Process report

for the

4th MA ID semester

by

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TITLE SHEET

Synopsis

4th MA ID semester
Industrial Design
Architecture and Design
Aalborg University

Title:
Noise in open offices

Period:
From the 2nd of February
to the 3rd of Juni

Supervisor:
Bente Dahl Thomsem

Summary
This project is about noise in open offices. The research is divided into three main categories; noise, materials and shapes to prevent noise distribution, and activities in open offices.

The research about noise is conducted with help from a consultant from Acoustics at AAU. The consultant also assisted with the research regarding materials and shapes to prevent noise distribution.

The research about activities in open offices was carried out through interviews.

The development phase was primarily done by sketching hand, 3D and scale models.

Thais Andreas Bjerregaard Pedersen

TITLE SHEET

Contents

REPORT

Introduction

A short introduction to the report and its content.

This project is about prevention of noise in open offices. As a part of the idea of knowledge flow open offices has grown more and more popular. But with open offices comes a higher level of noise distribution. In this project noise will be defined as unwanted sound. This however is not entirely unproblematic as a sound can be wanted by one person and unwanted by another; e.g. phone calls.

Research phase
The research phase is revolving around gathering information about topics relevant to the project. The main topic for this project is sound; both the technical aspects and the psychological. Other topics of importance is material properties, evaluation of existing products and interviews with people located in offices with noise problems.

Development phase
The development phase is about using the information gathered in the research phase to a suitable design for the problems found in the research phase. This will be done by analysing the data from the research phase, by brainstorms in text and sketches; hand drawn and in 3D, and by models.

It is this process that will be described in the report.

The project, process and report will end with a presentation of the design achieved through this semester.

Research phase

SOUND

Psychological effects

This section about sound will consist of a short description of the psychological effects of noise, a more technical description of sound but without the mathematics. In the end there will be a sum up on design requirements, what to prevent and what to take advantage of, derived from the section.

The Trade Work Environment Committees for Social & Health, Finance/Public Offices & Administration and Education & Researchs joined web page, http://arbejdsmiljoweb.dk, gives some factors that makes noise more disturbing:

"When the noise level increases it is experienced as more disturbing. But other factors also have an effect:

- Constant, uniform noise affects you less than noise that varies.
- If you can predict the noise it will seem less disturbing.
- If you have control of when the noise comes, it will be less disturbing.
- If you have to concentrate or solve difficult tasks in a noisy environment, you have to strain more, and will therefore be more tired."

The psychological effect of noise in open offices are much more than just a annoyance. The government's Palaces and Properties Agency and Trade Work Environment Committees for Finance/Public Offices & Administration's publication "Arbejdsmiljø I Åbne Kontorer - Forskningens Bud På Problemer Og Løsninger" also offers an explanation to why noise is so important to prevent.

Psychological effects

The number of noise complaints rises steadily with the number of people in an open office. With them follows complaints about concentration difficulties, headaches and so on. Nevertheless, another study shows no difference in job satisfaction, general health or mental health between single person offices and open offices.

The perception of what real work is is very important to how disturbing sound is perceived. If real work is only thought of as the time spent in front of the computer or otherwise producing, talking and small informal meeting will be perceived much more disturbing than if talking was also regarded as work.

The older the staff the harder it is for them to work in an open office. This is due to the combination of noise camouflaging the speech and their hearing failing due to their age making it even harder to hear what is being said. In average the hearing loss for a 65 year old is 35 dB at 4000 Hz, which is rather serious as 10 dB is equivalent to a doubling of the sound level. Therefore a younger person is doing better than older people in an open office.

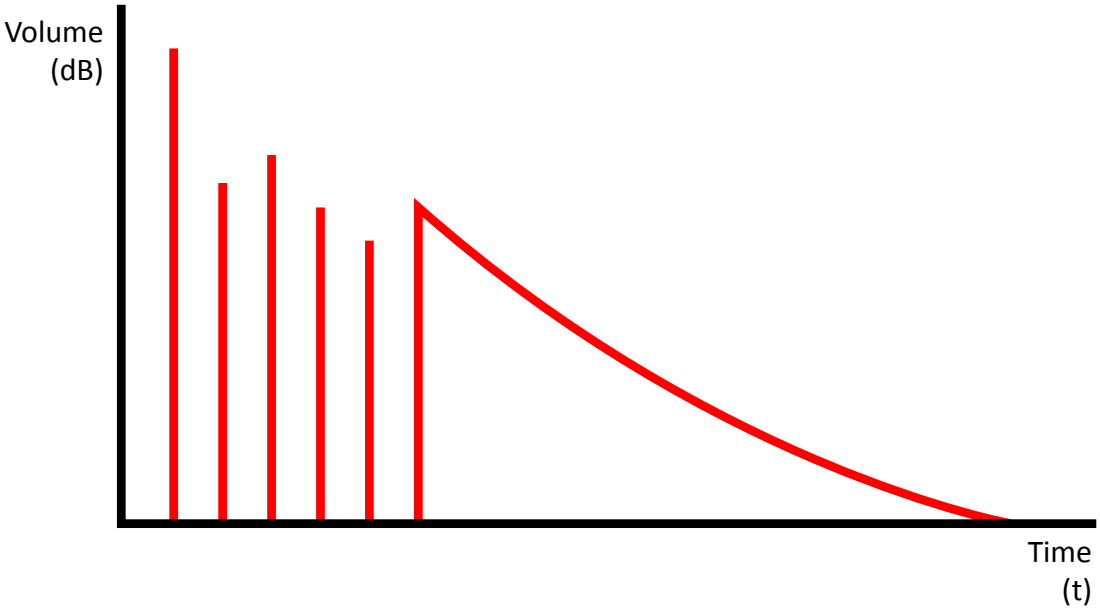
Technical: Reverberation

This section will explain the relevant technical aspects of sound that can be considered in the design of a noise reducing product. The results of the section will be a part of a design specification.

A short reverberation time is crucial for a conversation to be carried out without any strain for the listener or loss of the message itself.

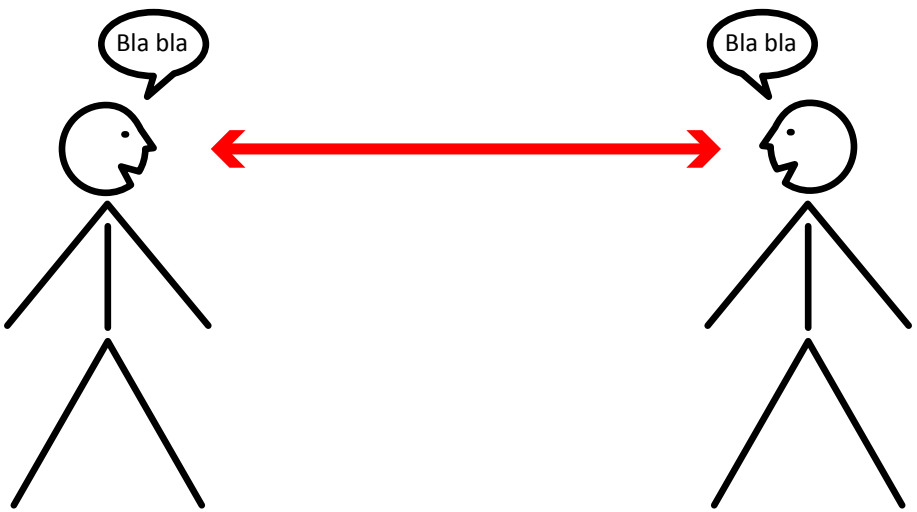
The reverberation time is defined as the time it takes a stabile level of sound energy to reach zero. Even if the sound energy is only stabile for a very short period of time, e.g. a gunshot, this definition is still valid.

The illustration shows the reverberation time of a short burst of sound energy, the first four reflections and the diffuse reflections. The reverberation time would have the same definition if the sound was continuous.



Direct sound

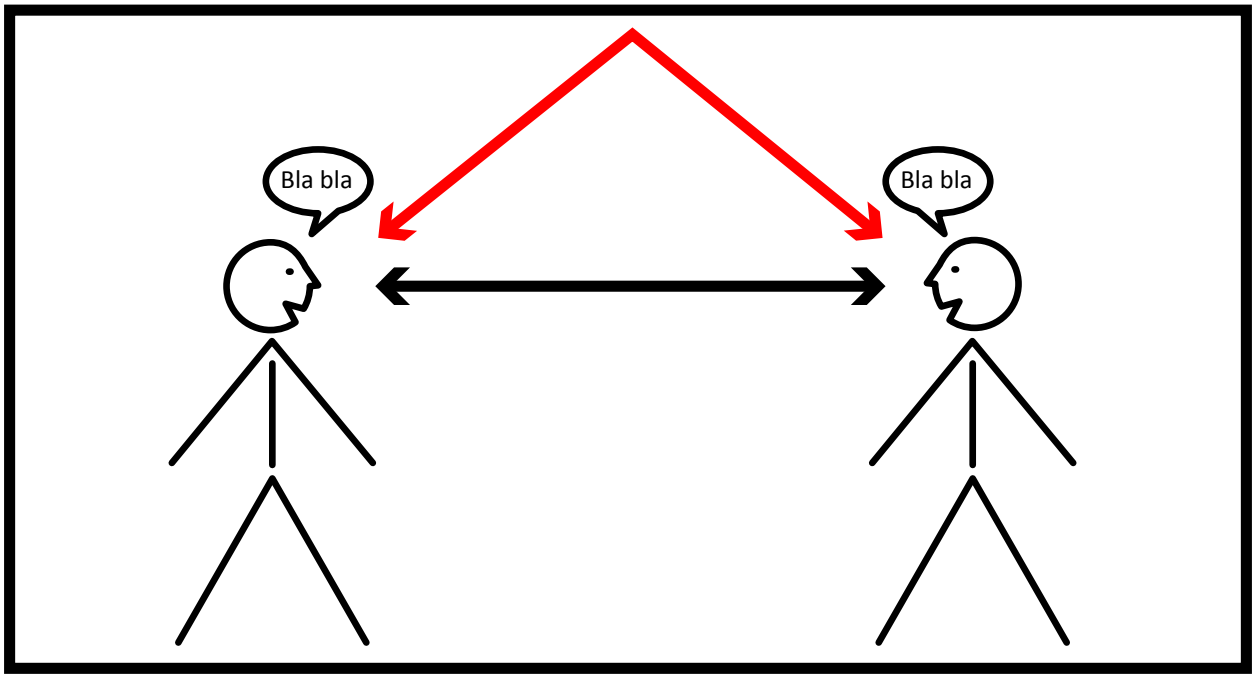
Direct sound is defined as the sound that passes from the source directly to the listeners ears with no obstacles in the way. The direct sound can be blocked by objects, but not all materials are able to do so. Some are only able to lower the dB level and/or diffuse the sound.



Reflected sound

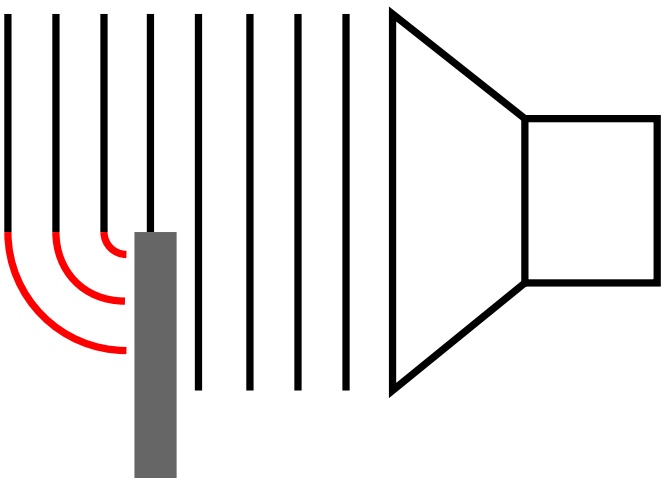
The reflected sound is the sound that reaches the listeners ears via reflective surfaces such as ceilings, walls, floors or furniture.

The reflected sound will always reach the listener slightly after the direct sound due to the longer travelling distance.



Diffracted sound

Diffraction of sound waves works the same way as diffraction of waves in water and light. If an obstacle prevents the sound from progressing, the diffraction will spread the sound behind the object. The sharper the edges of the object, the more easily the sound waves are diffracted.

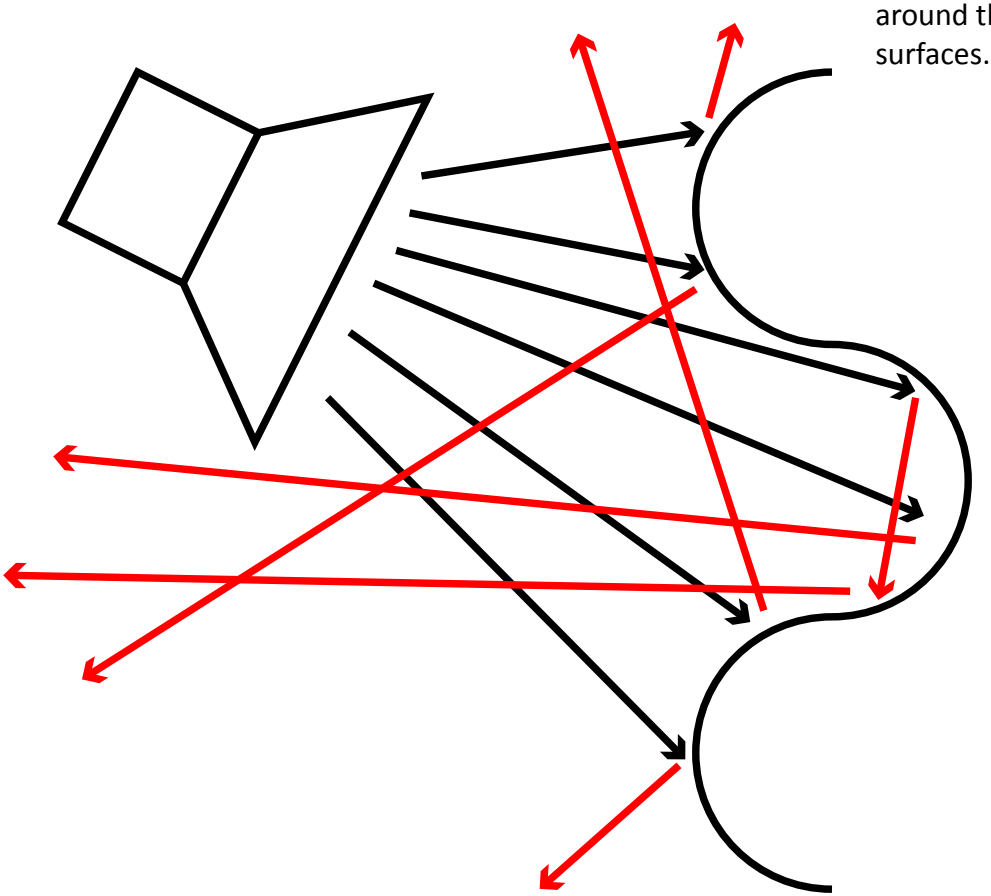


SOUND

Diffusion

Diffusion of sound occurs when sound is transmitted through a material and thereby disturbing the sound waves and making them go through the material at slightly different speeds.

Diffusion also occurs when the sound waves are reflected on non-plane surfaces. By reflecting sound on non-plane surfaces the sound waves will be dispersed in the room and deadened faster than it would being reflected more directly around the room on plane surfaces.



Absorption

Absorption is a materials ability to stop sound waves from reflecting via the material itself. There are three ways a material can absorb sound waves:

- By reflecting the sound waves around inside an open-cell material.
- By converting the sound waves into heat by deformation in a dense viscoelastic material.
- By combining hard and porous materials to a membrane.

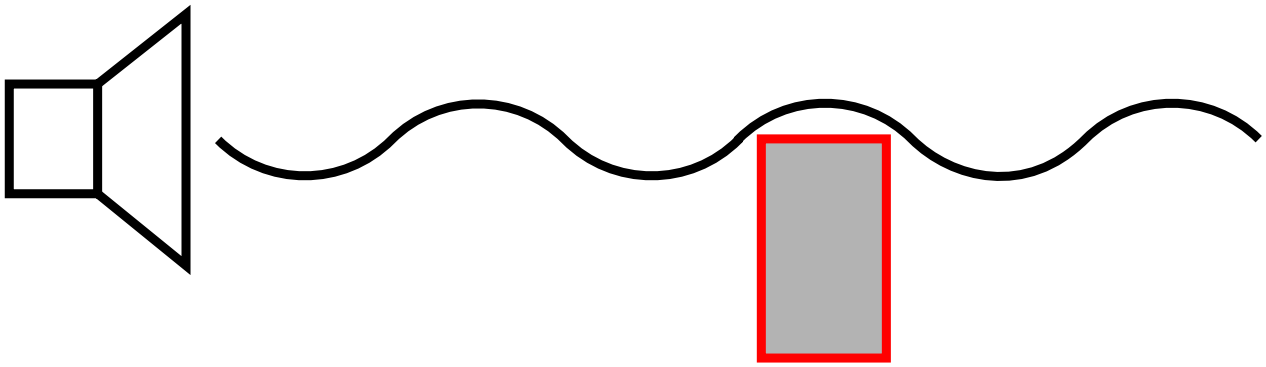
The difference between these three methods of absorption is the frequencies they can be applied to. The open-cell material is best for the higher frequencies and the dense viscoelastic material is best for the lower frequencies.

For the low frequencies the use of different materials can also be applied. Such a construction could be a membrane consisting of relative thin and hard materials like wood panels on the surface and a thicker and porous material between the wood panel and the wall.

There is of course a limit as to how high or low frequencies that can be absorbed, which also relates to the volume of the frequencies though some materials can lower the volume with up to 9 dB for the low frequencies.

Wavelengths

The wavelength of sound is also to be taken into account because the higher the frequency the shorter the wavelength. High and low frequencies can be absorbed by the same material or construction because sound waves go around objects that are smaller than its wavelength. That means in practice that low frequencies are not stopped until it reaches the walls of the room. A sound of 100 Hz has a wavelength of 3.34 m and is as such not stopped by objects smaller than 3.34 m on all three axes. The voice of a grown man is between 100 Hz and 150 Hz.



SOUND

Sum up

The general goal for a more comfortable environment is to lower the reverberation time.

To do so there are several aspects of sound that must be achieved.

On a psychological level the main priority is to lower the sound level in general as low volume sound will reverberate for a shorter period of time than high volume sound. The shorter reverberation time will lower the cases of concentration difficulties, headaches and better work environment for elderly.

On the technical level there are parameters to prevent and parameters to exploit. Fortunately the parameters to exploit can help relieve the parameters that are to be prevented.

These parameters and what to do will be listed here:

- Direct sound: to prevent direct sound the materials used must have good ability to absorb to avoid the sound being transmitted through the material.

- Reflected sound: to prevent reflected sound the materials used must have good ability to diffuse and absorb.

Sum up

• Diffracted sound: to prevent diffracted sound the materials used must have good ability to absorb and rounded edges.

• Diffusion: to exploit diffusion the materials used must be shaped as curved as possible; even plane surfaces must be altered to resemble for instance an egg tray.

• Absorption: to exploit absorption the materials used must be able to absorb the frequencies there are in the given environment.

Wavelength: the chosen design must take into account which frequencies it is trying to block or absorb.

MATERIALS

General properties

The sections will describe the best properties for materials to be used for noise reduction.

There is one main area where the material properties and combination of materials have an important influence on the products ability to reduce the noise; absorption. However, the materials ability to absorb noise changes according to which frequencies the material has to absorb.

In general the rule is that high frequencies are best absorbed by porous, open celled materials (foam) and the low frequencies are best absorbed by materials with a higher density (plaster) or visco-elastic properties (rubber).

Nevertheless, harder materials can be used in combination with foams in membrane constructions. These constructions are best suited for the low frequencies. A membrane construction could consist of a wooden panel covering a layer of foam. When the construction is used in corners it is also known as a base trap.

EXISTING PRODUCTS

Evaluating three products

The evaluation of three existing product will show some of the features in the market, what to match and what to improve. The results will be part of a design specification.

This evaluation of three existing products is set op as a SWOT analysis to simplify the result, but it will not be as thorough. The three products in the study have been chosen because they represent three systems of sound reduction: wall/ceiling based, divider based and both wall and divider based. The selected products are B6 AntiNoise (wall/ceiling), Privacy from Glimakra (freestanding) and design5mm (wall/ceiling and freestanding).

EXISTING PRODUCTS

Evaluating three products

AntiNoise by B6
(wall/ceiling)

Strengths:
• Simple aesthetics to not take focus from other tasks at the office.
• Good acoustic abilities in sound reduction above 500 Hz. Readings of noise reduction coefficient (NRC) at 0.99.
• Easy to dismount for cleaning.

Weaknesses:
• Anonymous aesthetics, very conservative to look at.

• Poor acoustic abilities in sound reduction below 500 Hz. At 125 Hz NRC is 0.19 and at 250 Hz NRC is 0.60.
• Will perhaps collect dust between product and wall/ ceiling.
• If placed on ceiling, reaching the product to clean might become an arduous task.

Opportunities:
• More focus on aesthetics could generate better sales.
• Mounting closer to wall/ ceiling would make it collect less dust.
• Other materials could help absorb the lower frequencies.

Threats:
• Can be overlooked because of its aesthetic features.
• Might be deselected for excessive need of cleaning

EXISTING PRODUCTS

Evaluating three products

Privacy by Glimakra
(freestanding)

Strengths:
• Interesting aesthetics with good graphics to brighten up an office.
• Easy to move around.

Weaknesses:
• No numbers on sound reduction, but if they are like other products from Glimakra they are rather poor even at high frequencies.
• One big piece of furniture. With no possibility to adjust its size.

Opportunities:
• Other materials could help absorb the high frequencies.
• Adjustable size or different sizes to choose from could make it easier to furnish with this product.

Threats:
• The product can be deselected for being too inflexible.

EXISTING PRODUCTS

Evaluating three products

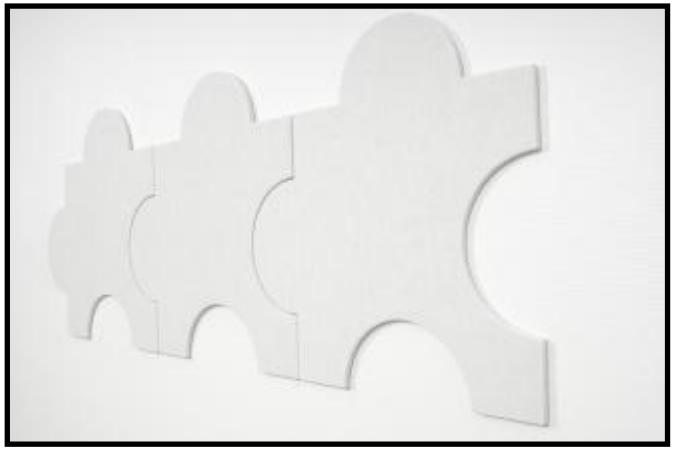
design5mm
(wall/ceiling and freestanding)

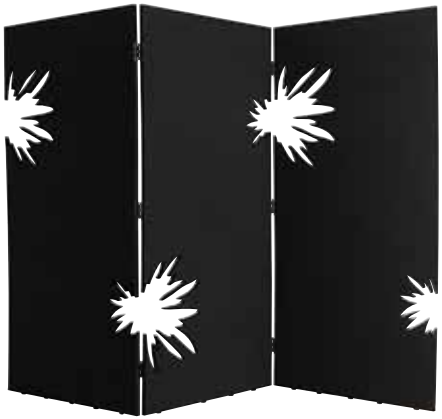
Strengths:
• Modular build secures a variety of sizes.
• Playful aesthetics that is easy to relate to.
• Flexible relocation ability (to a certain degree as some parts are suspended from the ceiling).

Weaknesses:
• No numbers on sound reduction ability but the material is very thin, so there will be limitations in sound reduction.
• Room dividers and fold screens can only be plane if suspended from the ceiling as they have no feet.

Opportunities:
• The ability to have freestanding size adjustable screens could be profitable.

Threats:
• Hanging screens might be considered too inflexible.





EXISTING PRODUCTS | Sum up

This sum up of the evaluation of three existing products is part of the design specification that will be presented later on in this report. Here the three main parameters derived from the evaluation will be presented.

Acoustics
The acoustic abilities of the new design must exceed the existing products and especially so in the frequency area below 500 Hz. The reason for this is that this is the area of the human voice and the interview clearly state that noise from other people speaking is a major distraction as will be shown in the interview section. Above 500 Hz most of the evaluated products do very well and there is virtually no room for improvement.

Interaction
Under interaction there is one main parameter; mobility. Under this there is the possibility to move freestanding screens, easy install and re-install for wall mounted designs, and possibly a modular build for making these easier and more flexible.

Aesthetics
There are also some requirements for the aesthetics; simple, decorative, interesting, playful. These requirements are very open, but still important as they demand more than just a square.

INTERVIEWS

Interview one

Three interviews were carried out to determine which noise problems the users of open offices experiences. The results will be a part of a design specification.

Interview with Lene Koudal Cinicola from TopDanmark Forsikring

Facts about the office
- Size: app. 130m^2.
- Number of people: 6 – 35, depending on their tasks the particular day.
- The building was build around 1930.

Work methods
The majority of the work is independent work as the employees have their own customers to take care of. The work includes phone calls, meeting with one or two clients and small meetings with colleagues.

Materials in the office
- Carpeted floors, thin, firm carpet.
- Acoustic tiles on the ceiling.
- Bricked outer walls, fixed plasterboard walls and steel columns.
- Wooden furniture and divider screens. The chairs had cushions on seat and backrest but no higher than half way up the back.

Unfortunately company policy does not allow photographs to be taken in the office.

INTERVIEWS

Interview one

Experience of noise
There is only one problem regarding sound at the office: dialogue. Because of the many phone calls and meetings and the number of people in the room, dialogue is a very big issue. Even with very few people in the office it is easy to get annoyed by other colleagues dialogue. Workers in the office may not be able to hear all of the colleagues dialogue, but enough of it to be distracted.

Policies about noise
Due to the voices carrying so well in the room, it was decided that non-work conversation should be kept in the cantina and that people should try to keep their voice as calm as possible. The reason for the voices carrying so well is that the office lacks absorbing materials between the employees. The only screens are made of approximately 8 mm plywood with decorative holes. They only serve a visual goal.

Interview two

Interview with Hanne Riise Dalgaard from the Technical and Environmental Department at Aalborg Kommune

Facts about the office

- Size: app. 50m^2.
- Number of people: four, but soon eight.
- Built 2003

Work methods

- A big part of the work is conducted at individual desks. If something has to be done by two persons they can choose to do it by one of the desks for the smaller tasks or go into a small room for group work.
- The nature of the work is administrative, so no big meetings are held there. Phone calls and conversations are the biggest source of noise.
- Possibility to work from home office.

Interview two

Materials in the office

- Hard wood floors.
- Acoustic tiles on the ceiling.
- Three concrete walls of which one had two windows and one glass and wood wall facing the common areas.
- Wooden furniture, either solid wood or chipboard with laminate. Chairs have cushions on seat and backrest but no higher than half way up the back.

Experience of noise

So far there are no major problems with noise because the people using the office are aware of the potential problem. However, when four more people move in more noise are expected. They will talk more and sit closer. Therefore agreements are planned to prevent too much noise in the office, and a silent booth for work that needs concentration is also applied for.

Policies about noise

There are no specific policies about behavior but the employees are aware of the need for workplace for meetings and group work.

Interview three

Interview with Sebastian Johnsen Poulsen from Danske Bank

Facts about the office
- Size: app. 200m^2.
- Number of people: 20 (40 if the department from Boulevarden is there for the weekly meeting).
- The building was build around 1970.

Work methods
- A team meeting each day.
- App. two customer meetings each day of one to two hours duration.
- App. 20 phone calls each day.
- One weekly meeting with both the Algade and Boulevarden department.

Materials in the office
- Carpeted floors.
- Acoustic tiles on the ceiling.
- Bricked outer walls, and steel columns.
- Wooden furniture and glass divider screens. Chairs have cushions on seat and backrest but no higher than half way up the back.

Interview three

Experience of noise

The noise problem at Danske Bank is regarding the customers and has two main areas: the customer meetings disturb other meetings and the customers should not hear something that is not their own business.

The customer meetings typically include between two and five people including the bank worker. They will all be talking and drinking their coffee with all the noise that includes. For the nearest eight tables these conversations are very easy to overhear and are sometimes very disturbing.

The other aspect of the customer meetings is that they might hear something that they are not supposed to hear. If for instance the bank employees are discussing a weak customer, if someone has an overdraft or other personal business, this information has to be kept in the bank.

Policies about noise

Due to these problems the management has emphasised strongly that the employees evaluate what kind of information they are discussing and seek areas of the bank without customers if required.

Sum up

In general there is a need for sound reduction in the frequency area of the human voice span. In all three offices the dialogue, either with people in the office or over the phone, was very important to the work they were doing.

Just as important was the fact that they needed to have the opportunity to concentrate without being distracted by other conversations in the office.

There is also an aspect of privacy to be taking into account. Some offices, both public and private, deal with personal information and they have to be very cautious as to what they discuss when other clients are in the near proximity.

Therefore a design to relieve noise from dialogue in open offices is essential to the people working there and their clients.

RESEARCH PHASE

Design specification

The design specification is put together from the results of the interviews, evaluation of existing products, study of technical aspects of sound and information from an interior architect. The full statement (in danish)can be seen in Appendix A. As for the material research, the general result was the materials should be chosen by whatever the main problem might be.

Source / Subject	Statement from interior designer
Acoustics	
Interaction	• Practical functions; for atmosphere of the interior, and style and aesthetic expression. •People moving after the function (health related). • Dimensions related to humans.
Aesthetics	• General expression instead of flexibility.

RESEARCH PHASE

Design specification

Sound	Existing products	Interviews
• Absorb sound by porous, viscoelastic materials or other combinations in membranes. • Diffuse sound by the shape of the materials. • Avoid sharp edges to prevent diffraction.	• Good sound reduction ability above 500 Hz. • Better than existing sound reduction below 500 Hz.	• Reduce noise in the frequency area of the human voice span.
	• Possibility to move; light design or otherwise movable (for freestanding screens). • Easy to install and re-install (for wall mounted products). • Addit ional features; shelving or pin-up board etc. • Modular build.	
	• Simple. • Interesting. • Playful. • Decorative.	

Development phase

DEVELOP-MENT

Launch

This section will deliver a short presentation of the preliminary development. The sketch process was much more complex than it will be presented here.

The first action taken in this phase was to establish the main problem found in the design specification and to choose if other problems should be incorporated in the final design.

As all three interviewed had complained about speech related noise establishing the main problem was done very easily. Noise related to speech was to be the main focus of the design. That means that the absorption of noise below 500 Hz and especially around 100 Hz to 250 Hz should be reduced even better than in the existing products.

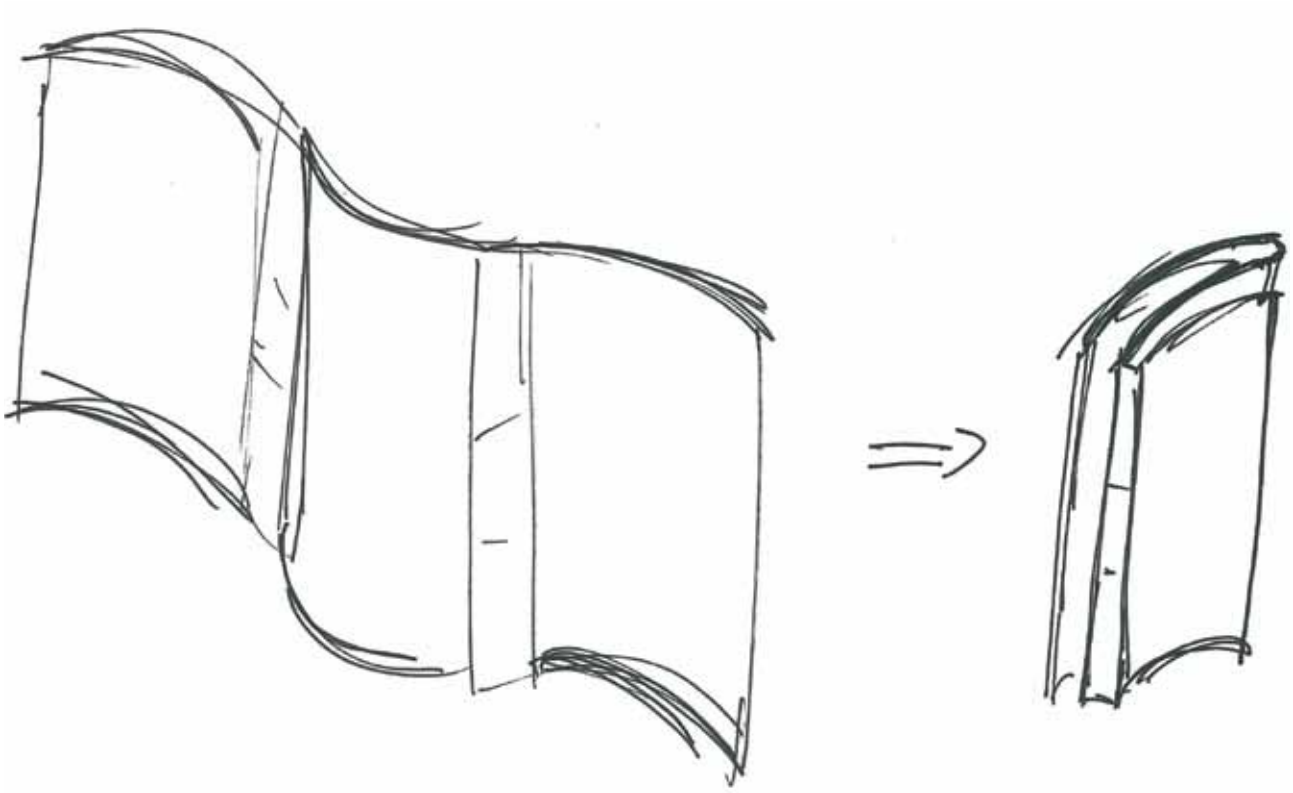
Although the process is presented visually each sketch bears technical consideration found in the research phase.

As the interviewed people primarily complain about speech noise it is apparent that the solutions sought in this project must be a two part design. A divider screen alone will not help the speech noise problem optimally but only reduce the direct noise. A design for a wall mounted low frequencies absorber is needed together with a divider screen or similar.

In the first round of sketching in the development phase the sketches produced were only addressing one other item from the design specification, besides reducing noise, at a time. Some addressed the necessity of a design that should be easy to move and other addressed the modular built to put several products together.

DEVELOP-MENT

Shape and function

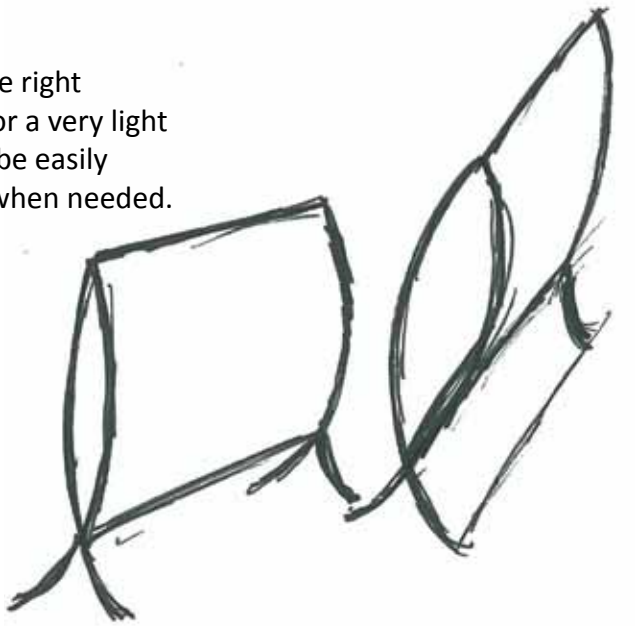


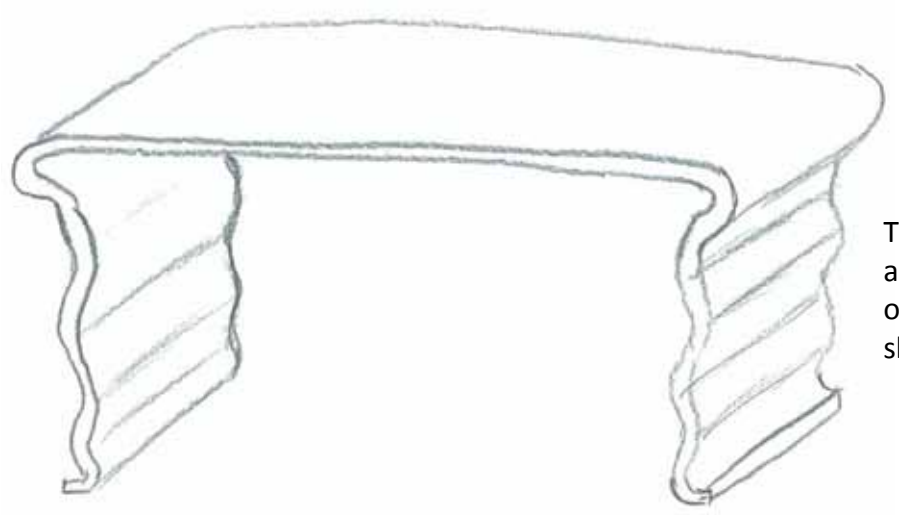
The sketch above shows an idea for a foldable screen that by its curve also has a modular built that allows it to be put together with other screens.

DEVELOP-MENT

Shape and function

The sketch to the right shows an idea for a very light construction to be easily moved around when needed.





The sketch to the left shows an idea for a table clad in felt or similar to absorb and with a shape to diffuse the noise.

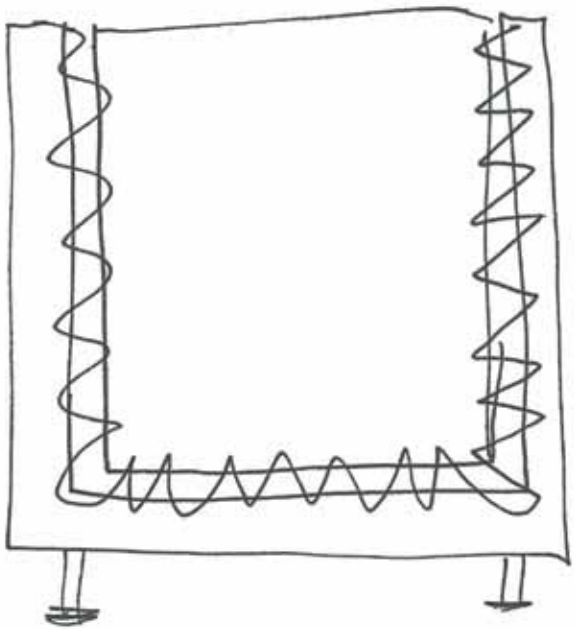
DEVELOP-MENT

Shape and function

Other problems than those found in the research phase were also a part of the development process. Among those were cleaning and maintenance, but also the aspect of getting sun light into the parts of the office that is farthest away from the windows was being looked into.

Therefore these problems were also investigated through sketching. At this point other functions such as shelving also came into play.

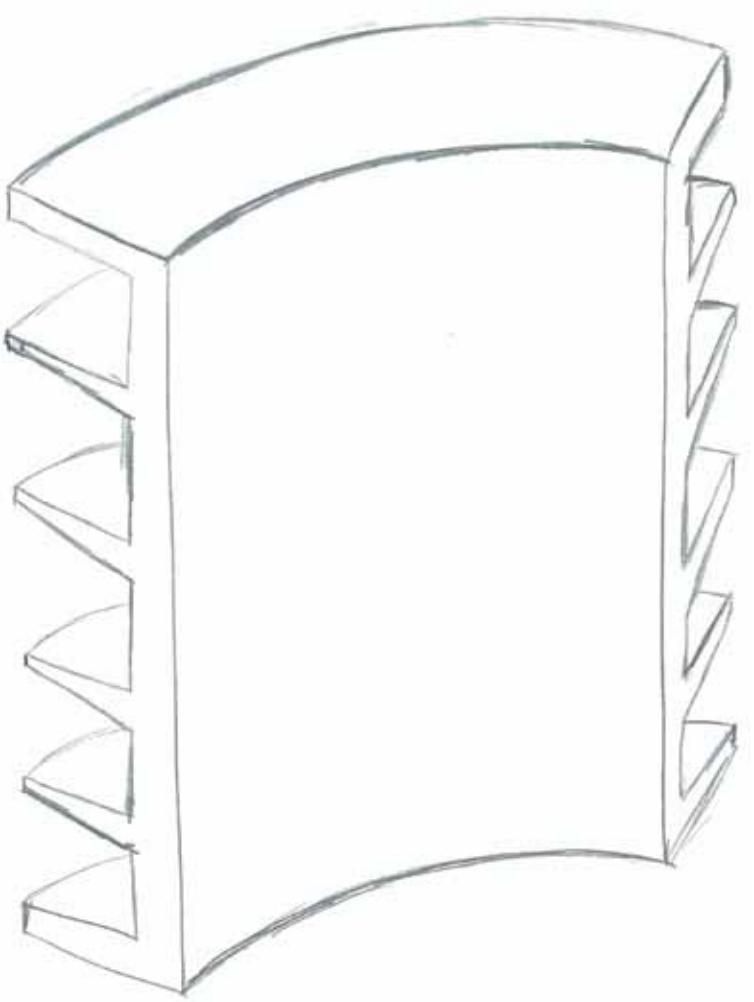
The sketch below shows an idea for a screen with removable cloth for easy cleaning and maintenance.



DEVELOP-MENT

Shape and function

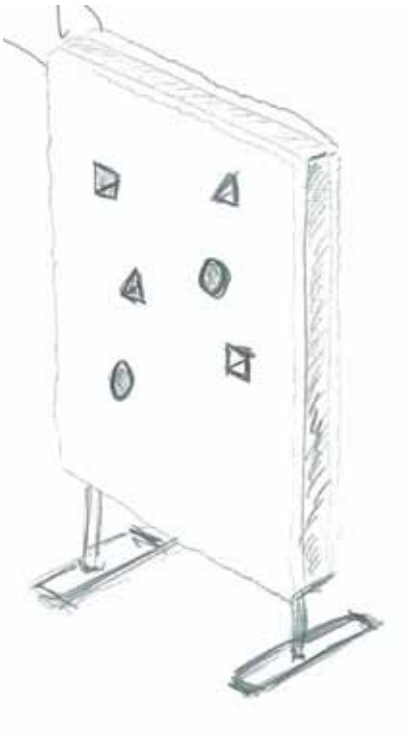
The sketch below shows an idea for a shelving unit produced in gas concrete, which with its open surface has a noise reducing effect.

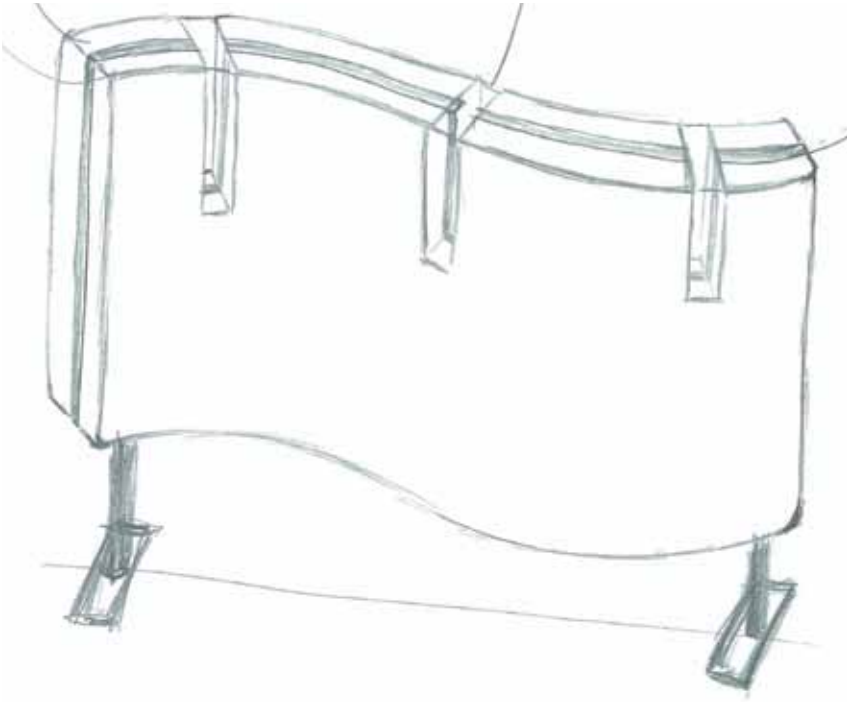


DEVELOP-MENT

Shape and function

The two sketches on this page show ideas for letting sun light deeper into the office. The one on the right has inserts of transparent gel in different shapes to allow the light into the deeper parts of the office.





Another transparent gel idea is shown on the sketch below. Here the gel inserts are placed at the top of the screen to allow more light to penetrate the screen. The screen has also received a wave shape that diffuses the noise not absorbed by the screen.

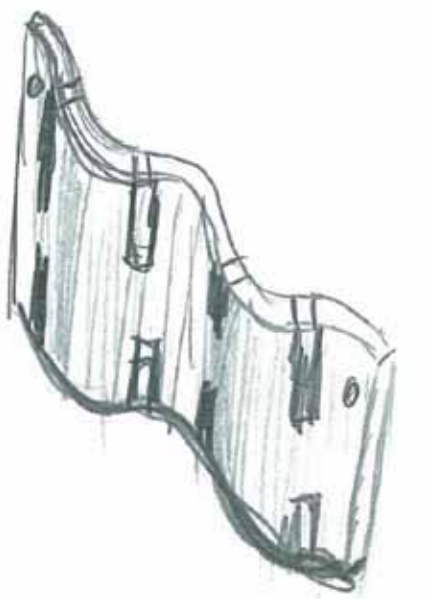
DEVELOP-MENT

Shape and function

From this point the process took a turn into the more technical aspects of noise absorption. At the same time the keywords about aesthetics from the evaluation of existing products; simple, playful and decorative also came into play as well as materials became more explicit. From this came an idea of a design for both wall mounting and divider screen with a puzzle function.

The sketch below shows the idea for the wall mounted design. It has taken shape from the bottom sketch on page 39.

The design consists of two layers: a thinner layer of hard felt to keep the shape and a thicker layer of viscoelastic material to absorb the low frequencies. The design is curved to diffuse the noise that is not absorbed. On the top and bottom edge it has cut outs to let two items intersect as a sort of puzzle to be put on the wall.



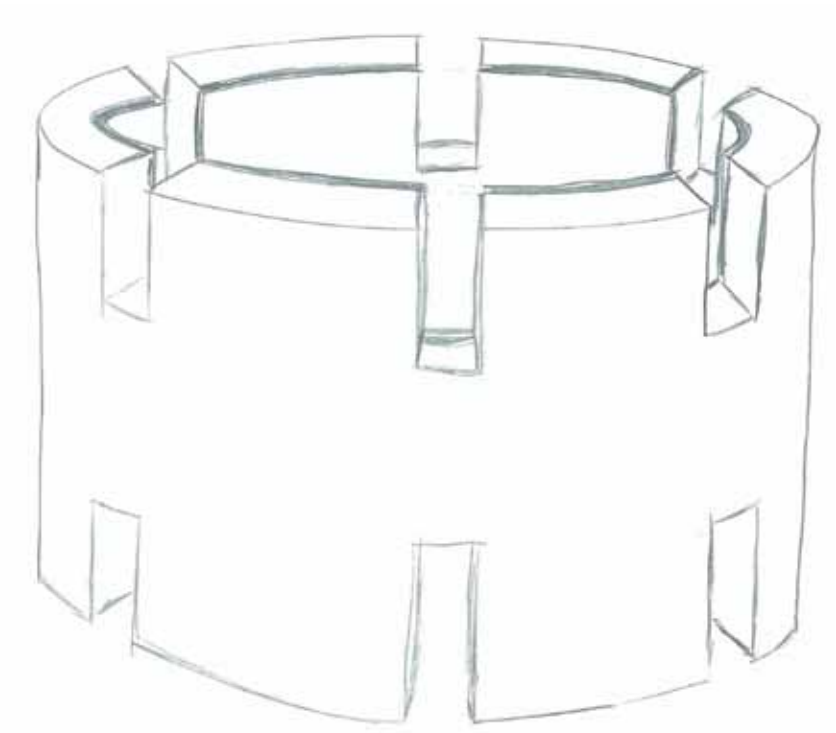
DEVELOP-MENT

Shape and function

The sketch below shows an idea for the divider screen design. The design consists of two layers: a thinner layer of hard felt to keep the shape and a thicker layer of foam to absorb the low frequencies. The design is circular to obtain better stability and to diffuse the noise that is not absorbed.

On the top and bottom edge it has cut outs to let two or more items intersect as a sort of puzzle.

The puzzle idea was chosen to be worked with further in the project and the sketching moved on to 3D.

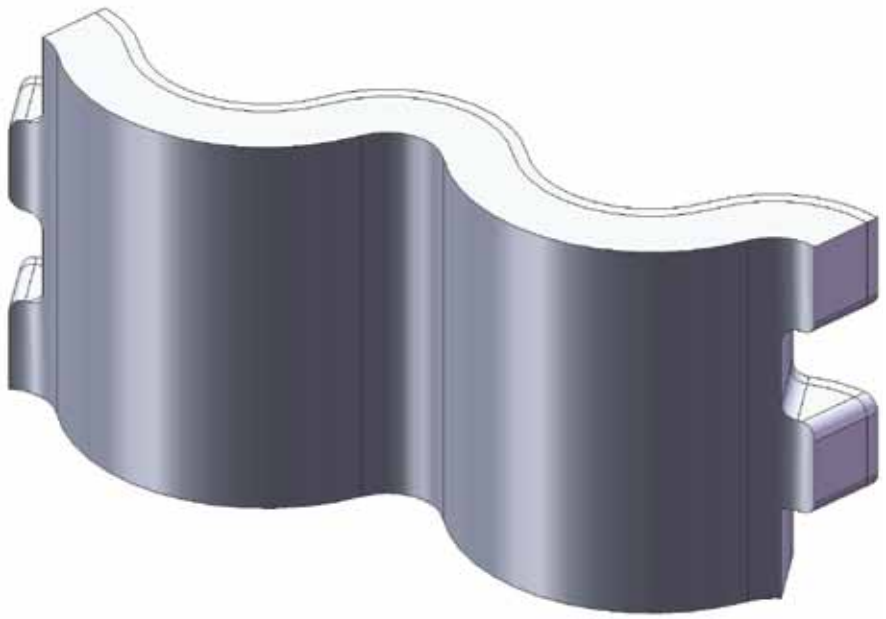


DEVELOP-MENT

Shape and function

This section will explain the development of the wall mounted product and the divider wall product separately even though the process was simultaneous. The process of the wall mounted will be described first. The process required thinking in new materials and construction. The wall mounted product will from this point be called wave, and the divider wall product will from this point be called tube.

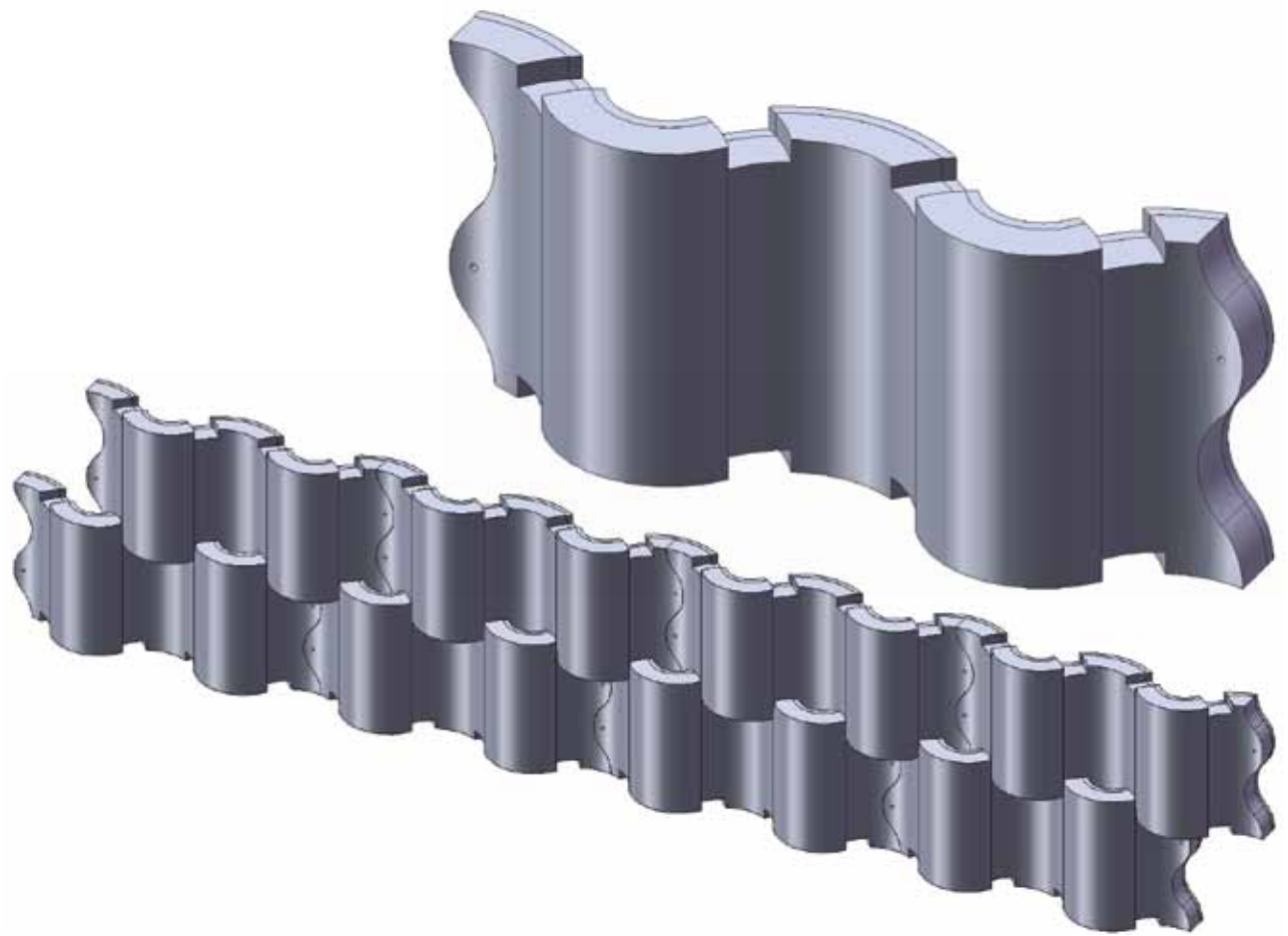
The first 3D sketch of the wave has big teeth on each end to intersect with the waves to each side. The thin layer of hard felt is closest to the wall and it will be mounted on to the wall to make the construction stronger and expose the viscoelastic material for it to absorb the noise. The ends, however, was too inelegant and was changed to for the next version. The same is the case for the diameter of the curves.



DEVELOP-MENT

Shape and function

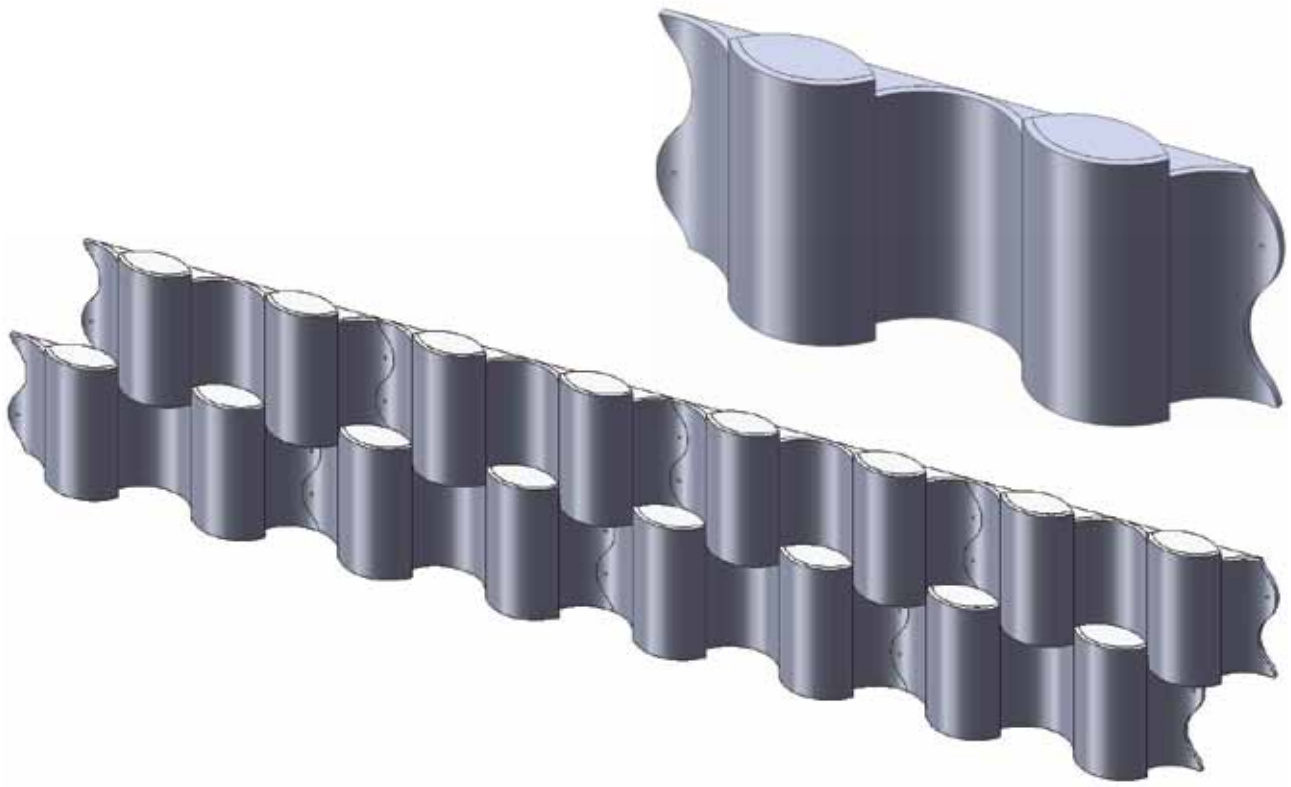
The second version of the wave has curves instead of teeth on the ends and has had the diameter changed so that the visible side of the curves on the wave has the same size. It also has a hole for a screw on each end and cuts on the top and bottom edge to intersect with another wave as can be seen on the lowest illustration.



DEVELOP-MENT

Shape and function

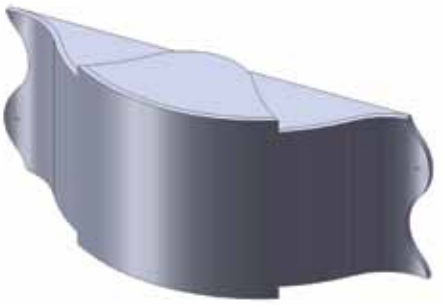
New information from another acoustic consultant at AAU Acoustics showes that a membrane construction would be more effective at absorbing noise. Therefore another wave construction was made as well as the materials was rethought. In this version the hard felt is replaced with a new material; a PET fiber based felt material that can be thermo shaped and water cut. The material will be described later. A foam material is placed behind the felt and together they make a membrane that can absorb noise. The screw holes, curves at the ends and cuts on top and bottom edge have all been preserved.

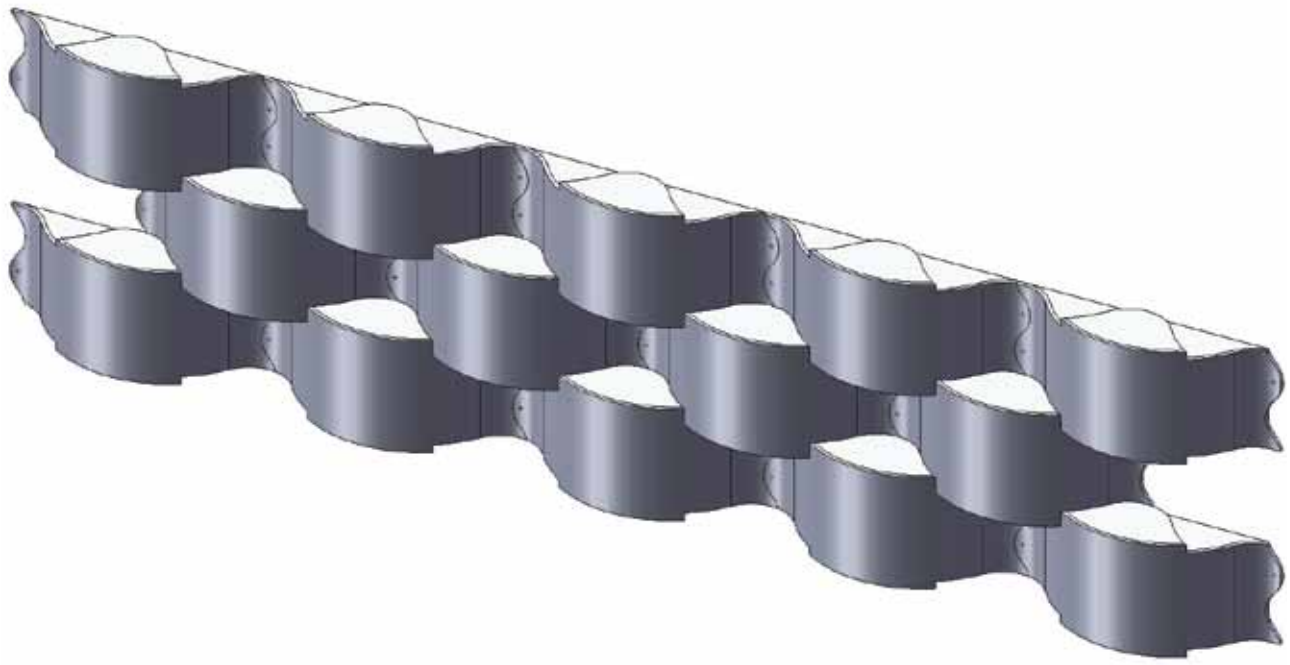


DEVELOP-MENT

Shape and function

This version has only one outward curve instead of two. This was done to increase the volume of the foam. However, the aesthetics suffered under this and the idea was deselected. The two outwards curves were therefore re-selected.



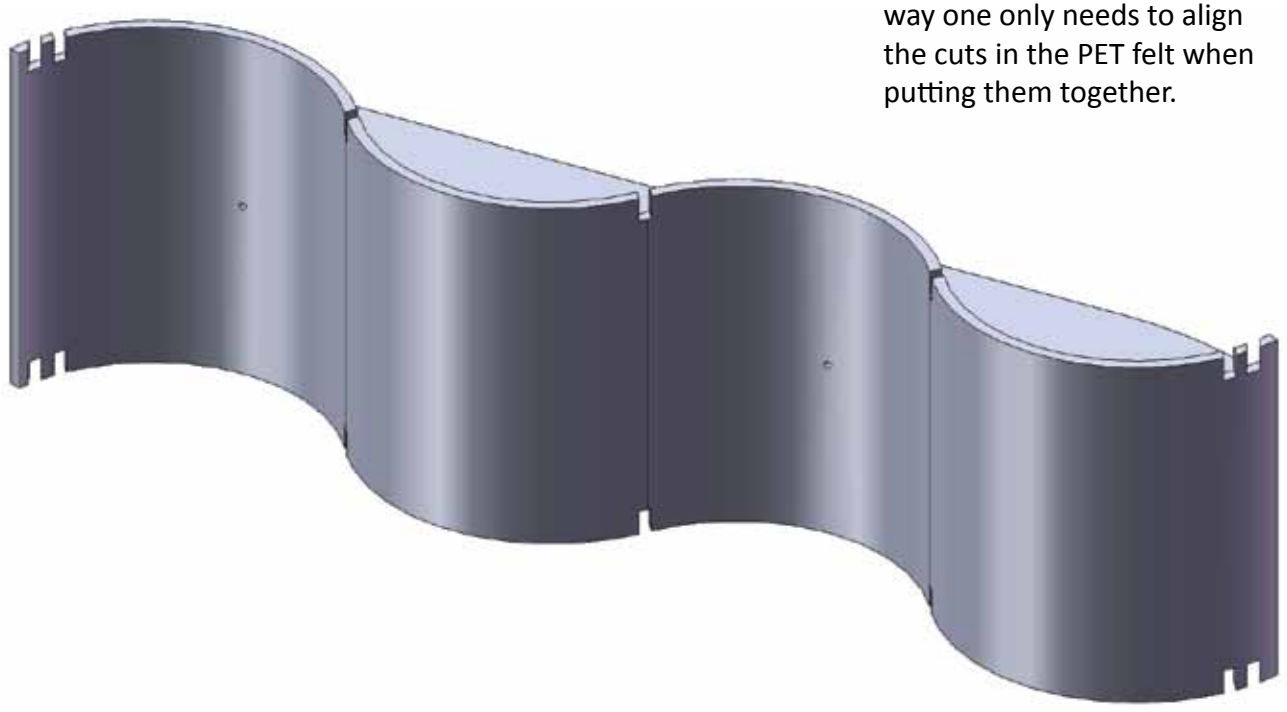


DEVELOP-MENT

Shape and function

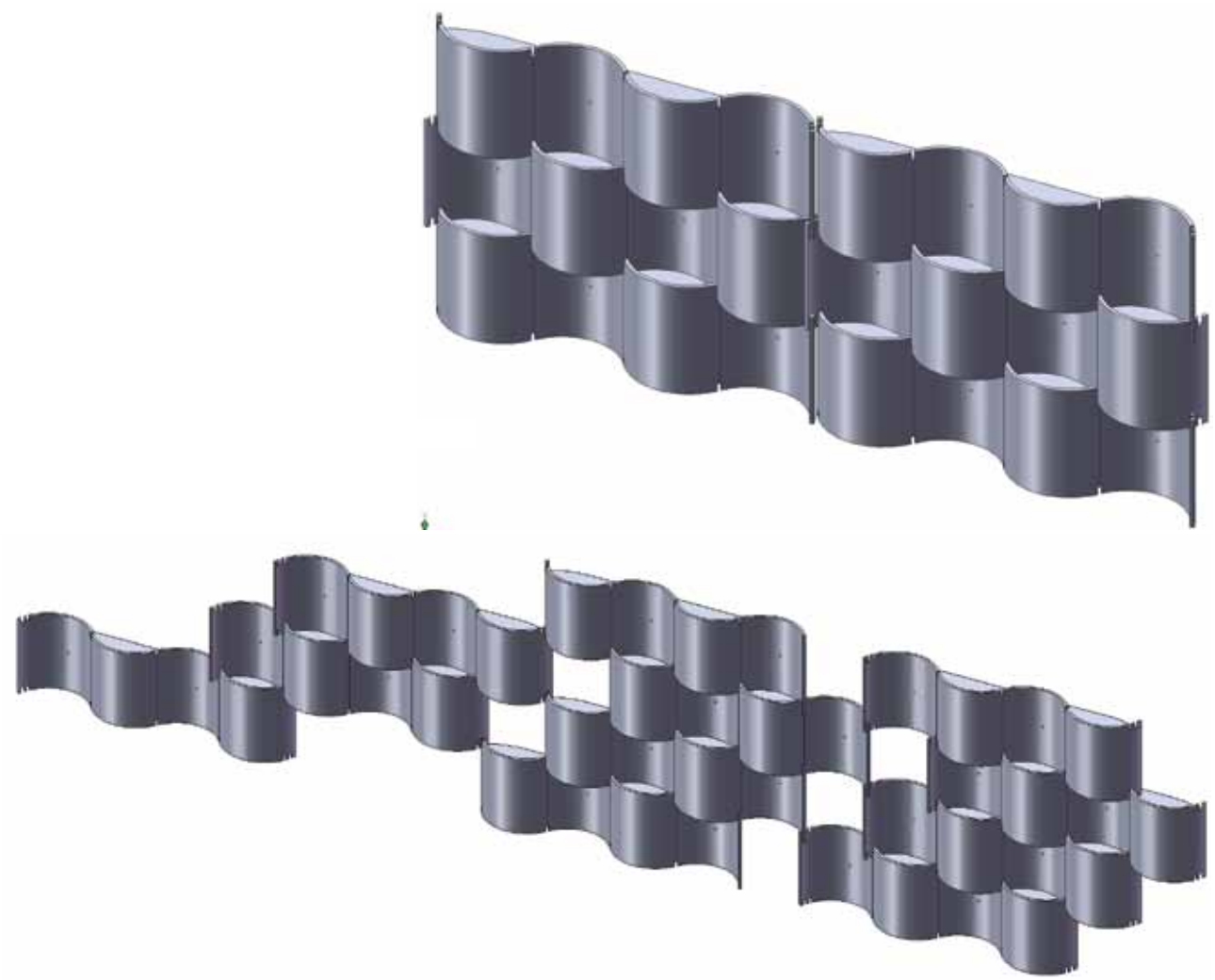
Even if the two outwards curves was to be kept, there were still problems with the ends of the wave. The curved ends did not seem right and there was only one possibility of letting the waves intersect. The curves at the ends are not actually necessary and the ends themselves were in fact blocking an opportunity for letting the waves intersect in more ways.

Therefore the five curves was reduced to four and each end received an extra cut on both top and bottom edge. These cuts allow the waves to be put together in two different ways; a rectangular and a diagonal composition as can be seen on the two sketches on the next page. The foam on the wave does not align with the top and bottom edge to make the installation easier; this way one only needs to align the cuts in the PET felt when putting them together.



DEVELOP-MENT

Shape and function

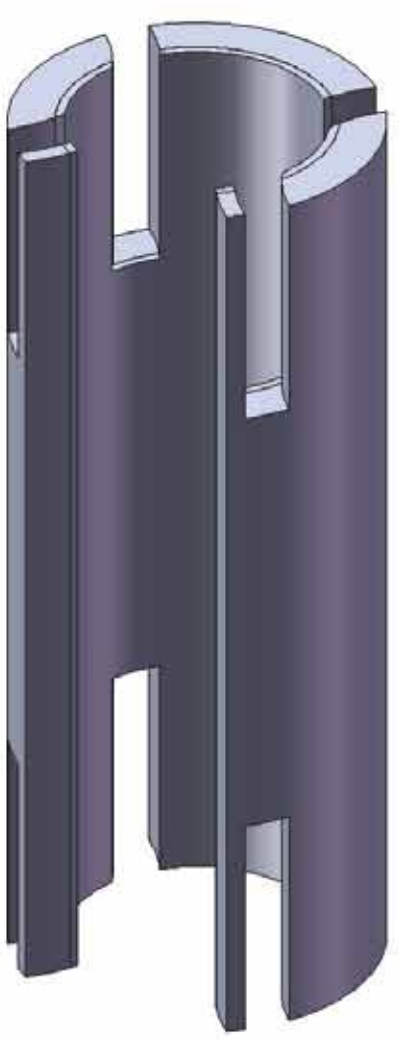


DEVELOP-MENT

Shape and function

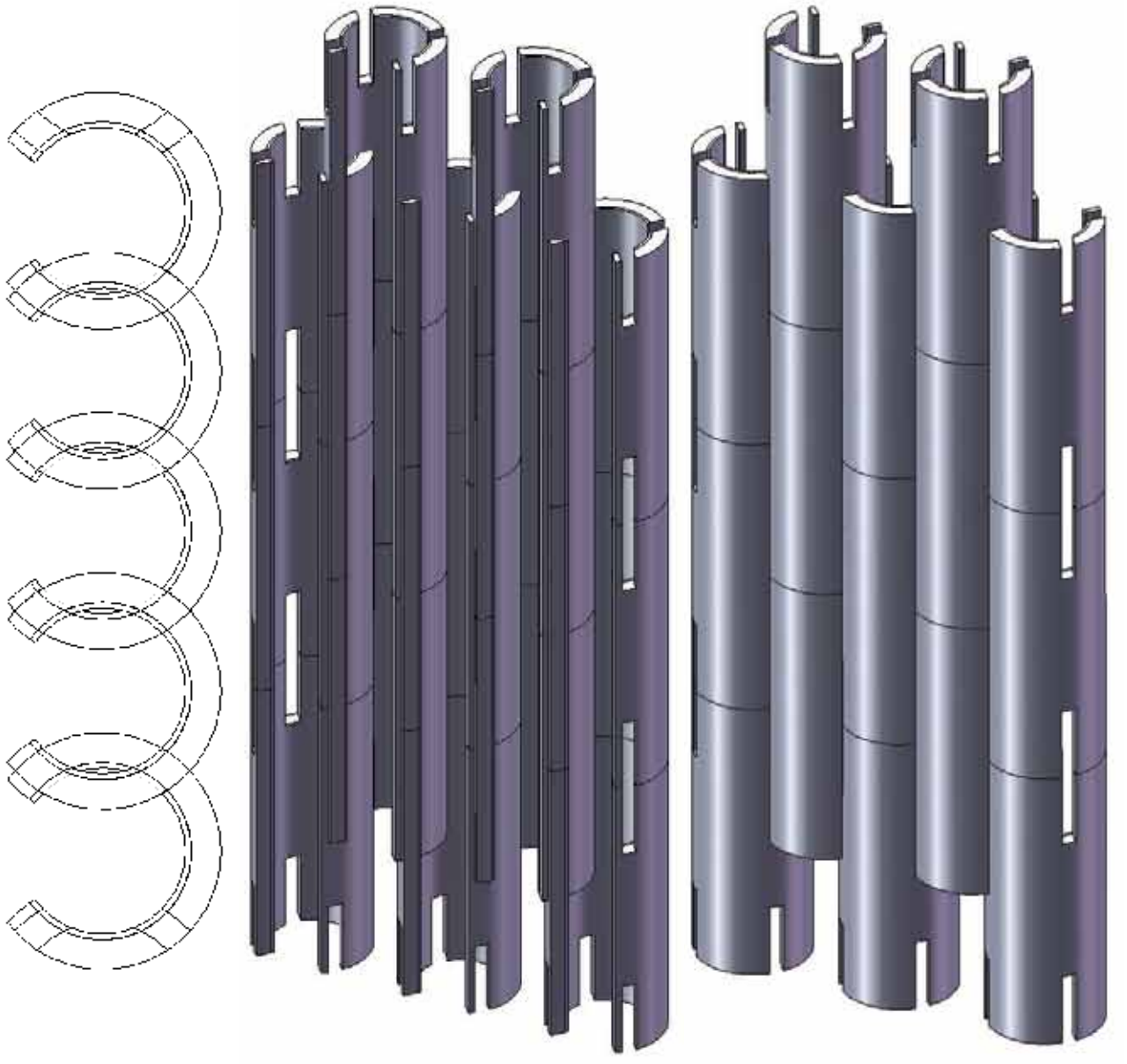
The divider screen product, the tube, was initially thought to be tubes stacked on each other to form a wall. However, an idea of putting small shelves for pencils and other office equipment soon emerged and a cut was made in the full length of the tube to exploit the room inside it. This gave the divider screen two diffrent looks; an open look where the shelves should be and a closed look on the other side. The first version had no possibility to put in shelves and the intersection of the tubes was rethought.

As the wave the tube was made of a thin layer of hard felt with foam on the outside.



DEVELOP-MENT

Shape and function



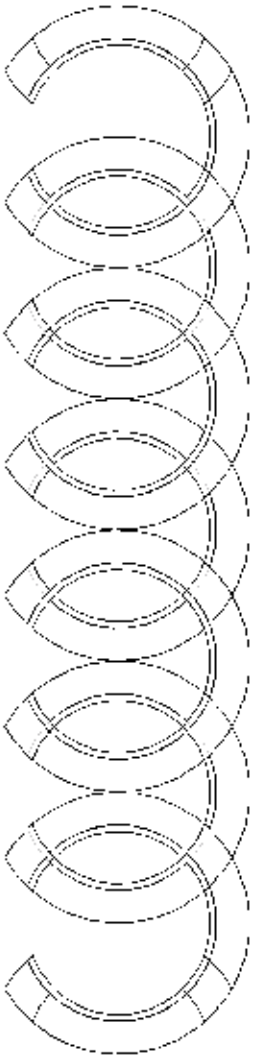
DEVELOP-MENT

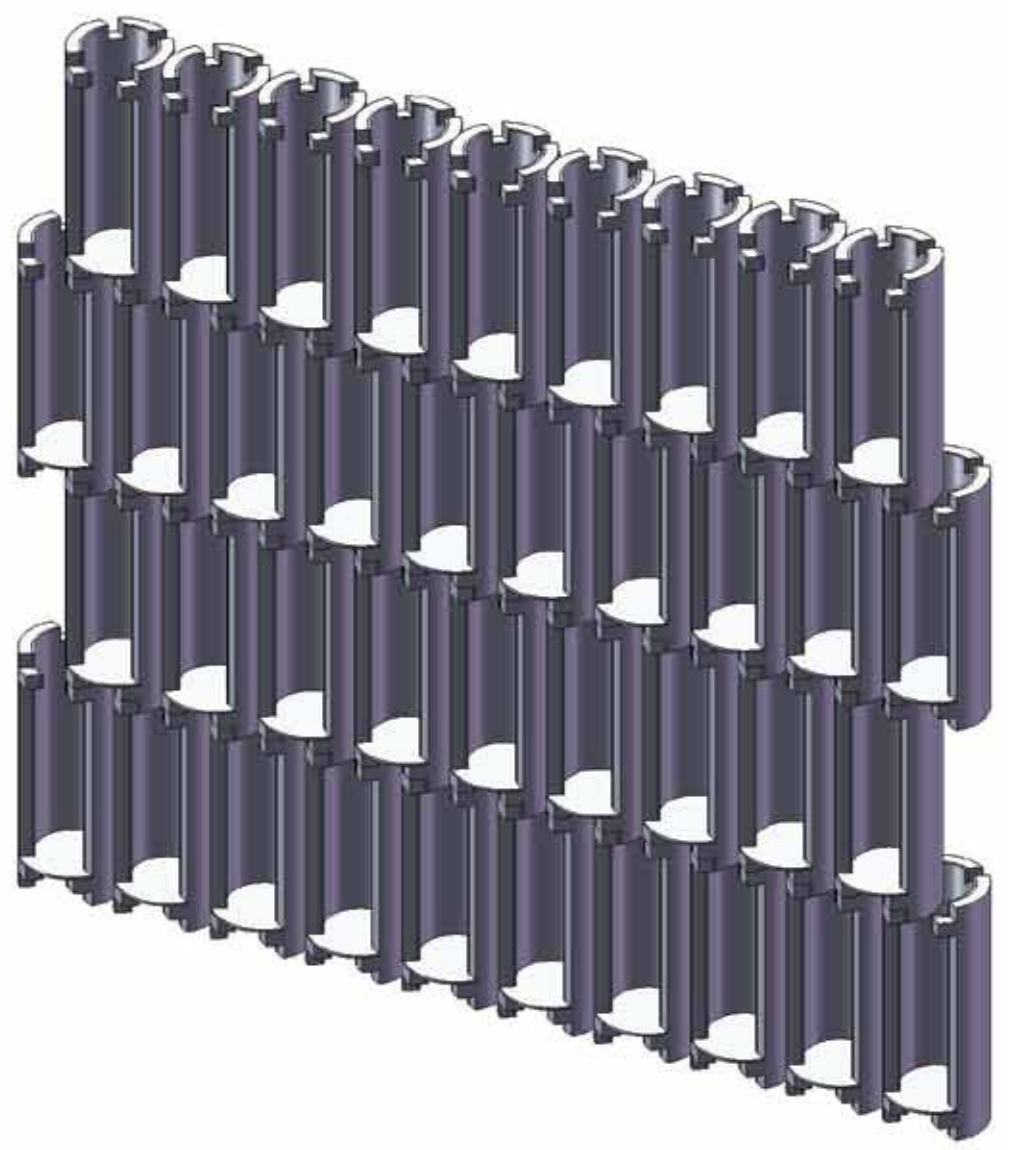
Shape and function

For the second version of the tube the intersection was made much shorter but the tubes were placed closer together. This construction made it possible to place a small plate inside a tube resting on an intersection thereby creating a small shelf. However, even though the shelf worked, it was too small and the access to it was even smaller; a grown man could barely fit his hand in through it. Therefore the entire tube idea was deselected.

DEVELOP-MENT

Shape and function



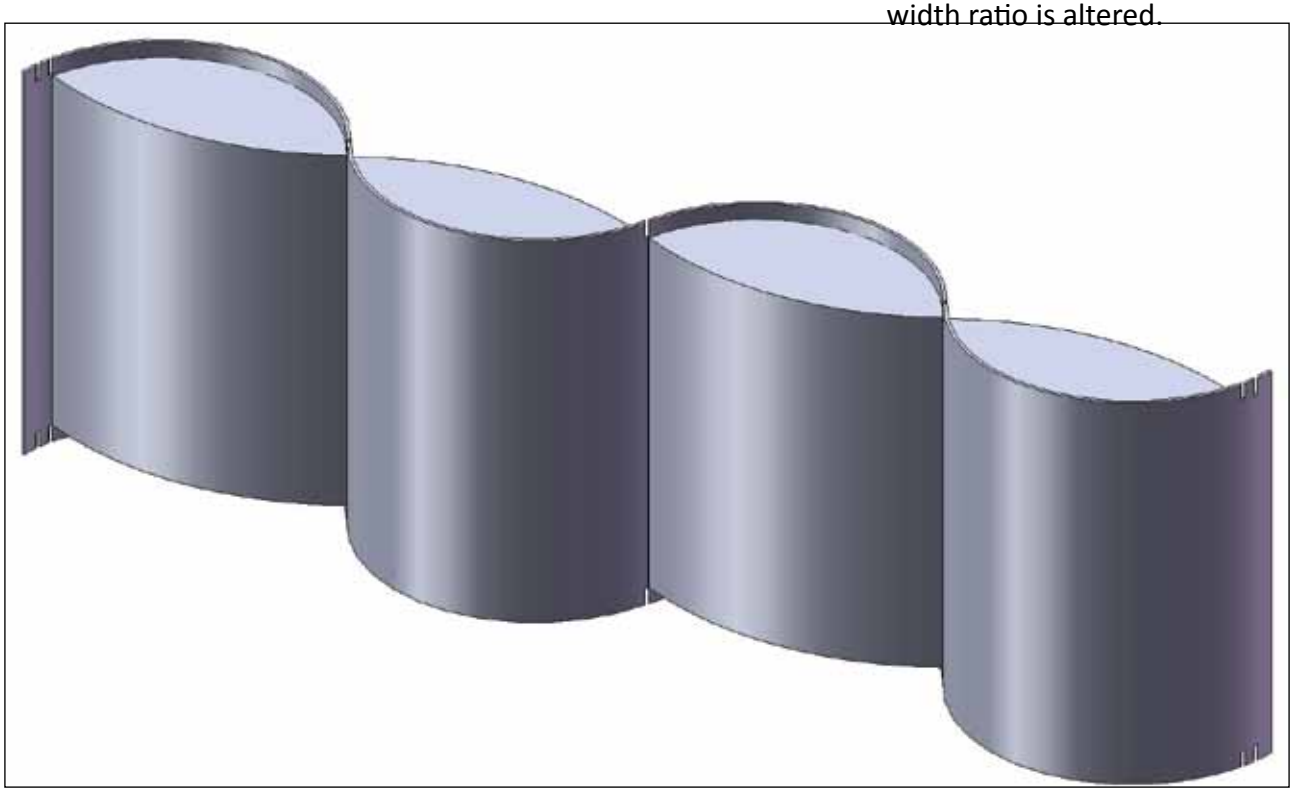


DEVELOP-MENT

Shape and function

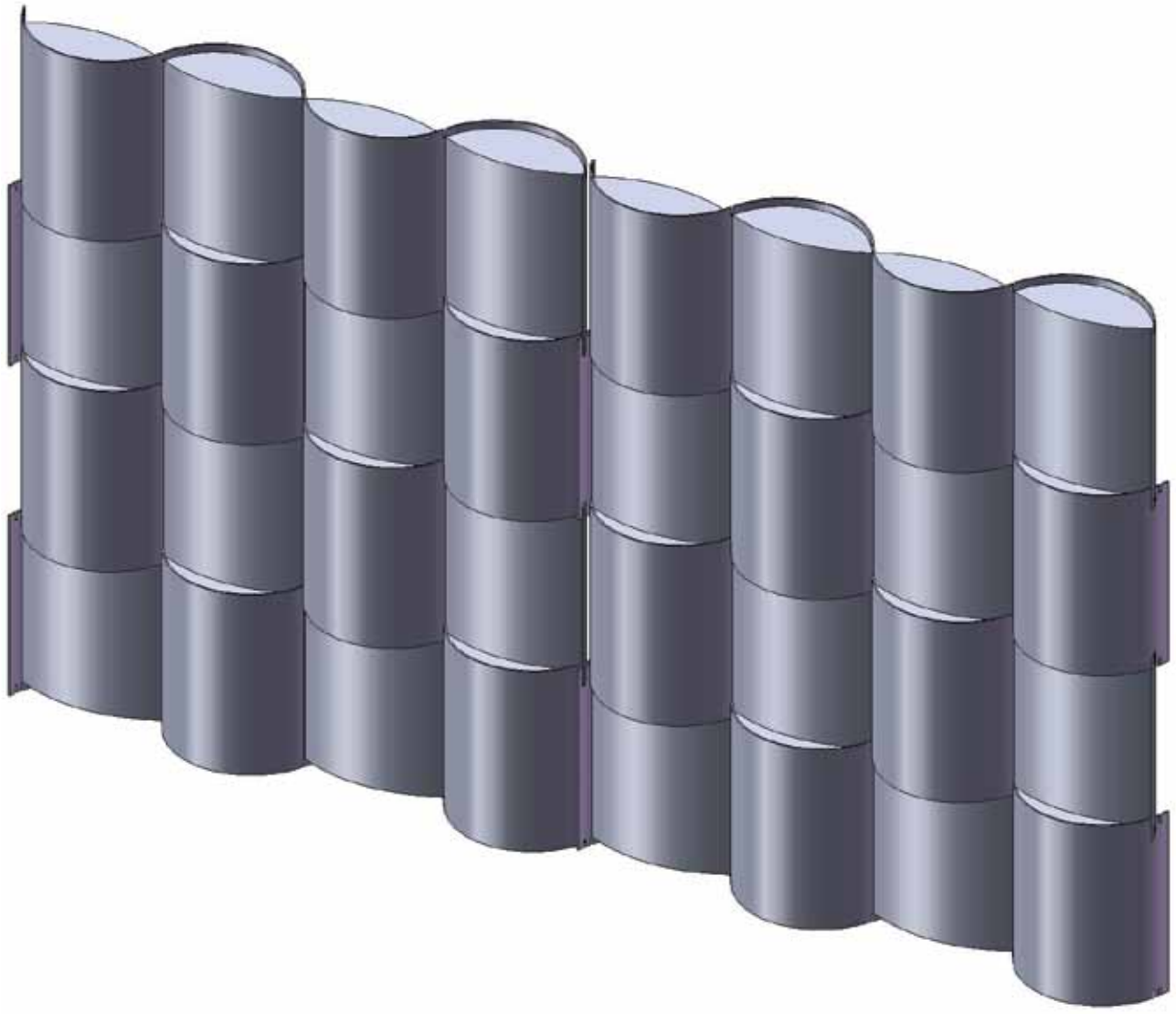
Instead of the tube it was decided to make the divider screen to have the same mode of expression as the wave to be mounted on the wall. In fact the divider screen was decided to look like a scaled up model of the wall mounted wave. From here on the wall mounted product will be called mounted wave and the divider screen product will be called divider wave.

Even though they look alike, there are a few differences between them. The divider wave has no screw holes and the PET felt is thicker since it has to be self supporting. The dimensions also do not match a scale model as the height to width ratio is altered.



DEVELOP-MENT

Shape and function



DEVELOP-MENT

Shape and function

To determine the size of the divider wave cardboard models were used. They gave an indication as to how big the divider wave should be in proportion to an office table. As the model of the divider wave was harder to make than the table the table was made in different sizes. That way the model of the divider wave appeared to be in different sizes. The model tables were scale models of a 160 cm * 60 cm table.

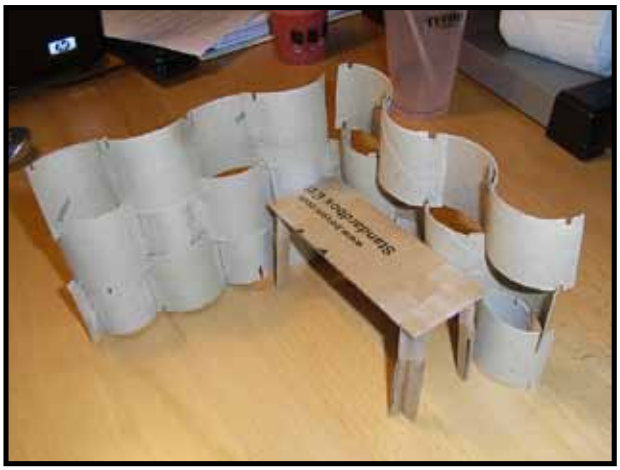
Form these small tests it was decided to make the divider wave a little bit longer than the table. There are two reasons for this decision; one is that it will give the worker a sense of privacy and the other is for aesthetics. If the table is longer than 160 cm the divider wave will not be able to cover the full length of the table and that would give an unfinished look to the product and the office.

The two top photos on the next page shows a divider wave longer than an average office table, the lowest photo shows a divider wave at equal length as the table.

The height of the divider wave is the average height of a grown man (180 cm) minus 25 cm; the approximate height of a head. Therefore three divider wave section on top of each other is 155 cm high. Each section is therefore 55 cm tall.

DEVELOP-MENT

Shape and function



DEVELOP-MENT

Shape and function sum up

The primary function of the divider wave is to block and absorb noise above 500 Hz. Therefore PET felt is chosen as the core material as it has good acoustic abilities to block noise and is strong enough to be self supporting.

To help absorb more noise each inward curve is padded with 28 to 30 kg/m3 foam. The face of the foam will be clad with a thin PVC surface with acoustic perforation. The PVC's smooth surface serves to differentiate the foam from the PET felt's fabric like surface instead of trying to imitate the PET felt. It also indicates a change in function as the PET felt primarily block noise and the foam absorbs.

The primary function of the mounted wave is to absorb noise below 500 Hz and therefore the foam is placed between the PET felt and the wall.

Nevertheless, for the final mounted wave foam is also applied to the front to give it the same mode of expression as the divider wave.

Dimension of the divider wave

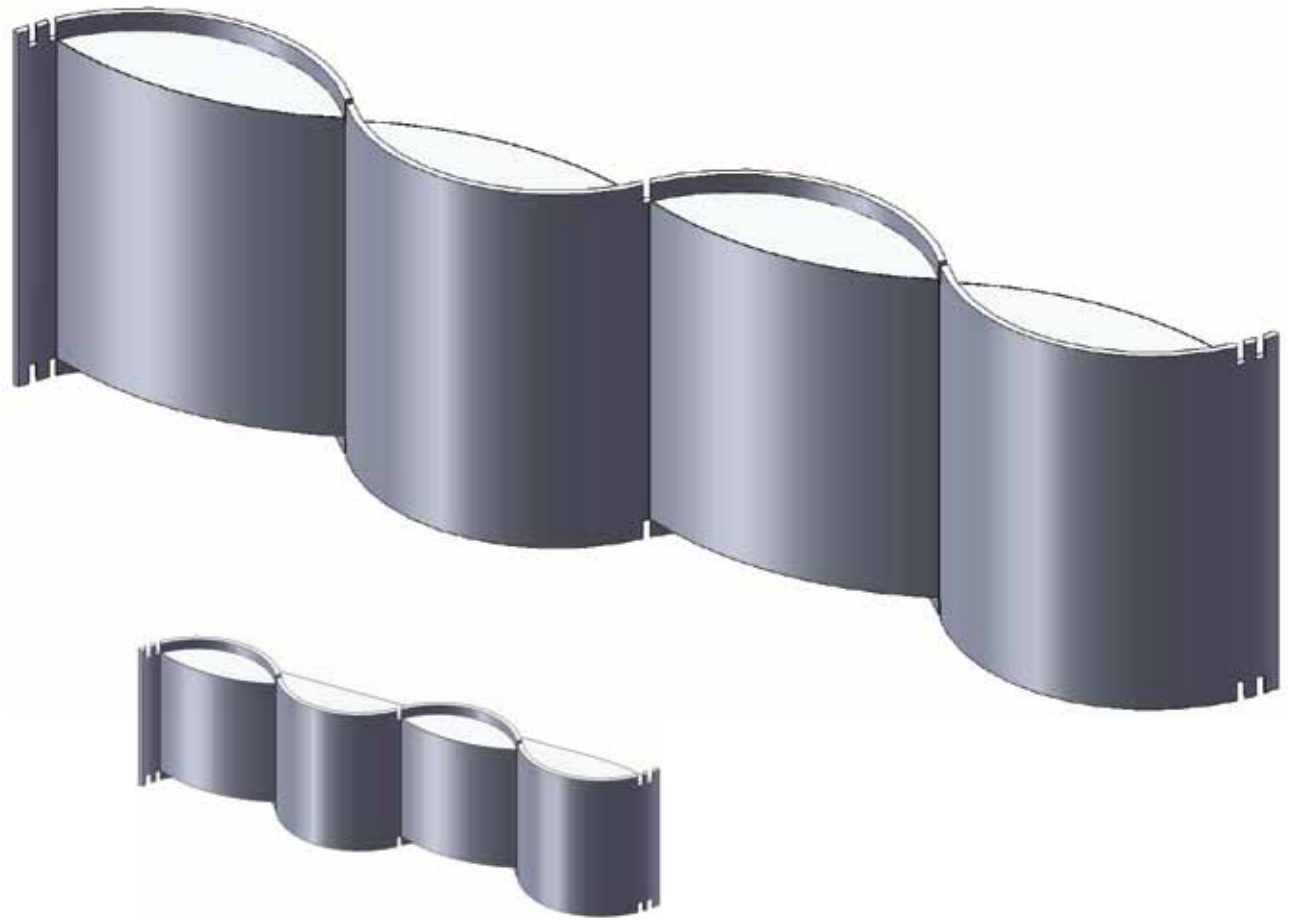
- The divider wave is 169.3 cm long, 55.0 cm tall and 21.4 cm deep.
- The inner radius of the PET felt is 25.0 cm and the outer radius is 26.0 cm.
- The PET felt is 1.0 cm thick.
- The radius of the foam pieces with PVC surface is 50.0 cm and they are 45 cm tall.

Dimension of the mounted wave

- The divider wave is 54.1 cm long, 15.0 cm tall and 7.5 cm deep.
- The inner radius of the PET felt is 7.5 cm and the outer radius is 8.0 cm.
- The PET felt is 0.5 cm thick.
- The radius of the front foam pieces with PVC surface is 15.0 cm and they are 13.0 cm tall.
- The back foam pieces are 11.0 cm tall.

DEVELOP-MENT

Shape and function sum up

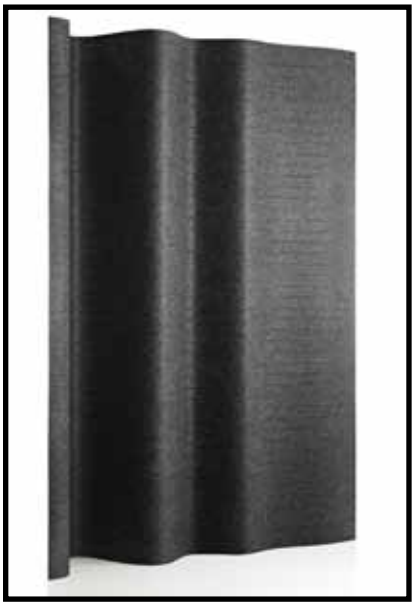


DEVELOP-MENT

Materials

This section will describe the materials and why they were chosen.

The PET felt is invented by Komplot Design in cooperation with Gubi. Together they have made chairs and divider screens, which can be seen below. The material is partly recycled water bottles and is therefore semi-environment friendly. Komplot Design was unable to give any specific details to the strength of the material as many more factors than just thickness are of great importance to the strength. They did however inform of the divider screen made in cooperation with Gubi. Based on their divider screen it is concluded that the divider wave is possible to manufacture. The PET felt will be thermo shaped and water cut to shape it into waves. As the PET felt is made of plastic it can be dyed in any color. The PET felt costs 70 € per square meter of unprocessed felt.

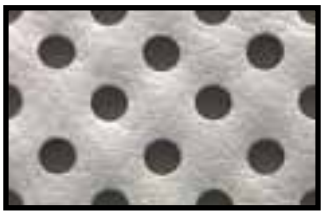


The foam used for the waves is standard 28 kg/m3 polyether foam. The foam will be kept in a dark gray or black color to avoid that it takes too much of the focus from the PET felt and PVC foil.

DEVELOP-MENT

Materials

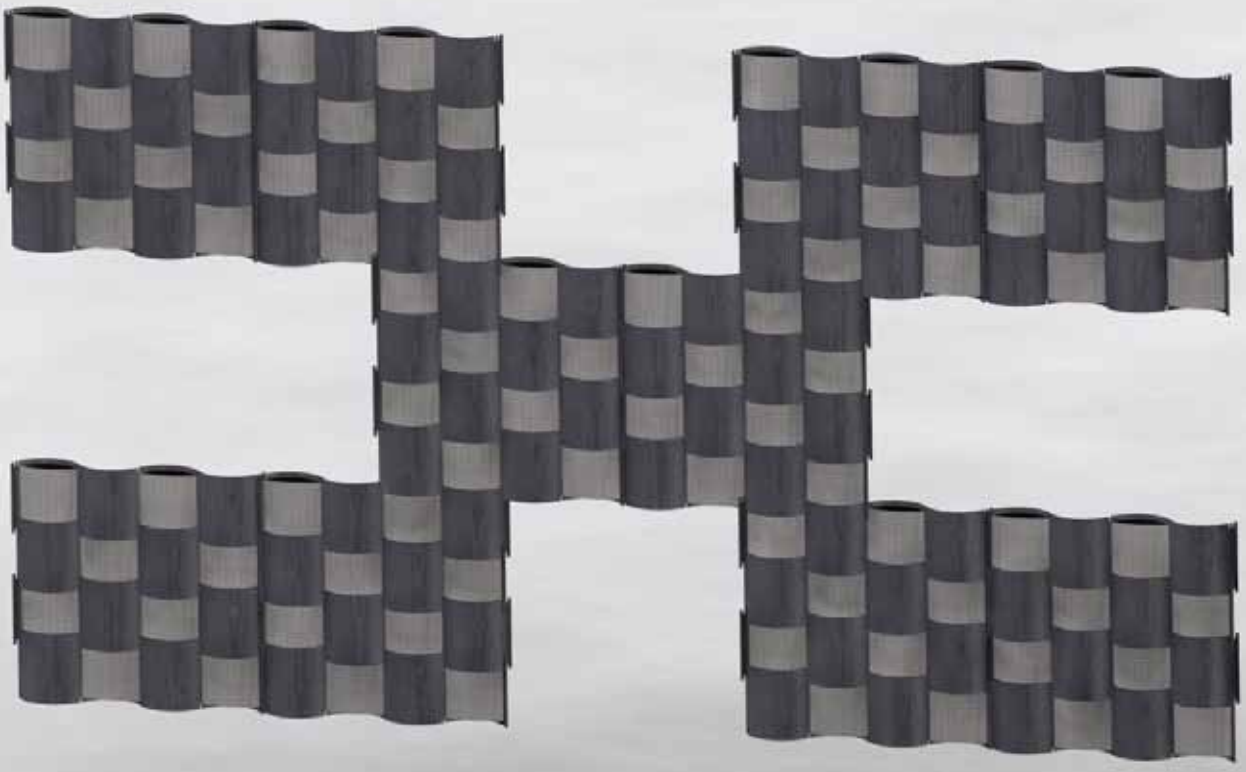
The PVC foil will be used to hide the face of the foam and to differentiate the foam from the PET felt, but also to indicate that another function, noise absorption and not just blocking, is taking place here. This function is also indicated by the perforation of the PVC foil.



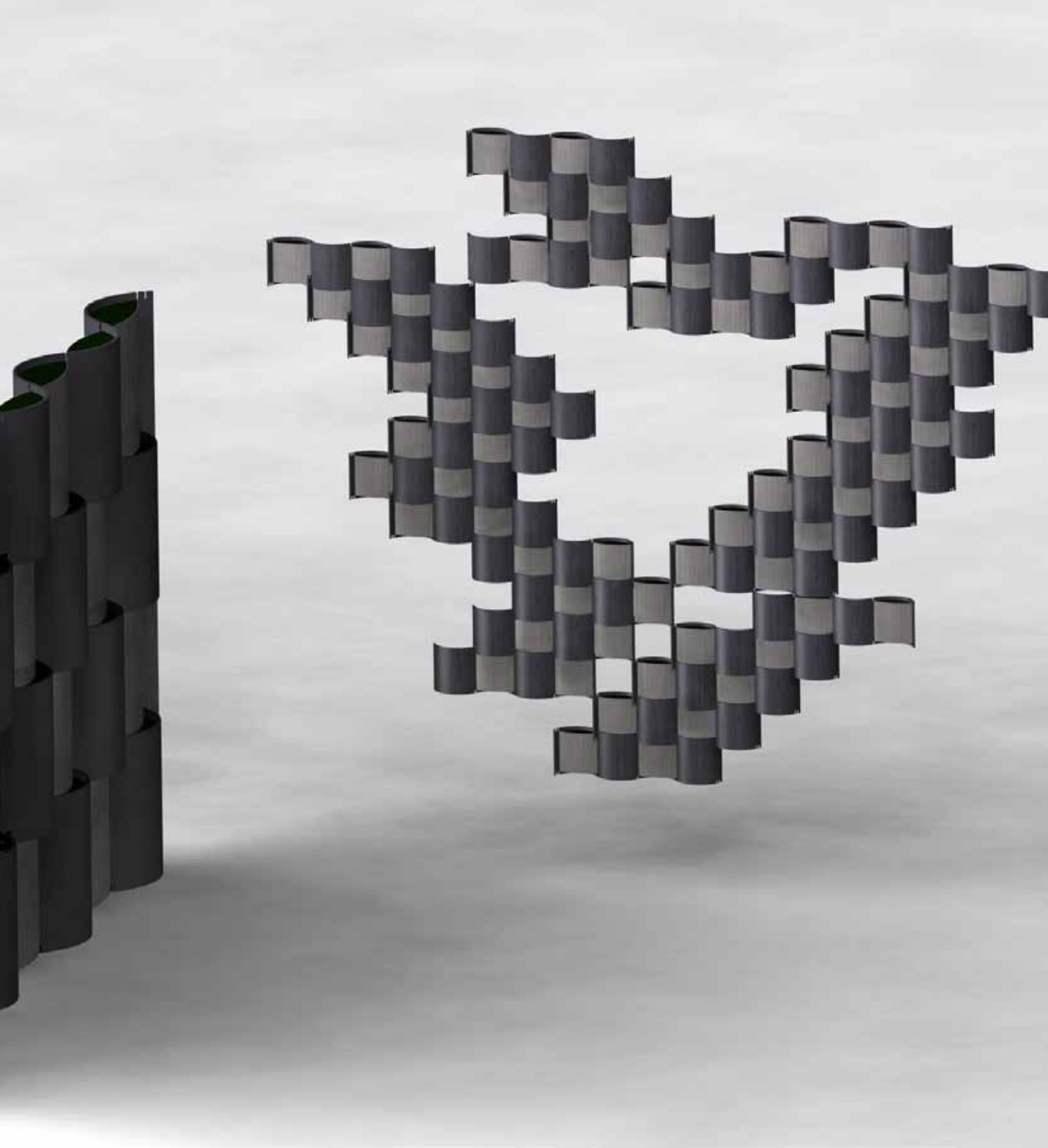
To put together the foil and foam, and the foam and felt, the glue must be a type with 60 – 70 % solvents because of the plasticizer in the PVC and the surface tension of the felt. The glue will need a period of time to dry and it will then be safe to take into the office. The glue chosen is 3M™ Scotch-Weld™ and the solvent methyl ethyl ketone as this was recommended by the adhesive expert at 3M.

Maintenance

The maintenance of the waves will be done by vacuum cleaning on the felt and foam and a wrung cloth for the foil.



Product presentation



PRODUCT

Presentation

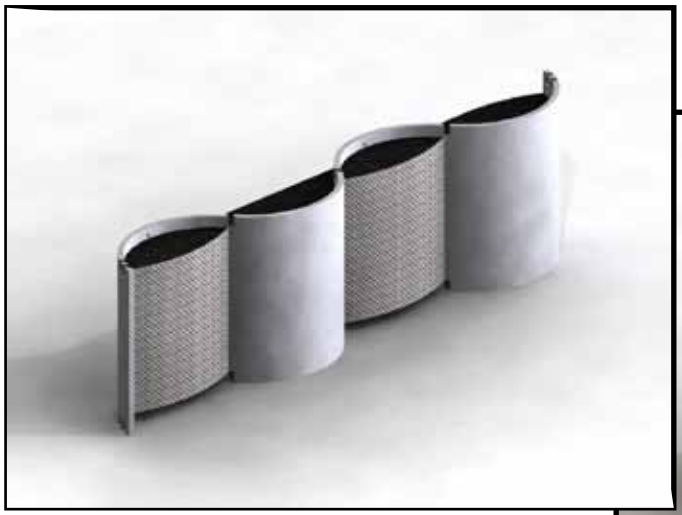
This section will present the design visually with comments to its function.

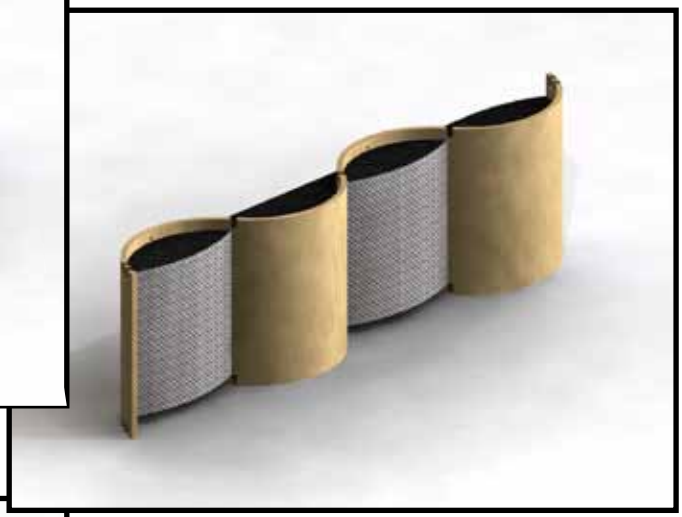
The rendering below shows a single divider screen wave.

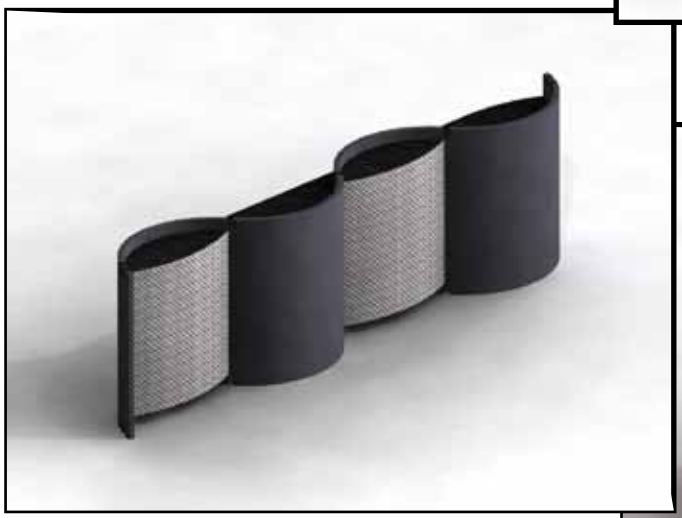
The PET felt can be dyed in many colours. For this design mellow colours is chosen to avoid disturbing the workers. If necessary it could also be dyed white to blend with the wall colour.

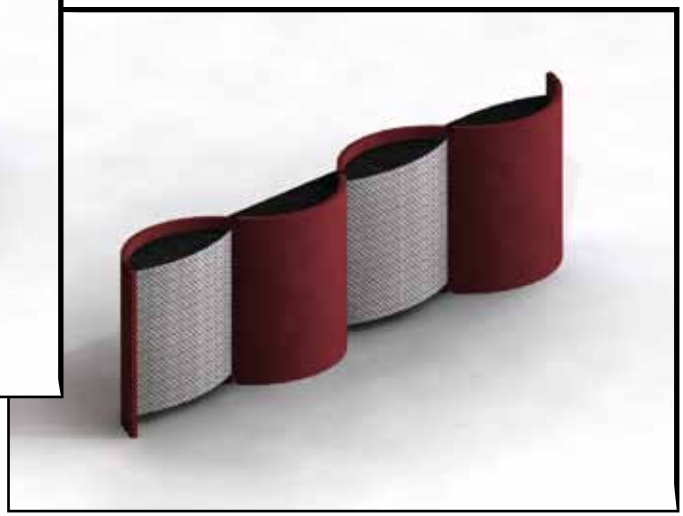
PRODUCT

Presentation



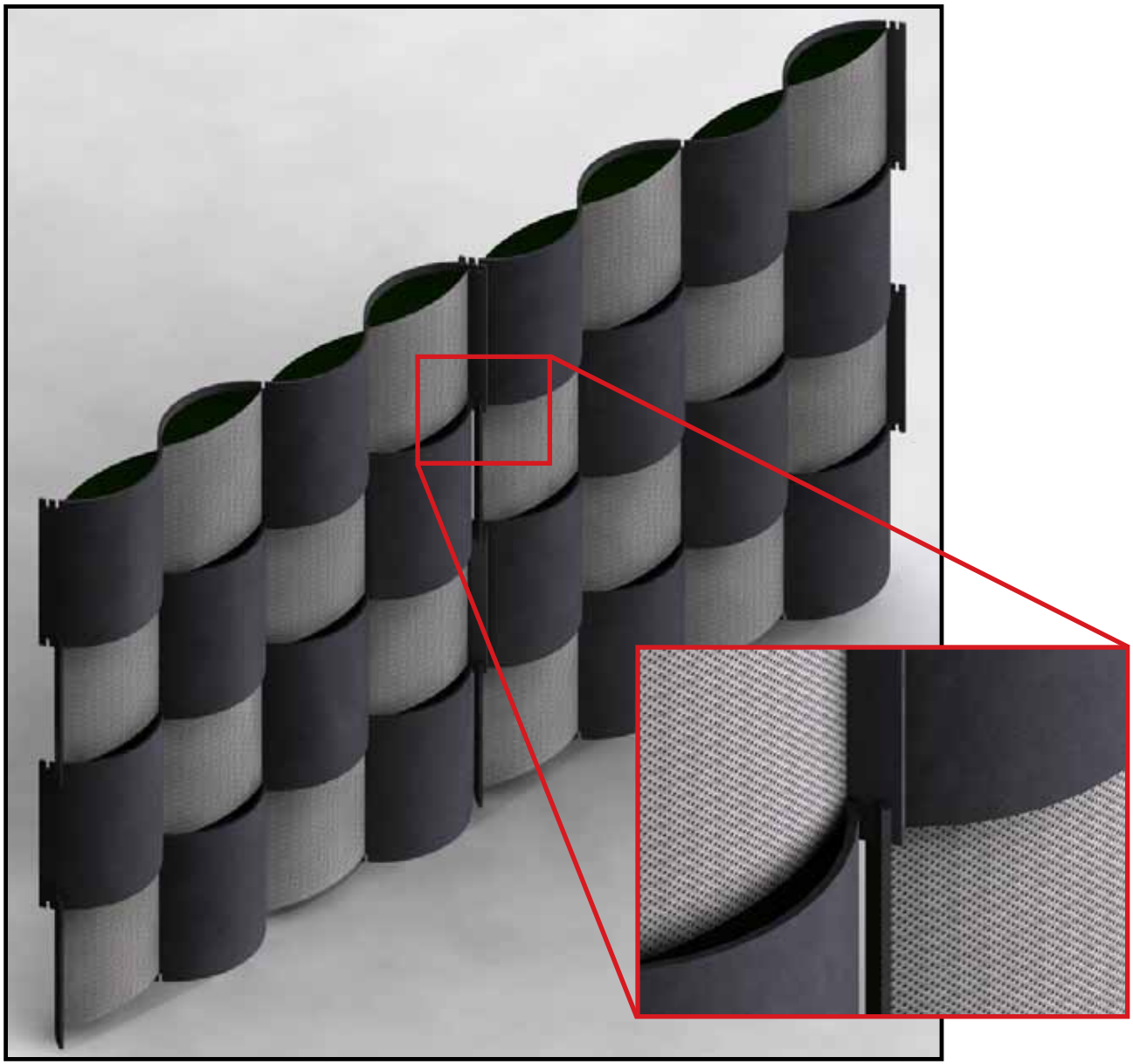






PRODUCT

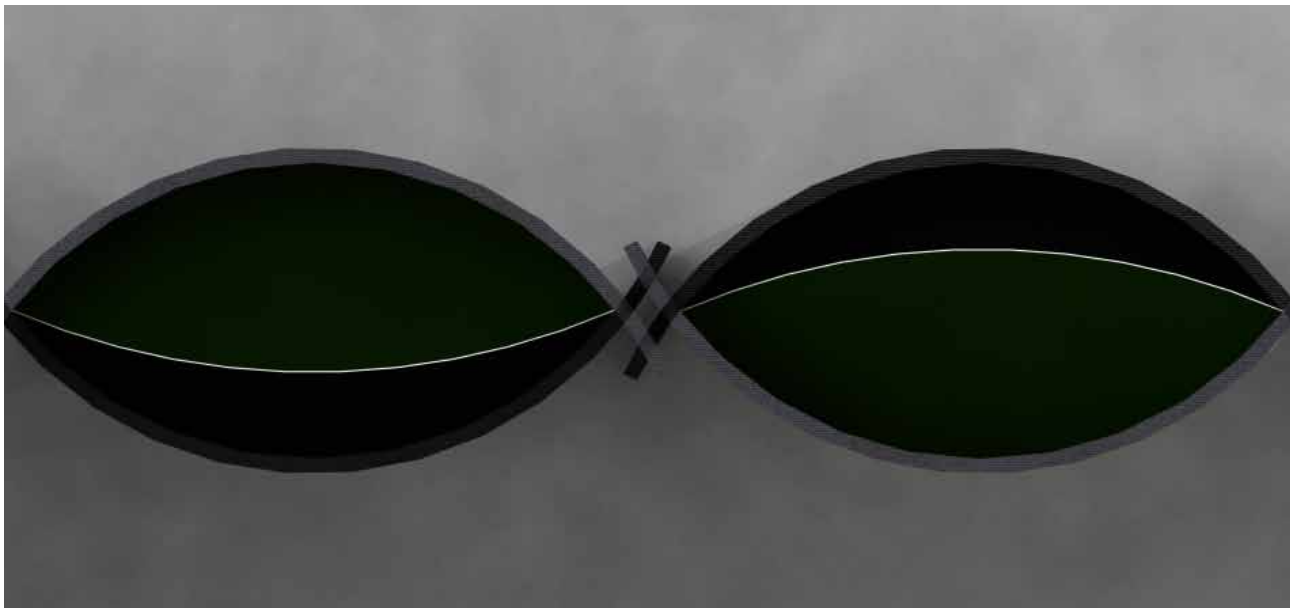
Presentation



PRODUCT

Presentation

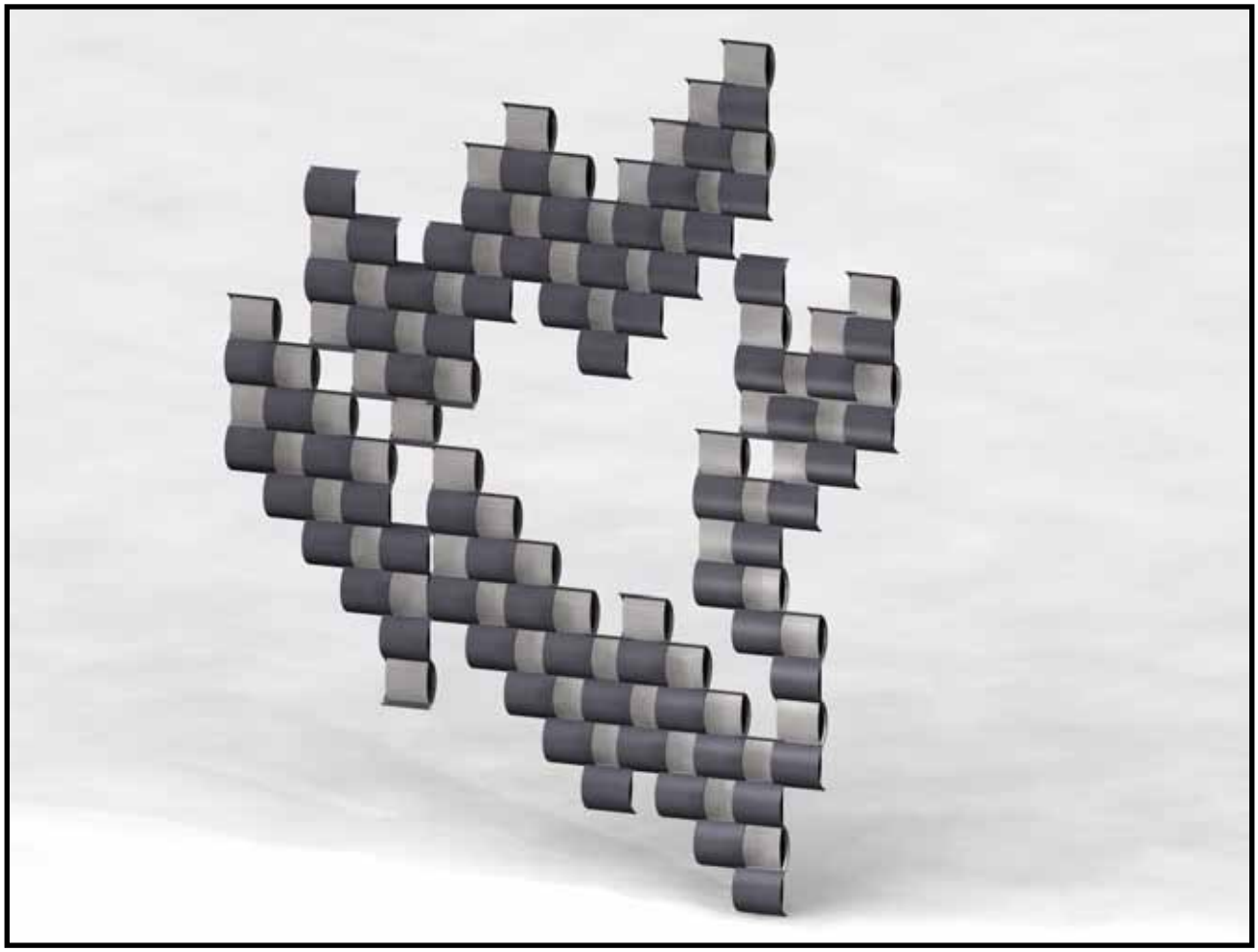
The intersection between two waves gives the impression that the wave is continuous as shown to the left. Below the intersection can be seen from the top



PRODUCT

Presentation

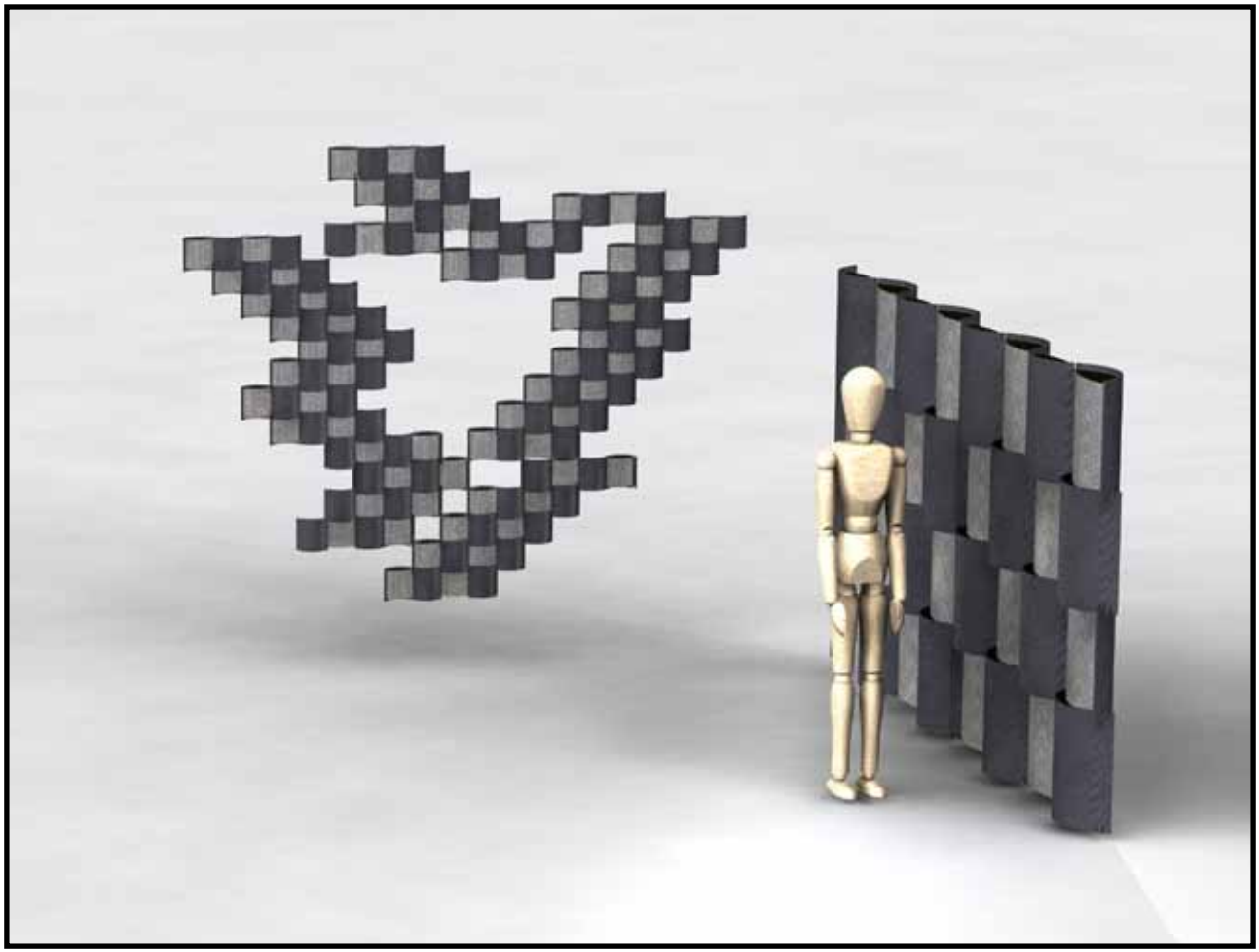
The wall mounted wave can be placed both horizontally, vertically and diagonally if needed.



PRODUCT

Presentation

The rendering shows the relation in size between a grown man and the waves.



SOURCES

References

Page 6: www.arbejdsmiljoweb.dk

Page 8 - 14: Flemming Christensen, AAU Acoustics

Page 17: Flemming Christensen, AAU Acoustics

Page 19: www.b6akustik.dk

Page 20: www.glimakra.com

Page 21: www.design5mm.se

Page 23: Interview with Lene Koudal Cinicola, TopDanmark Forsikring

Page 25: Interview with Hanne Riise Dalgaard, Aalborg Kommune

Page 27: Interview with Sebastian Johnsen Poulsen, Danske Bank

SOURCES

Illustrations

If nothing else is stated the illustration is of own production.

Page 19: www.b6akustik.dk/46_rumakustik.htm#galleri

Page 20: www.glimakra.com

Page 21: www.design5mm.se/Walldesign.htm
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foam.jpg

Page 59: www.b6akustik.dk/66_overflader.htm

APPENDIX

A: Statement from interior designer

Kære Thais

Der er ingen krav. Heldigvis ;-). Ellers ville verden da være kedsommelig ens.

Til hver opgave tilpasses indretningen de ønsker, som den enkelte arbejdsplads måtte have dels til praktiske funktioner, dels til indretningens stemning og atmosfære, dels til stil og æstetisk udtryk.

Det er *netop* designerens opgave at have processer med kunden, hvor ønskerne defineres og at byde ind med et antal forskellige løsninger under processen, der kan tilfredstille ønskerne. På et højere plan, end hvis kunden skulle indrette alene.

Kontormøbelfirmaerne sværger til forskellige "modebegreber" fra tid til anden - så de kan producere nye typer af møbler og dermed (igen) sælge nyt.

Eksempelvis har det nogle år været mode at de markedsfører sig på begrebet "fleksibilitet". I møbelproducentens verden er det lig-med-møbler-på-hjul. I min verden en garanti for en indretning absolut uden æstetik!

Det betyder nemlig at kunden udskyder stillingtagen til, hvor noget skal placeres i en indretning: man kan jo alt. Det fører til endeløse diskussioner om, hvor noget skal rulles hen, om det må stå på den ene eller anden måde - fokus bliver på rulleriet og ikke på, hvad det var vi egentlig skulle kunne foretage os og hvordan det skal opleves.

Hvorimod den fleksibilitet der opstår ved fastplaceret inventar, der har så generelt et udtryk, at det kan anvendes på mange måder - i sidste ende er langt mere fleksibelt og lettere at håndtere for kunden. Denne kan lettere koncentrere sig om, det der skal foregå - og en vis "skønhed" i indretningen er dermed også sikret.

I dag er der heldigvis blevet langt mere fokus på, at det ikke er møbler, der skal rulles rundt, men mennesker der skal flytte sig efter funktionen (bla andet også opstået pga fokus på sundhed: vi skal bevæge os mest muligt).

Til gengæld opstår der ny mode: "og her skal så hænge en fladskærm", hvor fokus er på produkter eller ting, som anses for vigtige for en god indretning, men ikke med bevidsthed om, hvad produkterne egentlig skal bruges til eller om de overhovedet er hensigtsmæssige i enhver sammenhæng.

Indretning handler ikke om bestemte "rigtige" løsninger, men om *guidelines for indretnings**processen***. Disse

APPENDIX

A: Statement from interior designer

guidelines er vi mange, der først nu er ved at definere, fordi det ikke tidligere har været tradition at kunden skulle inddrages i den kreative proces, som det er i dag.

BST definerede også i en årrække en række ”anvisninger” til de enkelte arbejdspladser/arbejdstationer, mest gående på ergonomi, krav til belysning o.lign.. Disse blev af mange virksomheder opfattet som krav, selvom jeg blandt mange andre indretningsarkitekter har været kaldt ud til kunder, hvis omgivelser ikke fungerede efter hensigten - efter at BST havde været på banen.

BST-medarbejdere er kontoruddannede og har derfor intet begreb om at udvikle nye løsninger for noget, man ønsker at skulle foretage sig i en indretning eller æstetik og atmosfære. BSTs bogholderi-agtige ”krav” er med virksomheders fokus på kreativitet og innovation, de senere år blevet anset for stivnethed, der hæmmer nye muligheder. BST må jo også som mange af os andre måttet henholde sig til det, som producenter kunne fortælle om deres produkter og erfaringer fra situationer i det virkelige liv.

Så pas på, når du støder på ”krav” - der er ingen!!

Til gengæld er der generelle mål, der skal overholdes: siddehøjder, plads bag et bord, ganglinjer hvor man skal kunne passere hinanden osv. Det er ikke ”krav”, for du kan sagtens minimere eller øge, men det handler om hvad der er forsvarligt i hvert enkelt tilfælde, hensyntagen til generelle størrelser på mennesker og til hvad kundens mål med møbleringen er. I mange år har man regnet med - meget overordnet set - 60x60 cm, samt 60+30 cm, der passer til mange standard-elementer i byggeri (komfurer, skabe, køkkener osv. er produceret efter det modul).

Generel viden om perception - hvordan mennesker oplever den fysiske verden, kan du også anvende som ”retningslinjer” i indretninger, men ikke ligefrem krav. Den forhenværende professor Arne Karlsen fra Arkskolen i Århus har vist skrevet en del om gamle mestre som Børge Mogensen, Arne Jacobsen og Kaare Klint. Ellers se litteratur om arkitektur, f.eks. ***Elements of Architecture, from Form to Space*** af Pierre von Meiss (ISBN 13: 978 0 419 15940 7), der handler meget om generel perception til brug for designere/arkitekter - dog ikke specielt for indretning.

Du kan også google dig ind på NWOW (New Ways of Working). Eva Bjerrum har lang erfaring i forskning med storrum på Alexandrainstituttet. Bla har hun skrevet en bog sammen med Ole Nielsen fra Cowi: ”Bliver

APPENDIX

A: Statement from interior designer

man småsær af at have sit eget kontor?" - skrevet i en periode, hvor det blev moderigtigt med storrumskontorer. Mange af de indretninger, jeg involveres i, handler om, hvordan man igen kan opdele de store rum i mindre enheder, fordi storrum er anledning til stress. Ikke kun pga støj, men pga uro i bred forstand, mangel på mulighed for fordybelse o.lign. Problemet er, at du kan stuve flere arbejdspladser sammen i storrum og skal den plads opdeles, skal der være færre arbejdspladser.

Jeg håber du kan bruge ovenstående til noget ;-)!

De bedste hilsner

Mette Milling
cand arch / ekstern lektor

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