The Problem of Sound pollution in close quarters living situations

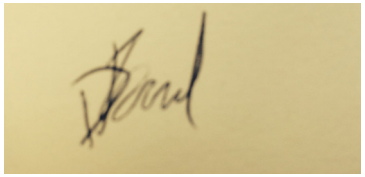
Design Research Methods

Daniel Broad
13005560

Coursework Declaration

Coursework Declaration
The coursework submitted is my own work and has not (either in whole or in part) been previously submitted towards this award, or any other award or qualification, either at UWE or elsewhere.

I have read the UWE Plagiarism Policy which can be accessed on http://www1.uwe.ac.uk/aboutus/policies and understand that cheating, collusion, plagiarism and other breaches of assessment regulations are taken seriously by the University.

Signed  .....

Contents

Introduction *Pages 1*

Project Brief *Pages 2*

Research Overview *Pages 3*

Primary Research *Pages 4-11*

Observations and Insights *Pages 12*

Secondary Research *Pages 13-29*

Design Brief *Pages 30*

Initial Concepts *Pages 31-32*

Concept Selection *Pages 33*

Development *Pages 34*

Developed Concepts *Pages 35-36*

Final Selection *Pages 37*

Design Specification *Pages 38*

Conclusion *Pages 49*

Bibliography *Pages 40-42*

Introduction

This Report looks at the effects of loudspeaker music volume creating sound pollution as well as the user behaviours in setting up and how they use their system. Looking into various technological solutions to this problem and how Directional sound could be a key driver.

Since 2009 there have been between 200-500 noise complaints in the Bedford area each year.

For the noise to count as a statutory nuisance it must do one of the following:

unreasonably and substantially interfere with the use or enjoyment of a home or other premises
injure health or be likely to injure health

The permitted noise level using A-weighted decibels (the unit environmental noise is usually measured in) is:

34 dBA (decibels adjusted) if the underlying level of noise is no more than 24 dBA
10 dBA above the underlying level of noise if this is more than 24

Project Brief

To research into the problem of noise pollution and sound leakage from loudspeakers focusing of Directional speakers as a possible technology for the solution, but also looking into current solutions and the technology they use.
The aim of the project is to research into what current solutions are out there and how they work, but also why are they not being commonly used. The theory Behind Directional sound has been around for some 20 years but only recently are products using this technology being brought into use in public areas but now needs to be developed for home use and transform the way we listen to music.

Research Overview

"If everyone liked the same sounds, noise would not be a problem. What's music to your ears, your neighbour might dislike."
nidirect Government services, Noise Nuisance and Neighbours

Standard home speakers cause unnecessary noise pollution due to their standard design where the sound waves spread out covering a larger area than the user requires. This causes not only a nuisance to others in the house at certain times of the day, but also neighbouring households especially in locations where many houses are in close proximity.


Primary Research

Expert Talk

Dr David Creasey
Senior Lecturer in Computer science and Creative Technologies at UWE.
David's teaching spans a number of areas, including:
- Audio recording theory in practice
- Acoustic instrument physics
- Architectural acoustics
- Audio processes

(1) You need to make a very clear decision about the balance of your investigation. Aesthetics/ visual form and the technical aspects are both huge subjects, so you need to decide where you are spending your time. As a general rule, a technically excellent speaker generally looks very boring, as any unusual shaping tends to have strange effects on the sound.

(2) If you are interested in how cabinets are designed to suit particular loudspeaker drivers, then you the place to start is the work by Thiele and Small, and you will need a decent grasp of maths.

(3) Different types of loudspeaker target different results. For studio monitors the aim is excellent frequency and phase response. For public address/sound reinforcement the aim is high power output and physical robustness. As a general rule, you cannot have both, so you need to decide which you are interested in.

(4) Students in the past have found that reading a good book on the subject gets them a long way to their destination. Which one is most appropriate depends on your target area, obviously.

Expert Talk

Dr Chris Nash and Martyn Harries are both senior lecturers in Music Technology at UWE, with experience in music composition, sound mixing and how sound works in general

(1) Room nodes and low frequencies are the main problems when it comes to sound in close quarters living.

(2) Would need to use a lot of anti-wave speakers to cover a neighbouring wall which could work on ceilings as panels but side walls more difficult. Speaker Art is a possible solution there though.

(3) Adding either foam or decoupling under the speaker can reduce transferring vibrations to where the speaker is placed.

(4) A Directional Speaker paired with noise cancelling sound could be a possible solution, with the directional sound for the high frequencies and the anti-wave for the low frequencies.

(5) A tracking system so the speaker would move to face where you move to could help make directional speaker more effective as a solution.

(6) The main aim will be to reduce transferring energy between the floor or walls as that's where the problem occurs as the sound/vibrations resonate off them.

(7) Using more than one Directional speaker, as a way to have more than one user, would cause issues as the more systems you have the less likely they are to be in phase. E.g. Surround sound systems all have differnet sounds produced by the speakers.

(8) You can use phasing to create directional sound as well by filing a room with speakers that all cancel each other out apart from in one spot, creating a bubble of sound.

(9) The design will need minimal vibration to make it more effective.

(10) Piezo transducers/buzzers are a good viable option and cheap to work with.

(11) There is limited opportunity in the design of a casing as it would cause omnisound rather than directional, so the speakers need to be exposed.

Expert Talk

Notes taken from a phone interview with Tom Tucker, Director at Pasce Ltd Minirigs, and has a degree in Industrial and Product Design from UWE.

(1) Directional speakers are generally not great for sound quality

(2) High frequencies are the carriers for directional sound as they are narrower

(3) Narrow beamy frequencies will work but their sound quality is limited

(4) What level volume does the speaker have to be at to effect neighbours and is it worth it?

(5) Noise cancelling is complicated in an application that isn't headphones as it works on a small area encasing the ear

(6) A Directional speaker would work and would be possible to mock up a prototype

(7)There's possibility to split a TV and beam the two different sound sides to individuals so each person wouldn't be effected by the other

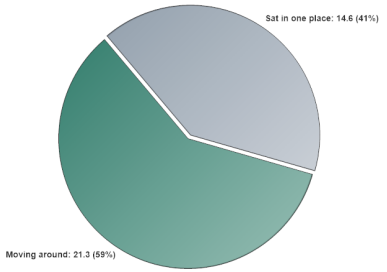
(8)Limited by the type of speaker but still a lot of scope to make the casing look cool once you understand the technology

(9) Think about the routes you want to take and how that effects the technology you use and the end result

User Survey Results

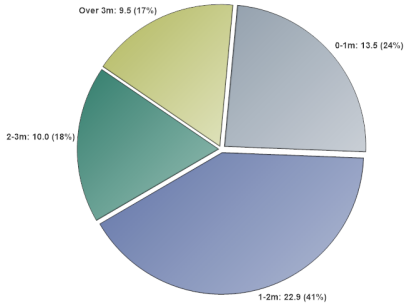
An anonymous survey set up to find out about how people used their music speakers and whether noise pollution and sound leakage was a problem for them with theirs or other peoples speakers. the survey was answered by 21 people with additional information left in the comments section by some.

When listening to music at home are you sat in one place or moving around?



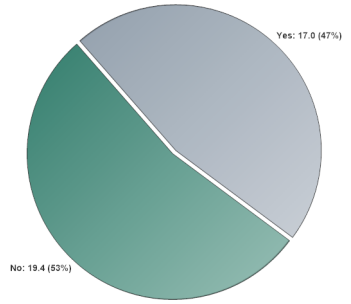
The first question asked was about whether people choose to move around doing things while listening to their music or sat in a constant position. 41% of those asked stayed seated showing that its almost an even balance between how they listen.

How far away are you usually from your speaker?



In terms of distance people were from their speaker when in use there was a clear majority at 1-2m away folowed by 0-1m. Showing that users are generally in close proximity to their speaker.

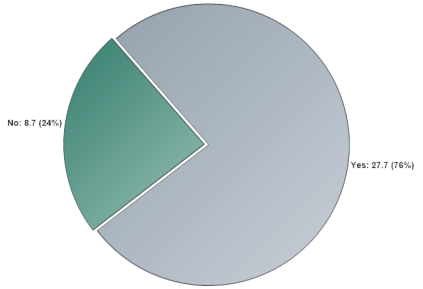
Have you ever had complaints from neighbours or housemates about your music volume?



Question 4 on the survey validated some of the earlier assumptions that people often get complaints about the volume of their music, with 47% saying they had.

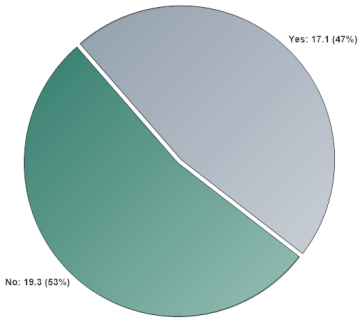
Whereas on the otherside 76% had said they had been disturbed by other peoples music, whether they themselevs complained or not this shows theres a problem.

Have you ever been disturbed by the volume of music from neighbours or housemates?



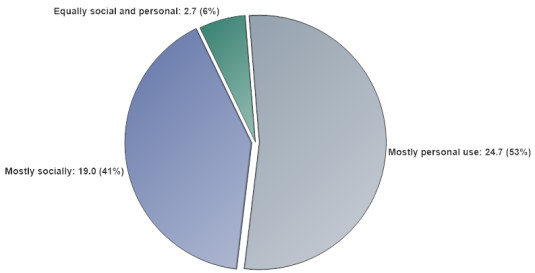
User Survey Results

Do you use your speaker system for more than just music?



Question 5 found that 47% used their speaker things over than music. in a follow up question people said they used their speaker for television, gaming, movies and generally anything that came out of the TV itself.

Is your speaker system mainly for personal use only?

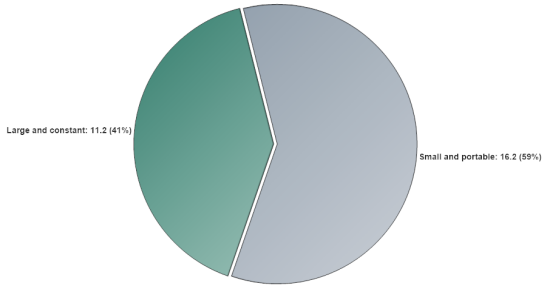


When it came to speaker set up small portable speakers came out slightly higher for the reason they could constantly be re-set up or easily connected to different devices. However larger speaker systems weren't far behind with one person saying how his ony had one plug and was still fairly easy to move.

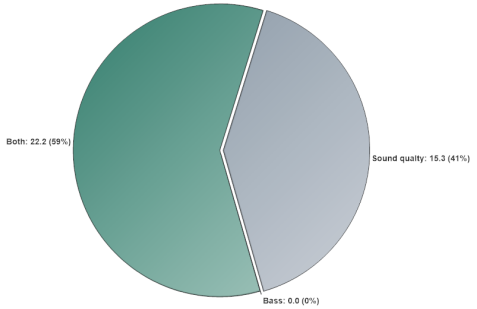
The final question found that most users want both good sound quality and good bass elements to the speaker they buy. With no one saying theyd buy a speaker just for bass though.

In regards to when people chose to use their speaker the majority at 52% mainly used theirs for personal use when its just them listening. Whereas not many used it for social listening only.

Is your speaker system small and easily moved or large and a constant set up?



Do you choose a speaker for clear sound quality or bass capabilities?



Speaker Decibel Readings

Decibel reading of a speaker set up in a bedroom with the intitial reading taken from where the user would be sat.

Distance from speaker: 1m
Max decibel reading before music: 50.8dba
Max reading with music: 81.3dba at 50% volume

From the other side of the wall
Max reading before music: 59.8dba
Max reading with music: 66dba at 50% volume
71dba at 75% volume

Decibel reading of a speaker set up in a living room in the furthest chair from the speaker.

Distance from speaker: 2m
Max reading before music: 57.7dba
Max reaidng with music: 82.3dba at 50% voulme
89.8dba at 75% volume

From other side of the wall
Max reading before music: 52.6dba
Max reading with music: 64.5dba at 50% volume
74.7dba at 75% volume

Decibel reading of a speaker set up in an open plan hallway facing into a kitchen.

Distance from speaker: 4m
Max reading before music: 61.7dba
Max reaidng with music: 73.8dba at 50% voulme
90.1dba at 75% volume

From other side of the wall
Max reading before music: 41.0dba
Max reading with music: 60.3dba at 50% volume
73.6dba at 75% volume

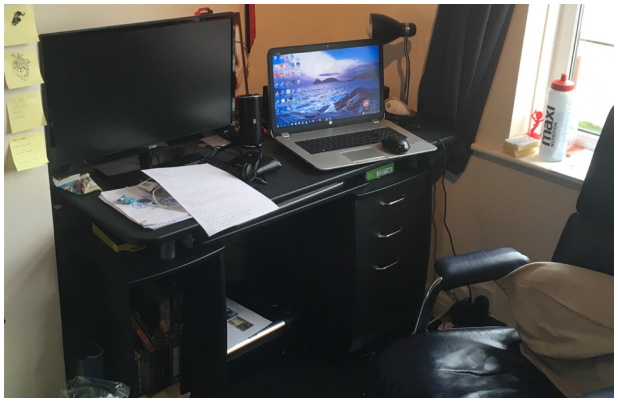
Speaker Placement Research

The first speaker is one placed in a kitchen. it is set up on a neighbouring house wall and aimed at the nearest wall as well meaning quicker sound reflections.

Second is a better placed system, set on an inside wall and facing into an open hallway leading into a kitchen so plenty of room for the waves to spread without reflection.

The third is a tv sound bar with a hidden sub woofer. The bar is set up on a non-neighbouring wall and facing into an open living lounge and hall so there are few walls to cause null points from low frequency reflections

The final speaker is a small portable bluetooth system connected to either the TV or the laptop. it is positioned by a neighbouring wall, however the user is sat at close distance so the volume is kept lower.



Observations and Insights

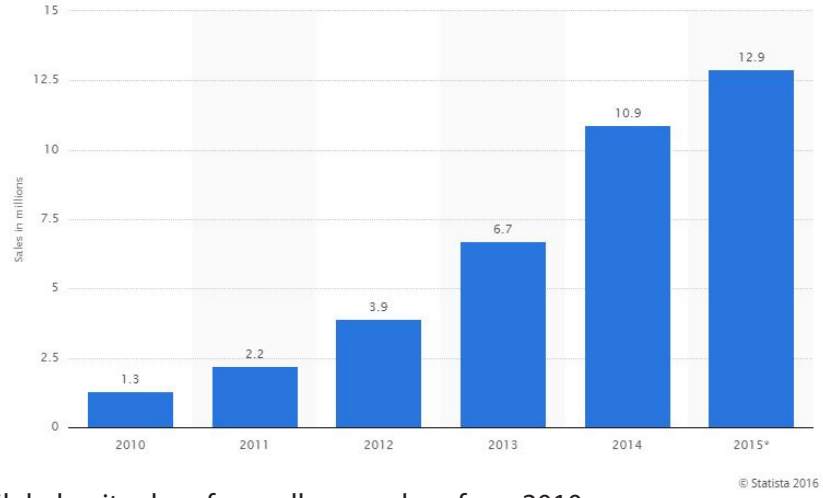
One observation made was through the decibel readings. The make and quality of the speaker effected the amount of sound and vibration coming through the neighbouring wall.

A second was that People tended to place their speaker onto a neighbouring outside wall, straight away leading to vibrations being passed through but also the omnidirectional nature of loudspeakers causing sound to reflect and go straight through the walls

A third was taken from the user survey and the speaker placement photographs where it was found that not many people use their speaker for just music these days and that it is a key part of them watching television and films also to have a greater experience.

Secondary Research

Market Research



Global unit sales of soundbar speakers from 2010 to 2015 (in millions)
This statistic shows the global unit sales of soundbar speakers from 2010 to 2015. In 2013, 6.7 million units of soundbar speakers were sold worldwide

"Home audio sales are driven by slim one-piece amplifi ed soundbars, wireless multi-room audio systems and other networked-audio products."

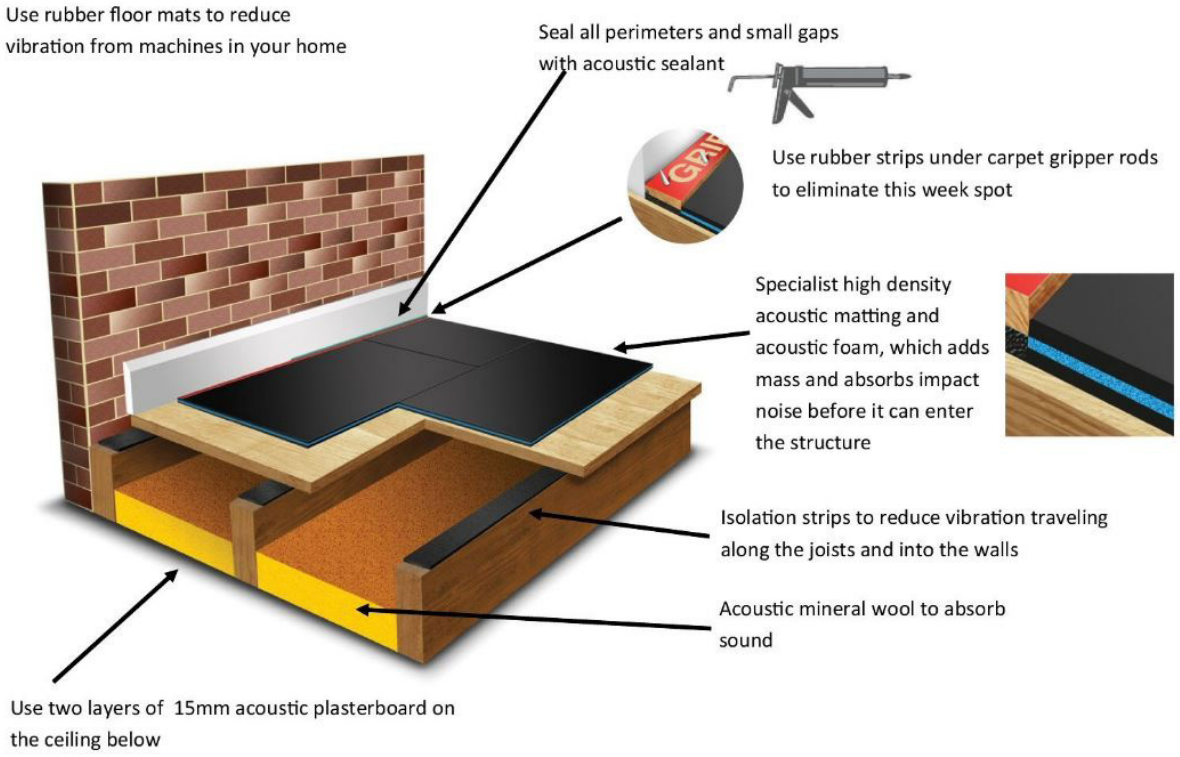
"Sales of portable Bluetooth speakers are surging because they play back music wirelessly from any Bluetooth-equipped smartphone, tablet or laptop."

"Factory level sales of portable Bluetooth speakers surged an estimated 111 percent in 2014 and will jump 21.8 percent more in 2015 to $989 million, CEA statistics show."

Sound Proofing

"Sound is an energy that travels in two ways. The most common is airborne noise such as people talking and TV; the second is impact and vibration noise such as footsteps on floorboards and vibrating machines.
Sound proofing works in one of three ways."

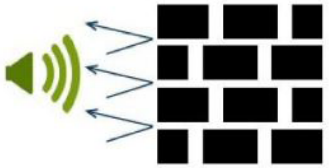
"The First is to de-couple one structure from another, stopping the sound vibration travelling though the structure."



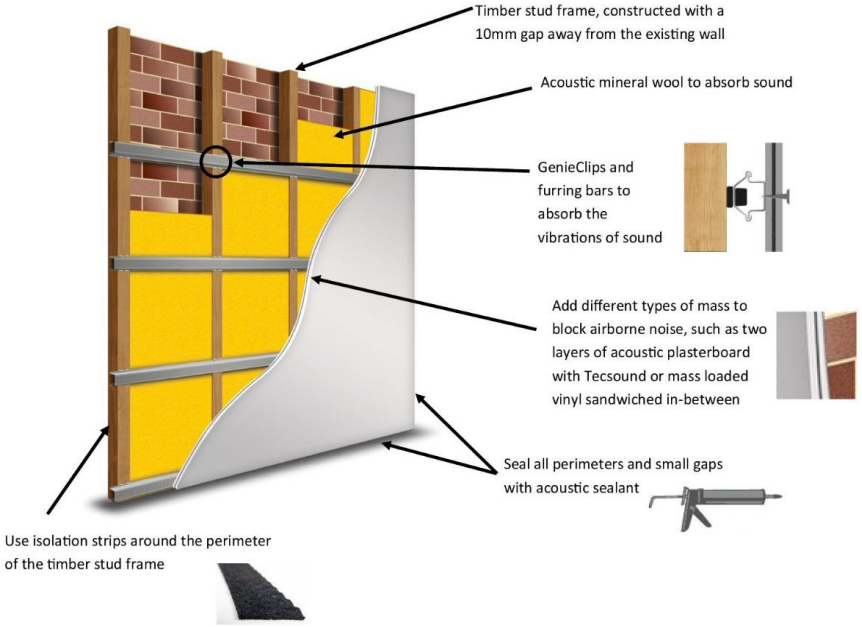
Sound Proofing Guide

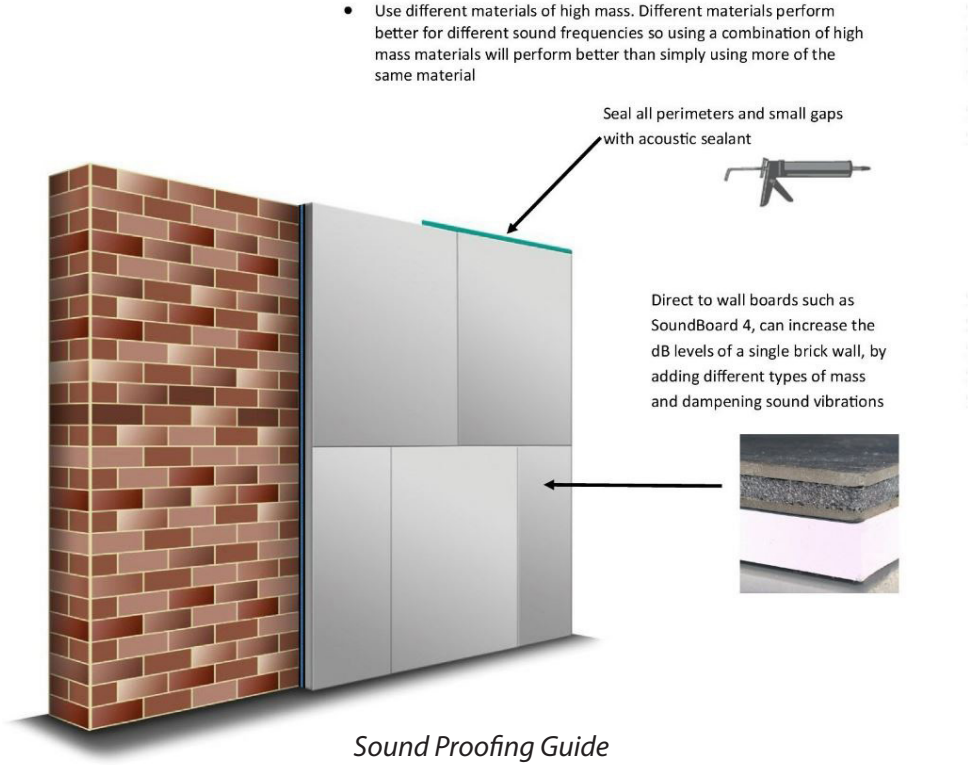
Sound Proofing

"Second is to block noise by adding mass to a structure so that the energy is reflected."



The higher the density of the wall, the better its performance

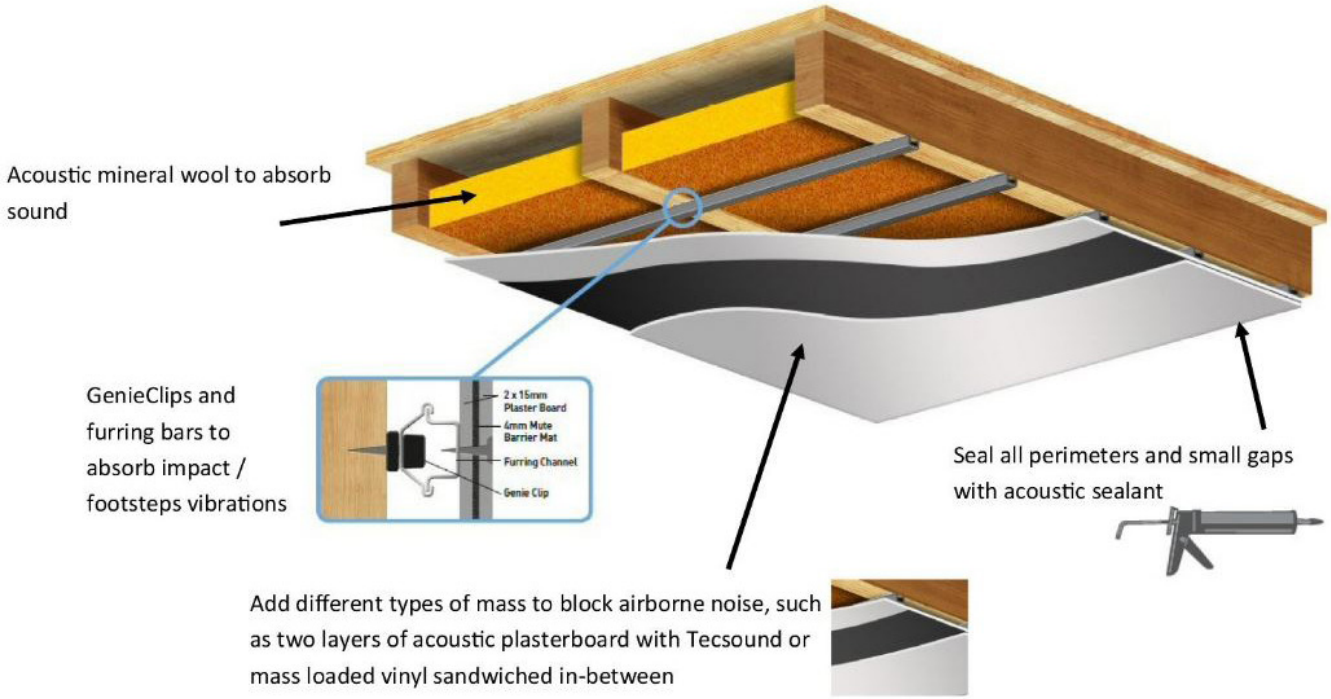




Sound Proofing Guide

Sound Proofing

"The Third is sound absorbtion. sound is absorbed by a material which reduces sound levels and echo amplification."



Sound Proofing Guide

Directional Speakers

What is a Directional speaker?

Directional Sound refers to the notion of using various devices to create fields of sound which spread less than most (small) traditional loudspeakers. Several techniques are available to accomplish this, and each has its benefits and drawbacks. Ultimately, choosing a directional sound device depends greatly on the environment in which it is deployed as well as the content that will be reproduced. Keeping these factors in mind will yield the best results through any evaluation of directional sound technologies.

Wikipedia, Directional Sound

How do Directional speakers work?

"Directional speakers work in an entirely different way from conventional loudspeakers. The biggest difference is that they don't produce ordinary, audible sound waves with a single, moving electromagnetic coil and cone. Instead, they generate ultrasound (high-frequency sound waves) using an array of electrical devices called piezoelectric transducers.
These are simply crystals, such as quartz, that vibrate back and forth tens of thousands of times a second when you feed electric currents through them, producing very high frequencies of sound.

Ultrasound is used because its higher-frequency waves have a correspondingly shorter wavelength and diffract less as they travel, which means they stay together in a beam for longer than ordinary sound would.
Having an array of many, small transducers makes sound diffract less than it would do from a single, large transducer."

"Effectively, then, the ultrasound travels out from a directional speaker in a narrowly focused column, like a flashlight beam. But when it hits something, it turns back into ordinary sound you can hear.
a directional speaker sends its sound in a much more tightly focused column, with far less energy dissipation. In practice, that means it can travel something 20 times further than sound from a conventional speaker."

Where are Directional speakers used?

"The U.S. military has been using directional speakers since 2004."
- They are used in muesuem exhibitions
- Hospitals to not disturb a large group of people
- Advertisements
- And are new to home use

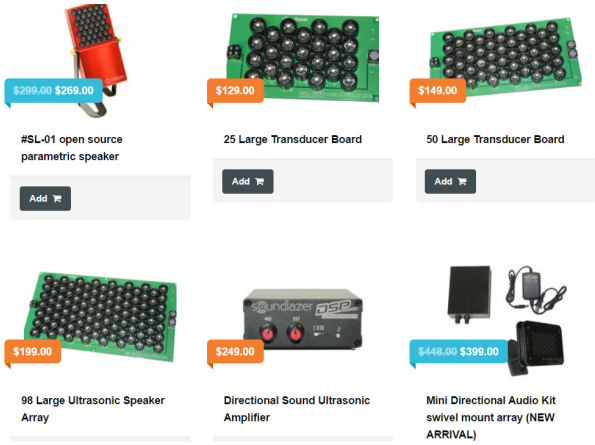
Explain That Stuff, Directional Loudspeakers

SoundLazer Parametric

Parametric speaker

Soundlazer uses a focused beam of sound to put audio where you want it to be. It is an open source project to provide the basic technology for others to then take this further and change the way we listen to music.

An on board signal processor conditions the audio from your iPhone, iPod, iPad, computer or any other source. The sound can only be heard by someone standing in the Soundlazer's path. Like a laser, the parametric array sends the audio signal over a ultrasonic beam which can also be bounced off of walls, statues or any other hard object to make the sound appear to be coming from another direction.



They sell various size piezoelectric transducer boards to be able to create your own directional speaker. With the complete soundlazer speaker you get the open source plans and software to be able to maximise its potential, however just for this small speaker its $269.

Brown Innovations Directional

Brown Innovations Directional audio

Brown Innovations focusing array loudspeakers reduce sound bleed and put the sound where you want it. Brown produce more commercial products than consumer, mainly being installed in public places and museums for exhibits, advertisement and signpost announcements. Current users of their technology are Heathrow airport, the Rock and Roll Hall of Fame Museum and also the Metropolitan Museum of Art.

Brown's produce six variations of speaker each to fit a different requirement. Two angled types for scenarios such as a museum exhibit where the sound wants to be coming from below. Three are regular directional soundbars in various sizes. And the final one they produce is a flat panel for ceiling installations.

Holosonics Audio Spotlight

Audio Spotlight 168i
Reference: AS-168i
The smallest and most affordable model, best suited for reproducing brighter sounds.
Designed for targeting single, stationary listeners in very quiet environments.
Small form factor, perfect for kiosks, ATMs, and point of sale integration.
Recommended model for home bedroom listening
Built-in microSD player, and balanced and unbalanced audio inputs standard
Bluetooth and motion sensor options available
Standard VESA100 mounting pattern

Holosonics produce directional speakers for both business and consumer use. Their systems are installed in museums, retail stores, digital signage, libraries and hospitals worldwide.

Their consumer section is a new venture using the same systems as the business side, which have drawbacks of not being able to easy adjust its direction.

City of Mississauga Library, able to use a directional speaker for audio books while keeping the quiet environment.

Active Noise Control

"Active noise control, also known as noise cancellation, or active noise reduction, is a method of reducing unwanted sound by the addition of a second sound specifically designed to cancel the first.
A noise cancellation speaker emits a sound wave with the same amplitude but with inverted phase to the orginal sound. The waves combine to form a new wave, in a process called interference, and effectively cancel each other out."

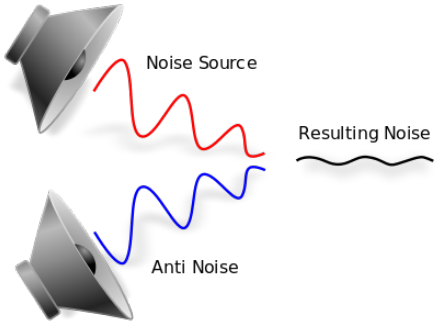
"A noise-cancellation speaker may be co-located with the sound source to be attenuated. In this case it must have the same audio power level as the source of the unwanted sound. Alternatively, the transducer emitting the cancellation signal may be located at the location where sound attenuation is wanted. This requires a much lower power level for cancellation but is effective only for a single user.
Noise cancellation at other locations is more difficult as the three-dimensional wavefronts of the unwanted sound and the cancellation signal could match and create alternating zones of constructive and destructive interference, reducing noise in some spots while doubling noise in others. In small enclosed spaces global noise reduction can be achieved via multiple speakers and feedback microphones, and measurement of the modal responses of the enclosure."

Wikipedia Active Noise Control

Noise Cancelling Headphones

To cancel the lower-frequency portions of noise, noise cancelling headphones use active noise control. They incorporate a microphone that measures ambient sound, generate a waveform that is the exact negative of the ambient sound, and mix it with any audio signal the listener desires.

Drawbacks
- Makes the product more expensive
- Increases the size of the product
- The noise cancelling may reduce aduio quality and add high-frequency hiss.



Most noise-cancelling headsets in the consumer market generate the noise-cancelling waveform in real-time with analogue technology. In contrast, other active noise and vibration control products use soft real-time digital processing.

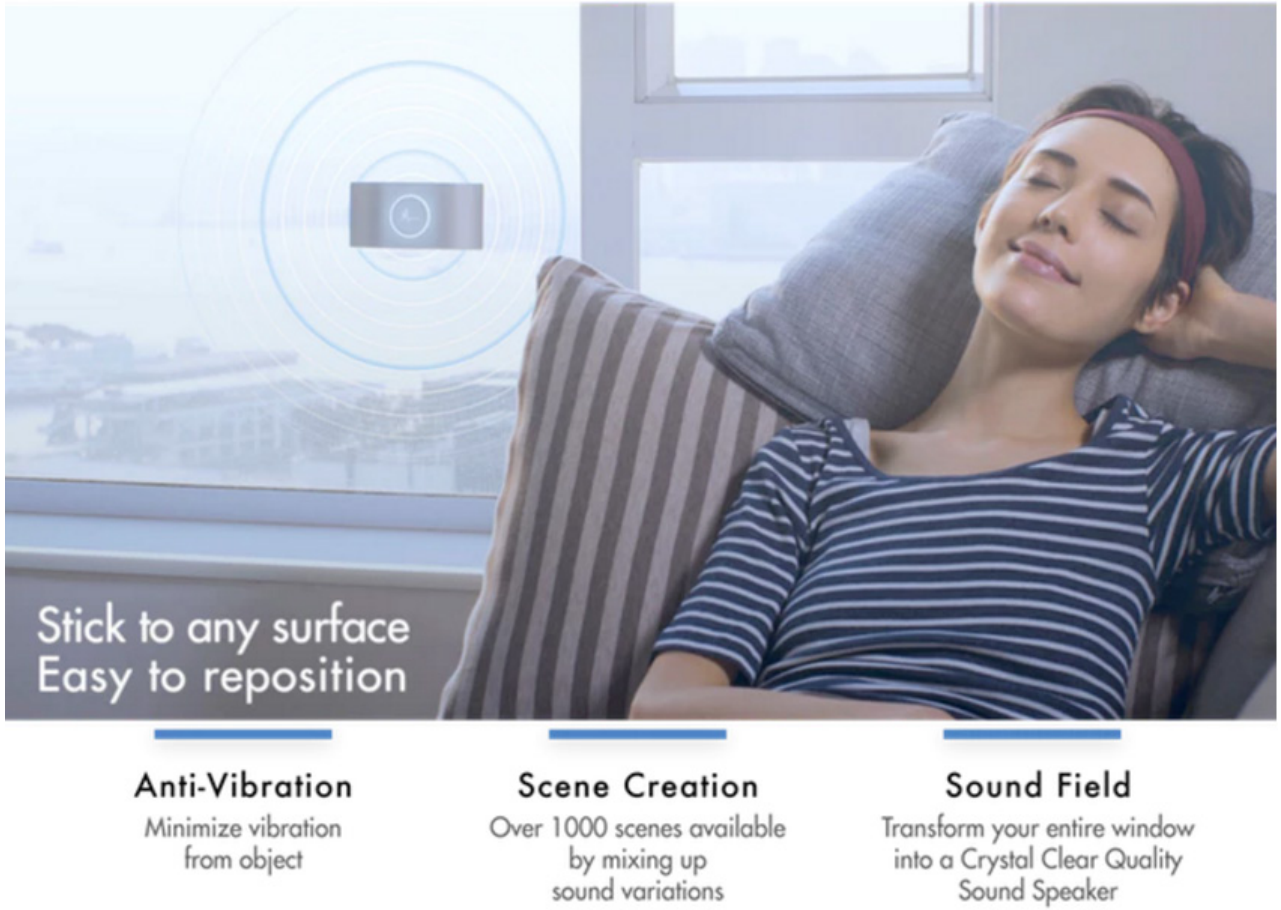
To prevent higher-frequency noise from reaching the ear, most noise-cancelling headphones depend on soundproofing. Higher-frequency sound has a shorter wavelength, and cancelling this sound would require locating devices to detect and counteract it closer to the listener's eardrum than is currently technically feasible, or would require digital algorithms that would complicate the headphone's electronics.

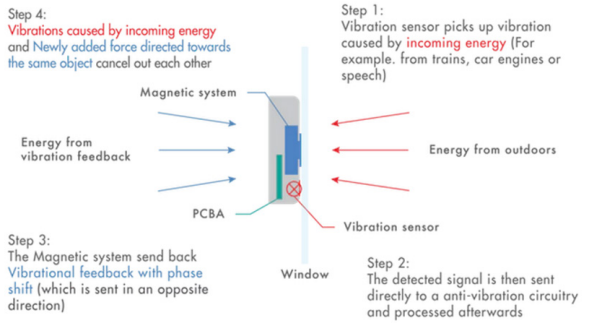
Noise-cancelling headphones specify the amount of noise they can cancel in terms of decibels. This number may be useful to compare products, but does not tell the whole story, as it does not specify noise reduction at various frequencies.

Wikipedia Noise Cancelling Headphones

Muzo

Muzo, Anti-Vibration and Sound Privacy



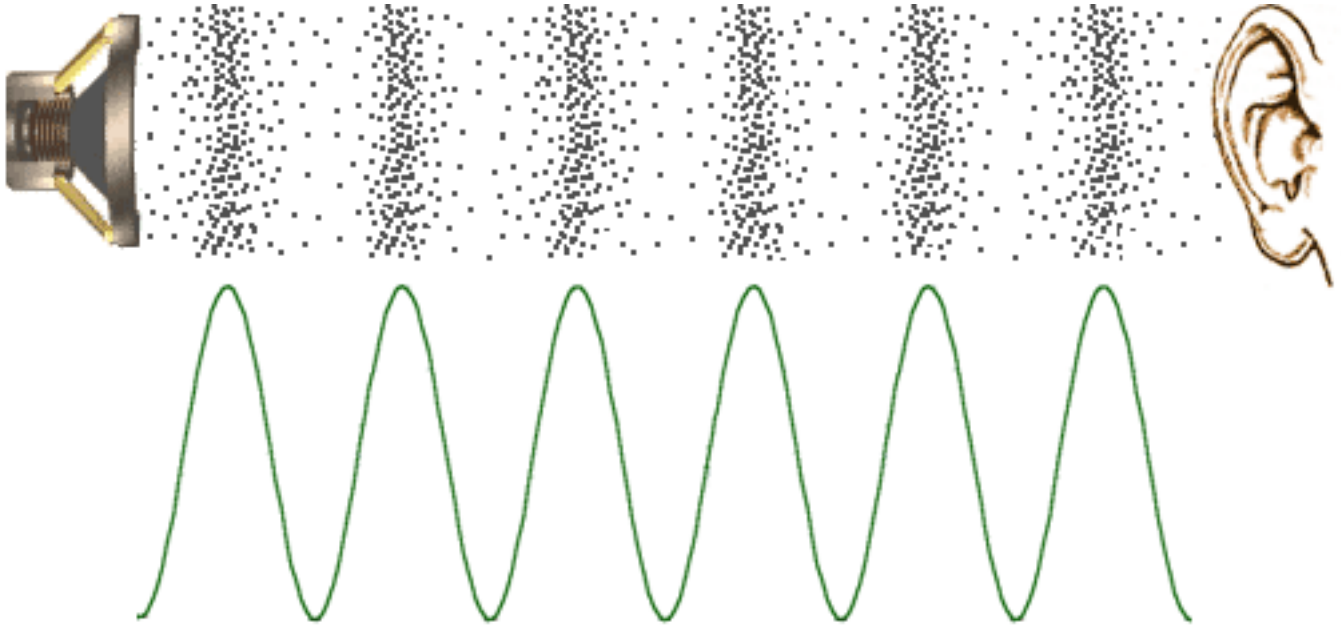


Muzo has 3 functions to it; one is Serenity, where it eliminates vibrations to create silence. Two is Sleep mode, where it uses scene creation to improve sleep quality.

The Third and final function is Secret mode, where it protects your converstions by masking the sound.

Audio Research

Sound Waves



"Sound waves can be defined as those with a frequency range that lies within the audio spectrum."

"Sound waves require a material medium for propagation eg. air, water or wood."

"When sound travels through the air, which is the way it usually reaches our ears, the wave motion is longitudinal. the waves consist of variations in air pressure, oscillating alternately above and below the prevailing barometric pressure."

"When sound reaches the ear, the loudness we hear is not strictly proportional to the energy of the soundwave. The sensitivity of our hearing depends upon the frequency and the intensity of the sound."

Sound recoding and reproduction

Audio Research

Loudspeaker Design and Placement

"Even though a loudspeaker's cone moves only back and forth, it can do so at more than one rate simultaneously, reproducing more than one frequency at a time."

"The basic design of dynamic (Electromagnetic) loudspeakers has been around since before 1900, though modern versions are greatly improved and have much higher fidelity."

"It's impossible to design a single speaker driver that can produce the entire range of audio frequencies from 20Hz to 20KHz. Single-driver loudspeaker systems are available, but none actually cover the full range efficiently, and they're overly directional at high frequencies. Therefore, most loudspeaker systems use two or three different driver types, each optimised for one portion of the audible range."

"Loudspeaker system design requires an endless list of engineering trade-offs, not just a choice of crossover frequencies and driver types. Indeed if there was one 'best' way to design a loudspeaker, they all would be made the same."

"Placing the loudspeakers and listening position correctly is the first step to getting good sound, especially at low frequencies."

"Tweeters should also be at ear level and pointed toward you for the flattest response."

"Bass frequencies are the most difficult to tame in a small room because the wavelengths are long, which requires thick absorbers called bass traps."

The Audio Expert

Audio Research

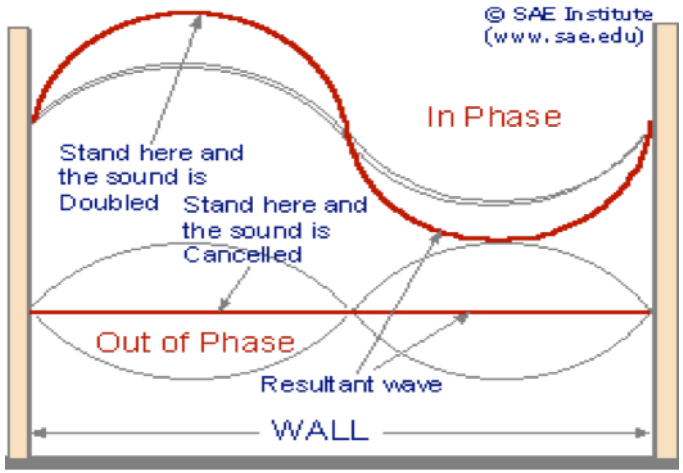
Room Nodes

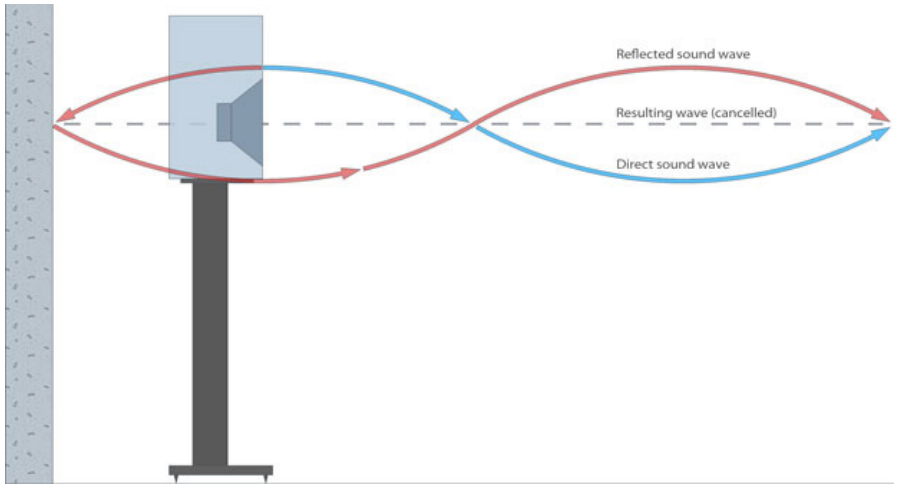
"A node is a location in a room where two waves collide out of phase creating a null. For example, nodes occur at predictable quarter-wave distances from the rear wall behind a listener."

"In rectangular rooms, the low bass response is most lacking at the halfway points, halfway between the front and rear walls, halfway between the left and right side walls and halfway between the floor and ceiling."

"When a loudspeaker is in a room's null spot, its output is reduced considerably at low frequencies whose wavelengths are related to that dimension."

"In many rooms, the main problem is deep nulls caused by reflections from the wall behind you combining out of phase with the direct sound from the loudspeakers



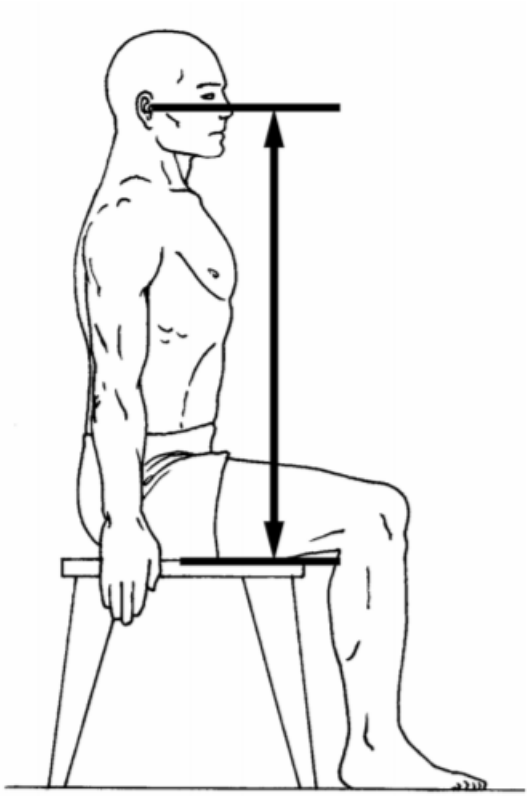


The Audio Expert

Anthropometric Data

Eye Height Approximation, Sitting

FEMALE N = 2208			MALE N = 1774		
Centimeters		**Inches**	**Centimeters**		**Inches**
72.85	**Mean**	28.68	78.30	**Mean**	30.83
3.31	**Std Dev**	1.30	3.38	**Std Dev**	1.33
84.00	**Maximum**	33.07	89.30	**Maximum**	35.16
63.00	**Minimum**	24.80	67.70	**Minimum**	26.65
	Percentiles			**Percentiles**	
65.48	1st	25.78	70.14	1st	27.61
66.27	2nd	26.09	71.17	2nd	28.02
66.78	3rd	26.29	71.81	3rd	28.27
67.48	5th	26.57	72.66	5th	28.60
68.59	10th	27.01	73.93	10th	29.10
69.37	15th	27.31	74.77	15th	29.44
69.99	20th	27.55	75.43	20th	29.70
70.54	25th	27.77	76.01	25th	29.92
71.03	30th	27.96	76.52	30th	30.13
71.49	35th	28.15	77.00	35th	30.31
74.93	40th	28.32	77.45	40th	30.49
72.36	45th	28.49	77.89	45th	30.66
72.79	50th	28.66	78.32	50th	30.83
73.22	55th	28.83	78.75	55th	31.01
73.66	60th	29.00	79.19	60th	31.18
74.11	65th	29.18	79.65	65th	31.36
74.59	70th	29.37	80.13	70th	31.55
75.11	75th	29.57	80.64	75th	31.75
75.69	80th	29.80	81.22	80th	31.97
76.36	85th	30.06	81.87	85th	32.23
77.19	90th	30.39	82.68	90th	32.55
78.41	95th	30.87	83.83	95th	33.01
79.17	97th	31.17	84.53	97th	33.28
79.71	98th	31.38	85.02	98th	33.47
80.52	99th	31.70	85.71	99th	33.74

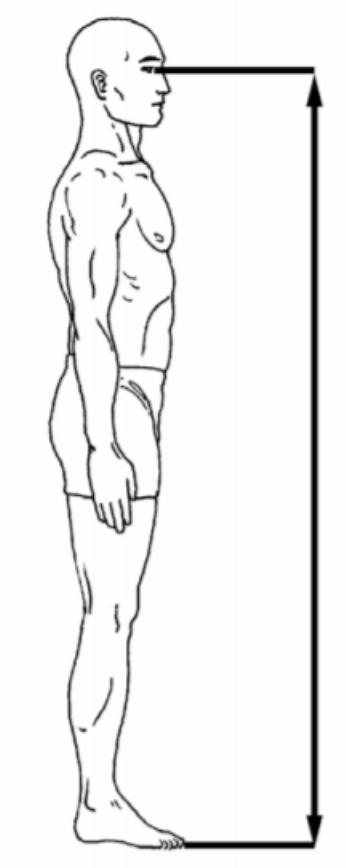


The Ergonomics Center

Anthropometric Data

Eye Height, Standing

FEMALE N = 2208			MALE N = 1774		
Centimeters		**Inches**	**Centimeters**		**Inches**
151.61	**Mean**	59.69	163.39	**Mean**	64.32
6.25	**Std Dev**	2.46	6.57	**Std Dev**	2.59
175.30	**Maximum**	69.02	191.20	**Maximum**	75.28
132.50	**Minimum**	52.17	138.10	**Minimum**	54.37
	Percentiles			**Percentiles**	
137.39	1st	54.09	148.40	1st	58.43
139.07	2nd	54.75	150.22	2nd	59.14
140.11	3rd	55.16	151.33	3rd	59.14
141.52	5th	55.72	152.82	5th	59.58
143.67	10th	56.56	155.08	10th	60.17
145.13	15th	57.14	156.60	15th	61.05
146.29	20th	57.59	157.82	20th	61.65
147.30	25th	57.99	158.88	25th	62.13
148.21	30th	58.35	159.84	30th	62.55
149.06	35th	58.68	160.73	35th	62.93
149.87	40th	59.00	161.59	40th	63.62
150.66	45th	59.32	162.42	45th	63.95
151.45	50th	59.63	163.26	50th	64.28
152.24	55th	59.94	164.10	55th	64.61
153.05	60th	60.26	164.96	60th	64.94
153.90	65th	60.59	165.85	65th	65.30
154.79	70th	60.94	166.79	70th	65.67
155.77	75th	61.33	167.82	75th	66.07
156.86	80th	61.76	168.97	80th	66.52
158.14	85th	62.26	170.29	85th	67.04
159.75	90th	62.90	171.29	90th	67.69
162.13	95th	63.83	174.29	95th	68.62
163.35	97th	64.43	175.73	97th	69.18
164.75	98th	64.86	176.72	98th	69.57
166.43	99th	65.52	178.15	99th	70.14



The Ergonomics Center

Design Brief

The opportunity
There is an opportunity here to revolutionise the way we listen to music and sound in general, allowing people to be closer together but without the disturbances to one another when doing their own thing. Such as listening to two TV channels at once without having the sound crossover.

The Idea
The idea is to design a product that has third party benefits as well as to the user creating a better environment.

Concept Outline
The outline of the concepts will be to look at the various ways to set up a directional speaker to create a sound bubble and minimize the impact of vibrations and soundwaves. They will also draw upon the anti-wave side of the research looking at ways to eliminate or isolate music or sound without significant adjustments to the room.

Target Market
Target market is 16-40 year olds. There are two different target markets going into the concept stage, one is for those wanting music without the disturbances standard speakers produce. And the other is those people who want more privacy and want to cancel the sound out to create a silent atmosphere.

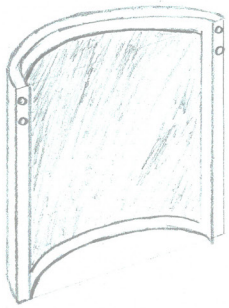
Stakeholders
The main stakeholders in this are the user getting better sound quality at distance, as well as others in the house and neighbours that as a result are no disturbed at any time of day by the volume of others music or Television sound.

User Benefits
User benefits include; more focused sound over distance so volume can be lower, sound exactly where you want it, less unwanted vibrations,

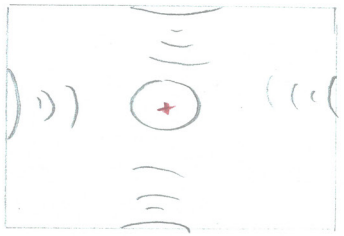
Likely Features
Likely features in the product would include; Bluetooth connectivity, vibration reduction methods, parametric speakers, piezoelectric transducers, anti-wave noise cancelling technology and room tracking sensors.

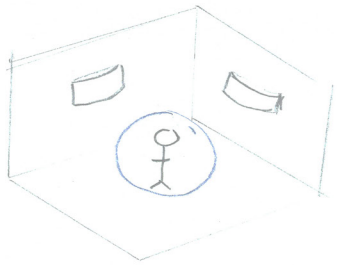
Assumptions Made
Assumptions made are that most people are going to be roughly the right height for the idea to work. Everyone has the same thickness walls and doors and that sound is travelling the same through every house.

Directional Concepts

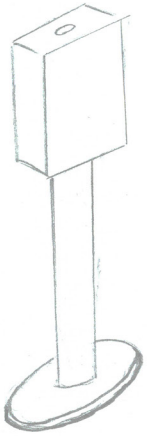


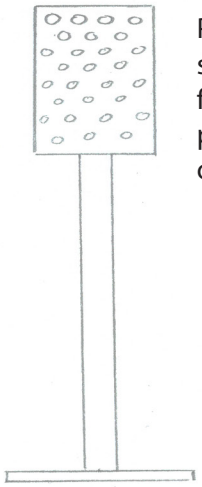
Curved shape to encapsulate the head with sound, as well as giving support for the tickness of the concept.



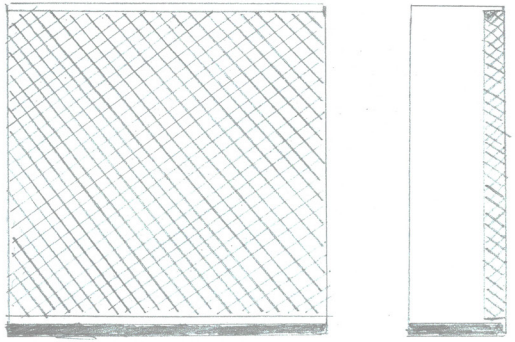


Speakers set up on each wall of a room using phasing to create a central bubble of sound in the room surrounding the user.





Parametric speaker mounted to a raised stand to make sure its at optimum height for listening as well as preventing vibration passed onto surfaces such as desks and other wooden furniture.



Standard piezoelectric speaker with rubber base added to reduce passed on vibrations

Anti-wave concepts

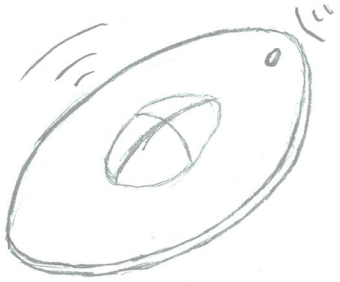
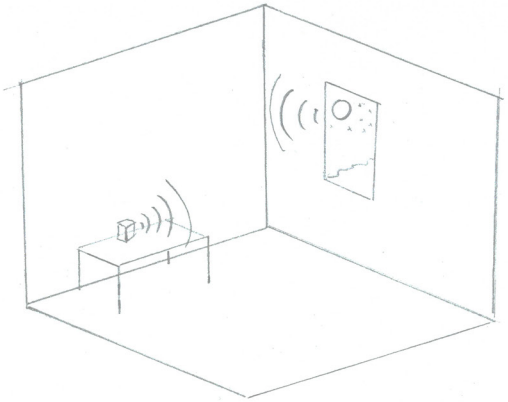
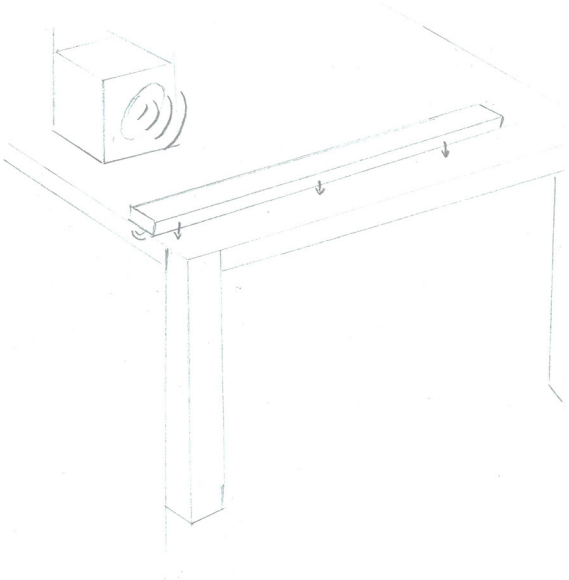


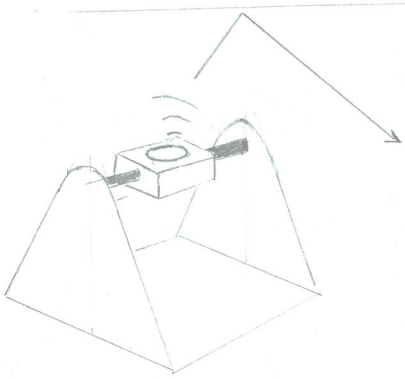
Table top anti-wave device that picks up unwanted sound in its microphone and sends the opposite frequency to counter it

Anti-wave speaker art that is a more subtle way to counter your music from spreading to the next room or from neighbours sound from coming into the room through the wall



Thin anti-vibration bar to counter the effects of subwoofers. by creating small vibrations of its own to send into the surface it reduces the effects of the sub.





Adjustable anti-wave device that can be used to face the user striaght on or angled to reflect off a wall or ceiling to cancel sound from behind or a certain direction.

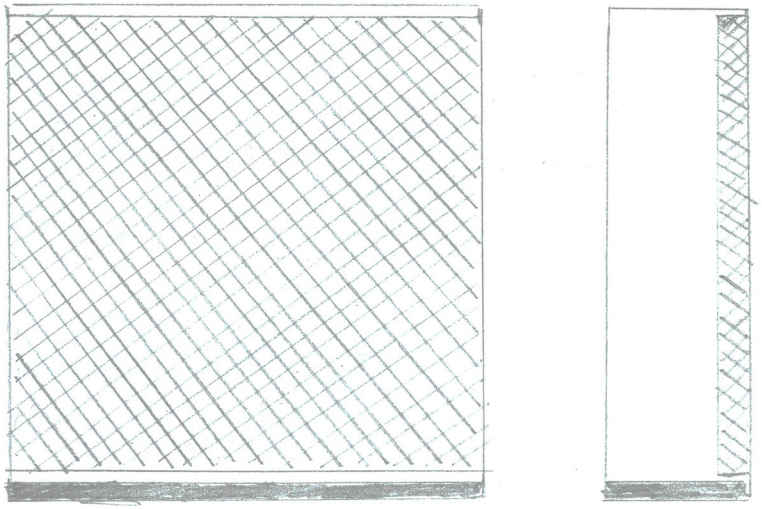
Concept Selection

The concept chosen to take forward to development was just the standard directional speaker with the rubber base.

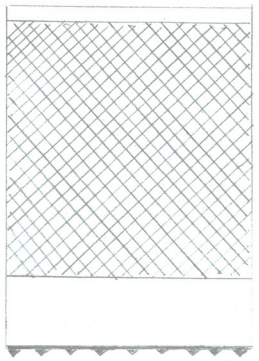
Although a simple and boring design at this stage i feel theres room to expand on the idea of a rubbe anti-vibration base.

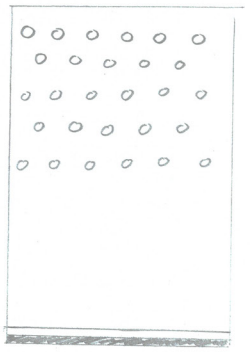
The main issue with design for directional speaker's is that the front panel needs to remain flat to be able to keep the sound directional, and so nothing interferes with the piezo speakers themselves.

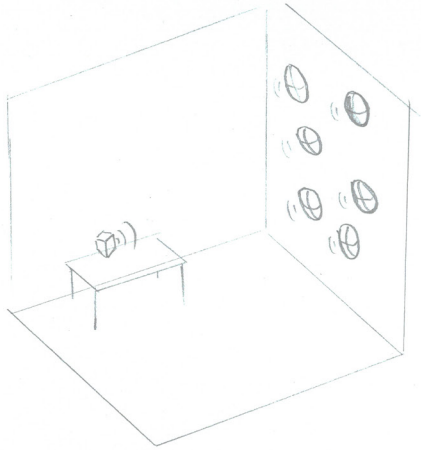
However due to the size of the speakers there is opportunity to greatly reduce the size of this design making it lighter and easier to move. This leaves the most scope for using the back of the casing to lead the form and become one of the feature parts of the product.

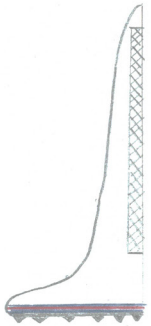


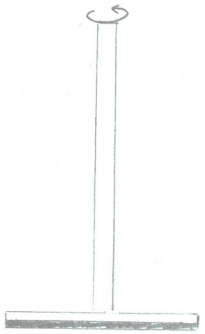
Development

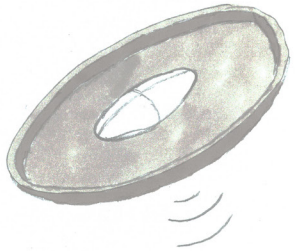


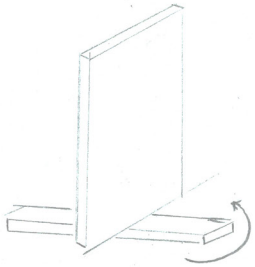




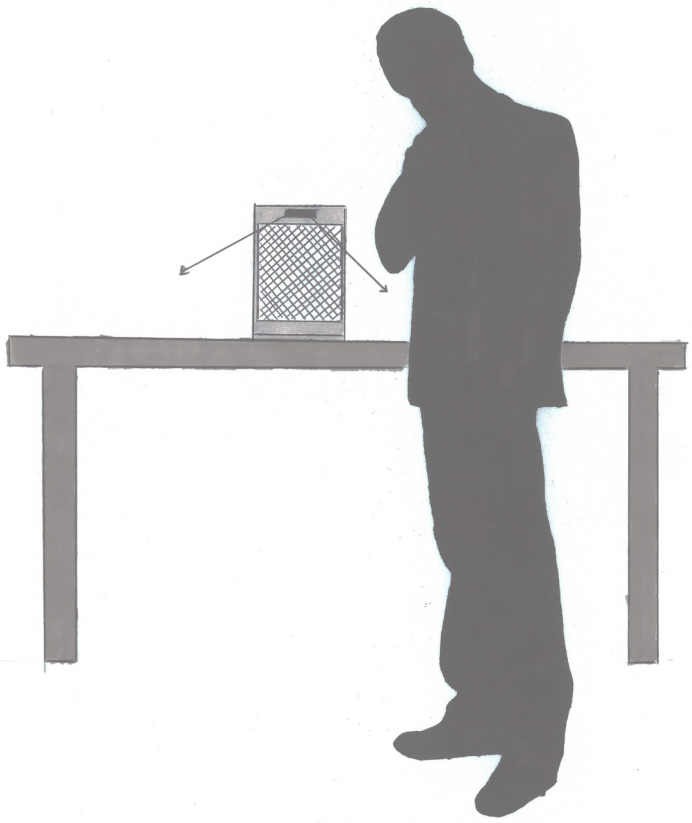


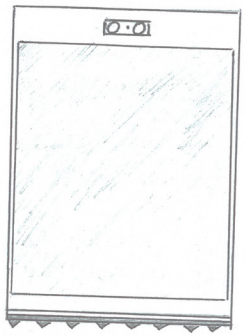




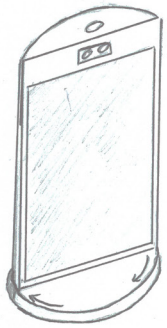


Developed Concept 1

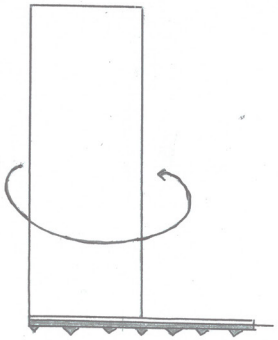




This concept uses room mapping and motion tracking sensors at the top of the product to sense where you are in the room and focus the music directing the sound at where you are.

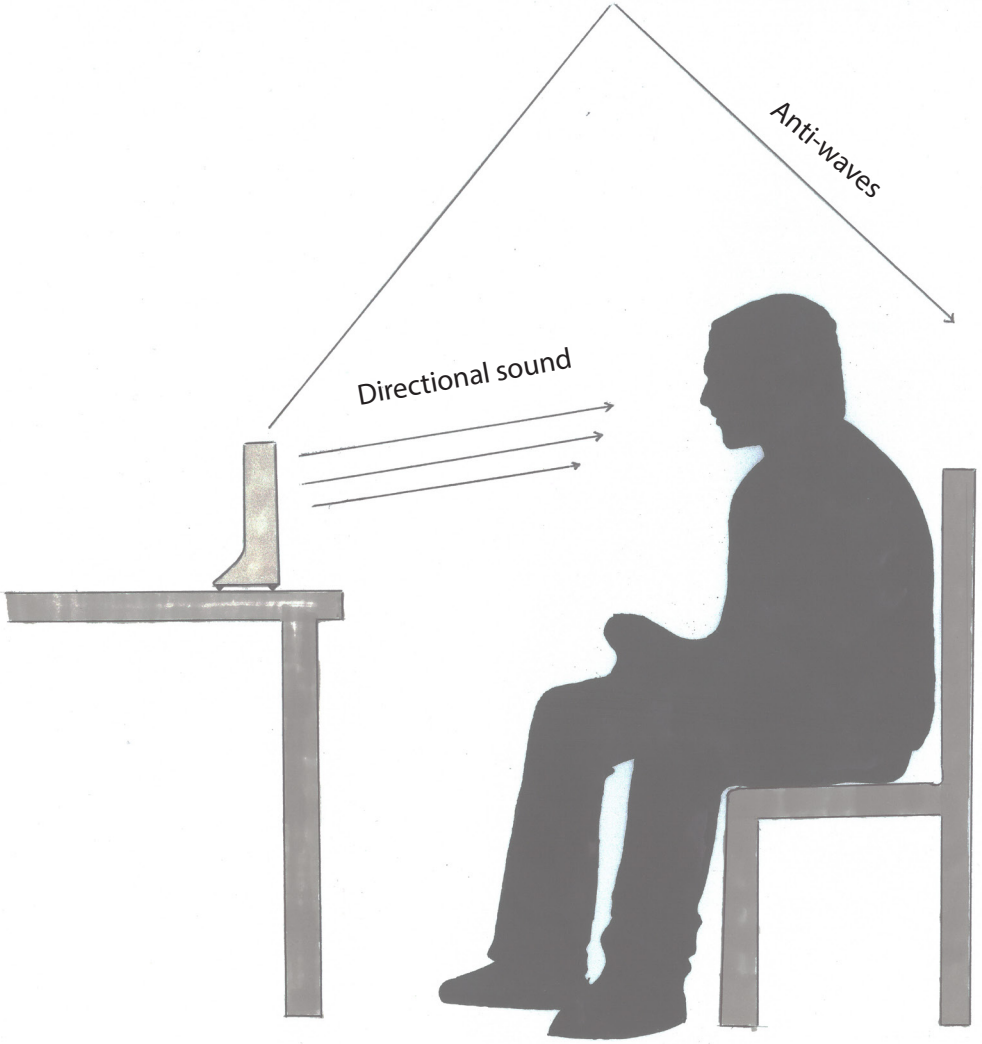


It rotates around the base to be able to follow your movement around the room, while the base is also there to keep it stable and upright as it moves.

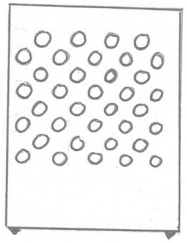


The bottom of the base has a rubber layer with small spikes to reduce its contact area with the surface it is placed on. both of these reduce the vibration from the lower frequencies of the sound outputted and limit what is passed on to the table, desk or shelf.

Developed Concept 2

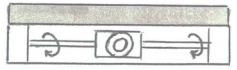


The top of the speaker is partly open housing an adjustable anti-wave speaker procuducing sound waves of the opposite frequency to the music being played and reflectiong them off the ceiling to eliminate what gets past the user

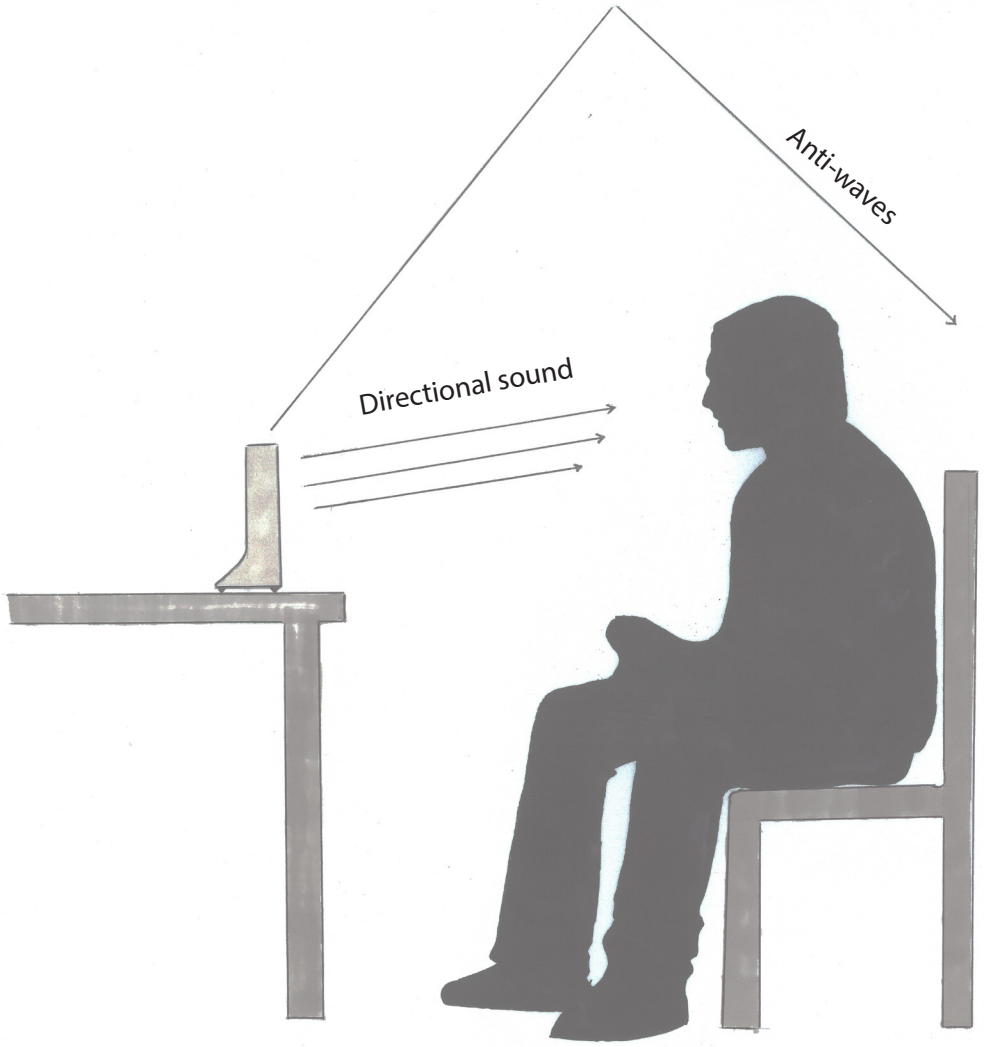


The front panel uses a parametric array of piezoelectric transducers to produce the directional sound.

The bottom section has a three layer foam sound proofing to asorb and reduce some of the vibration given off from the speaker.



Final Concept selection



This concept was chosen as my final selection as catering to the group of users that were sitting when they use theyre speaker seem to be the bigger market. This group of users not only listen to music this way but are using their speaker for TV, gaming and films which the use of this concept can also benefit them.

The combination of both directional sound and noise cancelling was an idea highlighted at the start of my research in the expert talks and through my research found a possible solution to combining them.

This concept not only focuses on providing the user with clear high quality audio but elimates disturbance for others in the house and neighbouring housing.

Design Specification

Performance
• Able to project sound clearly to a distance of at least 5m
• Be able to minimally hear the sound from the speaker with 1m of its sides

Environment
• Dust proof
• Suitable for indoor use only

Ergonomics
• Speaker aimed at ear height to maximise directional waves
• Mean ear height when standing is 151.61cm for females and 163.39cm for males
• Mean ear height when sitting is 72.83cm for females and 78.30cm for males

Service life
• Product life span of approximately 10 years

Customers/consumers/end users
• Target market of 16-40 year olds,
• Main users of music listeners, gamers and movie lovers
• Ergonomics for fully grown adult

Target manufacturing cost/Factory gate price
• RRP- £150 or less
• Main competition of Holosonics consumer model products

Size
• Weight 3kg or less
• Max size: Height – 300mm, Width – 200mm, Depth – 50mm

Shipping
• Product packed in a secure box with protection for transporting
• Shape of the box to maximise numbers that can be shipped in one go and to maximise amount that can be stacked on an instore retail shelf

Market constraints
• Need for different mains socket attachments to enable it to be distributed worldwide

Materials
• Aluminium
• Polypropylene
• ABS
• Neoprene rubber
• Mineral wool
• Acoustic foam

Conclusion

In conclusion, the idal target market for this speaker type is those that sit down while listening to music or using it for their television as it can be permanently at the right angle to maximise the directional sound. The use of both a directional speaker and anti-wave together seems to be the best combination to be able to elmininate as much sound leakage as possible and ensure that those around and on the other side of the wall hear very minimal noise if anything at all.
Through the research it became apparent that low frequencies and vibrations are one of the leading issues but by looking into sound proofing and applying that to speaker design there is an oppotrunity to greatly reduce the vibration that they give off, using rubbers and foams to absorb the unnecessary.

Bibliography

Books and Articles

Alkin, G. (1996) Sound Recording and Reproduction. 3rd ed. Linacre House, Oxford: Reed Educational and Professional Publishing.

Winer, E. (2012) The Audio Expert. Kidlington, Oxford: Elsevier.

Winer, E. (2012) Loudspeaker placement. Broadcast Engineering [online]. 54 (12), pp. 10-12. [Accessed 05 December 2016].

Websites

NIDirect Government services, Noisy Nuisance and Neighbours. Available from: https://www.nidirect.gov.uk/articles/noise-nuisance-and-neighbours [Accessed 08 October 2016]

Noise Act 1996 [Online] Chapter 37. Available from: http://www.legislation.gov.uk/ukpga/1996/37/contents [Accessed 08 October 2016]

Sound Proofing Guide. Available from: https://www.soundproofingstore.co.uk/soundproofing-guide [Accessed November 2016]

Active Noise Control, (2016) Wikipedia [Online]. 19 November. Available From: https://en.wikipedia.org/wiki/Active_noise_control [Accessed 15 December 2016]

How does it work, Soundlazer. Available from: http://www.soundlazer.com/ [Accessed November 2016]

Sonic Beam Directional Audio, Brown Innovations. Available From: http://www.browninnovations.com/sonicbeam-directional-speaker [Accessed November 2016]

Audio Spotlight, Holosonics. Available From: https://holosonics.com/?gclid=CjwKEAiA-rfDBRDeyOybg8j-d2U4SJAAoE5XqUSaQ5cdmsU6hZcwe251egmR7Ms7A-2JtYakeNdphxRRoCmKzw_wcB [Accessed 10 December 2016]

Noise Cancelling Heaphones, (2016) Wikipedia [Online] 2 December. Available From: https://en.wikipedia.org/wiki/Noise-cancelling_headphones [Accessed 01 January 2017]

Woodford, C. Explain That Stuff (2016) Directional Loudspeakers. Available From: http://www.explainthatstuff.com/directional-loudspeakers.html [Accessed December 2016]

Directional Sound, (2015) Wikipedia [Online] 08 April. Available From: https://en.wikipedia.org/wiki/Directional_sound [Accessed October 2016]

Bibliography

Anthropometric Data (2006) The Ergonomics Center. Available From: http://www.theergonomicscenter.com/graphics/Workstation%20Design/Tables.pdf [Accessed 01 January 2017]

Bedford Noise Complaint, (2014) Bedford Borough Council. Available From: http://www.bedford.gov.uk/environment_and_planning/pollution/noise_pollution/noisy_neighbours.aspx [Accessed October 2016}

Noise Nuisances: how councils deal with complaints, (2015) Gov Guidance. Available From: https://www.gov.uk/guidance/noise-nuisances-how-councils-deal-with-complaints [Accessed 02 January 2017]

Global unit sales of soundbar speakers 2010-2015, (2016) Statista. Available From https://www.statista.com/statistics/326992/worldwide-sales-soundbar-speakers/ [Accessed October 2016]

Digital America, State of the U.S. Consumer Electronics Industry, (2015) Audio Trends. Available From: http://content.ce.org/PDF/2015DigitalAmerica_abridged.pdf [Accessed October 2016]

Bibliography

Images Used Sources

Beats Heaphones, Beats By Dre. Available From: https://www.beatsbydre.com/uk/headphones [Accessed December 2016]

UWE Staff Profiles, Available From: http://people.uwe.ac.uk/Pages/person.aspx?accountname=campus\dp-creasey

http://people.uwe.ac.uk/Pages/person.aspx?accountname=campus%5cm5-harries

http://people.uwe.ac.uk/Pages/person.aspx?accountname=campus%5ccm-nash
[Accessed December 2016]

Minirigs Logo. Available From: https://minirigs.co.uk/ [Accessed January 2017]

Is Speaker-Boundary Interference Killing Your Bass?, Arquen. Available From: http://arqen.com/acoustics-101/speaker-placement-boundary-interference/ [Accessed January 2017]

Sound Phasing, SAE Institute. Available From: https://charlottedpardy.files.wordpress.com/2014/07/picstandwave.png [Accessed December 2016]

Loudspeaker waveform, Media College. Available From: http://www.mediacollege.com/audio/images/loudspeaker-waveform.gif [Accessed 02 January 2017]

HP S6500 Bluetooth Speakers - Black, Snap Deal. Available From: https://www.snapdeal.com/product/hp-s6500-bluetooth-speakers-black/639942642612 [Accessed December 2016]