

A Soundscape for Art

An acoustic art pavilion at Lilla Stenshuvud, Österlen

AAHM01: Degree Project in Architecture, LTH 2009

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Elevation
Scale 1:200

“Yet, just as light and pictures do, so the sound medium embodies and unfolds today’s world, it mediates the passage between the outer physical environment and the inner experience.”

(Björn Hellström: Conference paper “Acoustic design in Commercial space”)



Introduction	4
Method	4
Short introduction to acoustic terminology.....	5
Observing: sound, space and individual.....	6
One place, three experiences	8
Acoustic explanations to observations.....	9
Art objects.....	10
La Petite Danseuse de quatorze ans.....	10
Public Figures	12
Tenderly yours.....	14
Connections between the tree objects.....	16
The Site	17
Suggestion for placement of the art pavilion	
Drawings and details	20
Acoustic design.....	27
Light	34
Appendix	42
A short lesson about sound and basic vocabulary	43
Acoustic design of today	47
Resources used to achieve acoustic accuracy	47
- Ecotect	48
Representing the atmosphere	49
Pictures from the process.....	50
Sources	56
Thank you,	57

Introduction

Humans use their senses to understand and analyse the world. For architectural experiences, sight, touch, hearing, smell and balance ought to be the most important.

Among architects, the vocabulary, documentation and methods used when planning, designing and presenting a project are however mainly visual.

Since a child, I have listened to buildings and experienced architecture through singing. Therefore, I took the opportunity to dedicate my diploma project to the world of sounds, hearing and the acoustics of buildings.

Description of the project

The aim with this project has been to design a building, starting with the acoustics. Questions such as: How important is the acoustics for the experiencing of space? How can I use the acoustics in the design process? What do I want the building to sound and feel like? How does a wanted acoustic feeling go together with the wanted visual expression in the room?

With these questions in mind I searched for a subject to explore the field of acoustics as an architect. My ambition was to find an area where I was free to focus on the possibilities and beauty of acoustics, and not only treating the subject as a technical matter of noise levels.

The physical frame was not defined when I had the first meeting with my tutor Christer Malmström in February 2009.

Luckily, I had found a tutor who understood the spirit of the subject, and gave me an idea about a building that could guide me in the search for the link between acoustics and architectural experiences.

The idea developed into a building for a small art collection where the acoustics created an extra layer to the exhibited piece; an exclusive building where each room is designed only for this purpose, without demands on multiple use or flexibility for different kinds of exhibitions.

The focus in the beginning of the process has been on the acoustics in the room and how the acoustics could colour the experience of the art. The acoustic environment can be seen as my own artistic addition to the art pieces. Developing the design, elements such as light and context has been equally important.

Method

A short description of the different elements studied in the project.

1. Literature studies

- Research on sound design. Sound and architecture
Björn Hellström, Chatarina Dyrssen, R.Murray Schafer among others

- Traditional acoustics

- Orientation and studies in physics and Room acoustics

2. Sound observations and analysis

- Case studies of different acoustic environments and everyday situations

- Structured analysis

3. Choosing art pieces

- Analysis, interpretation

- Choice of acoustic environment for the object

4. Creating the building

- How to achieve wanted acoustics by applying the knowledge from literature and the sound analysis

- Calculations, programs and consultations with acoustician Delphine Bard

5. Representation

- Traditional architectural presentation; models and drawings

- A mix of recordings of different places in Lund to audialise what I want to achieve

Short introduction to acoustic terminology

To make the discussions on acoustics and architecture easier to follow, I will briefly mention the most frequently used terms in room acoustics. More thorough descriptions and sources can be read in the appendix.

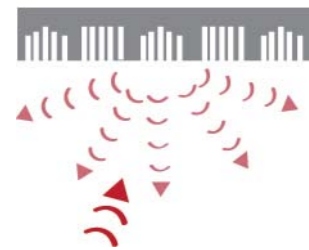
Reflection



A sound wave will be reflected the way light would if its dimensions are much smaller than the room: The angle of incidence is equal to the angle of reflection.

If a sound wave hits a heavy wall with a polished surface, almost all of the sound will be reflected back into the room in the same direction.

Diffusion



Diffuse sound means that the sound intensity is equal at every location. The impression will be that the sound comes from all around and the source will be harder to locate.

If the surface is uneven, the sound will spread in many directions. The obstacle needs to be bigger than the wavelength.

Reverberation time (RT60)

In common words, the time it takes for the sound to be inaudible. The reverberation time depends mostly on the volume and how much of the sound that is reflected back into the room.

Approximate values for different spaces and activities:

0,3 s music studio, cinema

0,5-0,7 s classroom

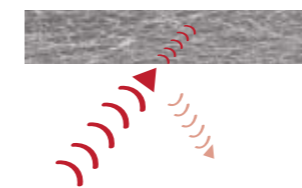
1,5 s auditorium

2 s concert hall

4 s cathedral

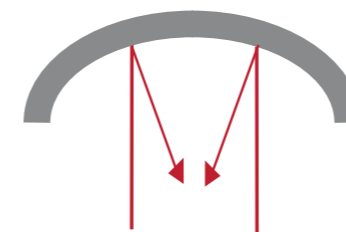
9-11 s roman churches

Absorption

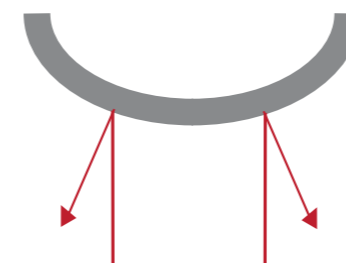


When sound is being absorbed, it means that the sound energy in a room decreases. Instead of being reflected, the sound will be transformed into heat or movement. This will decrease the reverberation in the room and give a more "dry" feeling.

Focusing/ Spreading of sound



As with light and lenses, the sound waves of certain frequencies will be focused when hitting a concave surface. The sound will be distributed unevenly in the room, with remarkably stronger intensity where the sound waves converge.



A convex shape will have the opposite effect and spread the sound.

Observing: sound, space and individual.

"Yet, just as light and pictures do, so the sound medium embodies and unfolds today's world, it mediates the passage between the outer physical environment and the inner experience."
(Björn Hellström: Conference paper "Acoustic design in Commercial space".)

Introduction

For musicians and audience, the importance of the acoustics is rather obvious; with acoustics suitable for the repertoire, a singer can have the feeling of having superpowers and the audience experiences the feeling of being completely surrounded by music.

Considering this, it is natural that we link acoustics only to specific types of buildings such as concert halls and music studios. What interests me is that no matter how a building is designed, an acoustic situation is created. Therefore, I would like to ask the following questions:

How do the acoustics influence the experience of architecture?

Is it possible to create architectural experiences more sensuous by considering the acoustics when designing?

To answer the questions one has to come closer to an understanding of what role the sound and hearing plays in the perception of space. A simple way to start is by listening and describing what happens when a person enters, takes a few steps and says a few words in a room.

What is heard? What does it feel like to speak and move in the space? Does the sound correlate to what is seen?

The aural qualities gives us a lot of information about the building and influences us in various ways, depending on who we are and our cultural background. The reasoning will be developed below in a number of everyday situations.

Hearing- a way of understanding our surroundings

Sitting on a bus with closed eyes, various sounds can be registered; the tires meeting the asphalt, the rumble of the engine and conversations among the passengers.

The vibrations and the sound of shaking seats are calmly interpreted as consequences of the bus moving.

Reflecting spaces

Likewise, in a public building, we understand that the sound of heels comes from us walking on the hard floor, and by listening we get a picture of the size and materials of the room. In addition, the sound constantly reminds us of our presence. In a church, or a place with few other sounds than the ones we cause ourselves, the eyes seem to be drawn instinctively to the surfaces where the sound comes from.

Interpretation depending on culture

We react differently to the perceived sound, depending who we are.

A person entering a public building with hard reflecting surfaces, for example a bank, immediately announces her entrance. Only by listening to the steps we can guess how the person feels and reacts to the sound caused by the heels on the floor. Are they slow, with the feet carefully placed after another? Hesitating, on toes? Is the person used to the sound, with a quick and determined walk? Does the person seem to be intimidated, or enjoying filling the room with his or her presence? The power of the bank director is emphasised as well as the weak position of the borrower.

No matter how we react to the situation, a few things can be stated:

-The sound will tell us something about the construction, volume and materials used.

-The sound reminds us of our presence in the room.

-The aural impression is immediate and arouses our curiosity, leading to visual investigations of the space.

Absorbing spaces

On the other hand, moving in a room with very dampened acoustics, the signals of its size and materials are harder to perceive. What is heard is only the direct sound.

The most speaking example is the cinema. Entering the auditorium, the almost physical feeling of the sound being drawn in to the walls can be sensed. Technically speaking, the acoustics are so absorbing, that any kind of sound can be performed inside the walls. The acoustics of the space will not interfere with the recorded sound, meaning that any kind of atmosphere can be established, from the feeling of a soft padded room, a crowded plaza, to a cave with dripping water.

The consequence for the spatial experience is equally interesting. By absorbing the most of the sound, there are hardly any reflections coming back to the visitors, calling for their attention. Instead of focusing on the outer physical boundaries of the space, the visitors can be "absorbed" by the imaginary world of the film.

Behaviour in different social situations

The example above, with the visitor of the bank, studies a person carefully experiencing a rather unknown space. How does the acoustics influence on our behaviour in other social situations? As mentioned above, the way people relate to the sound of their own actions in a room depends on the personality and the situation. A flamenco dancer proudly owns the space with the distinct sound of his or her heels. Studying couples dining in a fancy restaurant with hard walls and impressive ceiling height, gives another picture. The conversations bounce between the walls intimidating the almost whispering couples, until the alcohol makes them relax, the sound energy rises and the conversations are impossible to distinguish.

The alcohol in this case makes the individual relax in a situation that otherwise would be considered slightly uncomfortable. Visiting a place with a group where the individuals feel comfortable inside the group can have the same effect. Making sound recordings in the Cathedral of Lund, I

studied the people entering the church. My analysis told me I was going to meet people walking carefully on their toes, studying the architecture and the immense volume of the building. Instead, a group of 10 teenagers speaking loudly, walking with their eyes and minds in their mobile phones, announced their presence in the church.

The experience of sound is relative

Depending on the sound experienced prior to the present, the impression of sound will differ. Stepping out from the birdhouse at the Zoo, even the highway would be experienced as quiet. Listening carefully with closed eyes in the quiet department of a train, quite a lot of sounds are detected. The difference from the other parts of the train is however so clear, that a person not knowing the restrictions of the quiet department, by accident coughing or opening a bag of potato chips, evokes nervous reactions among the travellers. If the person is one of the more sensitive ones, he or she will experience every crunch as an insufferable moment, analysing the aural qualities of the chips in detail.

Footsteps

Compare the feeling of entering a room with marble floor or walking on a thick carpet in a hotel lobby. The carpet makes it possible to be unheard, unannounced, discrete or relaxed. And the hard floor allows happy stepping, solemn walking and quick energetic paths in high heels.

During the process with the diploma project, my personal awareness of sound has naturally risen above normal. Researchers mean however that we analyse the sounds around us instinctively and compare them to our personal bank of "recorded" sounds we have experienced during our lives. (Blessner/Salter: Spaces speak, are You listening?) A blind person is of course much more trained than a seeing person. Nevertheless, having tested the ability of distinguishing sounds among people around me, playing a series of recordings with people walking in different environments, with different kinds of shoes, I am convinced that even seeing persons use their ears to understand their environment to a much greater extent than we imagine. One clue is the phenomenon of knocking on things to see if an object or wall is real, solid, coulisse or made of the material it proclaims.

One place, three experiences

The examples in the analysis describe how different types of rooms, with different acoustic properties vary in the experience of sound and space. To emphasise the importance of the acoustics I will demonstrate how one physical place can be experienced as three completely different spaces depending on the sound. Lilla Hummelvik, Archipelago of St:Anna, Sweden.

Landscape

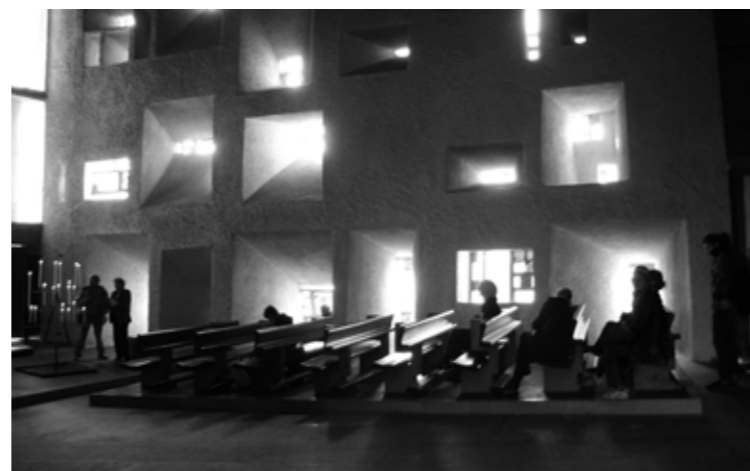


A summer day

The sound of water lapping against the boats at the dock. A light breeze. Laughing and screaming children. Motorboats. The water is a moving, sounding surface.

The place is experienced as a landscape. Different sound sources make it difficult to measure distances by listening. The higher the close sounds are, masking sounds farther away, the smaller feels the audial place.

Church



A calm morning in November

The silent mirror of the water forms a great reflecting floor. The sound travels over the water and comes back with an echo.

The landscape has turned into a large reflecting room where the returning sound demonstrates the limits of the space. The atmosphere can evoke the same feeling of respect for the silence, as in a religious place.

Cinema



A winter day

The water is frozen with a thick, absorbing carpet of snow.

Skiing on the lake, making a stop, the continuous sound of skies sliding and the clothes rustling cease. As if time stopped. Silence. A big soft silence, and the sound of your breath and snoring nose. Far away, a motor saw is working, demonstrating the difference between here and there.

The landscape is experienced as a big absorbing room, but still very close, since the things you here are the direct sounds of your body.

Acoustic explanation.

Previous in the text, the reactions to different kinds of acoustics have been analysed. In every situation there is a physical explanation to why the sound reacts the way it does. (Read more about the physics in the appendix)

With small pictograms, the acoustic situation and what the person in the room will hear is explained. The examples below are extreme situations with a great span between them in real life.

Reflecting space- large volume- one person



The sound is reflected back to the person. The volume and the reflecting walls allow the sound to “bounce” for a longer time, giving a longer reverberation time. The sound will demonstrate the volume of the room, giving an “aural image”. The walls are experienced as the boundaries of the room.

Reflecting space- large volume- many persons



The same conditions are applied as in the example with one person in the room, only louder and more chaotic. The sound energy of many people will be added, making it harder to hear what people say. The sound is experienced as a floating mass. (Swimming hall)

Small reflecting space

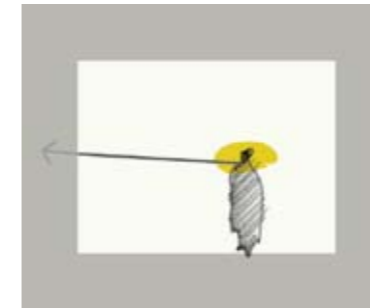


The reflections come quickly, giving an amplified, hard and distinct sound. The early reflection tells us that a wall or reflecting element is close to us. The walls are experienced as the boundaries of the room.



With many people in a small space, the sound energy increases rapidly. Since it is hard to make oneself heard, people speak louder, and louder. The volume and therefore the reverberation time will give the sound different characteristics than in a large volume, less “liquid” and sharper, like a physical mass of sound.

Absorbing Space- one person



In a very absorbing space, almost no sound energy is reflected back to the person causing the sound. Only direct sound is heard. The feeling is almost unnatural. When standing still, the silence of the space is close to absolute. Instead, sounds from and close to the body are accentuated; the fabric of a jacket rustling, breathing and snuffle will be experienced as much louder than normal.

Since little sound is reflected, the “aural image” of the volume will not be as clear as in a reflecting space. With closed eyes, the distance and the volume will be much harder to decide.

In a room with no reverberation at all, the own skull and body can be experienced as the boundaries of the space.

Since very few reflections come back to the listener reminding of his or her presence in the room, the focus is drawn from the outer boundaries to actions or objects in the room.

Absorbing Space – many persons



Same conditions as for one person. Even if many people are speaking at the same time, the words will be able to distinguish. The space will however be experienced as dry and uninspiring for activities where the voice is important.

Art objects

Three architectonic and acoustic situations for three art objects:
Each situation is designed to influence the experience of the object.

La Petite Danseuse de quatorze ans (1880-1881) Edgar Degas 1834-1917

Modelled in wax and cast in bronze 1930, after the artists' death. Skirt made of tulle.

My first encounter with La Petite Danseuse de quatorze ans happened fifteen years ago in Paris. In a large museum hall filled with other sculptures, the little dancer caught my attention. Today still, she touches me with her strong presence, deeply concentrated face imbibing the atmosphere, the proud posture and yet slightly tousled look.

Revolutionary in its choice of materials and presentation, the sculpture has been a subject for discussions during the years. At the time the realism of the details, the artist's intention of not trying to embellish the model, and the use of materials caused almost repulsive reactions.

What differs this sculpture from many other sculptures from the same time is among other things the situation it portrays. Seeing The Little Dancer is I pretend, what Degas saw making her. It is not a historic battle or Greek goddess, nor is she portrayed where we are used to see a ballerina-on stage in a ballet position. Instead the sculpture portrays a fourteen-year-old girl in the artist's atelier, so real that you almost feel her presence in the room.

It seems, the sculpture was meant to be exhibited in a glass case, as an object at a natural history museum. One questioned posed could be the one of how realistic a piece of art could be and still be considered art. Apparently, the common opinion at the time did not consider the scrawny adolescent dancer modelled in wax an object suitable for the established museums. Today however, copies of the sculpture cast in bronze can be seen at different places in the world and there are figurines in all sizes and designs sold on the Internet.



The ballerina has been given the assignment of being the first art-piece in the pavilion. First of all, she is the youngest in age, but also created first of the three objects. Secondly, her focused and attentive expression gives a solemn atmosphere to the entrance room, accentuating the contrast from the relaxed walk through the forest to the pavilion.

Interpretation

The sculpture tells me about two realities;
The one of the Ballet, with controlled muscles, flexibility, strength, and hard work for perfection in a world of grownups.

The other reality is the one of the child. Studying the sculpture closer, a fourteen years old girl stands out. The position is not the one of a ballet dancer. She is more relaxed, with her hair flat in the front and the tights wrinkled on her legs, still proudly standing model for the artist.

The contrast between the two worlds, the one of perfection and the other of imperfection, and also distance and closeness, is emphasised with the acoustics.

Acoustic situation

The first part of the room tells the visitor about the professional dancer. Entering the large sounding space after the walk in the forest, the effect will be striking and for some intimidating, for others challenging and playful.

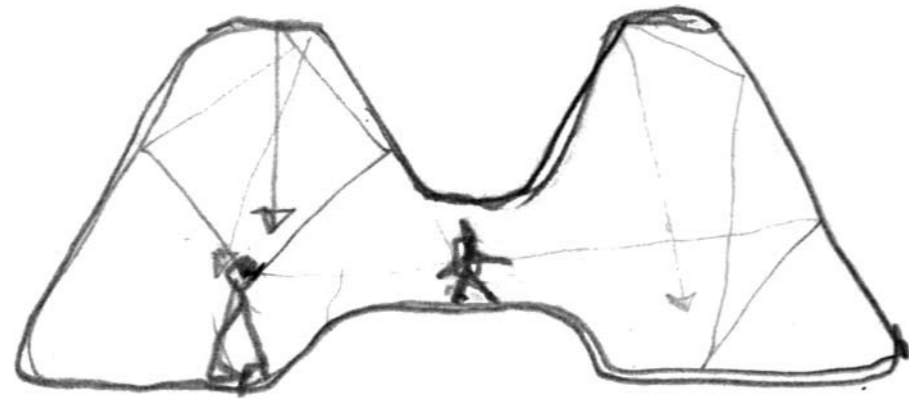
The sculpture seen from a distance, as on a stage with light sprinkling down from the ceiling, represents the strict culture of perfection. The visitor is constantly reminded of his or her presence in the room by the reflected sound.

Coming closer, the acoustics become drier, and the sounds of the visitors are reduced. When less energy is spent on relating to the space, the visitors will be able to come closer and focus on the sculpture, and hopefully meet the "little" dancer.



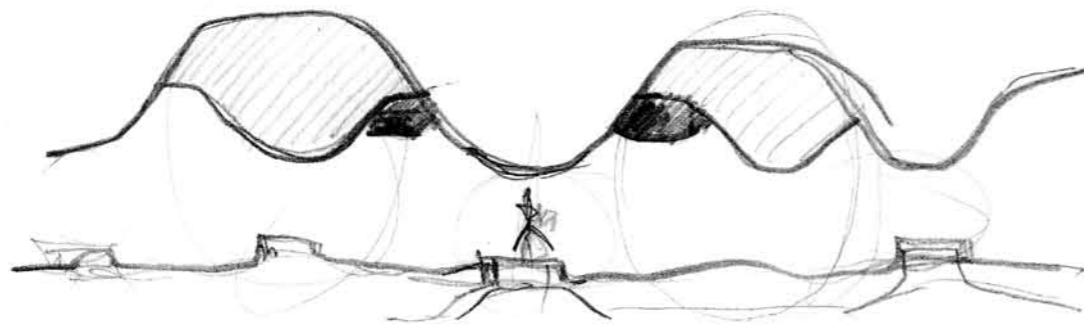
Sketches from the process

How could a room be designed to contain two different acoustic atmospheres?



Hörstär inte på ett
pöchlur, man
vare sig tillstånd

An idea about reflecting the sound away from the sculpture, back to the visitor.
The sound energy under the low ceiling would then be reduced.



Ett landskap som manar till att springa
omkring, och punkter där man, liksom
balleman, stannar upp, slappnar av och lyssnar
på tystnaden.

“Public figures” Erik Olofsen (1970-)

“Public Figures” is a film recorded when a train is coming in on a subway station. The people standing on the platform seem to be actors, standing so still that it feels unreal, and almost surrealistic. The film is recorded with a high-speed camera, but played with normal speed giving a feeling of slow motion, but with perfect resolution.

Interpretation

After a moment small and very slow movements are registered. The importance of scratching an ear or reaching for something in a pocket changes from a small matter to play the leading part of the plot. The slow tempo evokes a feeling of being an alien, with a much slower rhythm of life.

Acoustic situation

The acoustics will play two roles in this part of the building.

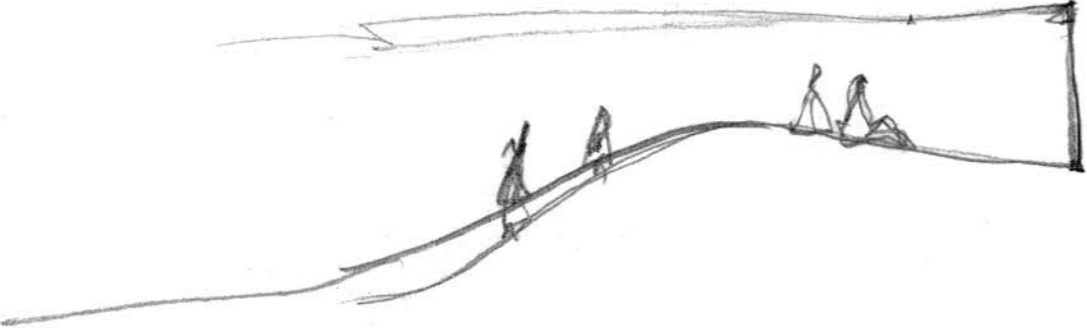
Firstly, to reinforce the effect of the film, the feeling of speed, then slowing down, and finally acceleration will be created.

The same way the speed of the film changes the importance and focus of the movements, the acoustics will change the focus of the sound perceived in a place. By absorbing as much sound as possible, the direct sound close to the body will be experienced as much higher than usual and the focus will be moved from the walls of the room to the leather jacket almost creaking or the sound produced when swallowing.

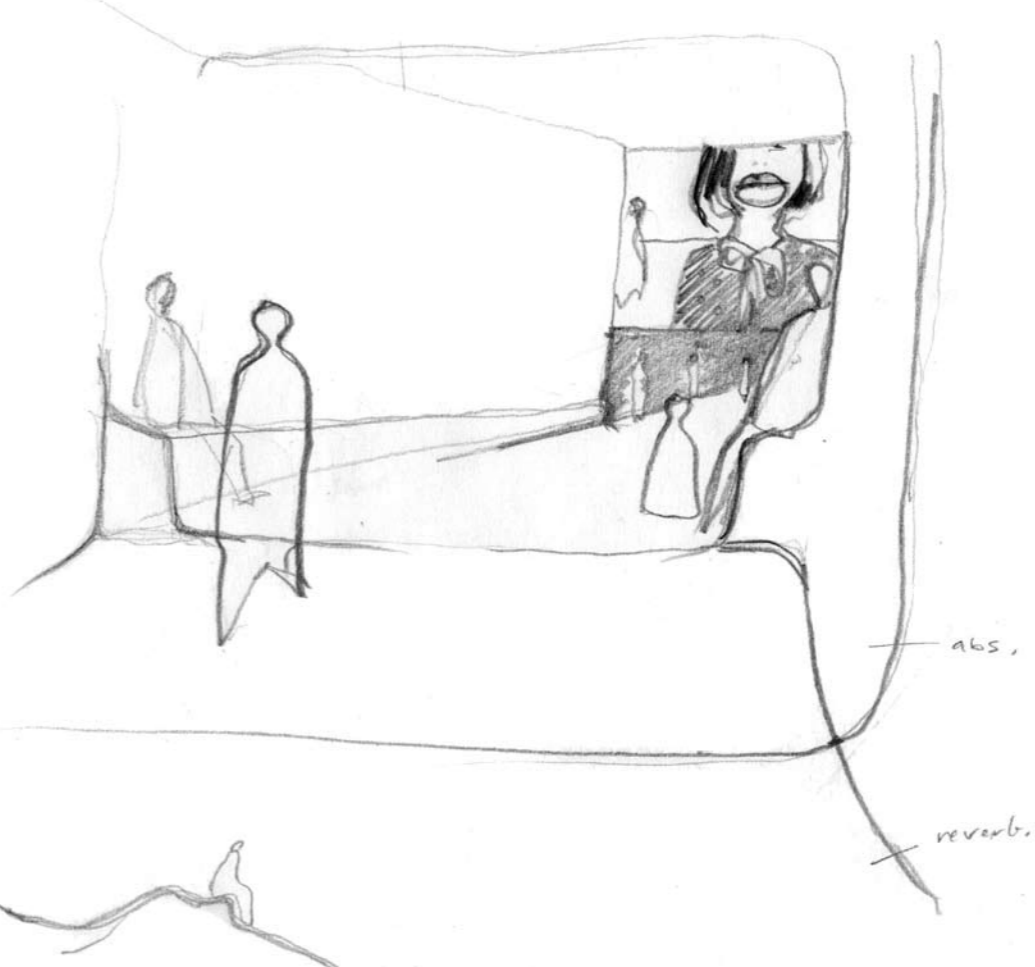
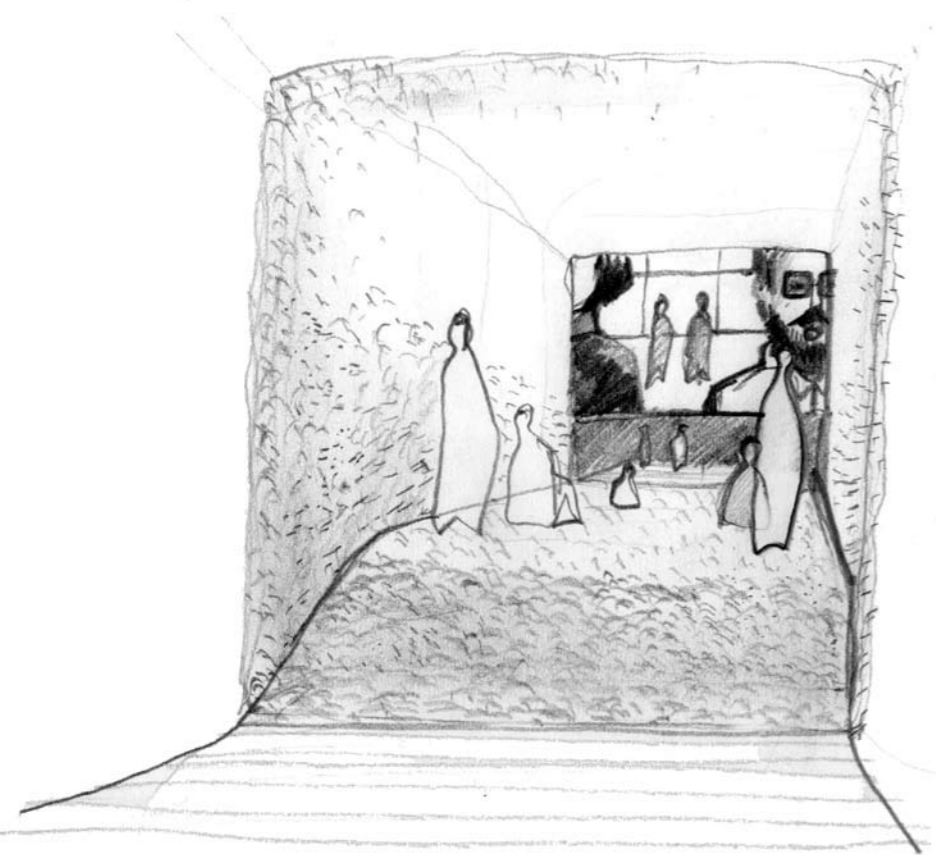


Sketches from the process

How could a room be designed to create the feeling of speed and slow motion?



Automatisk uppstannande rörelse



“Tenderly yours” Markku Salo (1954-)

Global Art Glass, international triennial 2005, Borgholm

Finish industrial designer and glass artist. Lives and works in Nuutajärvi, Finland.

“Tenderly Yours” is an installation with a glass sculpture and an industrial robot. The large, but delicate glass dress twists its upper body to the side, as if stiffened in a movement. The robot has a little scoop and a sponge attached to its arm, and washes the dress carefully. The water ripples from the scoop down in the little pond where the glass dress is standing.

At the Global Art Glass 2005, in the ruins of the old castle of Borgholm, Öland, the installation was placed in the servants’ department.

Interpretation

The first association that came to me in this place was the queen being washed by one of the servants, replaceable and programmable to suite the queen’s wishes. Getting to know the two figures a little better, they seem to have many different stories to tell.

The one that has become the most precious to me is about my grandparents. My grandmother was a strong and beautiful lady who at a rather young age got the disease Multiple Sclerosis. The functions of her body deteriorated slowly as her body withered away. Her husband, carefully taking care of her, kept the memory of her young body and soul.

It was with them as with “Tenderly Yours”; both individuals find them selves in a situation they are not meant for or have never tried before, but doing their best they keep their pride. The robot becomes a maid, and the agronomist a nursing assistant.

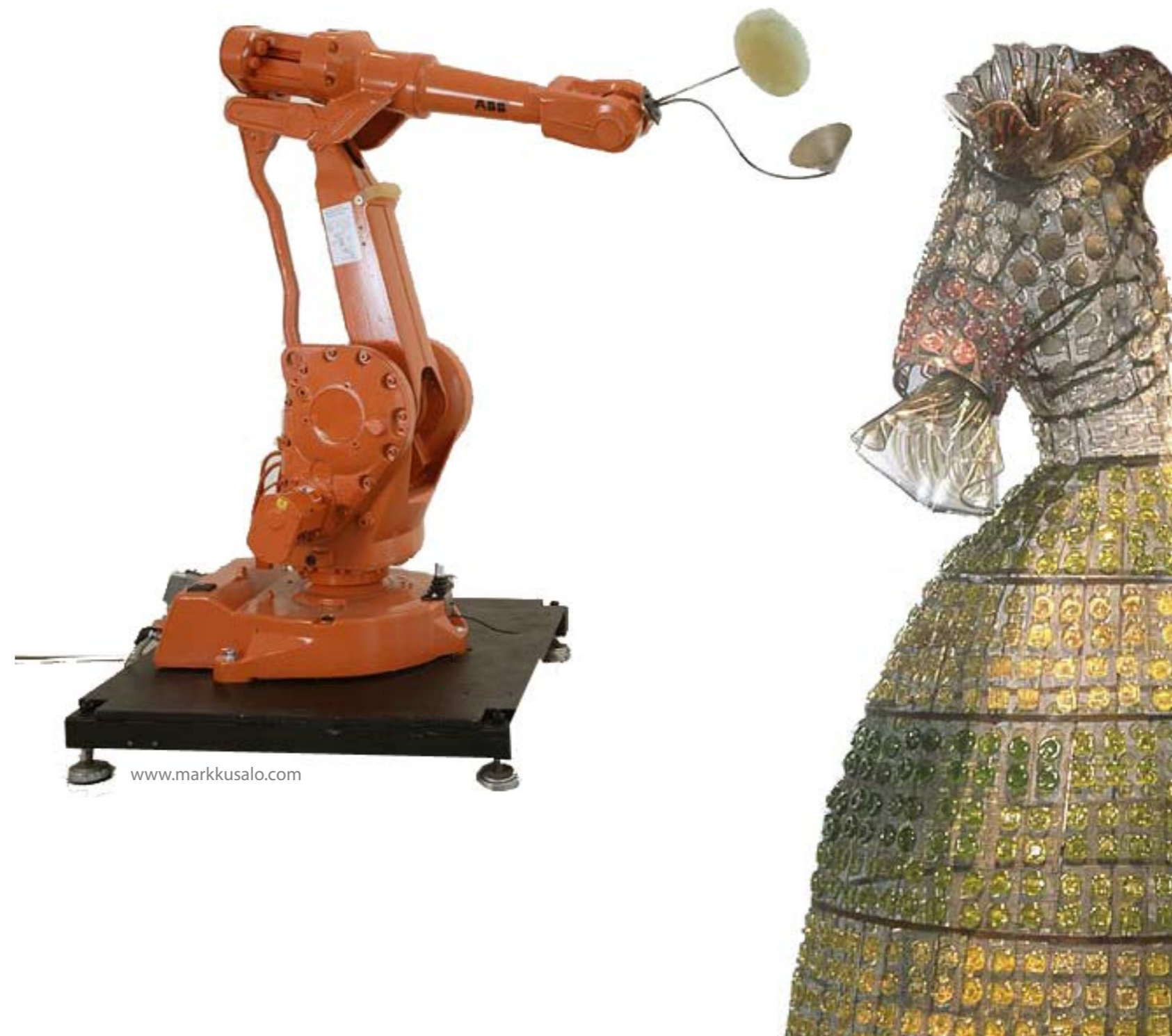


www.globalartglass.se

Acoustic situation

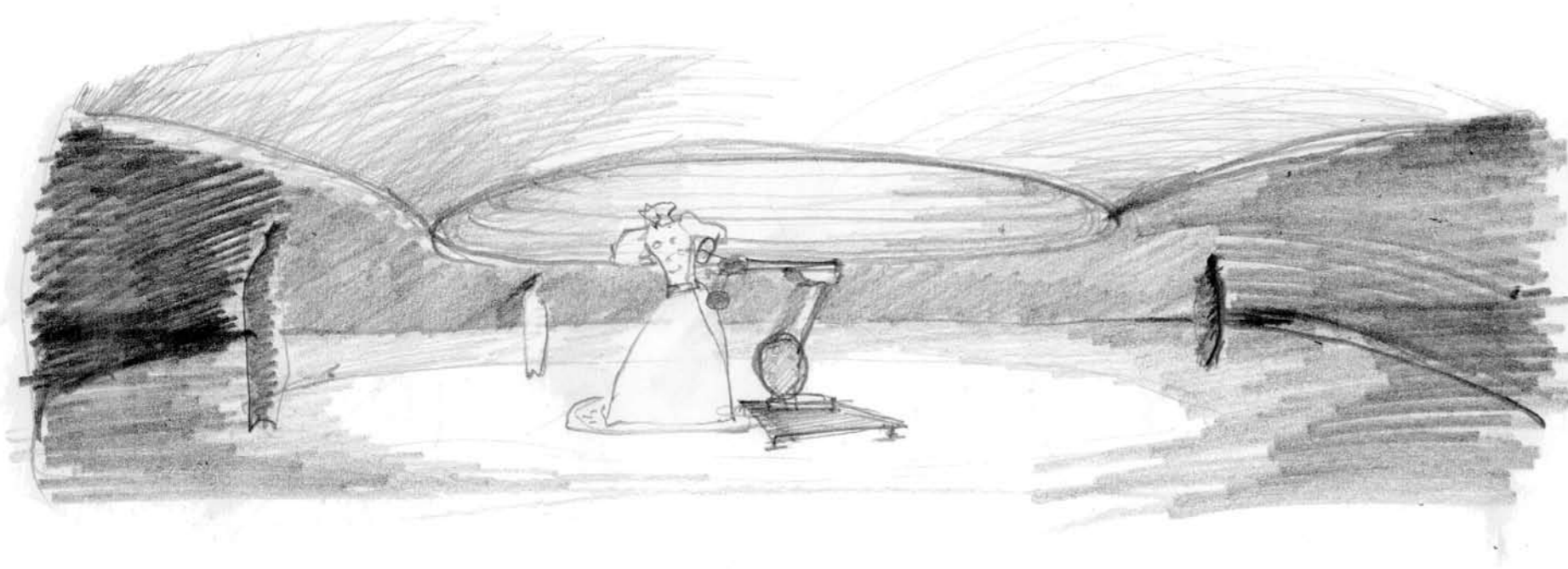
The scene of some one carefully taking care of another person is a scene of respect and trust. The visitor of the pavilion, will in this case be given the feeling of intruding the situation. At the same time, it should be possible to watch them calmly, without having the feeling of disturbing.

Acoustically, the visitor will come to a dark place with absorbing materials, removing the sound of footsteps. From the dark and soft atmosphere the visitor can watch and listen to the installation from a distance. To come closer, the visitor has to leave the safe area and step out on the hard concrete floor into the reverberating space. The closer the visitor comes to the couple, the more reverberating is the space. Leaving the dark area also means stepping out in the light. The observer becomes observed.



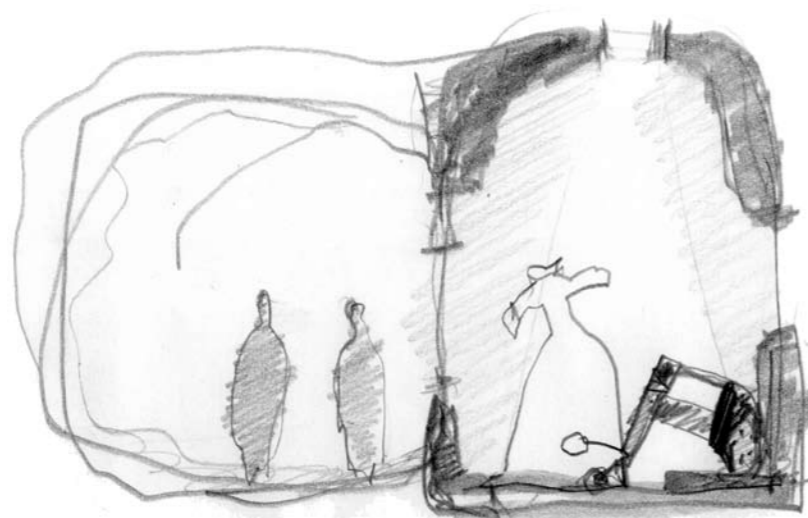
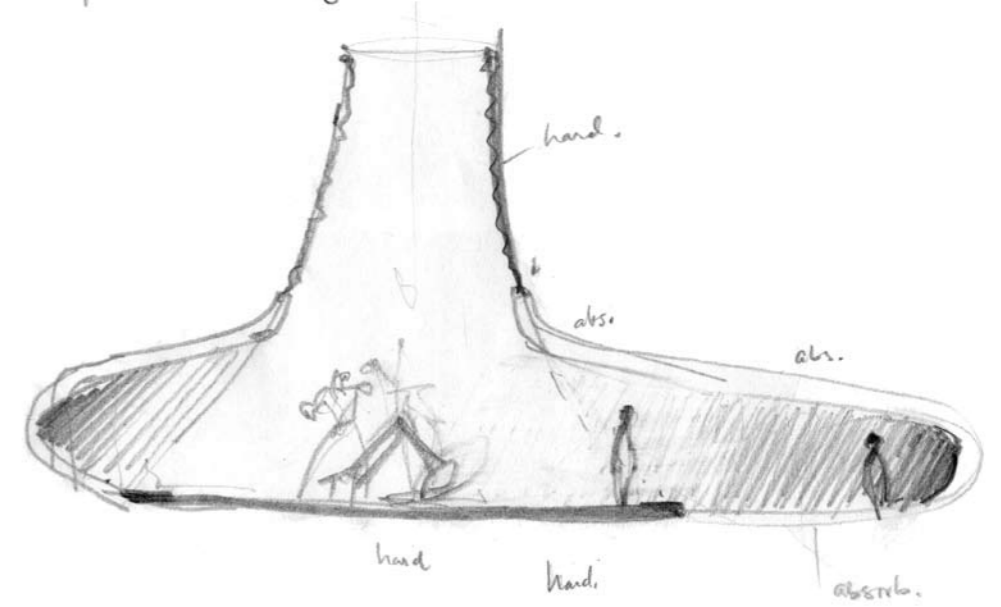
www.markkusalo.com

Sketches from the process



Hur monumental ska den vara? I mitten eller inne i ett hörn?

Redan innan man ~~är~~ inne i
den stora volymen hör man
lydets av sina steg.

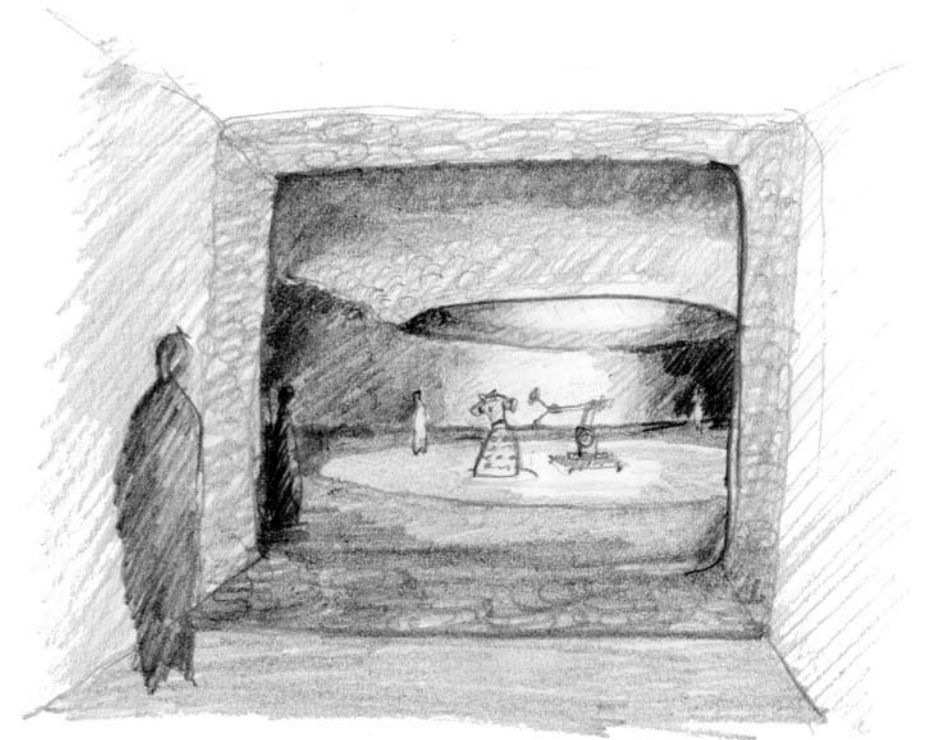


absorberande
så att den egna
rörelsen inte står
↑
lager

vatten ljud
- ribot sarr



Är ljuset tillräckligt
avskärmade? som ligger?



Connections between the three objects

The three objects are chosen individually, simply because they touch me in one way or another. Working with the objects and the order in the sequence, relationships between them have been distinguished to the extent that the art pieces seem to have an internal agenda...

The first and most obvious relationship is the one of movement.

- The little dancer not moving,
- The people in the film moving so slowly that they at first seem to stand still,
- and finally the Robot, without any doubts, moving around the glass dress.

Taking the analysis one step forward, the control of the movement can be considered.

- The little dancer standing still, controlling her body movements.
- The movements of the people in the film being controlled by the media of the film.
- The movements of the robot, controlled by the artist and programmer of the robot.

What happens with the experience of space and time in the different situations?

-Muscles controlling the the dancers body movements, eyes partly closed, enhancing other signals than visual from the surroundings. Every second is experienced intensively and the time seems to be stretched out into eternity for the struggling body and mind.

-A camera controlling the body movements of the travellers in the film, slowing down the time, changing the focus from large actions to small details.

-In the case of the glass dress, it is as if the question of time is to late; the process of making glass, working with a lively moving material, until it freezes in its final shape. Impossible to change without breaking the beautiful body.

Public or private?

-The little dancer is being studied, meticulously, eternally...
She is the only one aware of the situation and the only one able to run away.

-The people in the film are caught in a public situation where the slow tempo makes the most common situation seem private, revealing small facial expressions and gestures.

-The figures in "Tenderly yours" portray the most private situation, where the visitors intrude upon their tender moment. The one able to move in this situation cannot control its own movements.

The Site

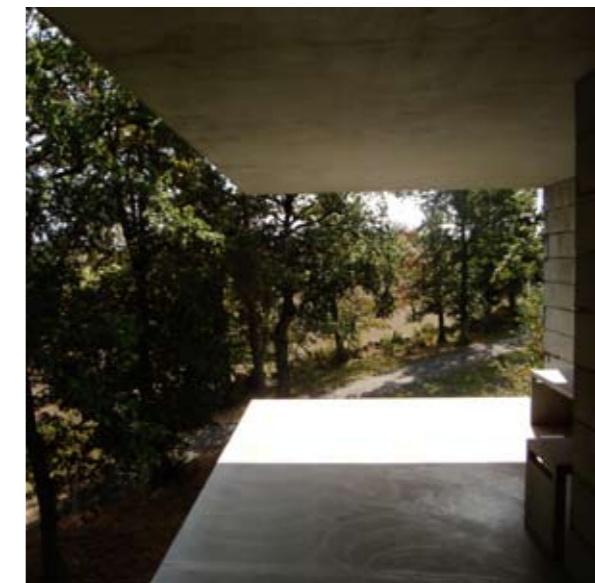
Kivik Art, Lilla Stenshuvud, Österlen



The entrance, Snøhetta Arkitektkontor



Snøhetta Arkitektkontor: "Moderskeppet"



View from Antony Gormly's and David Chipperfield's sculpture "A sculpture for subjectiv experience of architecture".

The art pavilion developed from three different acoustic situations to a sequence of sound where the floor and ceiling work with geometric shapes to influence the acoustics.

Developing from sound, to a section working with sound and light, the project needed a physical plot to get a three-dimensional shape. When searching for a site, the most important quality was the audial:

Which are the acoustical properties of the surroundings? What does it sound like entering and leaving the pavilion?

The quality I searched for was an environment that could be a contrast to the large resounding space I wanted for the Ballerina. For this reason contemporary art parks such as Wannås or Kivik Art- Bergdala Gård were qualified candidates; both situated in beautiful natural surroundings without too much background noise. An important advantage of the art parks is that they already have an audience interested in new art experiences.

In this rapport, I will as an example show the pavilion at Kivik Art, Bergdala Gård.

In an interview Sune Nordgren, artistic director for Kivik Art, describes the park as a place for architectural experiences in beautiful surroundings. The first year the contrast between the raw concrete and the nature was in focus. Every year new artists are invited and the goal is for the pavilions to be exchanged when sold. Good examples of sensuous experiences this year were the sculpture "Architecture for subjective experience" by David Chipperfield and Antony Gormley and "Moderskeppet" by Norwegian Snøhetta.

Several of the pavilions at Kivik Art treat the visual meeting between the built and nature. Like Le Corbusier, the sculptures of Norwegian Snøhetta frame the perfect view along a walk in the beautiful surroundings of Kivik, Stenshuvud nature reserve. The pavilions are focused around a hill with astonishing views towards the water. The art span from minimalist sculptures to smaller pavilions. New for this year is a pavilion from 1971 by the Finnish architect Matti Suuronen, working as a reception and information building and café.



The pavilion will be placed down the hill among the trees.

The soft ground and the trees found an absorbing and reflecting surrounding creating an important contrast in the meeting with the acoustics of the first room of the building.

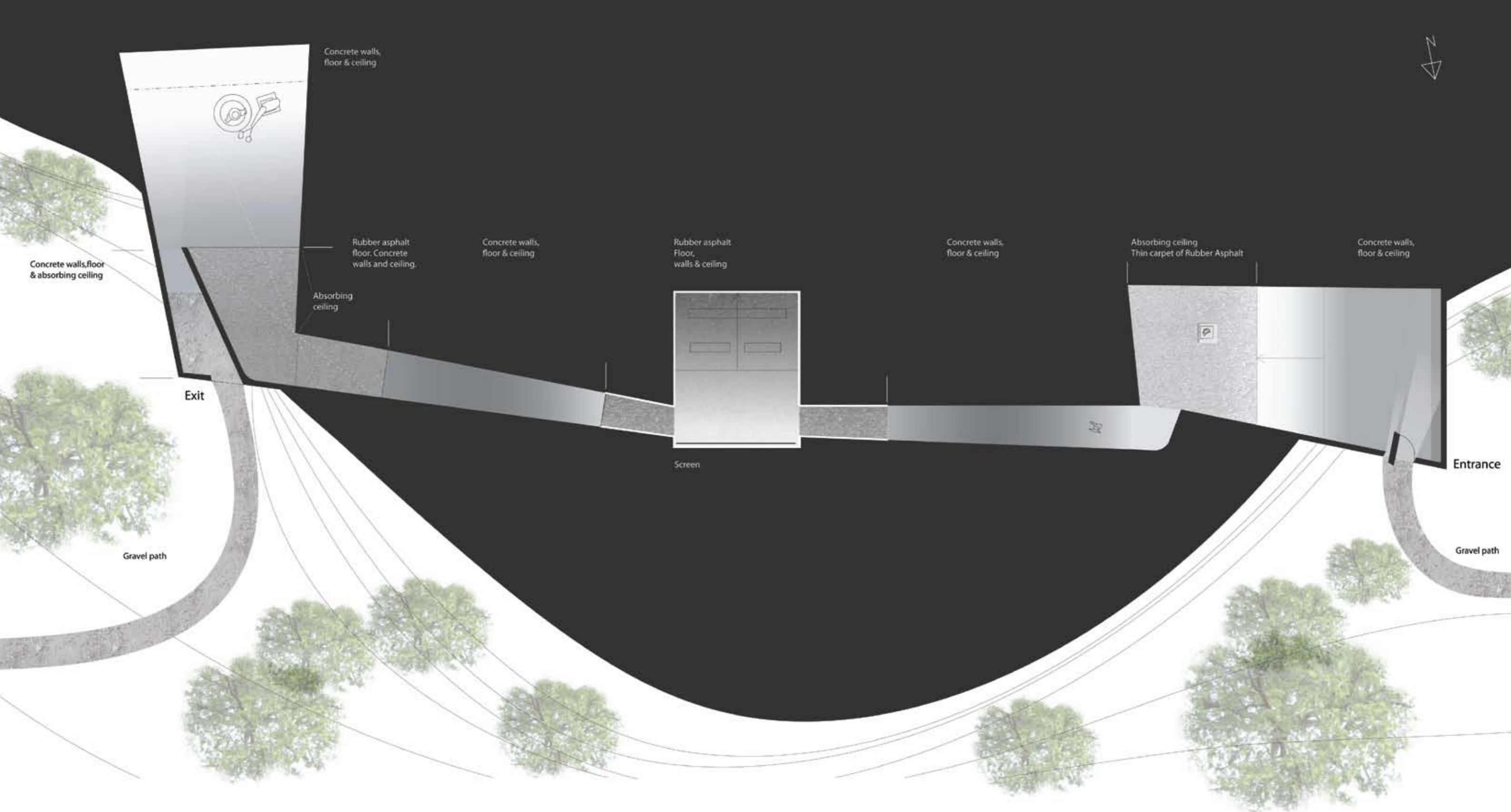
The exterior sound, both before and after the walk through the building, is an equally important part of the experience as the inside walk.



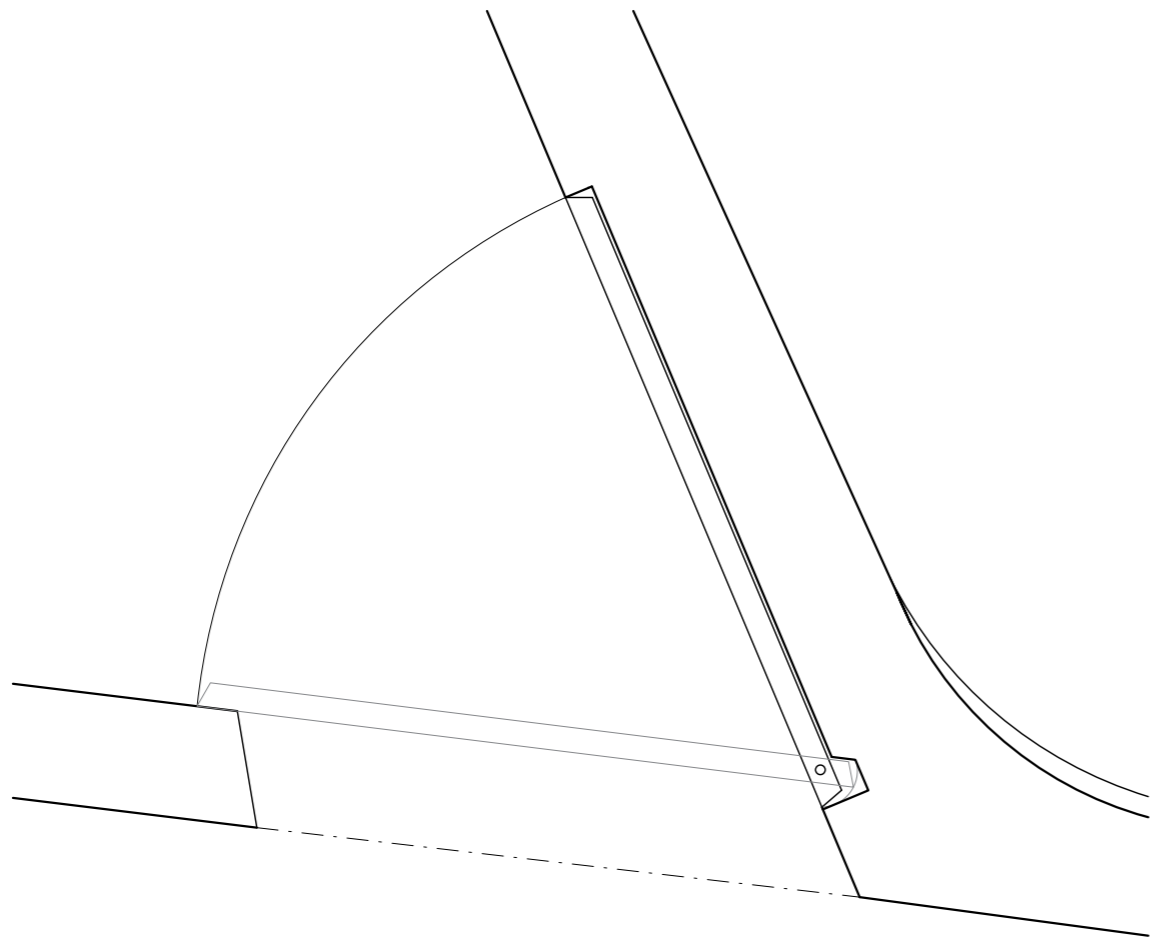
The slope back to the rest of the park.



Site model. Scale about 1:500

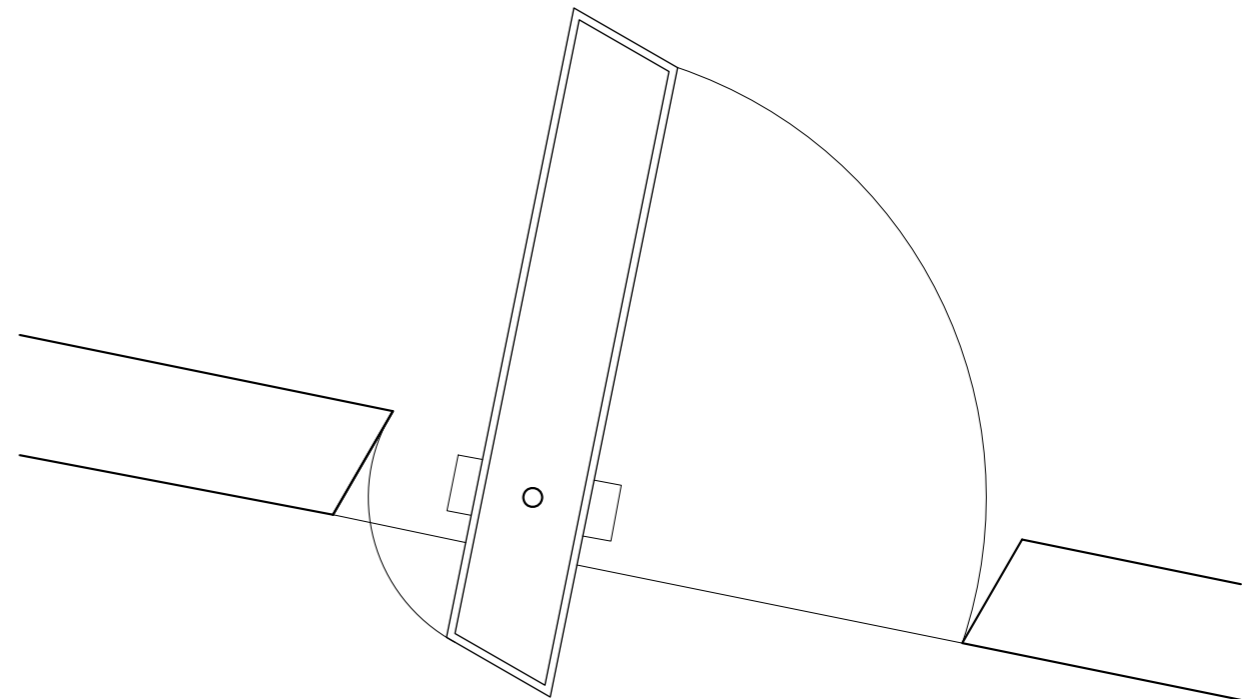


Plan- light and materials
Scale 1:200



Door Exit Scale 1:20

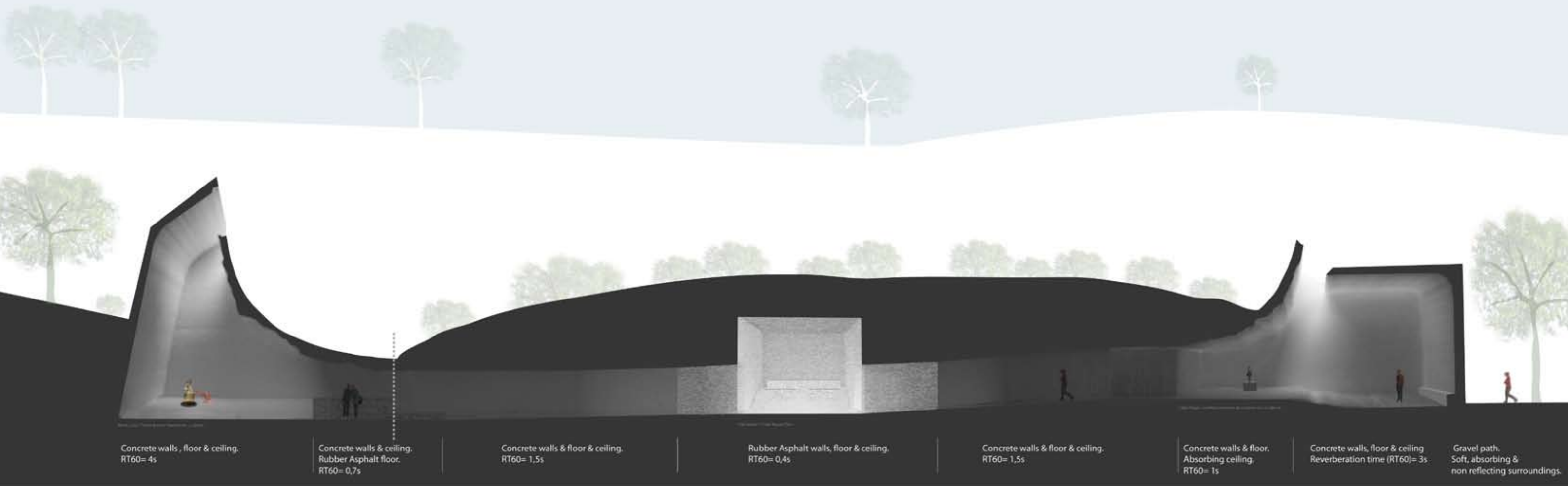
Pivot door inset in the wall. Open during opening hours. Steel.



Door Entrance Scale 1:20

Pivot door with automatic closing mechanism. Steel.

Sequence of light and sound

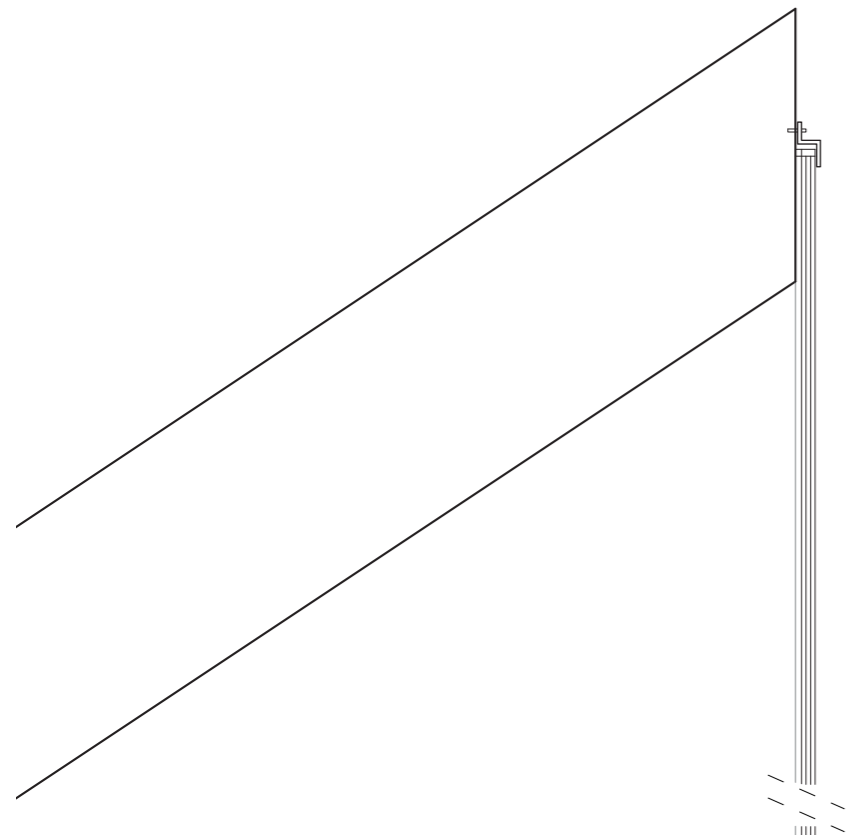


Exterior sound; Robot & Water

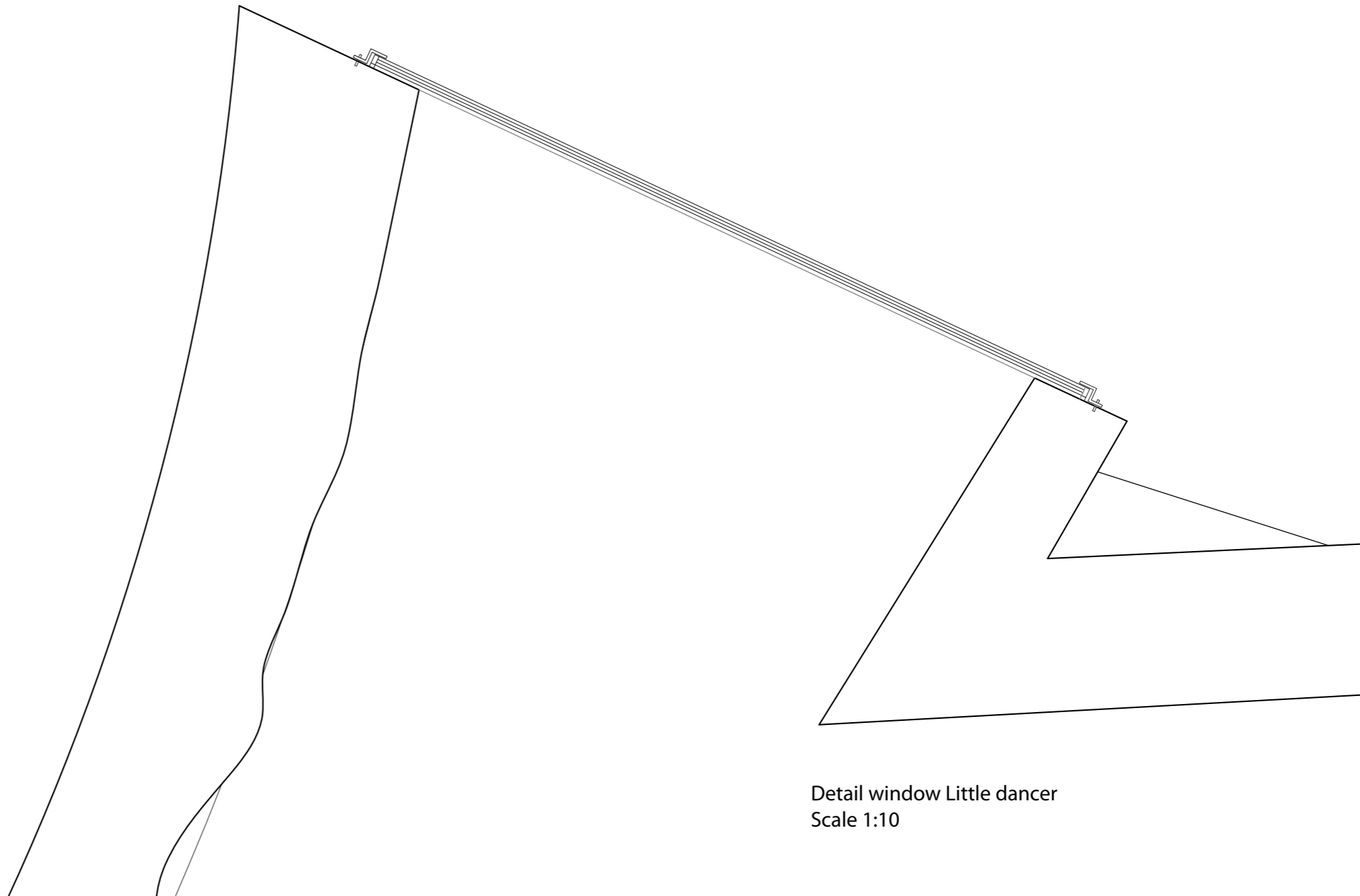
Exterior sound; Film sound (low bass)

Sound sequence through the building. Reverberance time.

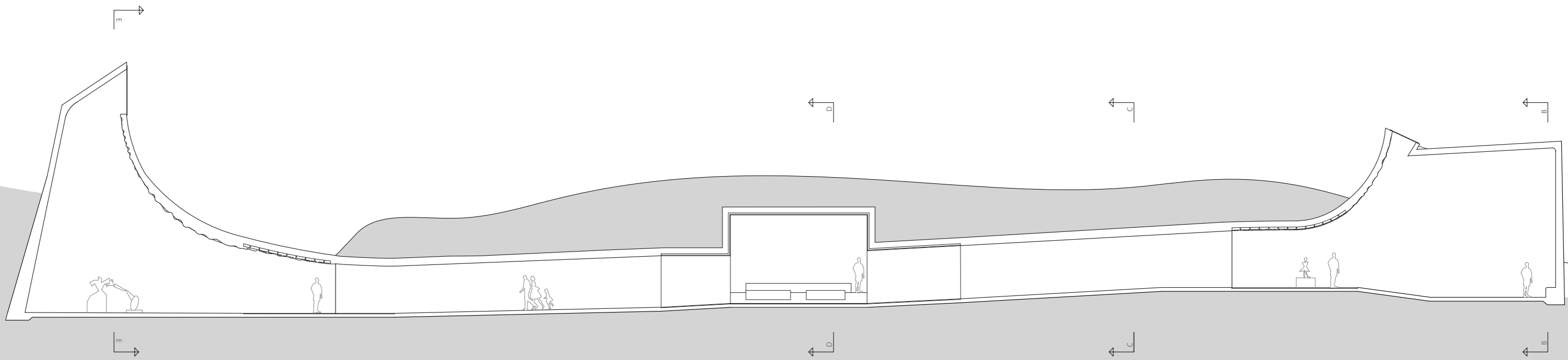




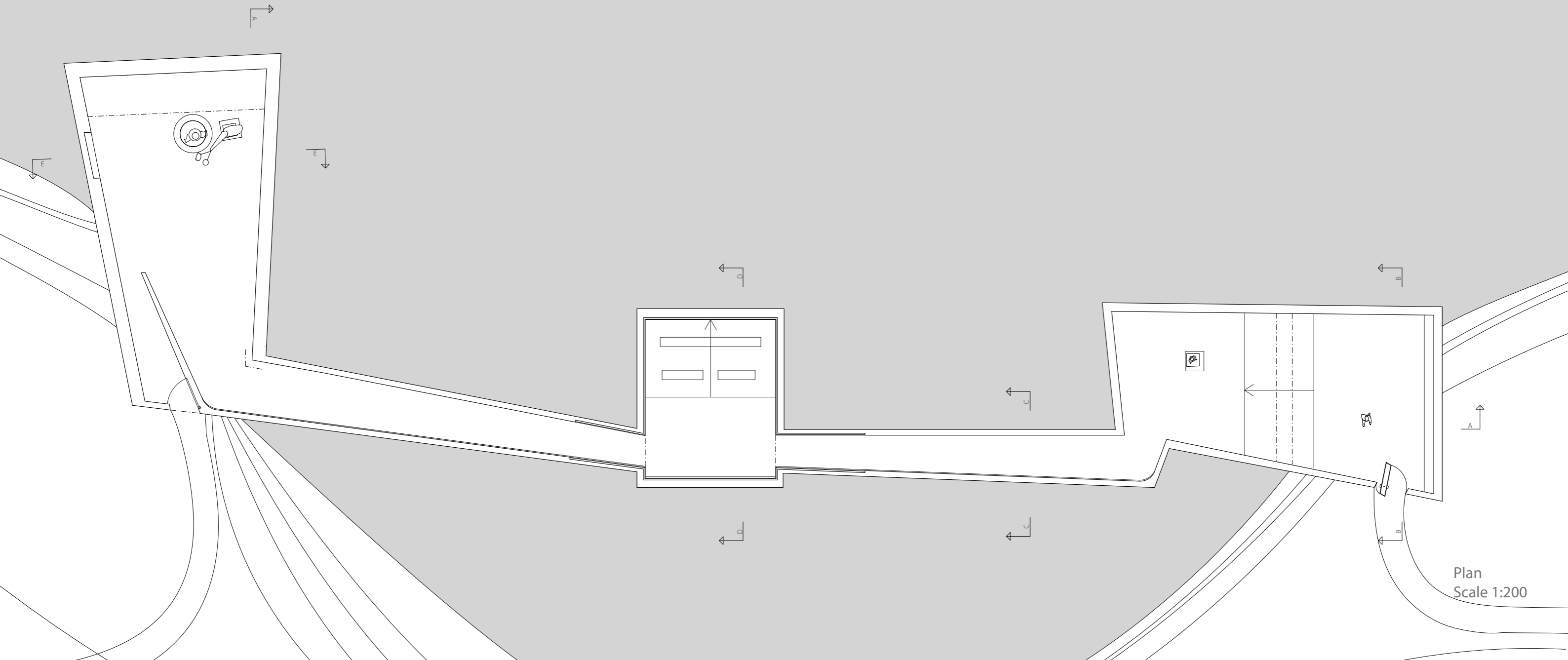
Detail window Tenderly Yours
Scale 1:10



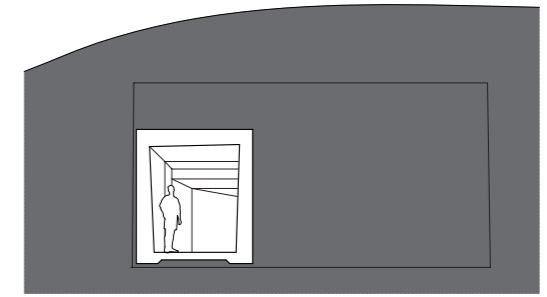
Detail window Little dancer
Scale 1:10



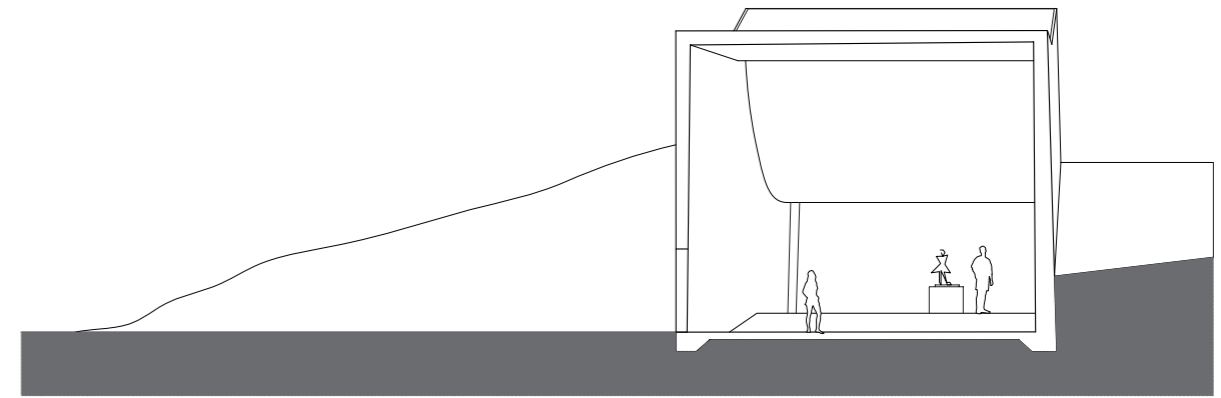
Section A:A
Scale 1:200



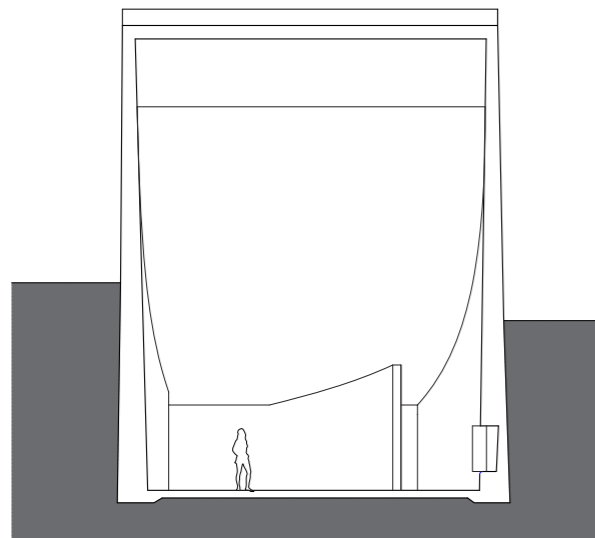
Plan
Scale 1:200



Section B:B
Scale 1:200



Section A:A
Scale 1:200



Section D:D
Scale 1:200



Section C:C
Scale 1:200





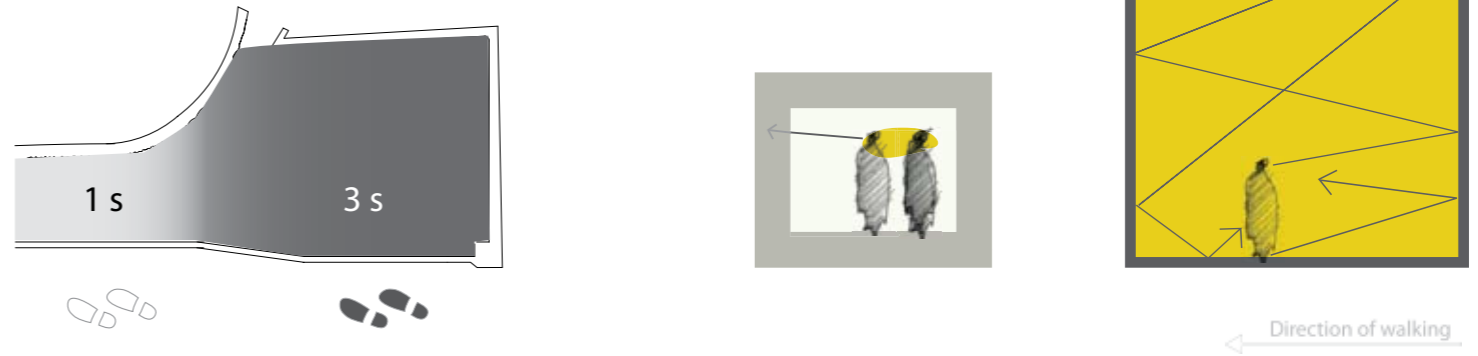
Detail absorbing ceiling

Acoustic design

Edgar Degas, "La Petite Danseuse de quatorze ans"

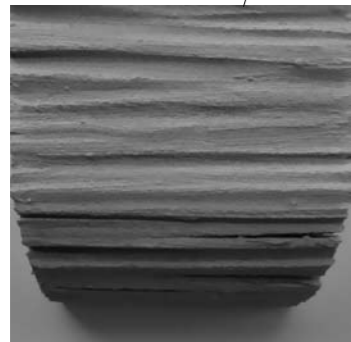
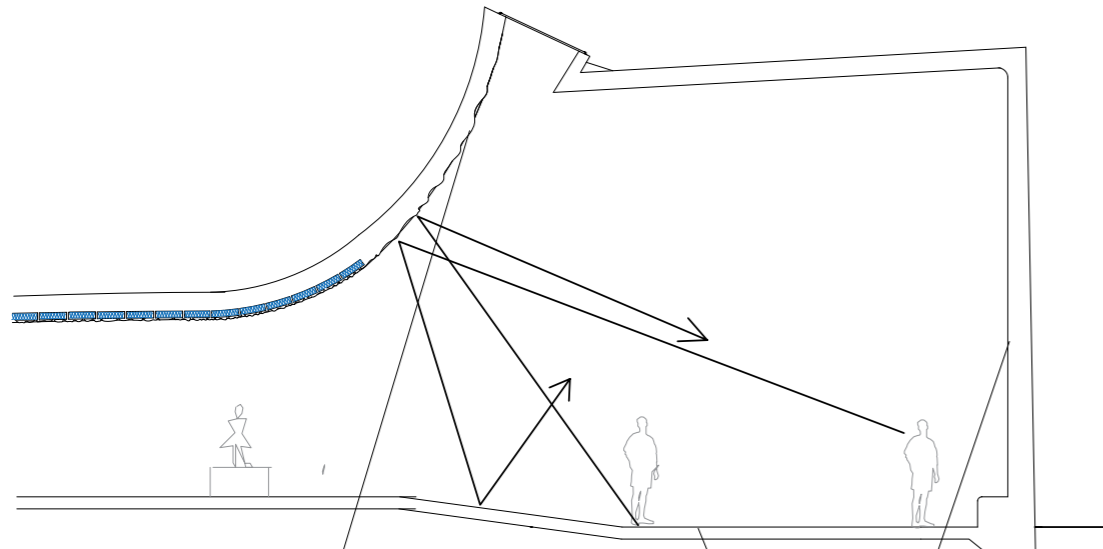
Wanted acoustic situation:

The entrance room has a sanctified atmosphere with a long reverberance of 3 seconds. The room answers to the visitors movements and footsteps, voices, coughs will be reinforced. Coming closer to the sculpture, the reverberance time decreases to 1 second and the foot steps are no longer as striking. More intimous atmosphere with focus on the sculpture and the "little person".

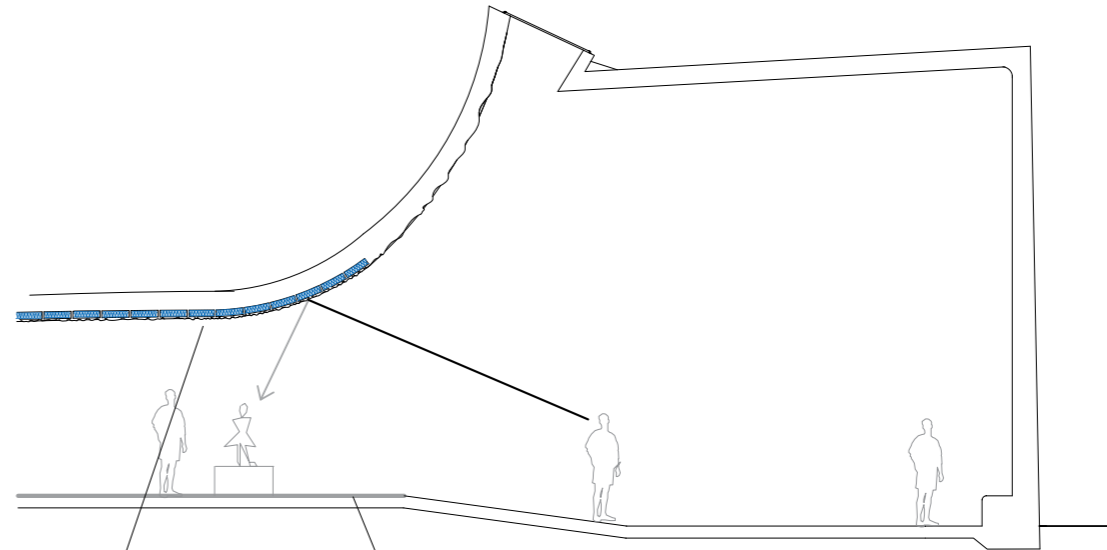


Technical solution:

Most of the sound energy from the first room bounces back and stays in the larger volume.



The sound reflected into the smaller volume is partly absorbed by the mineral wool integrated in the ceiling and the floor.



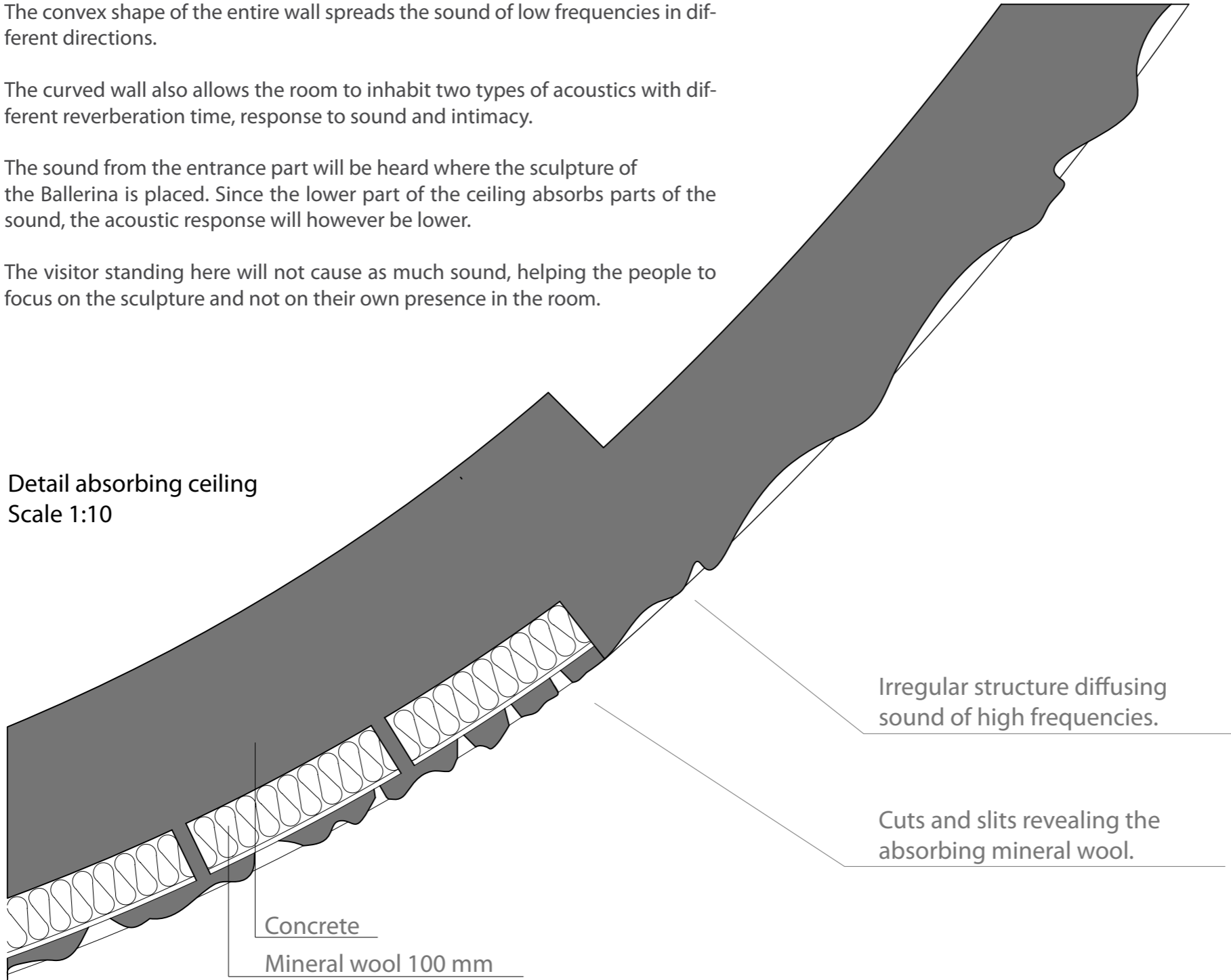
The convex shape of the entire wall spreads the sound of low frequencies in different directions.

The curved wall also allows the room to inhabit two types of acoustics with different reverberation time, response to sound and intimacy.

The sound from the entrance part will be heard where the sculpture of the Ballerina is placed. Since the lower part of the ceiling absorbs parts of the sound, the acoustic response will however be lower.

The visitor standing here will not cause as much sound, helping the people to focus on the sculpture and not on their own presence in the room.

Detail absorbing ceiling
Scale 1:10

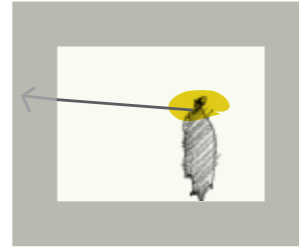


"Tenderly Yours": Markku Salo (1954-)

Acoustic situation

A low absorbing space gradually changing to reverberant. The closer the installation the more reverberating sound.

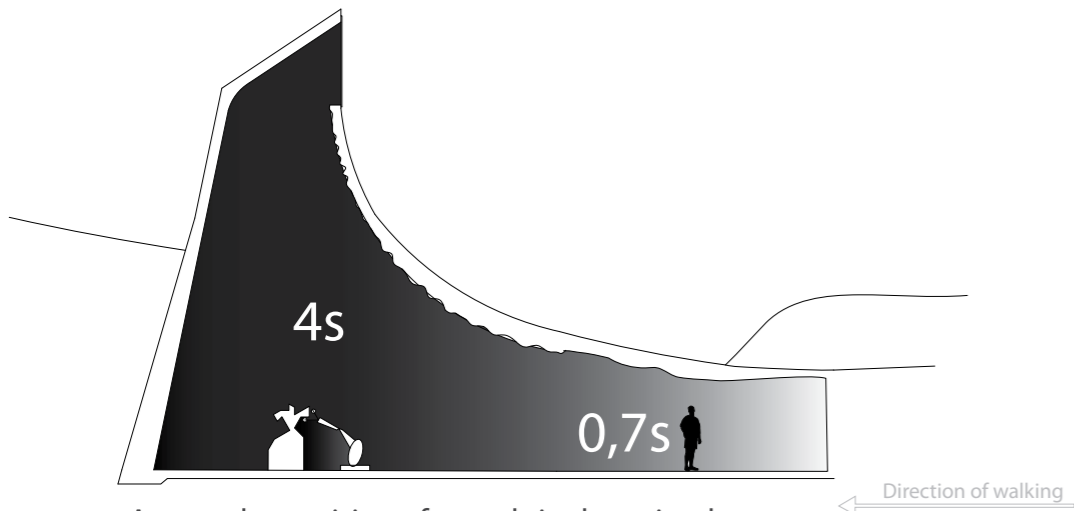
The atmosphere changes from soft and possible to hide in, both visually and audially, to hard and revealing.



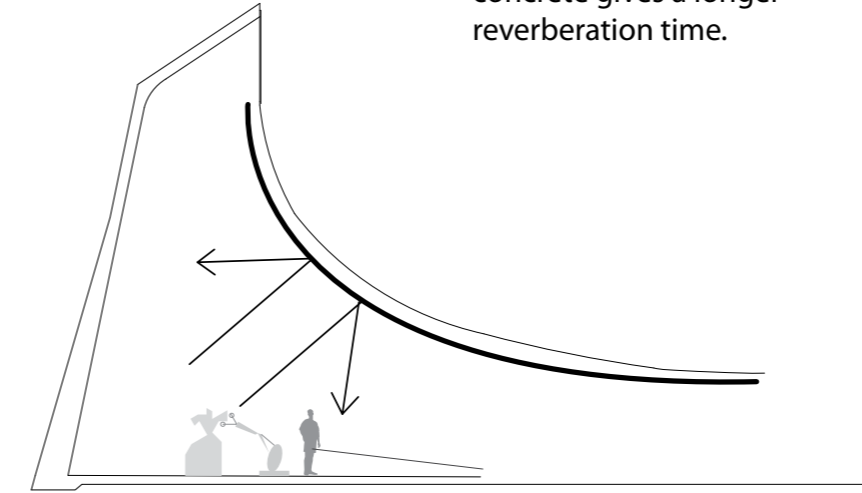
Direction of walking

The larger volume and the hard reflecting concrete gives a longer reverberation time.

The smaller volume, the absorbing Rock wool integrated in the ceiling, together with the absorbing floor shortens the reverberation time. Sounds of foot steps are avoided by the rubber floor.

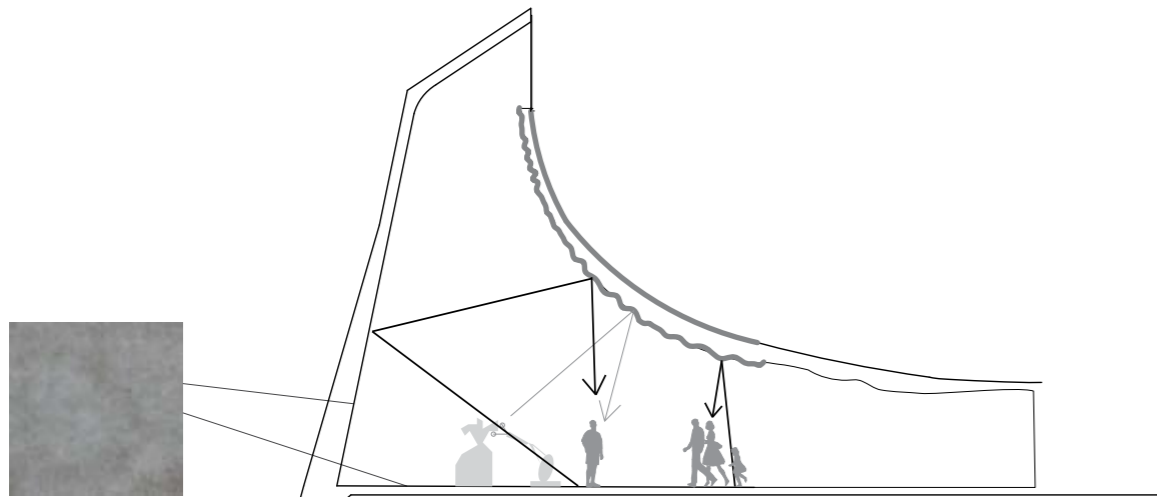
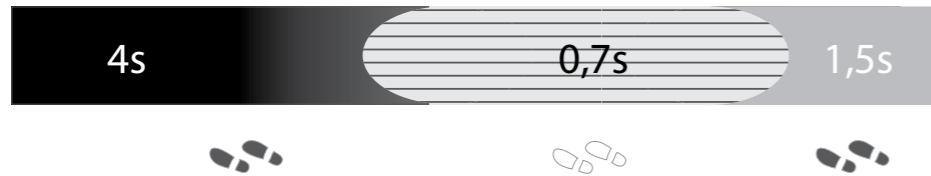


A smooth transition of sounds in the striped area. In the first part the sounds from the corridor will dominate, slowly changing to the sound of water from the installation in the large reverberating room.

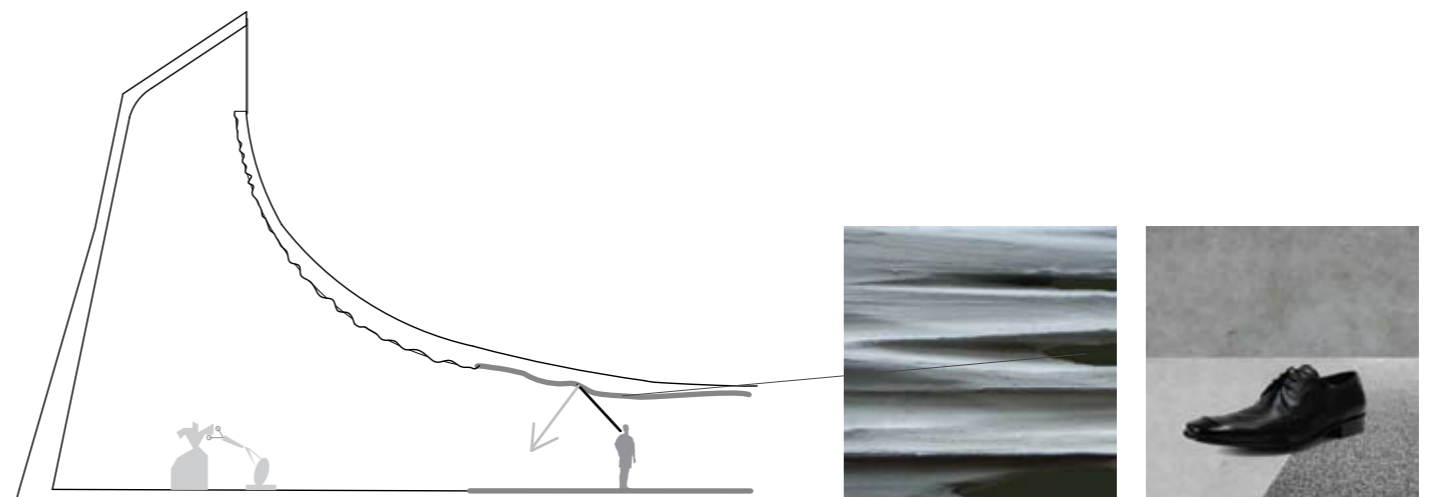


The curved wall reflects the sound back into the large volume. The sound is spread to give the impression of the sound surrounding the visitor.

Reverberation time



Under the lower part, with smooth concrete floor and no absorption, the reflections from the ceiling comes early with a distinct sound. The early reflection will give the sensation of a stronger sound. In the part with higher roof, some of the sound will be considered an echo.



Absorbing Rock Wool integrated in the ceiling (same construction as in the first room) Rubber Asphalt on the floor.



“Public Figures”
Erik Olofsen

Wanted acoustic situation:

A sequence evoking the sensation of speed, slowing down and finally accelerating back into speed. Unnatural focus on the sound of the body moving. In the flanks; the sound of speed and in the middle; the sound of the small body movements.

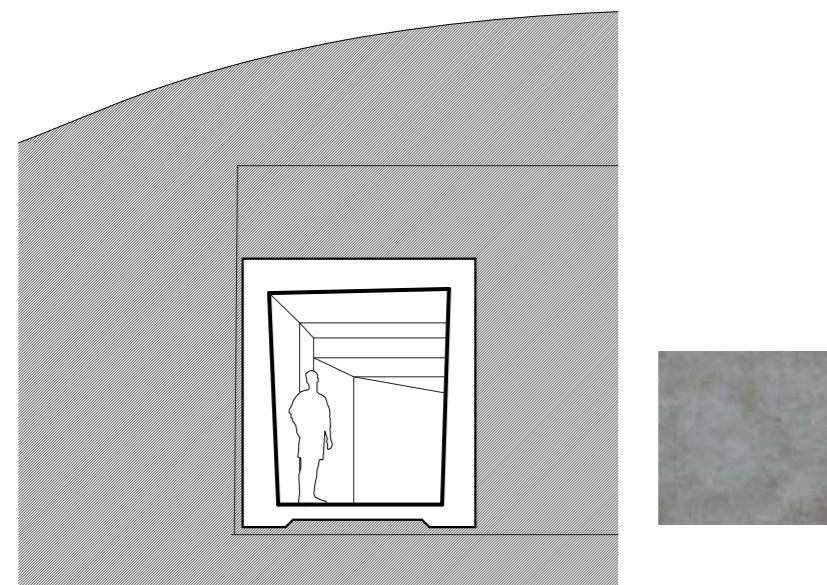
Technical solution:

A narrow reflecting corridor, interrupted by an extremely absorbing space, followed by another narrow space.

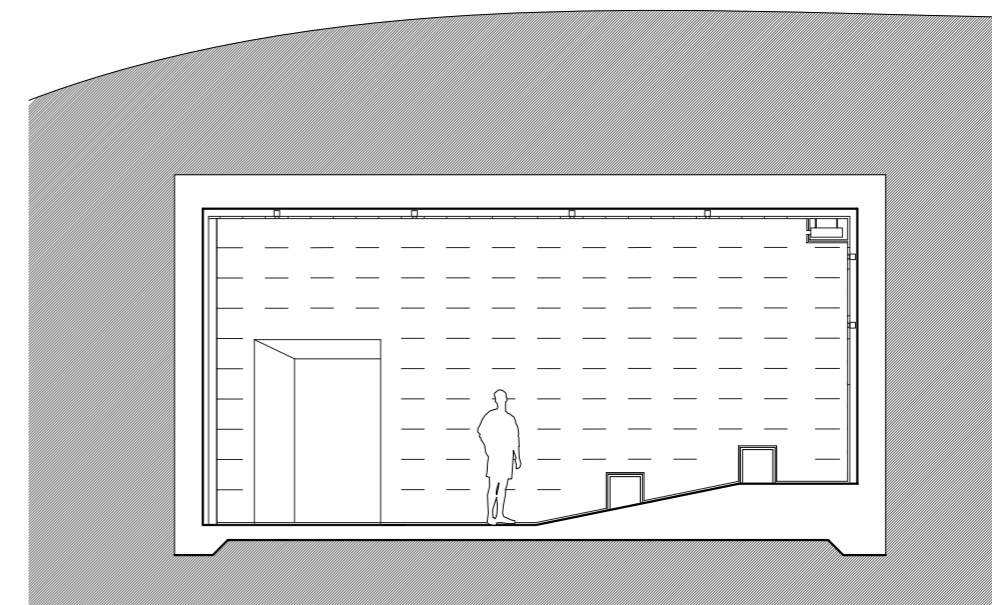
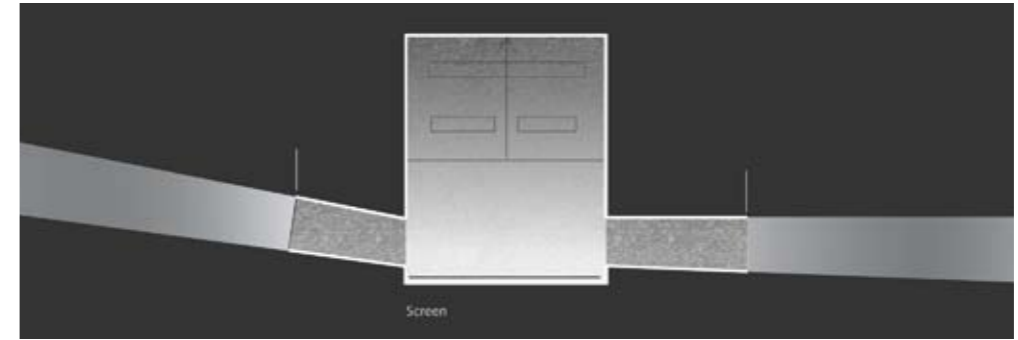
Björn Hellström mentions in an article how walkways of the subway create a rather stressful and monotonous environment. The hard reflecting surfaces together with the drumming sound of feet create the sensation of speed. To lower the tempo, a more dynamic sound environment is created. By varying the materials of the floor and by creating sound gates using absorbing materials on walls and ceiling the monotonous rhythm is broken up.

(Björn Hellström: "Akustisk design. Spola snacket- prata istället om ljudkvalitet! Väg- och vattenbyggaren 2-2007)

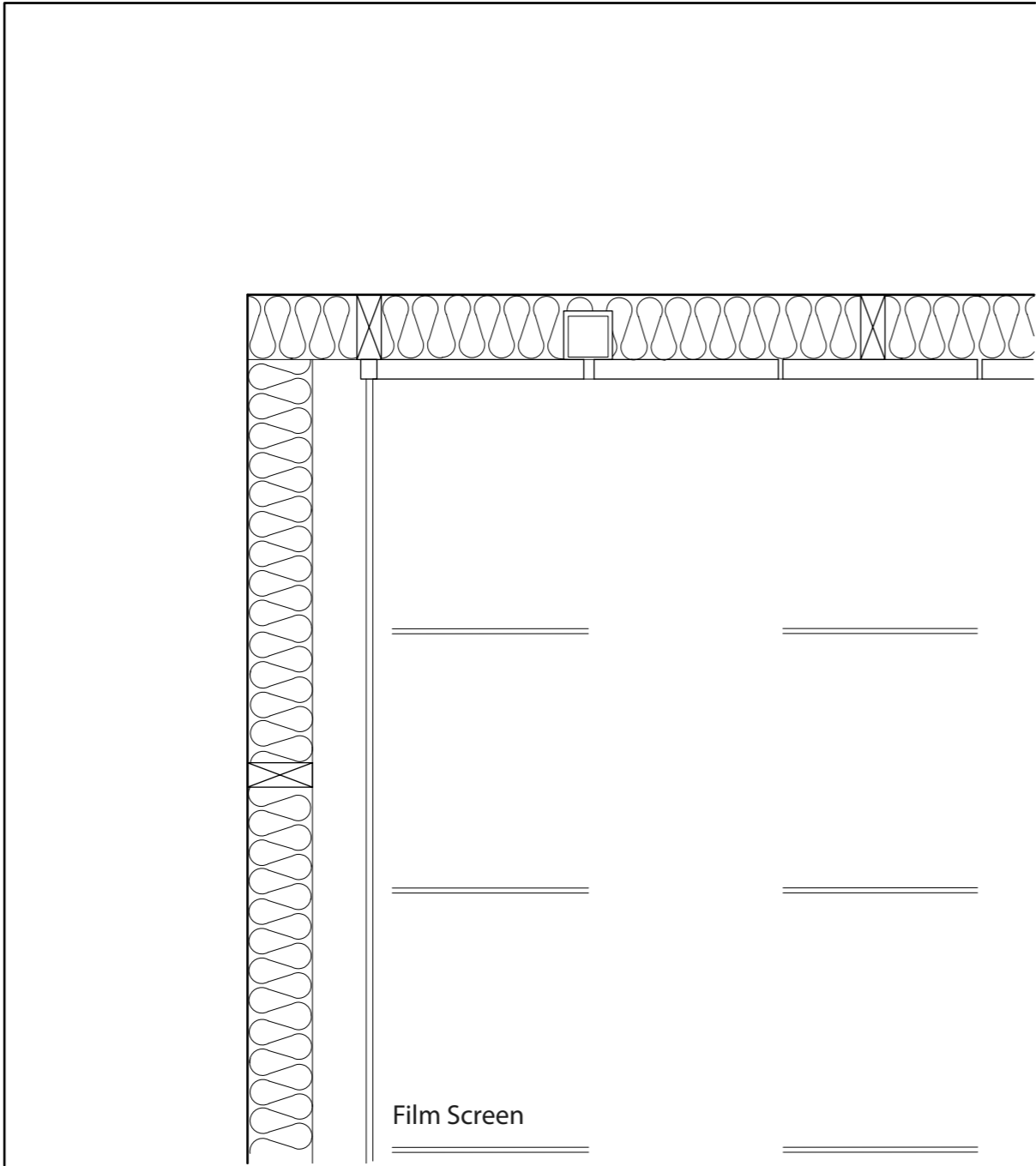
Entering a cinema, the sensation of the sound disappearing can be registered. Since the sound of feet, the “evidence” for speed disappears, the phenomenon can evoke a feeling of slowing down.



The walls are slightly angled to avoid flutter between the hard reflecting walls.



All surfaces are covered with light grey Rubber Asphalt, floor, walls, ceiling and benches. Slits in the surface reveals Rock Wool behind, absorbing even more sound.



Concrete 450 mm
Surface treated to cope with the pressure of water from the soil.

100 mm Rockwool, Integrated loudspeakers
30 mm Rubber Asphalt on floor, walls and ceiling

7 x 300 mm gap in Rubber Asphalt

Film Screen

Detail Film
Scale 1:10

Scheme for the sound sequence through the building.

The experiencing of acoustics depends on the contrasts between the experienced sound environments.

Principles for two sound environments meeting. (Björn Hellström, Noise design)



A



B



C

A = A sharp contrast between two sound environments. (Entering a church)

B = A gradual transition between two sound environments.

C = One sound scape inside a different surrounding sound environment.

Exterior sound; Robot & Water

Exterior sound; Film sound (low bass)

Reverberance time

Exit
Outside

1,5s

4s

0,7s

1,5s

0,4s

1,5s

1s

3s

Entrance
Outside



A sharp meeting between two different sound environments.
(Entering a church)



The darker the colour, the longer the reverberation time.
White is very absorbing.



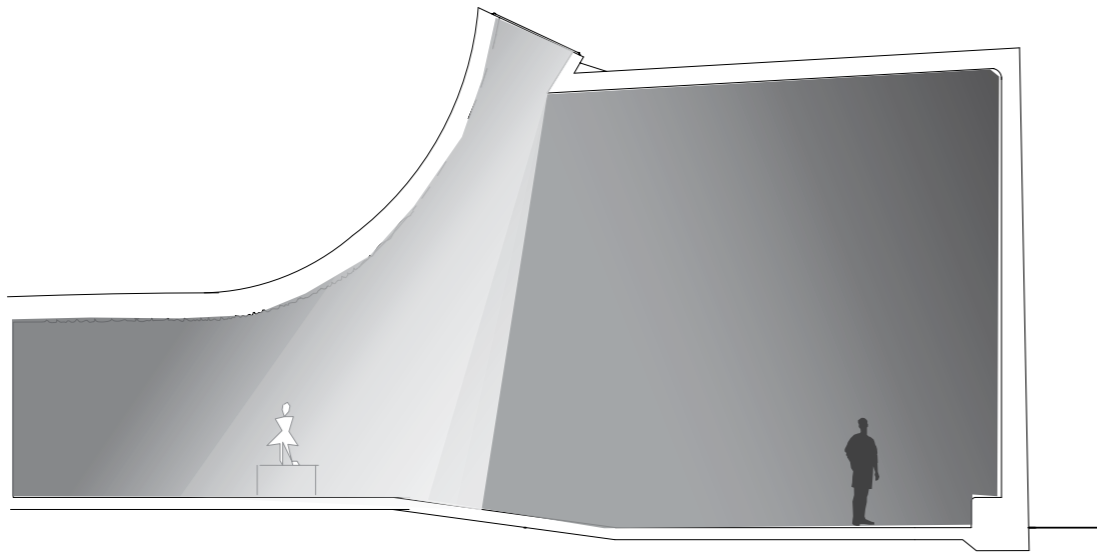
Striped area: The sound from the darker area is heard in the brighter area. The sound caused by the person in the brighter area is however much lower because of the shape, volume and integrated absorption. Since the sound is partially absorbed, the direct sound close to the body such as breath and movement of clothes will dominate.



The darker the colour, the stronger is the sound of steps. White is soundless.

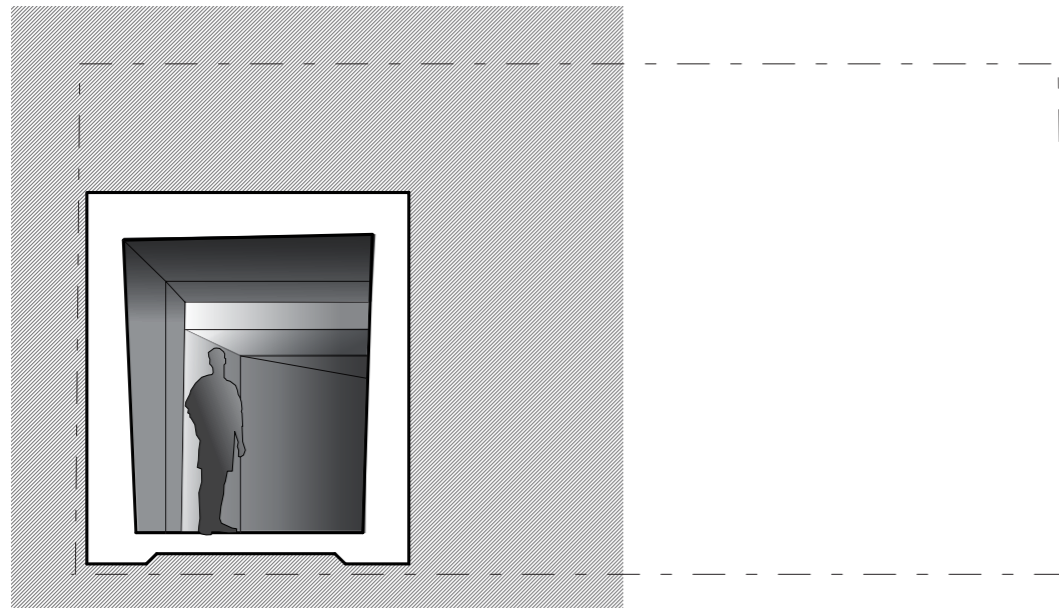
Light



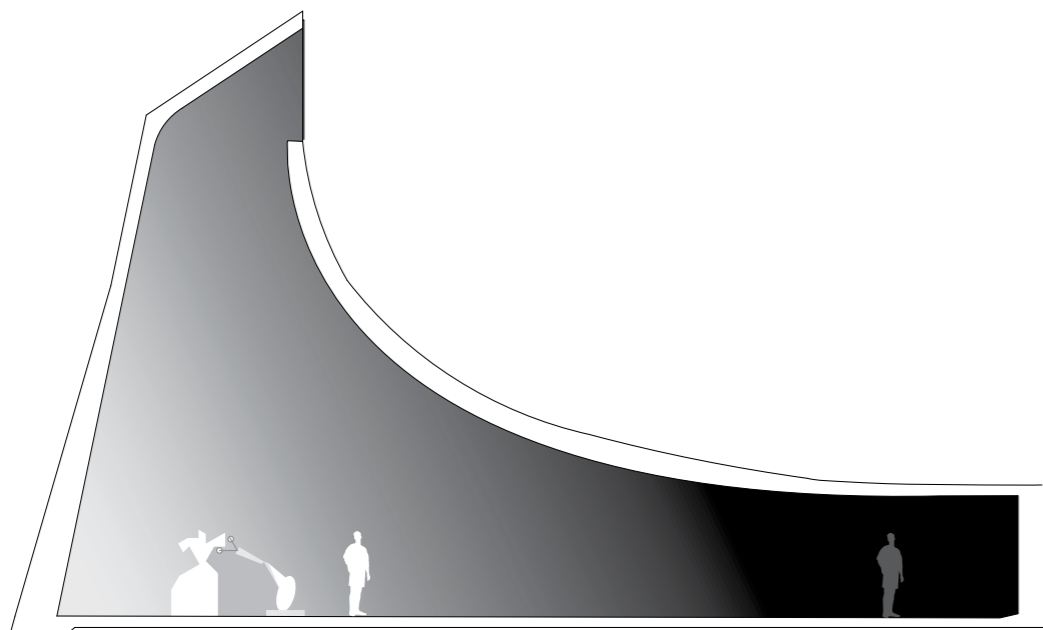


By dimming the vision when entering the pavilion, the impressions perceived by other senses are accentuated. In this case with focus on the hearing.

The roof light creates a natural spotlight, giving the sensation of The Little dancer standing on a stage. The structure of the curved wall will diffuse the light as well as the sound.

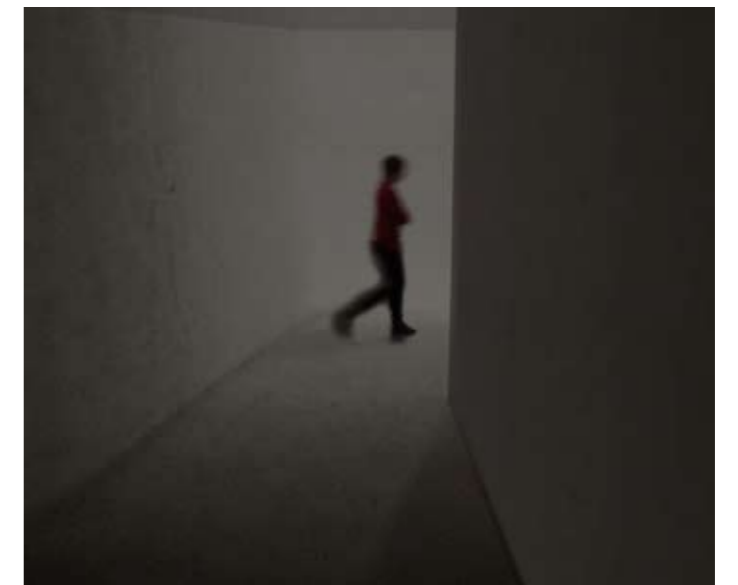


The film screen lights up the whole room and is the only light in the corridor. The colour of the Rubber Asphalt is light grey, for a daylight experience inside the cinema or "train station".



The closer the visitor comes to the installation, the brighter is the light. The observer becomes observed.













Appendix

A short lesson about sound and basic vocabulary	41
Acoustic design of today	45
Resources used to achieve acoustic accuracy	45
- Ecotect	46
Representing the atmosphere	47
Pictures from the process.....	48
Sources	54
Thank you,	55

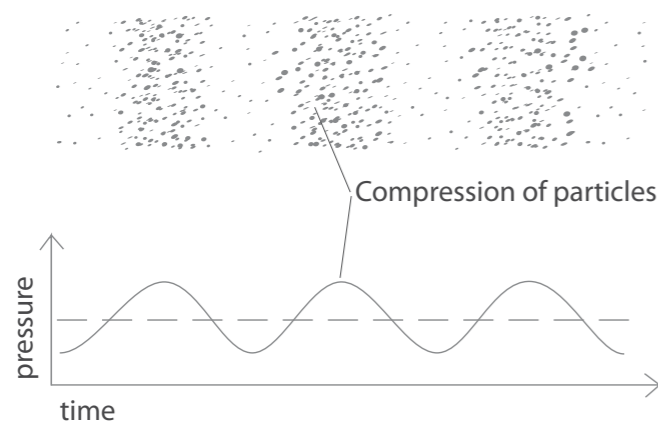
A short lesson about sound and basic vocabulary

The science of sound and acoustics can be divided into two areas: The area concerning physics with wave theory and geometry, and the psychological area explaining the human perception of sound. (Master Handbook of acoustics. F. Alton Everest 2001)

Only the theories of geometry and waves will be mentioned here.

Sound can be described as a wave motion in air or other elastic media. The most common picture to demonstrate this is a stone dropped in the water with the rings spreading out centric with a certain speed.

Particles being set in motion by a sound wave will vibrate around its equilibrium. The wave will press the particles together in some places and spread them out in others. The eardrum will start to vibrate, and the ear will register the difference of pressure as sound.

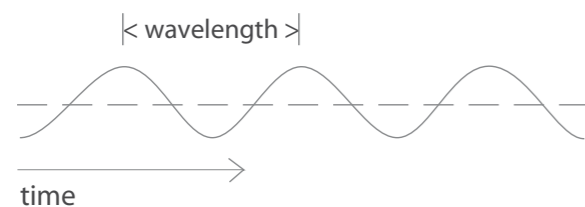


Wavelength λ

The motion of particles can be illustrated with a sine wave. (see the lower picture above)

The distance a sound wave travels to complete a cycle is called a wavelength.

The time it takes for a cycle to be completed is called T and is measured in seconds.



If the wavelengths are much shorter than the dimensions of the room, the sound will behave the way light does. The behaviour of sound can in this case be calculated with geometric models.

When the wavelengths start to reach the size of the room, the theory of modal resonance and standing waves is applied. The limiting value (frequency) for the different models depends on the size of the room and the transition between the two is smooth. For a car, the frequency is around 400 Hz, for a living room 180 Hz and a concert hall the value will be around 30 Hz; the lower the frequency, the longer the wavelength. (Room Acoustics, LTH, Delphine Bard).

The wavelengths for audible sound can alter from several meters to a few centimetres.

To calculate the length, the formula below is used.

$$v = \lambda f \quad \text{or} \quad v = \lambda / T$$

λ =wavelength (m)

v =speed of sound (≈ 340 m/s in air)

f =frequency (Hz)

T = the time it takes for a cycle to be completed. (s)

Frequency f

A more common entity than wavelength for measuring sound is frequency. If T is the time it takes to complete a cycle for the sound wave, the frequency tells us the number of cycles completed per second. (MHA. F. Alton Everest 2001)

$f = 1/T$ and is measured in Herz.

The frequency also tells us the pitch of sound. The higher the frequency is, the higher the pitch of the sound. When a song is played at higher speed, the voices not only sing faster, but also brighter.

In room acoustics the properties of materials varies with the frequency. The ability of absorbing sound will vary a lot for high and low frequencies.

Frequencies possible to hear for a young person spans from about 20 Hz to 20 000 Hz. To be able to handle the information when calculating different parameters of acoustics, the frequencies are divided into groups. A common way to do this is to divide the frequencies in octaves (ex. between c1 and c2 on a piano). The relationship between the frequencies is 2:1. The calculations in this project are made for 125, 250, 500, 1 k, 2k and 4k Hz.

Sound in Free Space

The sound from a loud speaker standing in free space will decrease with the distance from the source. The sound spreads evenly unless there are surfaces reflecting the sound.

The mathematical relation is explained in the Inversed square law: "The intensity of sound in a free field is inversely proportional to the square of the distance from the source." By doubling the distance, the intensity will decrease to 1/4 of the initial value. If the distance is increased four times, the intensity of sound decreases to 1/16. (Master Handbook of acoustics p. 10)

This explains why it is difficult to make yourself heard speaking from a distance outside. The sound will "disappear", since there are no reflecting surfaces. If we capture the sound between walls, the sound will have surfaces to bounce on, and you will be able to hear not only the direct sound, but also the sound coming back from the wall. Standing with a wall in your back when you speak outside, the sound will be reflected towards the listeners instead of continuing away behind you. Standing on a square with walls all around you, even more sound will be reflected back to the listeners, giving the feeling of being inside. The material of the ground is also of importance. A field will absorb the sound while stone, asphalt or the water of a calm lake will reflect it.

Reflection

As mentioned before, a sound wave with dimensions much smaller than the hit surface, will be reflected the same way light would: The angle of incidence is equal to the angle of reflection. The amount of sound reflected depends on the density of the surface.



If a sound wave hits a heavy wall with a polished surface, almost all of the sound will be reflected. If the wall is light, the wall itself will start to vibrate and a part of the sound will be transmitted to the other side of the wall. The rest of the sound will be reflected back into the room.

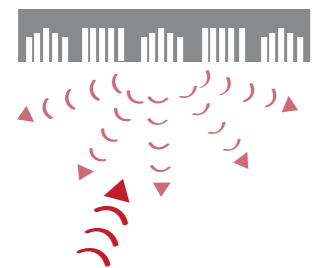
Flutter



If a sound wave hits the surface perpendicularly, it will be reflected 180° degrees. If this happens between two parallel walls with a hard surface (ex. Concrete) the sound will bounce back and forth between the walls. For high frequencies the phenomenon is called Flutter Echo and creates a hard metallic sound reminding of a steel spring. Flutter can be avoided by changing the angle of the walls, avoiding right angles, but mainly by adding an absorbing material on at least one of the surfaces.

Diffuse sound

A diffuse sound in an enclosure means that the sound intensity is equal at every location, and that the energy flows equally in every direction. (Room Acoustics, LTH, Delphine Bard)



For the sound to be diffused when reflected, the surface needs to be uneven. A smooth surface will reflect the sound in the same angle ($i=r$). The unevenness needs to be at least of the same size as the wavelength: To diffuse a sound with the frequency 1 kHz, the obstacle has to be at least 34 cm. ($T (1/1000) s * \text{the speed of sound } 340 \text{ m/s}$)

In a concert hall or a lecture hall, every listener should have more or less the same experience of the sound. It should be possible to hear what the lecturer says at every seat. A totally diffuse sound is however not always wanted. If the sound comes from every direction, the listener will not be able to locate the source. In many situations this will be confusing. There is normally no need to be worried to create a complete diffuse sound since it is rather hard to establish. The direct sound is normally stronger than the reflected sound.

Focusing

Concave surfaces can cause problems acoustically. As with light and lenses, the sound waves of certain frequencies will be focused when hitting a concave surface. The sound will be distributed unevenly in the room, with remarkably stronger intensity where the sound waves converge. A convex shape will have the opposite effect and spread the sound.

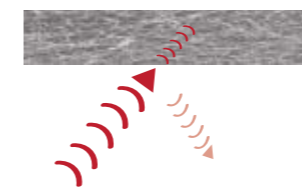
Concave surface focusing the sound.

Convex surface spreading the sound.

Absorption



When sound is being absorbed, it means that the sound energy in a room decreases. Instead of being reflected, the sound will be transformed into heat or movement. This will decrease the reverberation in the room and give a more "dry" feeling. (Room Acoustics, Delphine Bard)



People, chairs, windows, walls and doors are natural absorbers, with varying efficiency depending on the frequency. If this is not enough, absorbers can be used. Today there are two types of absorbers on the market:

1. Porous absorbers

Dense porous materials like polyurethane, fibreglass and heavy textiles efficiently absorb frequencies from 500 Hz and above. Hitting the absorbent, the sound wave will try to force the material and enter in the small channels filled with air. The air will start to vibrate and the friction will turn the sound energy into heat.

Materials used for insulating such as plastic with closed cells containing air should not be used for absorbers since the sound waves cannot flow through the material.

The reason why porous absorbers only work for the higher frequencies has to do with the wave-lengths. High frequencies have short wave-lengths, and low frequencies have long wave-lengths. When it comes to porous absorbers, the depth of the absorber has to be adapted to the wave-length. A long wave will pass almost without being absorbed. If the absorbing material is placed with some distance from the wall the absorption for lower frequencies will increase.

A carpet will absorb 8% of the sound at 125 Hz and as much as 73% at 4kHz.

(440 Hz is equal to a1, used in tuning forks and in older days the tone heard in telephones.) For frequencies about 125 Hz, the wavelength is almost 3 meters and the sound wave would pass the absorbent with almost no resistance. (Room Acoustics, Delphine Bard)

2. Panel absorbers and Helmholtz resonators

Helmholtz resonators are closed volumes with long and narrow openings. They are tuned in specific frequencies. When sound of the same frequency as the container enters the resonator, the air inside starts to oscillate and will put out the wave coming in. The Helmholtz resonators work well in the middle register. (Björn Hellström, Noise design)

Panel absorbers are made of an even panel of wood, metal, gypsum board or plastic mounted in front of a closed air volume. The volume is then filled with an absorbing porous material. The panel starts to vibrate, the sound is turned in to movement and finally into heat where the panel is clamped to the volume.

Windows will act the way panel absorbers do and start to vibrate at low frequencies. At 4 kHz, a window will only absorb 4 %, whereas 35 % at 125 Hz. (Room Acoustics, Delphine Bard)

Micro perforated absorbers

A micro perforated panel works for a wide range of frequencies. Sound waves start the vibration of air in the small holes. The friction turns the vibration into heat. Therefore, the panel should be made of a material transmitting heat such as metal.

Reverberation

An everyday experience of varying reverberation time can be studied when riding on your bike through a tunnel, talking to a friend (or to your self). For a few seconds your voice will be heard as stronger and with an almost metallic sound. What happens is that you go from outdoor acoustics, with hardly any reflecting surfaces (free space), to a tight and extremely reflecting space.

Reverberation time is written RT60 and describes the time it takes for a sound to decrease 60 dB. In common words the time it takes for the sound to be inaudible.

Experiences of reverberation time in different rooms (Karlén, L (1983) Akustik I rum och byggnader. AB Svensk Byggtjänst ISBN:91-7332-226-1

RT60= 0,3-0,5s

Extremely subdued, almost unpleasant to talk. The sound intensity falls quickly with increased distance. Appropriate for music studios and cinemas.

RT60=0,5-0,8s

Pleasantly subdued. Suits classrooms and practice rooms for musicians.

RT60=0,8-1,2s

Slightly subdued. Rich acoustics suitable for acoustic music performed in small groups. The reverberation time make speech float together a bit.

RT60=1,2-1,5s

Experienced as too much reverberation for speech in small rooms, but pleasantly subdued in larger rooms. An unfurnished living room will have a reverberation time of this length. Good response for music.

RT60=1,5-3s

Long reverberation suitable for concert halls and churches.

RT60=4s

Cathedral

Some roman churches can have a RT60= 9-11s

Early reflections

Equally important as the reverberation time is the time delay between the first original sound and the early reflections. The human ears are so sensitive to this delay that a blind and trained person can judge the size of a room by listening to the sound of a handclap. (Room Acoustics, Delphine Bard)

If the first reflection comes within 35 ms from the first sound, the reflection is considered as being a part of the original sound, reinforcing it. If it comes after, it will be considered reverberation and at last as an echo.

The intimacy of a concert hall depends of the dimensions. How long does it take before I hear the first reflections? Preferably, they should come from the sidewalls. By changing the angles of the wall, the reflection and diffusion of sound can be regulated.

If the first reflection comes early, this will contribute to a distinct and clear sound. By calculating how much of the total sound energy comes before the 20 ms, a measurement of clarity can be reached.

Sabins equation

The reverberation time can be calculated with Sabins equation.

-Absorption coefficient

To illustrate the different kind of colorations of sound (clarity etc), a comparison between two rooms with the same reverberation time can be made. According to Sabins the reverberation time depends on the volume of the room, the total surface area and the absorption.

The absorption coefficient is the fraction of sound energy absorbed at any surface. The value is between 0 and 1, where 1 is completely absorbed and there is no reflection. The absorption coefficient varies with the frequency.

$V = \text{Volume (m}^3)$ $S = (\text{area m}^2)$ $a = (\text{absorption coefficient})$

$RT60 = (0,161 \times V) / Sa$

The bigger the volume of the room, the longer is the reverberation time.

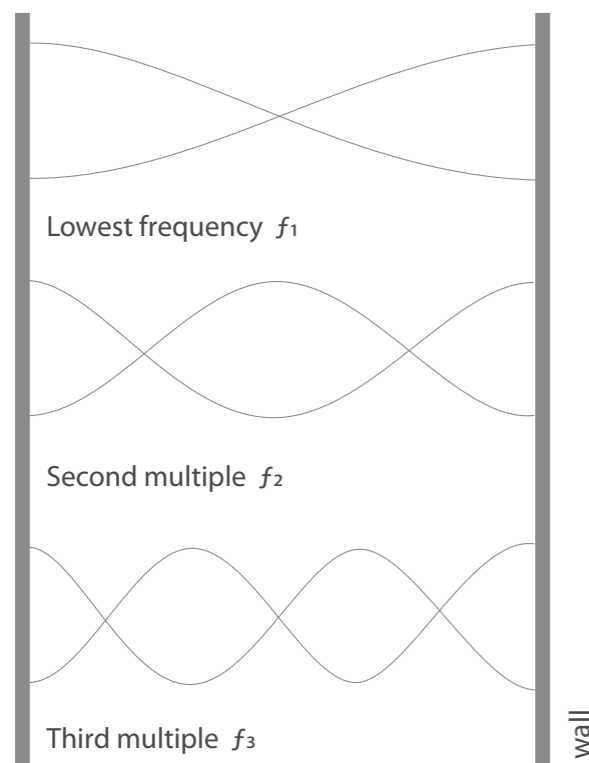
The higher the absorption coefficient, the shorter is the reverberation time.

According to Sabine's equation, two rooms can have the same reverberation time but different volume and materials: a bigger volume with more absorption and a smaller room with more reflecting materials. Considering the theory of first reflection we understand that the experienced sound will differ in the two rooms. In the smaller room the reflected sound will be considered as a part of the original sound since the first reflections will come earlier. The dimensions are also of importance. For a concert hall a narrow shape is better than a wide auditorium.

Standing waves and modal resonance

As mentioned in the beginning, the theory of modal resonance and standing waves is applied for wave-lengths with dimensions close to the dimensions of the room.

When a low frequency sound is performed between two parallel walls the sound wave will be reflected back and forth. There will be a wave travelling to the right and one wave travelling to the left. If we change the frequency slowly, the sound energy will increase at a certain point. If the frequency at this point is called f_1 , there will be a similar increasing of sound at $2f_1$, $3f_1$ and $4f_1$. What happens is that the wave travelling from the right interacts with the one travelling to the left, and the energy of both waves are added. A stable condition, called a standing wave is established.



The simplest mode is between 2 parallel walls, but similar waves can be established between 2 up to 6 of the walls in a room. (Master Handbook of acoustics. F. Alton Everest 2001)

The effect is easy to discover in a small room for lower frequencies. Standing in the stair way in school, between two painted parallel concrete walls, I heard my voice becoming much stronger speaking with a low voice. Moving a few steps up, where there was no wall behind me, the effect disappeared. The same effect can be discovered singing in a bathroom. The small square "Resonance room" in Therme Vals by Peter Zumthor uses this effect.

The number of frequencies giving a modal resonance increases with the volume and with the frequency; for large rooms in the high register, there is large number of eigen-frequencies.

The strategy when it comes to standing waves is to get them spread as evenly as possible. Diffusers to spread the sound in many directions and absorption to dampen the effect can be used in smaller rooms where there are fewer eigen-frequencies and the effect is more obvious. (Brandt: Akustisk planering, Statens nämnd för byggnadsplanering 1958)

The effect is easy to discover in a small room for lower frequencies. Standing in the stair way in school, between two painted parallel concrete walls, I heard my voice becoming much stronger speaking with a low voice. Moving a few steps up, where there was no wall behind me, the effect disappeared. The same effect can be discovered singing in a bathroom. The small square "Resonance room" in Therme Vals by Peter Zumthor uses this effect.

Acoustic design of today

The aesthetics of contemporary architecture, together with demands on flexibility and multipurpose use, cause a lot of acoustic problems. The field of acoustics has however taken a step into the public awareness the last years. Becoming an interesting field for designers, the market for absorbing panels and textiles increases every day. The discussion on acoustics would nevertheless profit from other aspects than only absorption and dampening of sound.

Björn Hellström, architect and acoustician, gives in his book *Noise Design- Architectural Modelling and the Aesthetics of Urban Acoustic Space*, a more nuanced picture of sound and noise. He encourages an active strategy for the planning of sound in our cities, and suggests a sound architect as well as a town architect with the overall responsibility for sound at the planning department.

The observations and arguments in the analysis on sound and space in this rapport mostly consider the sound of the building itself, interacting with its visitors. The situation for an acoustician is usually somewhat different.

Finding a balance

First of all, the building is usually already designed and sometimes even built. Not only the sound of people walking and talking has to be considered, but also fan systems and clatter of keyboards standing out when other sounds are dampened.

In a restaurant, a fairly high level of sound creates a pleasant and lively atmosphere. The guests nevertheless, want to hear what their company says, but they do not want to hear their neighbours, or at least they do not want their neighbours to hear them. Nor do they want to come home with ringing ears.

In an interview with sound designer Niklas Billström, he talks about finding a balance. Many times it is impossible to remove sounds since this only will bring other forward. Working with the interior sound of a train the balance for an understandable train environment where no sound is to prominent is strived for.

Process- Thoughts and comments

Starting in January, I did not know what to expect either from the process or final result. Seven months and a summer later I am satisfied and happy with the project and that I finally got the opportunity to learn more about the world of sounds. The project has lead me through heavy books on acoustics, visits to art museums, listening and analysing various situations of my everyday life- from the bus trip to school to visits to churches, restaurants and cinemas, to reliving early musical and acoustic experiences from my childhood. The number of friends and strangers sharing acoustic memories and experiences has been elevating and confirms the importance of the subject. It has been the most challenging and at the same time the most pleasant project I have worked with during my time at the University of Lund.

A space for art- choosing art

It became clear early in the process that I had to know what kind of acoustics I aimed at before starting designing. Together with my tutor I decided to create a space for art; three objects and the space around them. The focus should be on the acoustics in the room and how the acoustics could colour the experience of the art. I made it clear from the beginning that I had to work as an artiste, allowing myself to add my personal interpretation to the art objects. The interpretation of the artists and their work became the starting point for the building.

After having interpreted the art and decided what I wanted to reinforce around the three objects, it was time to precise the acoustic environment that could help me create this. To be able to decide what the acoustics could do to the art pieces and what feeling the acoustics could reinforce, I have made an analysis of different room types and reverberation lengths. The result from this analysis is then applied in the building.

Analysis

The analysis is mainly based on my own experience of acoustics and space and focuses on the individual verses space. Do the walls respond to my presence? What do I experience? The space? Or my own movements and actions? Other people's movements or actions? And, most importantly, how can I as an architect use this in my work?

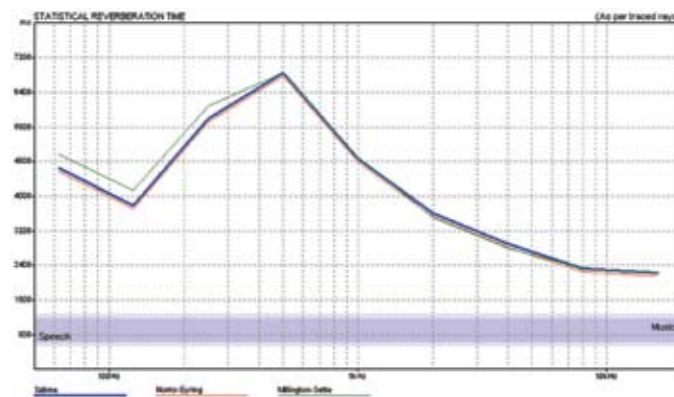
At first, the definition of the wanted acoustics around the objects has been rather vague and expressed only in terms of reverberant and absorbing. To communicate my intentions to the acoustician Delphine Bard at the department of Engineering Acoustics at Lund University, references to known buildings have been used, such as the cathedral in Lund, a small cinema and other public places. Along the project, the definition has become more and more precise with reverberation time and absorbing coefficients of the materials being used.

Resources used to achieve acoustic accuracy

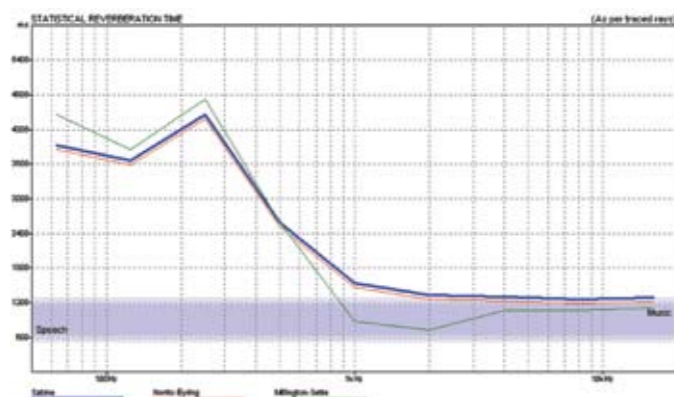
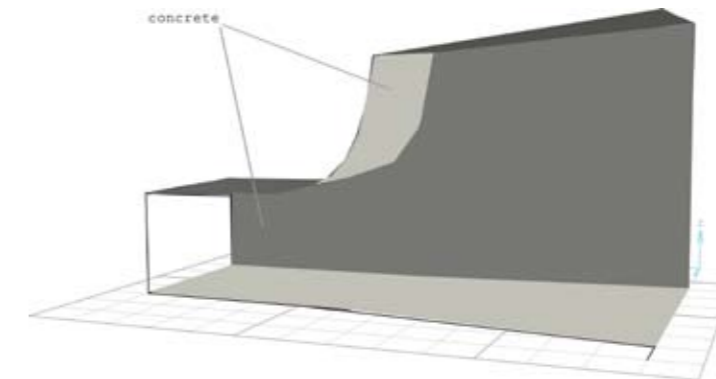
Consultations with Delphine Bard, PhD Engineering Acoustics.

During the semester I have been studying Room acoustics, and with support from Delphine Bard, I have discussed my ideas around the design to try the theories and develop the acoustic accuracy of the sequence. The studies have treated basic acoustic and physical phenomenon of sound. I have learned what causes unnecessary acoustical problems in buildings and how to avoid them. I have learned how to get good diffusion in a room, how to absorb bass frequencies and how to absorb frequencies in the higher register. I have also learned the basics in creating an

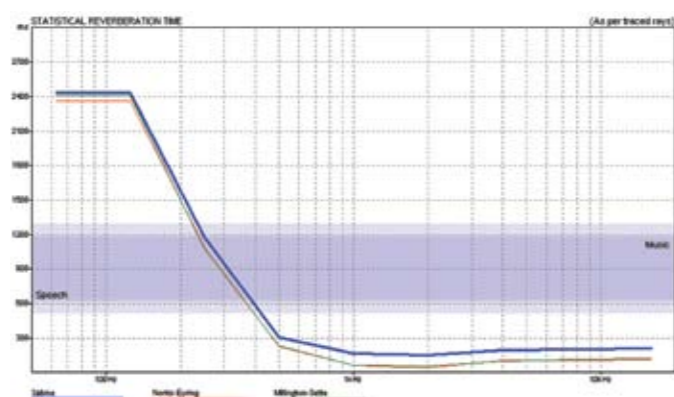
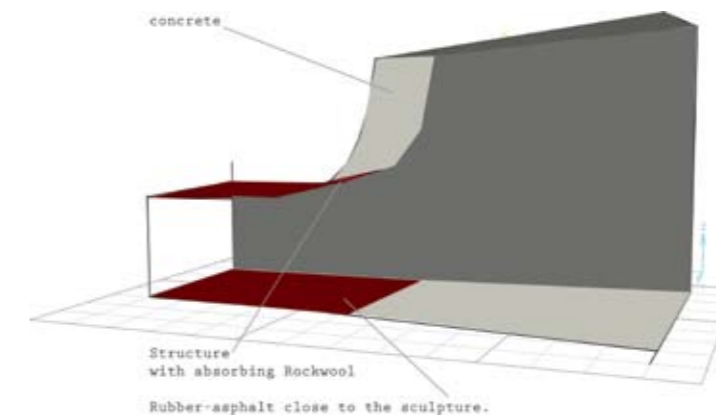
Resources used to achieve acoustic accuracy - Ecotect



The graph shows the Reverberance time (RT60) when all surfaces are made of concrete. The average reverberance time (RT60) is about 5 s.



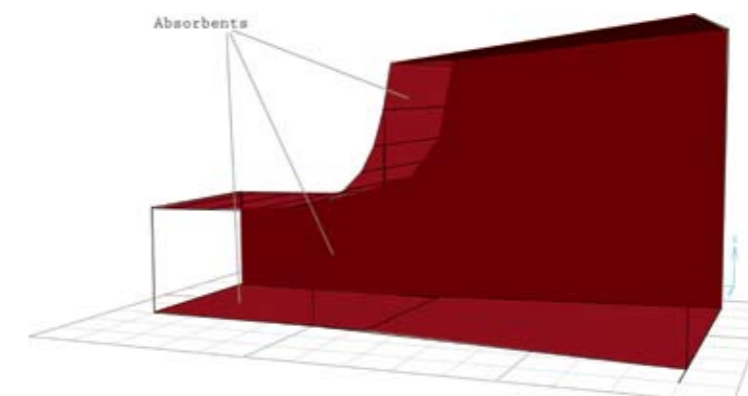
The graph shows the RT60 when the lower half of the curved wall has integrated absorbers as well as the floor in the lower part. The average reverberance time (RT60) is around wanted 3 s.



The graph shows the RT60 when the whole of the room for the Ballerina is clad with absorbers (walls, ceiling and floor).

The average reverberance time (RT60) is much below the wanted 3 s, for frequencies above 500 hz the RT60 is under 0,3s. (440 Hz is the same frequency as you normally have in a tuning fork)

The lower purple part of the graph indicates reverberance appropriate for speech.



auditorium and how to focus the sound to specific spots and many other things. This basic understanding for the behaviour of sound has been important for my liberty designing the space around the objects. The discussions with Delphine Bard has been very helpful and have first of all given me the confidence to think and create in terms of acoustic shapes.

My goal was a viable project, which Delphine Bard confirms. Of course, if the art pavilion were to be built, more thorough studies would have to be made to achieve the exact atmospheres and acoustic qualities desired.

Ecotect

Simple models have been made in Ecotect, a computer program treating environmental facts such as weather, sun and sound, to study the spreading of sound in the first reflection (for example at the convex wall in the entrance room) and to make rough calculations of the reverberance time of the different parts of the sequence.

Sabins equation

Before using Ecotect, simple calculations were made to get an understanding of the importance of the dimensions and absorption coefficient for the reverberance time. In an excel sheet, the reverberation time was studied changing the height, length, width and materials of the room. Learning Ecotect, I abandoned the calculator for the much quicker program...

Literature

The theory written on room acoustics mostly treats examples for studios and concert halls where a perfect diffusion and reflection of sound is crucial. The pavilion does not require the same standards, nor does it depend on clarity of speech. It has been a deliberate choice not to treat the surfaces the way a concert hall or music studio would require. I have instead adapted my demands to the wanted activity. I have made basic calculations to decide the volume needed for the wanted reverberation and absorption, and most important, asked Delphine Bard of her opinion.

Organisation of the building

Each acoustic situation around the object has initially been considered as a solitaire, without any consideration regarding the transition between them. The experiencing of acoustics however depends on the contrasts between the experienced sound environments.

Working with different models for connections between the three acoustic situations, the building has finally become a walk through a sequence of different sound environments.

At first, as a long sequence of the same width, where only the ceiling and the floor moved up and down and the acoustics determined the space around the art. Visually the visitors could see the next art object from the present but not experiencing the situation before standing close. For several reasons the idea has been developed to a pavilion where each art object was experienced on its own, both acoustically and visually.

Since situated in a park where the art is experienced along a walk, the experience of the building starts already outside the pavilion.

Representing the atmosphere

Recording – Acoustic walk

Technically it would have been possible to make an auralisation of the building. The pavilion would then be modelled in an acoustic 3-D program, with the building materials specified. The sound added would then act the way it would have, being performed in the building.

Since I have considered my role to be the one of the visionary and not the engineer, I decided to make a mock up of the sound I aim at, by recording sounds from different places, mixing them together in Logic. Like this I can communicate the goal and acousticians can help me to reach it.

A pavilion with or without art?

During the process I have asked myself the question whether the art objects are important for the final result, or if they only have been a way of generating new shapes. Would the building be able to stand for itself?

I am convinced that some of the effects I want to achieve will be able to perceive also without the art, and that the spaces created will be interesting architectural experiences. The point with the project is however to investigate, by consciously working with the acoustics as a design element, how the experience of a space, actions or placed objects in this space can be influenced.

Comments from the Artists

Dear Magdalena,

Your project is very interesting and beautiful !
You can use all material you can get.

All best for your project!
Markku Salo

Hi Magdalena,

Thanks for your mail. Your project looks interesting. I would be curious to experience the work in intensified acoustic conditions!

Best regards, Erik

Pictures from the process

Exterior strategy

The inside of the building will vary a lot from one part of the building to another. The question is if the exterior shape should be a result of the inner shape, or if they work more or less independently.



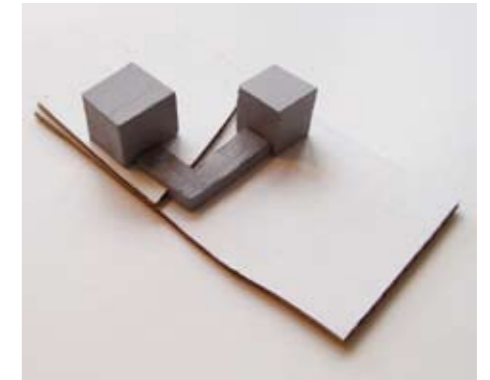
One rectangular body.
The shape of the building does not with its exterior reveal any of the interior acoustic shape.



One rectangular foot print.
The roof line of the building is adapted to the inside. The volumes of the different spaces can be read from the outside.

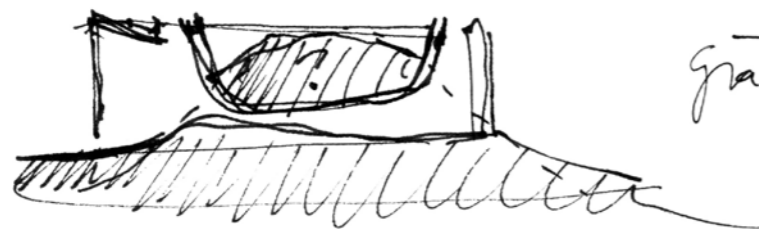
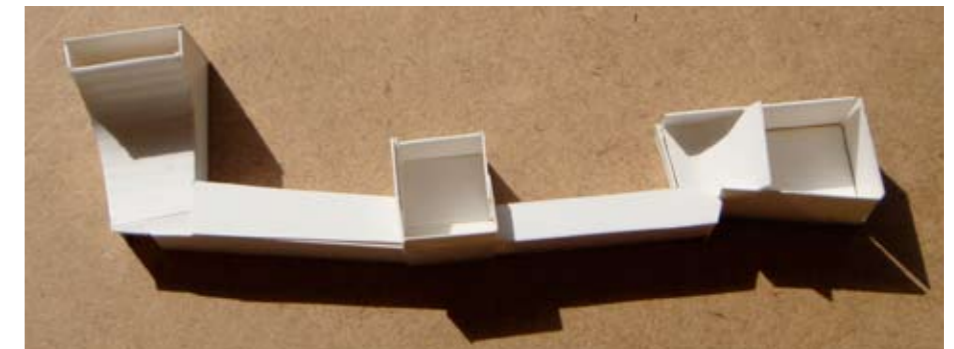


Each room has its own building.



Moving in angle.

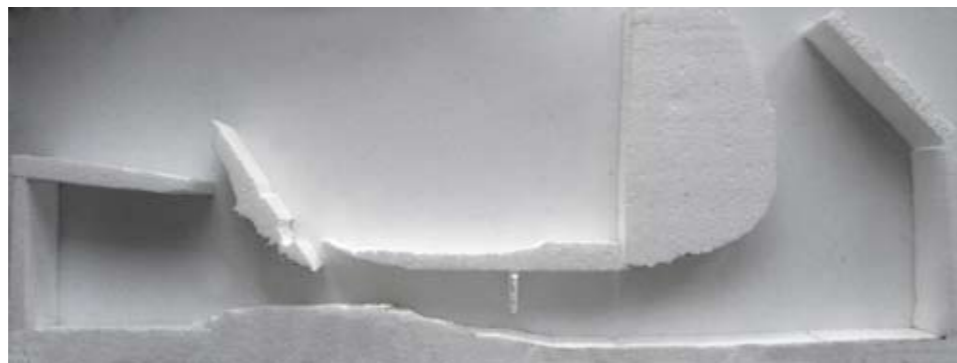
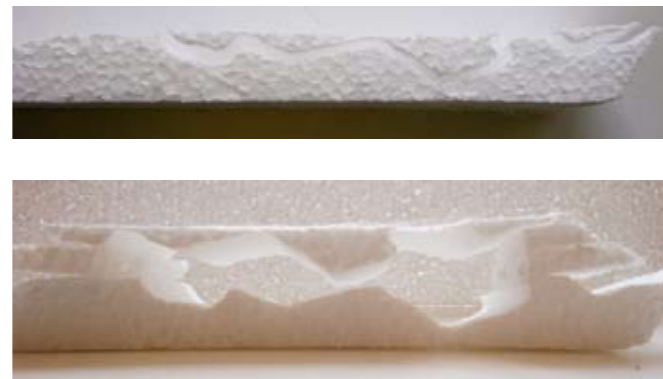
Two volumes in open air, one covered under the hill.
The acoustic shape and volumes can partly be seen from outside.



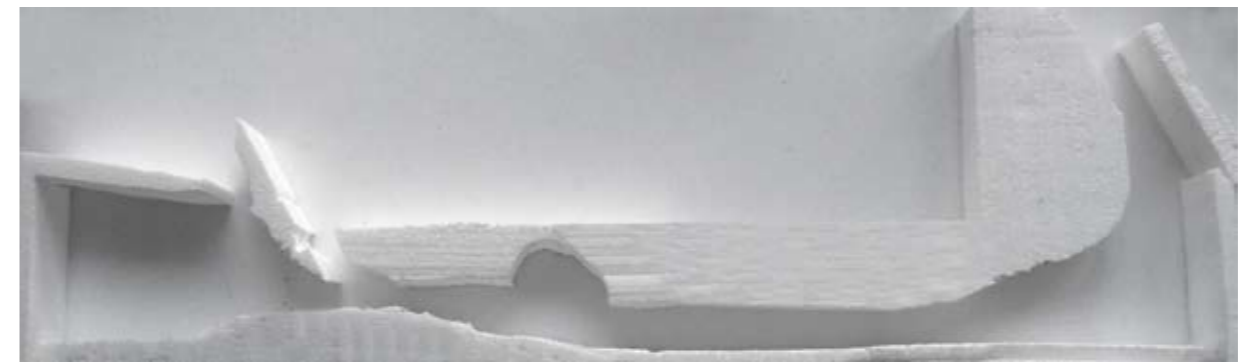
grava in i kulle?



Interior strategy



Developing the sequence, studying light and acoustic shapes.



Different sound environment need different materials.
What does the overlap look like?



Same material, different treatment.

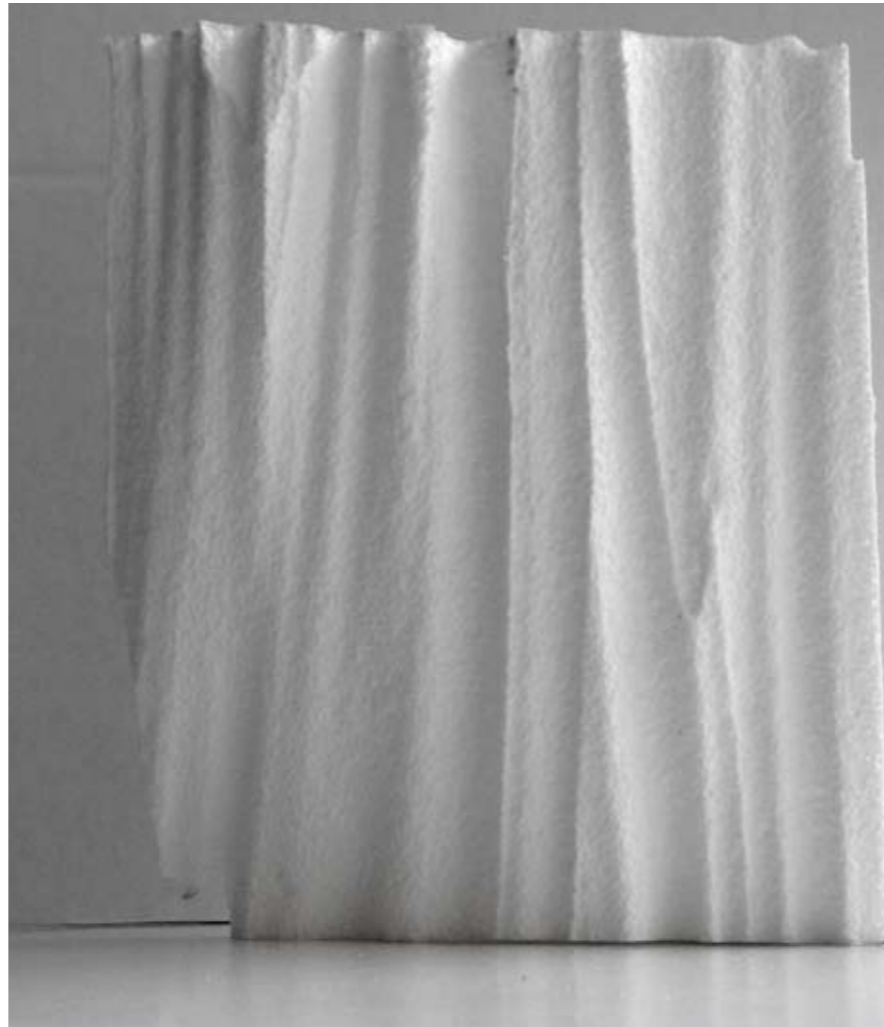
Ex. Concrete walls, plane surface for reflecting walls, surface with structure for diffusing abilities and perforated surface for spaces needing absorbing properties.



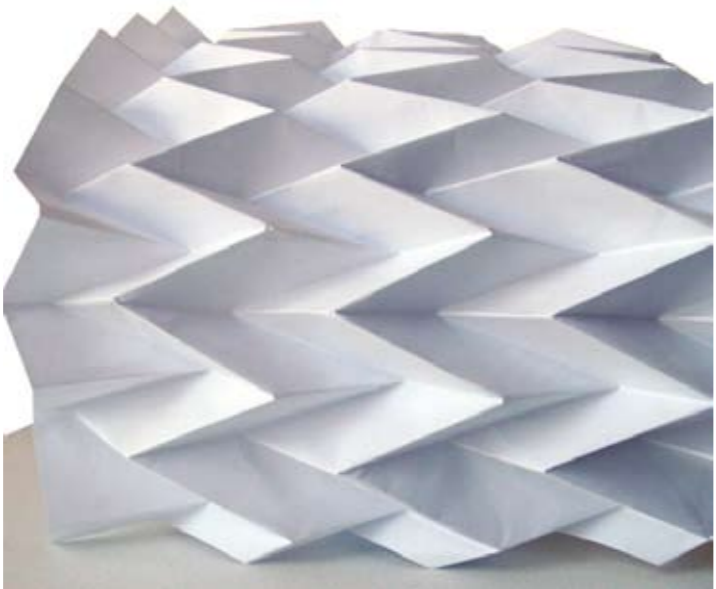
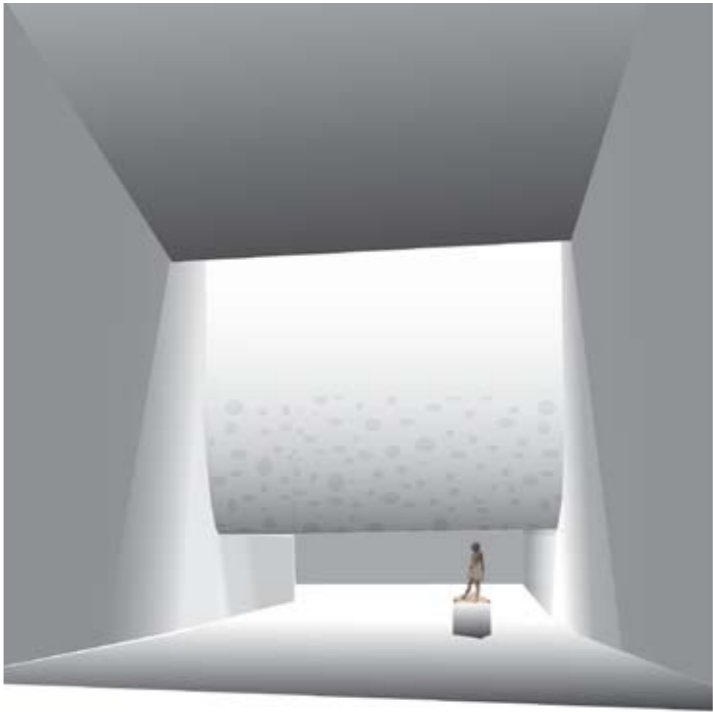
Different materials, absorbing and reflecting. Gradually changing or immediate change.



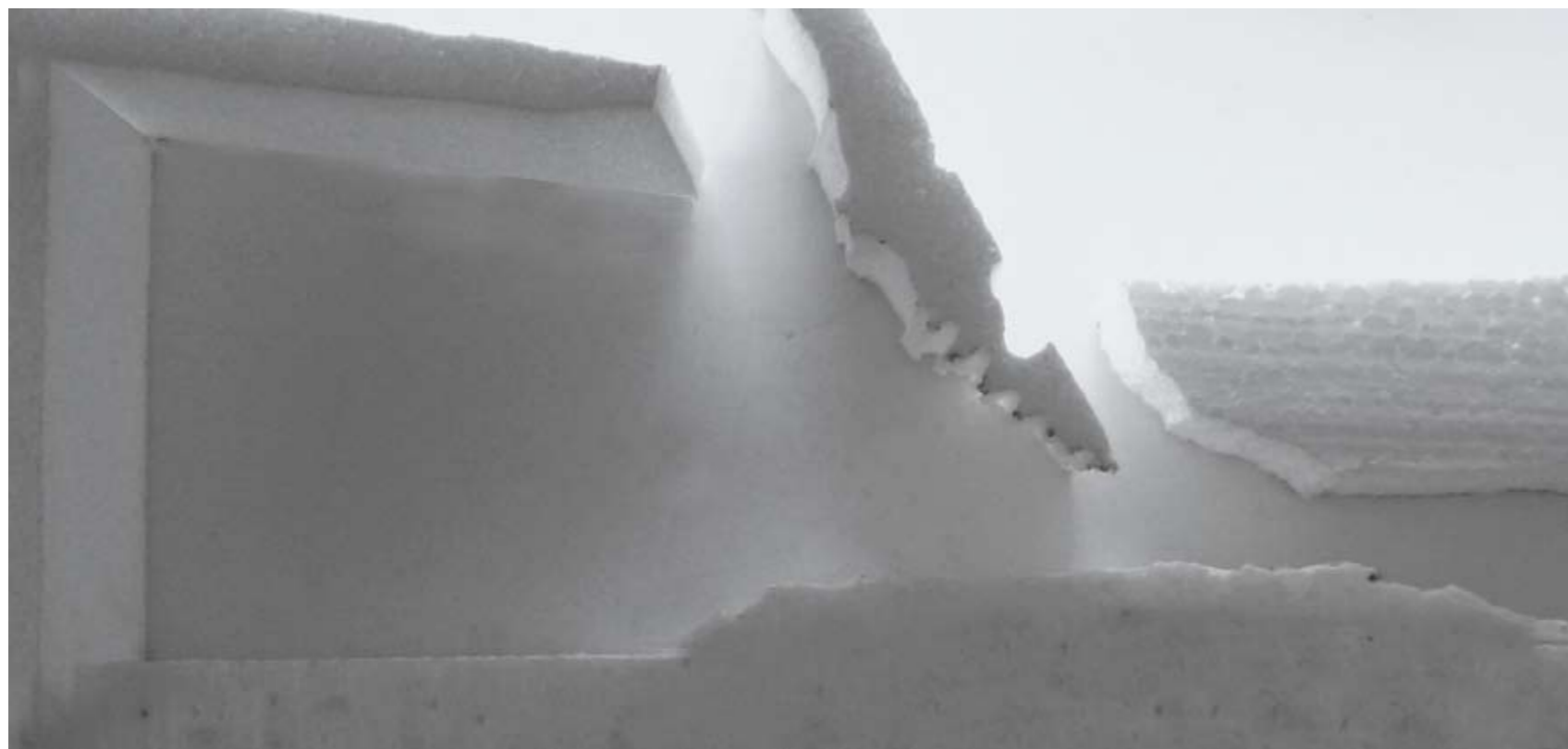
Structure - Diffusing walls



Structures on concave diffusing wall



Light studies





Art:

Markku Salo:

Dan Klein <http://www.globalartglass.se/html/konstnarer05.html>

Degas:

The making of the sculpture

<https://www.msu.edu/course/ha/446/richardkendall.pdf>

National gallery:

<http://www.nga.gov/education/degas-20.shtm>

Nationalencyklopedien

Inspiration: Mute room, Faulder Studio

http://faulders-studio.com/proj_mute_room.html#

bild med klotsar/ snölandskap i second life:

archidemo.blogspot.com/2008_07_01_archive.html

Erik Olofsen:

www.erikolofsen.com

Articles on Acoustic Design:

Björn Hellström: "Akustisk design. Spola snacket-prata istället om ljudkvalitet!

Väg- och vattenbyggaren 2-2007

Björn Hellström: "What do you want to hear?"

Interview in Resonance 2006

Björn Hellström: Conference paper

"Acoustic design in Commercial space". 13th International Congress on sound and Vibration, Vienna 2006

Björn Hellström: Noise Design – Ett sidokott från soundscape-rörelsen

Nutida Musik – Tema Ljudkonst, rumsliga aspekter, nr. 1, 2007

Books and articles on Room acoustics:

Catharina Dyrssen (1995)- Musikens rum-metaforer, ritualer, institutioner.

Bo Ejeby Förlag

F.Alton Everest (2001), -Master Handbook of Acoustics, Fourth Edition

McGraw-Hill

Hellström Björn (2003), Noise Design – Architectural Modelling and the Aesthetics of Urban

Acoustic Space,

ISBN 91 88316 38 6, Bo Ejeby Förlag.

R.Murray Schafer (1992) – Ljudbildning-100 övningar i konsten att lyssna och skapa ljud.

Bo Ejeby Förlag

Brandt (1958) -Akustisk planering

Victor Pettersons Bokindustri aktiebolag

And finally, one week before finishing the project I found this book confirming many of my thoughts and arguments. An interesting book for architects on acoustics:

Blessner/Salter: Spaces speak, are You listening?

Thank you,

Christer Malmström; Tutor

-for understanding the spirit of the subject and what I wanted to do, putting the project on tracks. Your calm attitude taught me to solve the problems when it was time and avoid worrying about them before.

-for sharing my curiosity and enthusiasm over sound phenomenon and art pieces. I am glad you knew as little as I did about acoustics from the beginning. It gave me the freedom to do it my way.

Lars-Henrik Ståhl; Examiner

- for inspiring discussions on music, sound and architecture.

Delphine Bard; Acoustic engineer with an artistic soul.

- for supporting and developing my thoughts. You gave me the courage to draw acoustic shapes and bring art and science together.

Nils Fjelkegård; Friend, recorder of sounds and mixmeistro.

- for acting both American tourist and couple from Kalmar.

- and for doing the last changes.

Staffan Mossenmark; composer and sound artist.

-for a nice afternoon with old memories and liberating ideas.

And, of course, to family and friends, especially Andreas, for supporting, listening and reading.