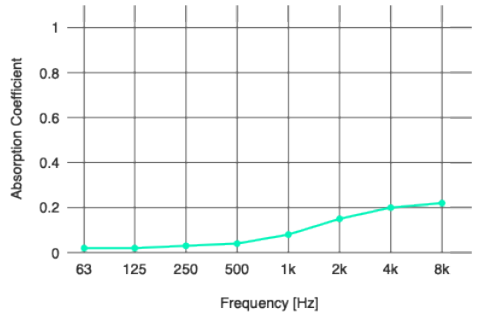
Fig 141 Double glazed unit





wooden flooring
50mm thickness

Fig 142. Wooden flooring



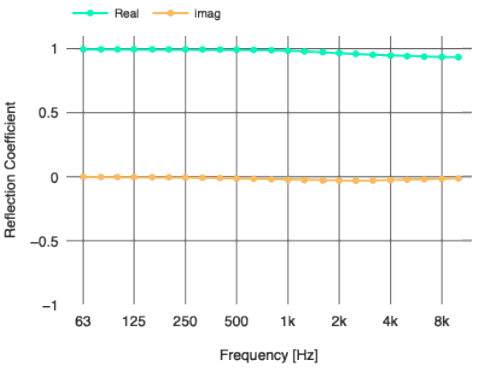
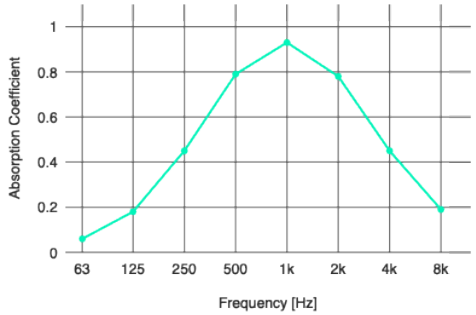
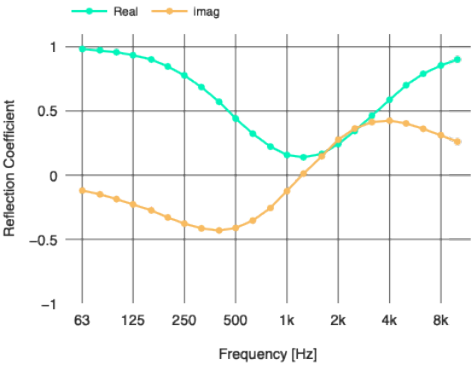


Fig 143. Material properties 9-12

wooden door
75mm thickness

Fig 144. Wooden door





ventilation grill

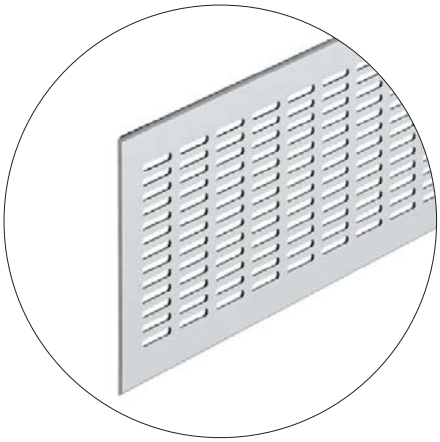
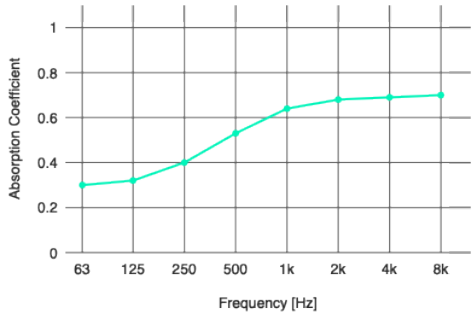


Fig 145. Ventilation grill



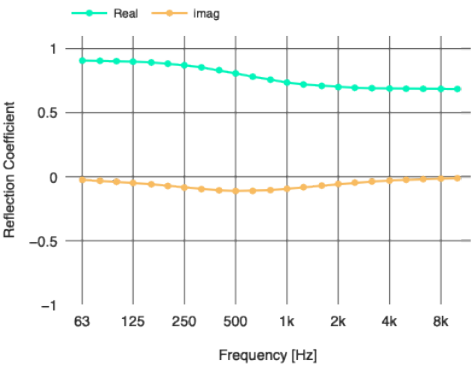
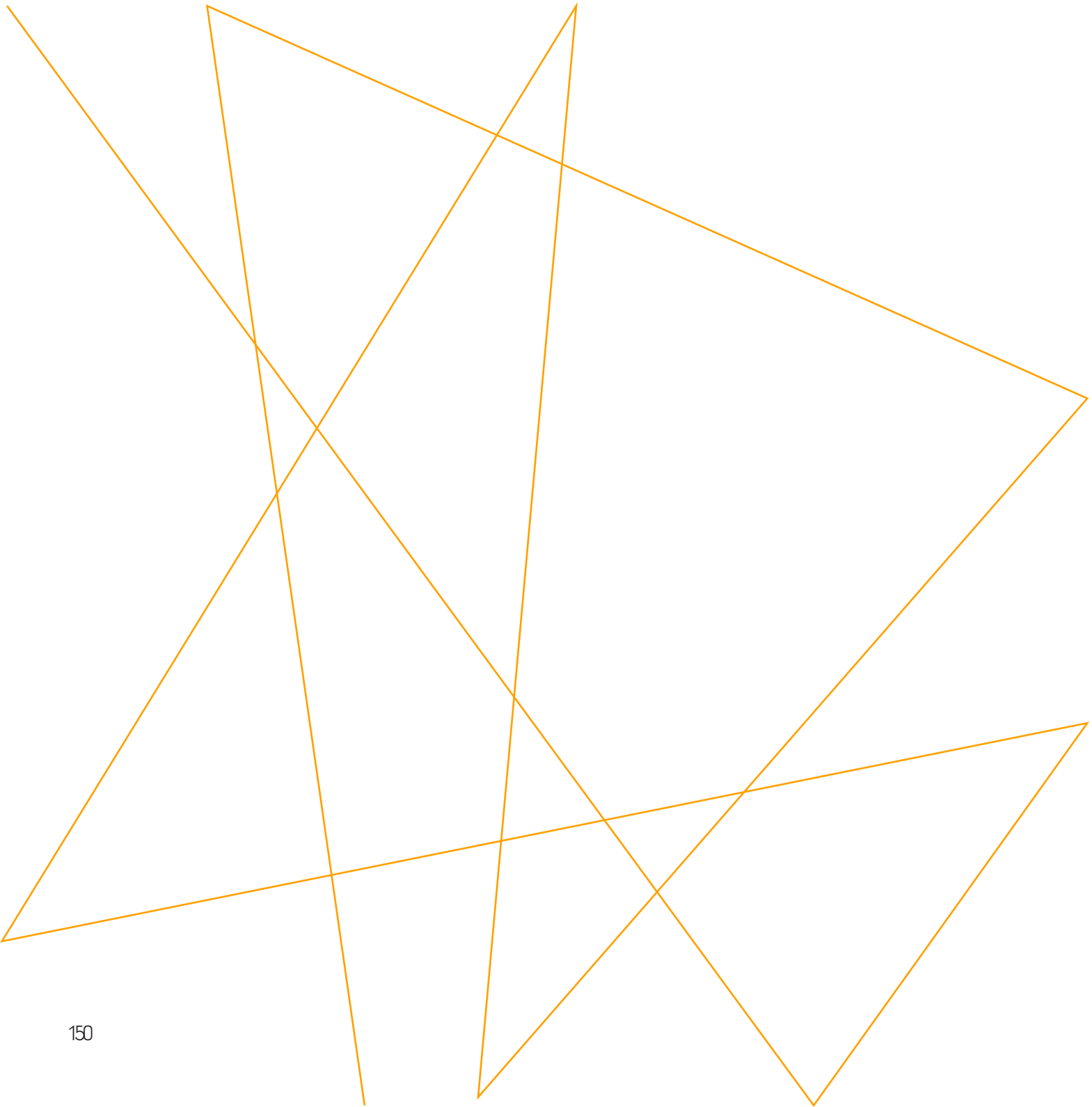


Fig 146. Material properties 13-16

epilogue



conclusion

The Co-working Space for Musicians presents itself as one-of-a-kind music facility, where the process of music making takes the centre stage. It is neither the point of departure, nor the destination. But it is what it is, the missing link between the two. It aims to play a role of showcasing music further than entertainment, and anchor itself in the history, culture and evolution of music. If it takes up a piece of Refshaleøen in land, it gives back at least in sound.

for musicians

The creative process of musicians is being reinforced, whereby musicians can immerse into their projects and at the same time socialize and explore their tribe. Though, they are working on their separate projects, spaces like the jamming foyer, breakout areas, soniferous garden are generators of both active and passive engagement between them. The spiral ramp adds a streak of joy and wonder as it manoeuvres through the common spaces, leading up to the first floor. People can just stand on it and overlook the jamming sessions taking place in the foyer. The fact that music is a part of performing arts, is also taken into consideration, by dedicating the building gable to the open concert ground. Musicians can work on their performance aspects by exercising their music in front of an audience.

Acoustically, the ensemble rooms offer a solid and user adaptive design solution to musicians. By using variable acoustics, it tries to accommodate the demands of various music genres and musical instruments. There is harmony between the acoustic and visual aspects of the room and an atmosphere, conducive to the musician's creative process is being achieved. Besides that, natural ventilation and daylight conditions of the room have also been taken into consideration. An earth air heat exchanger system is being used as natural ventilation strategy and a series of clearstory windows bathes the room with diffused light from the north.

for Refshaleøen

The building is an addition to the cultural and recreational destinations of Refshaleøen. Referring to Figure 61 in the site analysis, this project is indeed an important dot in the surrounding music scene. The building opens up to public as much as it does to the musicians, and the fine line between the public and private spaces is being tread over. Whether it be the acoustic parabolic mirrors, soniferous garden or the musicians playing music, the building slows down the speed of the passer-by and evokes curiosity and interest in them. By working with sound on both inside and outside the building, their sense of hearing is being activated and the culture of active listening is being promoted.

reflections

This has been an interdisciplinary research involving architecture, acoustics, music and sound. Since they are closely knit to each other, it was important to give considerable attention to each and still manage to deliver the project as a whole. Following are the reflections from the design process:

listening

We as humans are fundamentally drawn to visual communications, but it was crucial to incorporate the listening aspect in the design process of such a project. This was done by making sound recordings at the site, using auralizations asides to acoustic simulations, listening to music while sketching, making conceptual soundscapes for visualisations and so on. This approach has really helped in capturing the vibe and atmosphere of the project.

Technically, an epiphany occurred in the later stages of the project, when the simulation results of the Ensemble room looked quite good in numbers (refer next page). However, after listening to the auralization of the room, the Jazz ensemble sounded very dry or almost too clear. This helped to understand the acoustic parameters in a better way and the importance of listening while designing was verified.

building as the acoustic mirror or acoustic mirror as a device on the building

The decision to use the acoustic mirror as a device on the building was based on the general limitation in simulating environmental sounds and the time frame allowed for the project. Because of the matter being a very complicated and a scientific one, the case study of MIRRORS Aalst was being used to verify its application. The matter was discussed with its creator, who also acknowledged the very fine intricacies in the installation/designing process of these mirrors.

acoustic simulation process

Using the Treble software has been very instrumental in this project. Despite of it being recently launched during the thesis project, it was completely explored and implemented during the design process.

The decision to go for Volume 4 in the acoustic design iterative process (see page number 87) was not that much validated by the comparative results. It was based more on the literature and case studies regarding the state-of-the-art music making facilities.

artificial intelligence and the future of music

With the advancements of compositional artificial intelligence, the music industry is heading towards a scenario where making music will depend very less on the human skill and musicianship. On the positive note, the same artificial intelligence technology was so much useful in the acoustic simulation process of this project. With that experience, the way ahead in music or architecture is to generate a synergy between the human potential and artificial intelligence.

Music spaces with exceptional reverberation times or anechoic chambers are the spaces of the past. In future, facilities like "Co-working space for musicians" will boost the human experience of making music and use artificial intelligence as a parallel, to digitally morph the acoustic response of the ensemble rooms/ practice rooms into a cave or a hole or whatever one can think of. Keeping this future aspect in mind, the reverberation times of the final design of the ensemble room is kept on a moderate side, a room neither too live nor too dead.

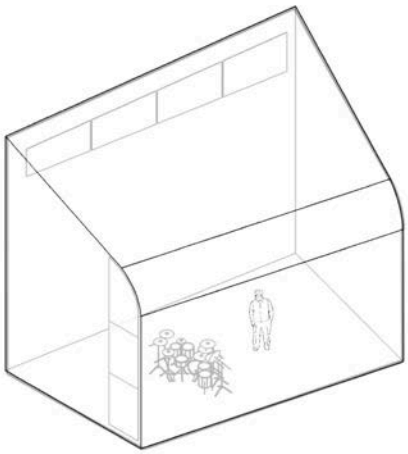
As a closing note, the medieval folklore suggests that the one to see the future is blind. So, are we really listening?

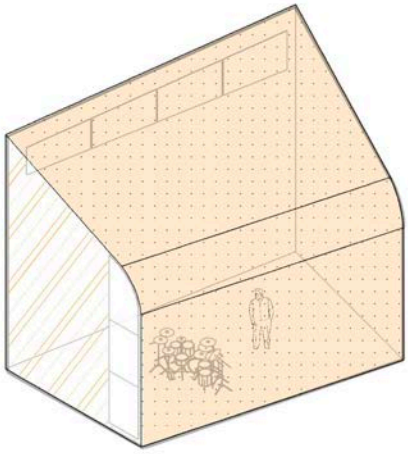
appendix

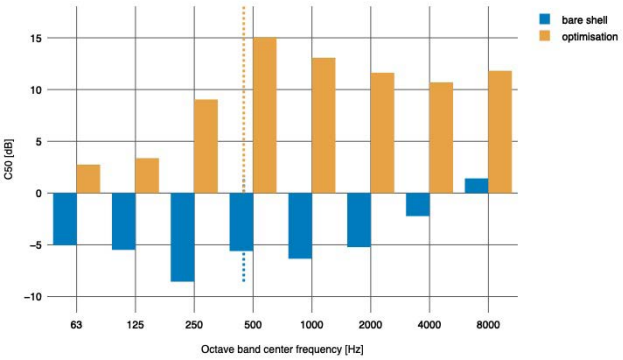
over-optimisation

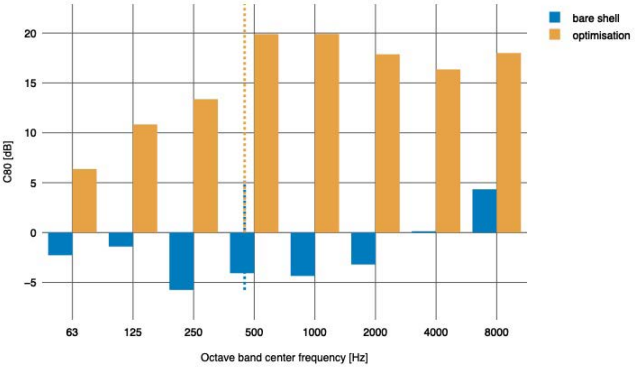
As discussed in the reflections, by using acoustic plaster on the three walls, in combination with floor to ceiling microperforated panels, high C50 and C80 were being acheived with a very balanced reverberation response across the whole frequency spectrum.

However, after listening to the auralization it was observed that the room sounded exceptionally dry and the musical instruments in the Jazz ensemble had no blending.









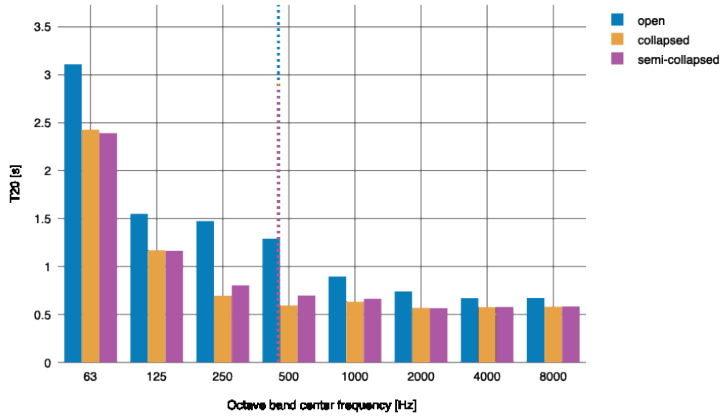
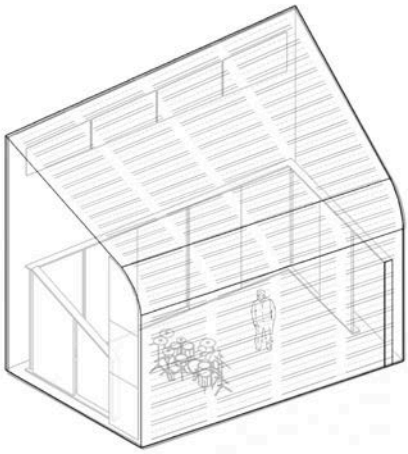
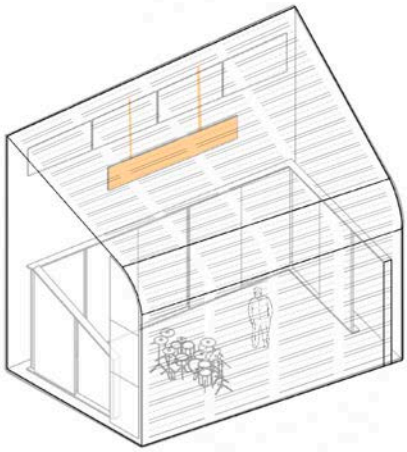


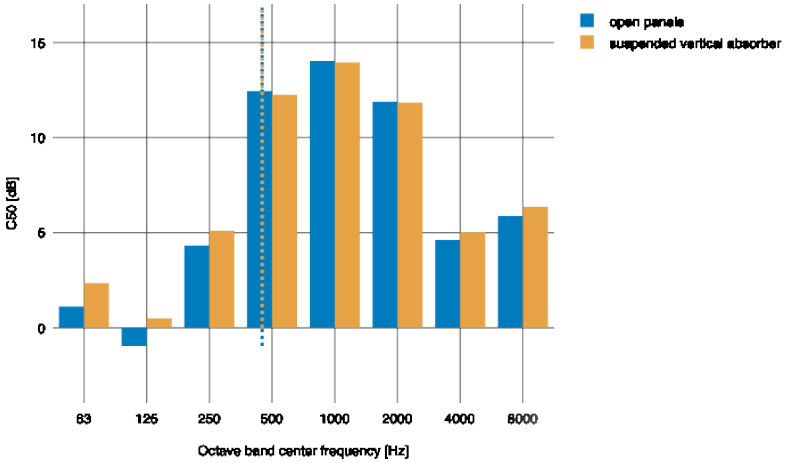
Fig 147. Appendix (over-optimisation)



Open panels
C50 = -1.0dB



Suspended
vertical absorber
C50 = +0.65dB

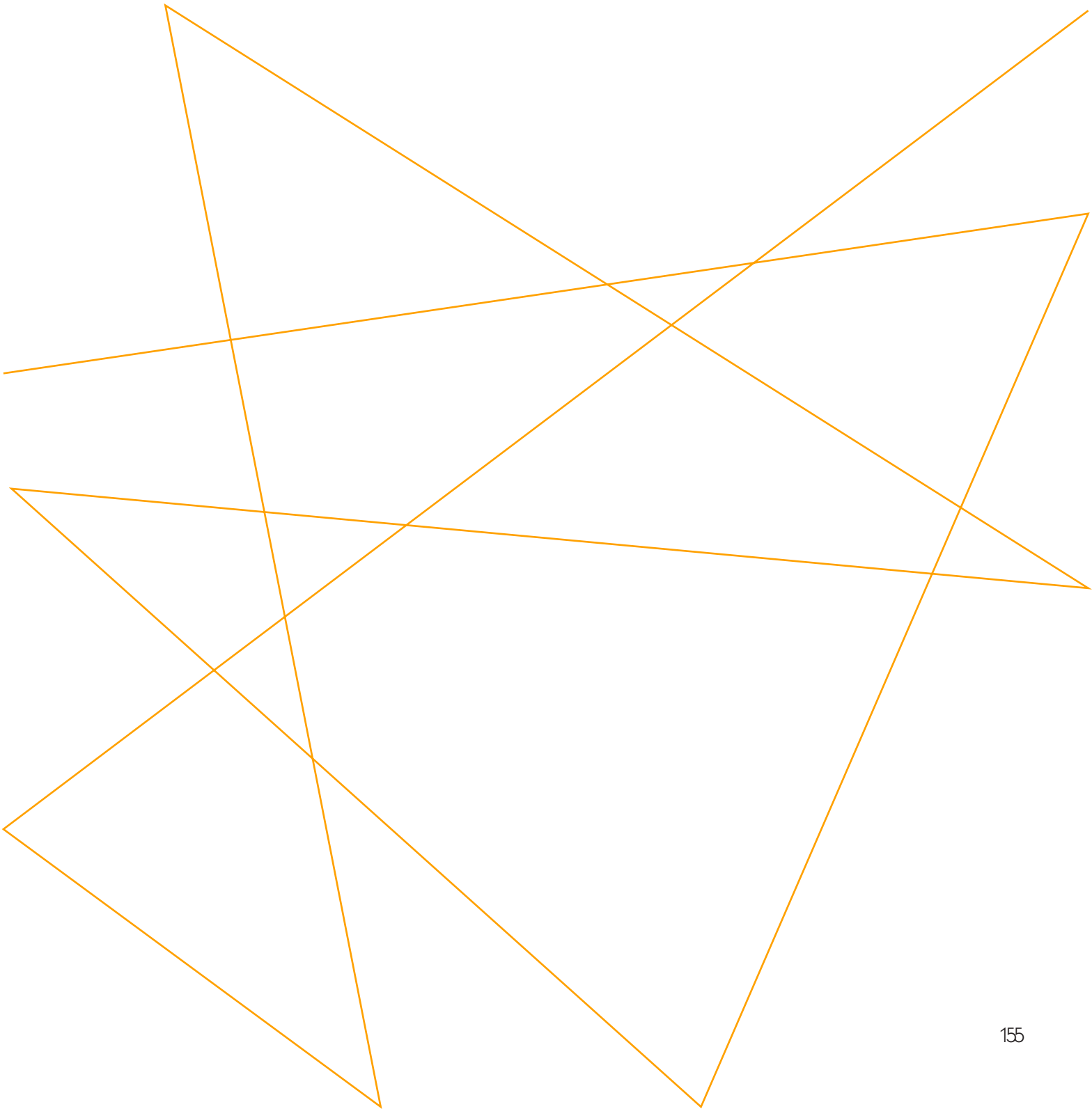


Experiments were being conducted to see the affect of the sharp corner in the acoustic response of the ensemble room. This was done by suspending a vertical absorber (85% absorption) from the ceiling along the edge of the corner. Its positive affect was detected in the clarity numbers (125Hz frequency range) , with a bump from -1.0dB to +0.65dB.

This slightly pointed in the direction that low frequency sound waves tend to get trapped in the sharp corners of the room. Because of time limitations, this process was not followed upon.

Fig 148. Appendix (low frequencies optimisation)

references



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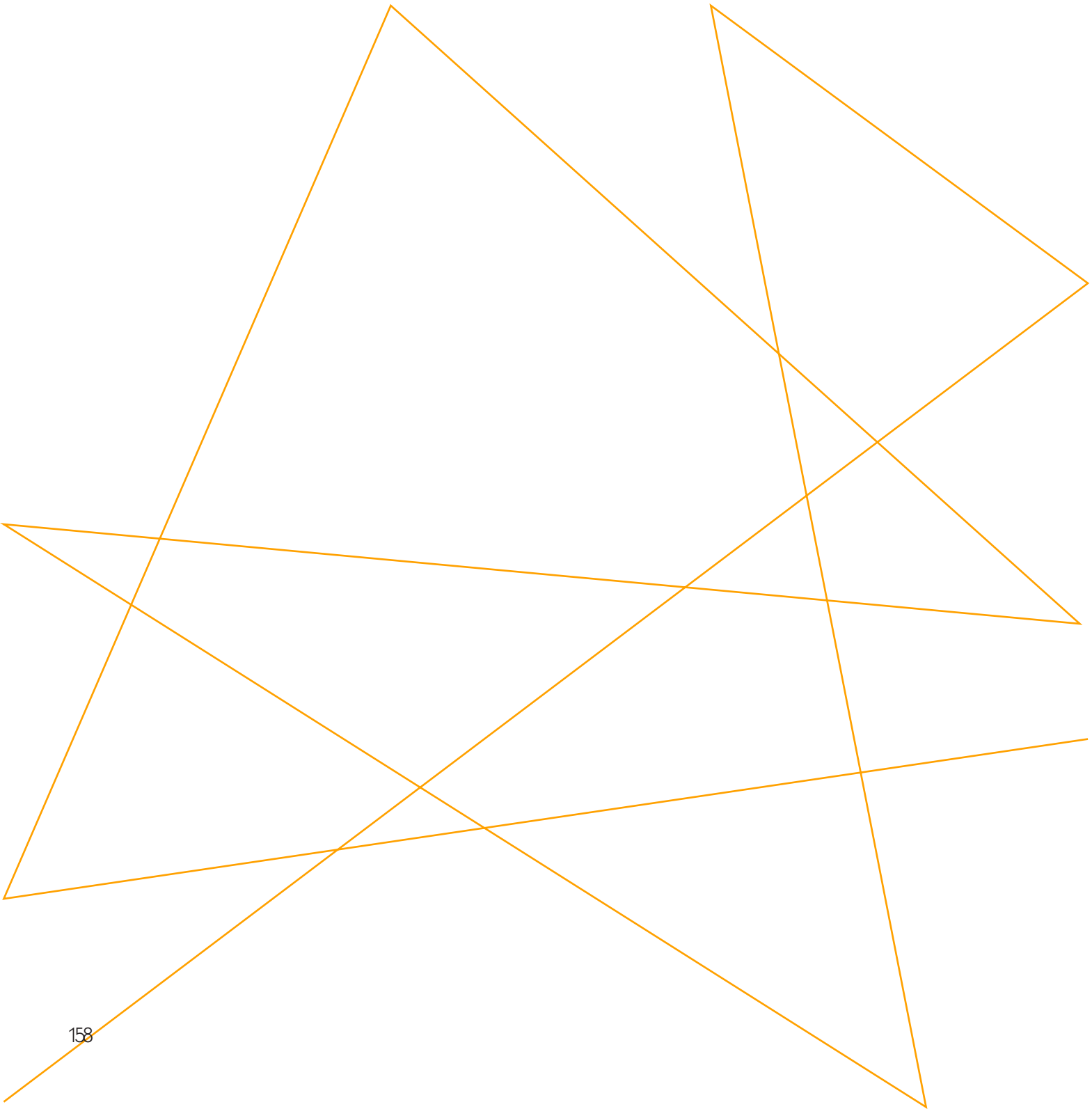
Material
Slotted panel, 30% open absorber 40mm thickness, description from Treble Technologies 2023.

figures



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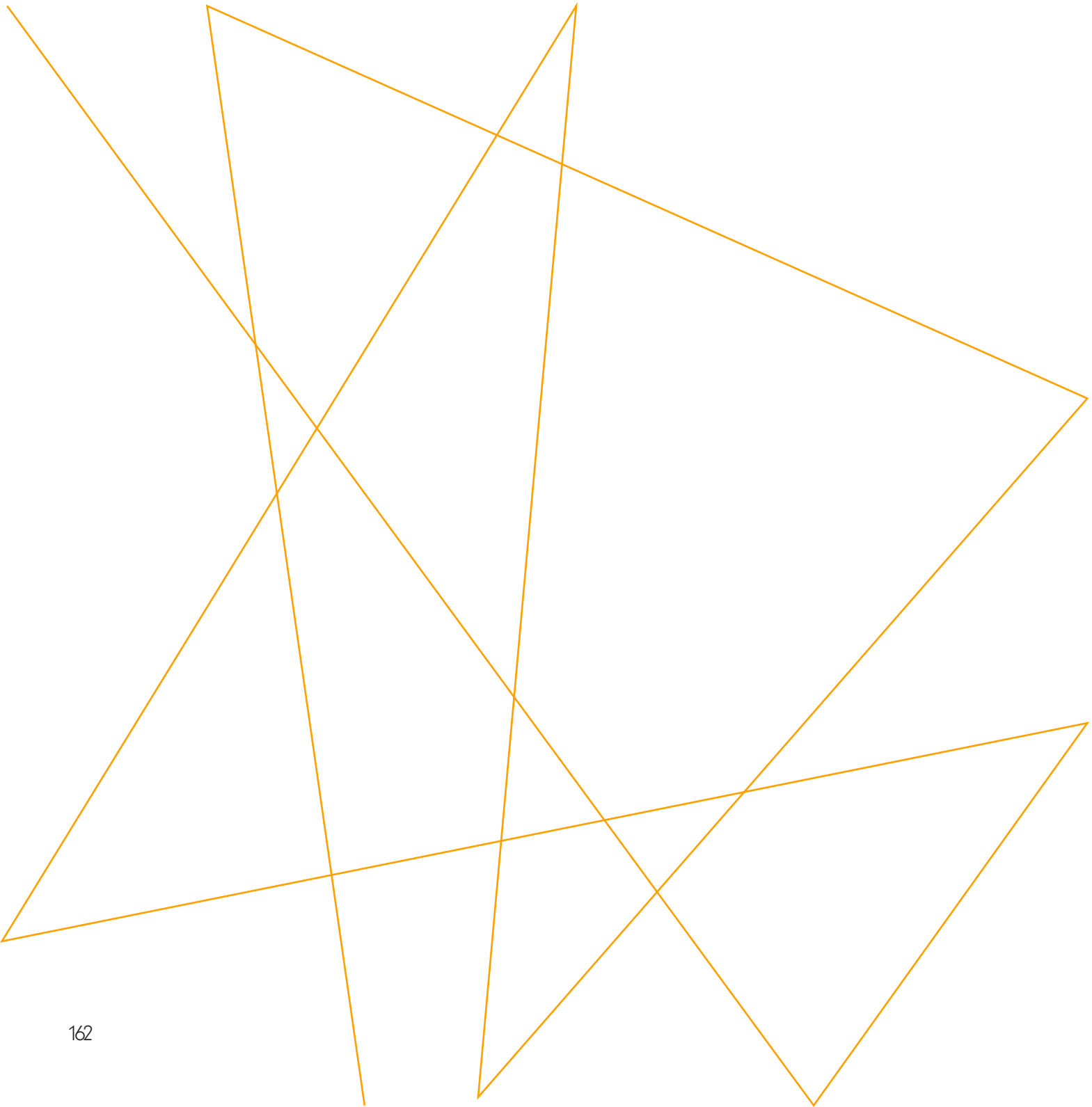

QR 1:
Harbour soundscape recorded at the site on 03/05/23: Own recording

QR 2:
Soniferous garden conceptual soundscape: Author

Bare shell
QR 3:
Percussions: Treble Technologies 2023

QR 4:
Jazz ensemble: Treble Technologies 2023

Optimisation
QR 5:
Percussions: Treble Technologies 2023

QR 6:
Jazz ensemble: Treble Technologies 2023

Open
QR 7:
Percussions: Treble Technologies 2023

QR 8:
Jazz ensemble: Treble Technologies 2023

Collapsed
QR 9:
Percussions: Treble Technologies 2023

QR 10:
Jazz ensemble: Treble Technologies 2023

Semi-collapsed
QR 11:
Percussions: Treble Technologies 2023

QR 12:
Jazz ensemble: Treble Technologies 2023