

DESIGN FOR USHER AND BEYOND

APPENDIX



Table of contents

Appendix A	4	Appendix I	34
Co-evaluation session results		Context decision questionnaire	
Appendix B	10	Appendix J1	40
Refer to Appendix L1		Ideation flow chart	
Appendix C	12	Appendix J2	42
Light physics		8 best idea sketches	
Appendix C2	14	Appendix J3	44
Sound physics		Idea ranking table	
Appendix D	16	Appendix K	46
Light and sound principles		Embodiment design process	
Appendix E	18	Appendix L1	54
Context description		Table of functions and requirements: elaborations	
Appendix F	20	Appendix L2	58
HA / CI connection means, interfaces and signals		Micall functions overview	
Appendix G1	22	Appendix M	60
Lighting products and trends		Bill of materials	
Appendix G2	24	Appendix N	62
Sound products and trends		Functional prototype process	
Appendix G3	26	Appendix O	64
Assistive technologies for the visually and hearing impaired		Flow-chart iPhone application	
Appendix H	30		
Informed consent: Micall test			

Appendix A

Co-evaluation session results

Personas

A: age 34, Usher, 2 hearing aids

B: age 42, Usher type 2, 2 hearing aids, (retired) lawyer, mother of two kids

C: age 52, Usher type 2, 2 CIs, secretary, mother of a daughter

D: a group of 5 people with Usher and deafblind people. Age varies from 44-62

E: 43, Usher, freelancer

Positive pub experiences (+)

+ Sfeer(vol) licht

+ Je bent er even uit (uit je huis)

+ Ontmoetingsplek

+ Ontspanning

+ Onder de mensen

+ Lekker drankjes en hapjes

+ Gezellig

+ Avondje uit

+ Genieten

+ Leuk bij 1-op-1

Negative pub experiences (-)

- Veel lawaai

- Muur van geluid / kakefonie

- Slechte verstaanbaarheid

- Dramatische akoestiek

- Donker, zwakke verlichting

- Inspanning om mensen te verstaan

- Route van en naar wc is lastig

- Verstaan barman lastig

- Je weet niet wanneer je aan de beurt bent aan de bar

- Vrienden halen drankjes, zelf lukt niet

- Afhankelijk van informatie van iemand anders

- Waar staan hapjes / drankjes op tafel?

- Waar moet ik naartoe?

- Wie moet ik aanspreken?

- Waar hebben ze het over?

- Wat moeten ze eraan doen?

- Wat doe ik hier, is dit leuk?

- Ik wil naar huis

- Onzeker

- Irritatie

- Ze zien me ongelukkig staan

- Ik sta voor paal

- Ik blijf wel thuis

- Liever alleen thuis dan alleen tussen de mensen

- Kleine wereld

- Niet of weinig kunnen zien

- Lastig aflezen lippen.

- Ongelukkig voelen

- Hekel aan glazen op een pootje.

- Een eilandje in een rumoerige massa

- Terugtrekken

- Ik wil niet alleen thuis zitten, nu al achter de geraniums is niets voor mij.

- Steeds switchen tussen programma's van het hoortoestel, dit helpt meestal niet.

- Bekaf na afloop

- Onafhankelijk bezoek aan de kroeg niet meer mogelijk.

- Onhandige bewegingen door slecht zicht

- Contact maken met bediening is lastig

- Pinnen in donker is lastig

- Hoe meer centraal het gesprek, hoe meer ik mis, hoe minder ik de draad verlies en stiller word.

- Dit hou ik maximaal 1,5 uur vol

- Eenzaam

- Groepsgesprekken kun je niet aan meedoen

- Warm

- Voorzichtig zijn om niks omver te lopen of om te stoten

Pub experience remarks (o)

o Veel mensen

o Waar kan ik het beste zitten voor zo min mogelijk last van omgevingslawaai en het beste / meeste licht?

o Met de rug naar het raam of naar het achtergrondgeluid (helpt met liplezen van andere mensen)

o Analyseren hoe het geluid is

o Alcoholvrij want graag de controle houden

o Leuk/ gezellig maar lastig en vermoeiend tegelijk

o Niet in de hoek (plek naast de hoek is altijd beter)

o Zorgen dat stok zichtbaar is om beperking te communiceren

o Niet bij de keuken gaan zitten

o Altijd zoektocht naar waar dan wel te gaan zitten

o Naast mijn vriend(in) zitten

o Speciaal het grote licht aandoen voor alleen mij is ook niks

o Even een drempel over in verband met lawaai en donker in de kroeg

o Eerst alleen afstappen op bekenden die weten dat ik slechthorend en slechtziend ben. En andersom: vrienden / bekenden stappen op mij af.

o Liefst in gesprek met een goed verstaanbare stem.

o Een licht plekje zoeken

o Alleen gesprek met degene naast me (het liefst een donkere stem)

o Overdag werken + 's avonds kroeg is onmogelijk vanwege vermoeidheid. Het is een van beide

o Checken van de glazen eens in de zoveel tijd (om niets om te gooien)

o Anderen laten pinnen met mijn pinpas

o Help! Rustig blijven, glimlach, geduld..

o Ik ga bijna niet meer naar de kroeg maar vind het eigenijk heel gezellig.

o Kaarsen op tafel strategisch neerzetten

o CI omzetten naar ander kanaal

o Gehoor verbetert door ontspanning

Prototype 1 (Portable light), positive feedback (+)

+ Extra lichtbron

+ Meer scherpte / duidelijker zicht

+ Beter aflezen mond (liplezen)

+ Draagbaarheid is belangrijk (niet te zwaar/groot)

+ Ik heb geen bezwaar/vooroordelen m.b.t. het meenenem van een eigen lichtbron

+ Oplaadbare accu is pluspunt vanwege milieuredenen

+ Mooi en praktisch formaat om mee te nemen

+ Prettig als de lamp er mooi uitziet

+ Niveau van of het erg is of de lamp opvalt is gerelateerd aan de staat van Usher. Hoe verder gevorderd, hoe minder erg.

+ Het heeft een kaarsvorm, esthetisch mooi

+ Het licht kan langzaamaan minder fel worden, zodat de ogen kunnen wennen aan het donker

+ Het duidt aan waar iedereen zit, laat zien met wie je bent

+ Het bevordert zelfstandigheid

+ Het helpt om te weten wat te bestellen (menukaart)

+ Het bevordert veiligheid en geborgenheid

+ Het bevordert zelfredzaamheid

+ Je kunt je tafel makkelijker terugvinden nadat je naar de wc bent geweest.

+ Fijn dat je de gezelligheid kunt aanpassen

+ Draagbaarheid is belangrijk, het liefst dat hij in de jaszak past, telefoonformaat

+ Het heeft effect als je gezichten kunt zien

+ Werkt als ankerpunt / oriëntatiepunt

+ Tool die op een leuke manier aandacht trekt

Prototype 1, negative feedback (-)

- Je moet wel weer een extra hulpmiddel meenemen
- Je moet uitleg geven aan de mensen om je heen
- Wanneer het voor jezelf fel genoeg is, is het voor de omgeving al snel hinderlijk
- Indirect licht (bijvoorbeeld melkglas) kan al gauw onvoldoende licht geven
- De ruimte om het op te hangen of neer te zetten is vaak beperkt
- Misschien niet bruikbaar voor als er nog meer slechtzienden aanwezig zijn, omdat iedereen zijn eigen lichtsterkte nodig heeft.
- Te weinig verspreid licht in dit prototype
- Risico op een te felle lichtbron
- Je moet het testen in het echt of het zal werken, of het bijvoorbeeld niet verblindt.
- Het idee dat hij opgeladen moet worden geeft stress.

Prototype 2 (Mic Pack), positive feedback (+)

- + Je betreft iedereen bij het proces
- + Je kunt meerdere mensen verstaan
- + Je kunt het volume regelen
- + Wegfilteren van ander geluid is essentieel
- + Goed als het groepsgesprekken kan faciliteren
- + De slechthorende kan zelf bepalen hoe hard iedereen staat en hoort het vervolgens zelf, onafhankelijk van input of output van de hulpmiddelen van anderen.
- + Volumeregeling dmv de app is handig
- + Aan/uitzetten dmv de app is handig
- + Het haalt het richten van de phonak-microfoon weg
- + Formaat van de koker is fijn vanwege lange en dunne vormfactor (in ieder geval geen blok zoals gebruikelijk)
- + Mooie app

Prototype 2, negative feedback (-)

- Instellen microfoons kost tijd
- Schakelen tussen personen moet soms snel
- Risico om ze vergeten mee te nemen vooraf en achteraf

- Vergeten om op te laden
- Skeptisch over kwaliteit van microfoontjes
- Skeptisch over compatibility en ontvangst
- Vaak veels te gevoelig
- Leeftijdsafhankelijk of het nodig zal zijn
- Deze prototype-microfoontjes zijn te zwaar
- Creeert gebondenheid omdat je gebonden bent aan de mensen die hem dragen, en je bent niet per se vrij om naar iedereen te luisteren die je wilt.
- Je bent wel de hele tijd met de app bezig
- Twijfel of het werkt in de praktijk
- Risicovol omdat doelgroep een perfect werkend product verwacht en deze vrij complex is om goed uit te voeren. Zodra het niet werkt krijg je het “Laat dan maar”-effect
- De signaal/noise-ratio kan lastig zijn om goed te krijgen

Prototype 3 (Light Pack), positive feedback (+)

- + Misschien mogelijk voordeel van aflezen spraak
- + Creatief
- + Combineert zicht en gehoor door de focus op de lippen
- + Out of the box
- + Leuk, ludiek, maar meer als aandachtstrekker
- + Lokaliseren van mensen mogelijk gemaakt
- + Kan goed werken om mensen te signaleren, om te oriënteren wie er aan het woord is.
- + Verschillende kleuren helpen om verschillende mensen uit te lichten, te laten zien wie er aan het woord is.

Prototype 3, negative feedback (-)

- Hygiëne, kans op overbrengen ziektekiemen
- Formaat is cruciaal
- Verlicht de mond, maar niet/onvoldoende van de lippen
- Te klein, snel stuk of kwijtraken, doorslikken
- Meer kans op negatieve reacties van personen/omgeving (Wat heb jij nou in je mond?)
- Misschien last van tegenlicht (onscherpte, felheid)
- Meerwaarde blijkt door het te testen

- Lastig om te articuleren met lampje in je mond, moeilijk verstaanbaar
- Moet redelijk klein zijn om te kunnen werken maar je hebt ruimte nodig voor de batterij
- Ergens anders bevestigen kan misschien gene opleveren
- Omgeving wordt alleen nog maar donkerder

Improvements & ideas concept 1

- o Eventueel mogelijkheid tot aansluiting extra batterijen of externe accu.
- o Should be affordable and portable
- o Should be waterproof
- o Should be subtle, unobtrusive
- o Should indicate battery status
- o How would you solve the situation when the battery dies suddenly and you're out of light?
- o App screen is beter leesbaar bij zwarte achtergrond en witte tekst
- o Oplaadbaar door geluid?
- o Licht van direct onderaf kan best iritant zijn, indirect licht is fijner (via de tafel of plafond). Dan zie je ook wat er op je bord ligt, en de menukaart. Wellicht een lamp in de breedte dan als een koker zoals nu.
- o Wellicht kun je de koker opdelen in 3 kleine lichtjes, om een groter gedeelte te belichten. (modulaire bajonetsluiting)
- o Het beste licht is indirect licht.
- o Zou fijn zijn als het licht naar beneden schijnt en de tafel verlicht.
- o Wellicht dat de lamp oplicht op plaatsen waar je hem aanraakt?
- o Wellicht kun je het lampje switchen tussen gericht licht en verspreidend licht: Bundel aanpassen zodat je zelf kunt bepalen hoeveel aandacht je trekt met het licht.
- o Misschien kun je het afschermen van tafels naast je, en daardoor reflecteert het meteen naar je eigen tafel.
- o Kijk naar diffuus licht in de nieuwe NS treinen als inspiratie.

- o Wellicht kan de lamp automatisch reageren op de lichtsterkte van de omgeving en alvast in de goeie stand gaan staan.
- o Misschien kan het licht een soort van wild gaan glowen om mee te leven met de gebruiker en de situatie.
- o Pootjes en lus uitklappen, en installeren. Lus kan ook 2 touwtjes zijn met magneetjes. De lus kun je ook verstoppen in de lamp ergens (deksel?).
- o Maak het zo dat andere mensen er geen last van hebben, bijvoorbeeld door een kapje bovenop
- o Idee van Indiase lunchbox? Op die manier modulair maken
- o Indicator bovenop om de ober te signaleren?
- o Microfoontjes / smartlink / rogerpen erin bouwen? Dan kun je kiezen of je audio, licht of beide wilt. Je kunt dan kiezen welke richting je de microfoon uit wilt laten wijzen.
- o Maken zoals een plafonniere, maar dan andersom: plat en rond op tafel, zacht en warm gezellig licht.
- o Mag 3-4 keer zo klein
- o Signaallampje bovenop de lamp kan bijvoorbeeld het personeel alerten op behoeften, of naar de mensen om je heen dat je wat van ze wilt. Dit geeft een gevoel van extra 'ability', iets voor hebben op een ander.
- o Ze mooi zijn als de lamp zou kunnen aangeven hoe luid de omgeving is, zodat mensen met Usher zelf weten hoe hard ze moeten praten.
- o Subtiel gloeien om herrie te communiceren
- o connect + control lamp through smartwatch?

Improvements & ideas concept 2

- o Idee van een AI-sensor verwerkt in een apparaatje het hoofd (bril), die weet waar je ogen naar kijken en zo kan schakelen tussen welk microfoontje je wel/niet wilt horen. Door de sensor heb je minder tijd nodig om te schakelen tussen mensen (anders loop je achter de feiten aan en mis je informatie).
- o Hearing is the most prominent information source when in a pub. It is nice to be able to see what is going on, but that's 'useless' when you can't follow any conversation. Het zien

helpt wel om lip te lezen maar als je al niks hoort kan licht ansich niet het probleem op lossen.

o Het is nieuw op de markt als je iets kunt brengen waardoor je een groepsgesprek kunt hebben in een rumoerige omgeving.

o Microfoonjtes achter je oor zetten? In de vorm van een klerenhangerhaakje?

o Eventueel bone-conduction maar dan andersom?

o Maak zo min mogelijk opvallend om gene tegen te gaan

o Hoe kun je alleen spraak laten binnenkomen en niet alle achtergrondnoise?

o Maak het ook zodat het voor meerdere settings gebruikt kan worden, bijvoorbeeld fietsen in de wind.

o Investeer in achtergrondgeluid en windonderdrukking

o Microfoontjes terugkrijgen op het eind van de avond door trilling? GPS erin?

o Laten zien op een app waar iedereen zich in het cafe bevindt?

o Microfoontjes met elkaar een lus laten vormen en zo het afschermen van een bepaalde omgeving

o App moet automatisch kiezen wie er uitversterkt wordt

o Richtmicrofoon verwerken in een vingerring om zo minder opvallend te 'interviewen' en minder opvallend een hulpmiddel te dragen

o Zorg dat degene die de mic draagt hem ook zelf uit kan zetten, voor privacy. Ze zijn zich bewust dat ze er een dragen en dat ze gehoord kunnen worden

o Spraak naar tekst omzetten?

o Zou je de Roger pen kunnen combineren met een licht?

o Een plat, rond licht + knop voor ober + lichtjes en microfoon die kunnen wijzen naar degene die aan het praten is; dat gebeurt automatisch want het reageert op het geluid van die persoon.

o Een apparaatje dat signaleert dat iemand met je wilt spreken

Improvements & ideas concept 3

o Misschien handig om een soort ketting met met twee verlichtte bollen te maken (Fatboy Bolleke / Spheremaker)

o Je zou het moeten testen in het donker

o Wij (Ushers) hebben er meer aan als je concept 1 en 2 met

elkaar combineert. Je ziet hierbij namelijk ook je omgeving (en stoot je je glas niet om bijvoorbeeld).

o Hoe kun je beide concepten met elkaar in verbinding brengen?

o Als in een product beide dingen zijn verwerkt, dan is dat wel specifiek voor Ushers, maar komt dat het product wel ten goede? (schaap met 5 poten)

o Lichtgevende lippenstift?

o Subtitles van de sprekende persoon geprojecteerd op het voorhoofd van de spreker?

o Moet veel kleiner wil dit goed kunnen werken

o Als je er een sierraad van maakt, zorg voor gelijkmatig licht en maak een unisex design, zodat zowel man als vrouw het kan dragen.

General insights

Misschien dat in de context van een kroeg geluid meer informatie geeft dan licht. wanneer je bijvoorbeeld over straat moet, dat licht dan meer informatie geeft dan geluid. Al het licht dat je extra hebt in de kroeg dat is dan meegenomen, maar het geluid is het meest prominente."

Deelnemer B heeft in de kroeg het liefst iets voor het gehoor, maar iemand anders die in een andere stage zit kan dat maar net andersom hebben --> behoefte voor dynamisch product

Anekdote die de thesis heeft geïnspireerd wordt ook bij andere deelnemers herkend en ervaren.

Het is van belang onderscheid te maken tussen ontwerpen voor 1 op 1 of voor groepsgesprekken.

Eventueel focussen op restaurants, vanwege wellicht iets beter haalbare situatie. Je bent namelijk altijd afhankelijk van het licht in een restaurant, maar qua geluid ben je eigenlijk afhankelijk van de hoortoestelfabrikanten, waar ontwikkelingen in zitten. In het licht-domein zitten niet echt ontwikkelingen omdat niemand voor deze contexten lichten ontwerpt, in ieder geval niet lichten die zijn gemaakt voor als je op pad gaat.

Idee voor een lampje op bestek zodat je je eten goed kunt zien.

Er is een verschil tussen visueel sterke en auditief sterke Ushers.

Apps die gebruikt worden: Flake, AVA, Nucleus Smart

Gebruiken van ieder concept moet makkelijk, flexibel, gebruiksvriendelijk en het moet altijd in het NU werken. Je wilt geen tijd besteden aan uitleggen en prutsen.

Al het geluid naar de CIs gaat via de iPhone-app. Dus iedere externe audio-bron kun je hieraan koppelen (Nucleus Smart).

Idee om een bubbel te creëren waar alles binnen de bubbel verstaanbaar is en alles buiten de bubbel wordt geblokkeerd qua geluid. Met een soort duct-tape een zone tapen (ringleiding).

Schotjes meenemen en plaatsen op tafel?

"Je wilt niet van anderen afhankelijk zijn"

Omgang met product hangt sterk af van ushergevorderdheid en mentaliteit.

"Met licht heb je het meest gewonnen"

Er staan altijd glazen en eten op tafeltjes wat moeilijk te vinden is of omgestoten kan worden

Bij kroeg: Hulpmiddelen: zaklampje, microlink/rogerpen
Oplichten lippen combineert beide beperkingen --> daardoor combineer concept 1 en 2 want samen zou dat een nog sterker effect hebben.

Elke situatie is weer anders, de ene keer heb je een grote tafel, dan weer een kleine, dan geen tafel. Hoe ga je hiermee

om? Groepsgesprekken gaan namelijk de hele tijd van de hak op de tak.

Er is een behoefte aan een product dat helpt grip te krijgen op de omgeving, daar is nog niet veel voor ontwikkeld.

Appendix B

See: Appendix L1

Appendix C:

Light physics

Introduction

The way people with Usher perceive light is dependent on their ability to see, to interpret what they see by hearing, different kinds of light sources and contexts they find themselves in. Knowledge about these domains help in understanding the situation at hand and how to act upon it. For example, there are no aids for people with Usher to increase the content of what the eye witnesses (like a hearing aid increases the audio for the ear) This sub-chapter shortly describes sound characteristics and how to control these. Chapter 6 (Design for Usher) will elaborate more on how to translate sound characteristics into a design specifically for People with Usher.

Light types and characteristics

Understanding how light behaves can help in the way light is included in the design process. Light is expressed in a number of elements and is always compared to natural daylight. Figure 6 to the right shows main elements. Controlling these elements means controlling the light situation in a certain context. A number of light technologies is used for commercial lighting, displayed to the right in figure 7 to the right. Each lighting type has its benefits and drawbacks, depending on its application.

Color (temperature)

In the visual spectrum of light there is an array of millions of colours, where blue and red carry the most and least energy, respectively. Colours are also strongly related to emotions; In the Netherlands for instance, blue has a depressing nature whereas orange is perceived as warm and cozy. These meanings differ cross-cultural wise (Adelson, R., 2005)). Color temperature is mainly about the amount of blue or red that is present in a light, or in other words, how cold or warm a light is. Color temperature is expressed in Kelvin, where a low Kelvin value corresponds with a warm light (1000-3000K) and a high value corresponds with a cold light (5000K and above).

Efficiency

Efficiency is the amounts of lumen that is emitted per amount of Watt lead through the light source. The higher the

efficiency, the less energy is required for a light to emit light. This is especially relevant when a light is battery powered, as a more efficient light corresponds with a longer battery life.

Color Rendering Index

The index which tells the quality of the reproduction of individual colours as compared to natural daylight. Natural daylight contains energy in the entire color spectrum, whereas, for example a LED bulb, mainly energises blue and yellow bandwidths (source). The more rich the energy over the entire spectrum, the more visual information is offered (source). This is for example the case with traditional incandescent and OLED lights.

Controlling light principles

The creation or control over the behaviour of lights can be done in different ways. For example, light can be dimmed, amplified, filtered, programmed, etc. An overview of different methods is given in Appendix D. Light can be controlled but is hardly sensed by one person only. Affecting a light source in a public space for example has an effect on more than just one person.

Conversion from light to different domains

Light itself can be used as a trigger to be converted in other domains. For example, a certain light intensity from a rising sun could trigger a motor to slide open the curtains or light picked up by a camera can be converted to text on a screen using artificial intelligence.

Conclusion

Light has different characteristics and can be adjusted in different manners. Light sources differ in color temperature, efficiency and color rendering index. Varying these variables makes for a different light experience. Adjusting a light in a space means adjusting it for more than one person. There are no aids to help in enhancing the sight like a hearing aid enhances sound to the ear. Sound can help however to help anticipating what is seen. (a dropping plate looks more like a dropping plate if the resulting sound corresponds with it). Light can be converted to other domains and thus extending its applications.

Definition

Light is electromagnetic radiation, and is visible to the human eye in a frequency range of 400-700 nanometers (Rathee et al). A light source emits its energy in both heat and light, where efficiencies of desired emitted light range from source to source.

"Light is any radiation capable of causing a visual sensation directly." (Colorimetry, C. I. E. ,1971)

Luminous flux (Lumen)

Total amount of light emitted in a room, the 'light power'. (Bryant)

Color temperature (Kelvin)

The color temperature expressed in a color scale, ranging from long wavelengths (reds) to short wavelengths (blues) with white in the middle. (Wyszecki, Stiles, 1982)

Light intensity / luminous intensity (lux)

The amount of light needed to light up a surface one lumen per square meter (Bryant).

Light intensity per unit solid angle (Candelas)

Amount of light which is being emitted in a specific direction (Bryant)

Color rendering index (Ra)

An index which tells the quality of the reproduction of individual colours as compared to natural daylight (Azuma 1974).

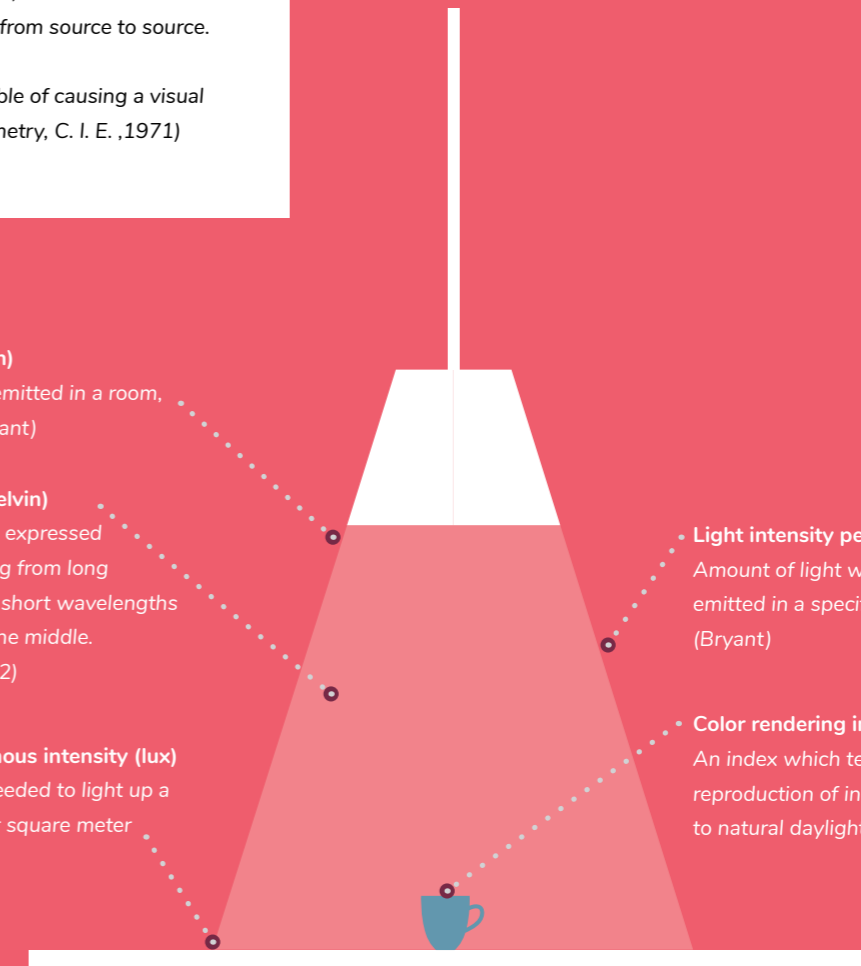


Figure 7
Light characteristics



	Traditional incandescent	Halogen Incandescent	Compact Fluorescent	LED	OLED
Color temperature	2700K	2700-3000K	2700-6500K	2700-6500K	3000-4000K
Lumen / Watt (efficiency)	14	24	62	84	90
Color Rendering Index	100	100	50	80	93

Figure 8
Lighting types and features
(TES Engineering, LUX Technology Group, LG Display, Energy Alliance)

Appendix C2:

Sound physics

Introduction

This paragraph describes sound characteristics that are important when (understanding of) speech is of importance. It describes the differences between normal and an Person with Usher's hearing as well as different sound aspects.

A physics of light paragraph (aspects for the sense of sight) is included in appendix C. Chapter 2 (Concept design) will elaborate more about how to translate sound characteristics into a design specifically for People with Usher.

Normal vs. Usher

For anyone to be able to understand speech, a number of aspects are of importance. The same goes for people with Usher; for them the aspects are just more critical. For example, for someone with Usher factors are their state of hearing, type of hearing products and different kinds audio sources of the contexts they find themselves in. When these factors are not optimal, hearing sounds distorted or muffled for example. Moreover, the ability to read body language or read lips is compromised because of deficits in sight.

'Normal hearing' can adjust automatically various factors and is thus better equipped in coping with dynamic sound situations. Healthy sight is able to read body language and read lips, which make up for possible lacking audio information.

Soundscape

Soundscape is the combination of all the sounds in an environment that a human can hear. Pijanowski et al., 2011) Next to the soundscape there are also - to humans - inaudible sounds like high pitches of a dolphin or low voices of whales. This is visualized in Figure 9 to the right.

Direction

The direction of a sound wave is important when information is of importance to a person. Low frequencies travel unidirectional, whereas high frequencies travel more directional. A high pitched voice may not reach people behind the speaker, whereas a low pitched voice might. Moreover, since a person's ears are located on different positions on the head, the position of the head relative to the sound source determines how a sound is perceived by the listener. (Jones et al., 1998)

Loudness

Loudness is the volume of a sound that perceived by a person. Loudness is expressed in decibels (dB) and is dependent on the intensity of the sound source and the distance between sound source and perceiving person. The larger the intensity, the higher the decibels, the further away to the sound source, the lower the decibels. Multiple sounds can be perceived as louder sounds, because of the intense stimulation of the hearing nerve fibers. (Zwislocki, 1969)

Sonic texture

Sonic texture is built up of a number of sound sources in a specific space and their relations to each other. The more different sound sources, the richer the texture. (Benward, 2014). A good example would be a busy cafe, a shopping street or a full orchestra.

Spacial location

The spatial location is the location of a sound source inside of the sonic texture. This tells a person where a specific sound is coming from, given that each sound source has its unique location but also its unique timbre (Figure 9). (Cariani, Michey, 2012).

Conversion from sound to different domains

Sound itself can be used as a trigger to be conversed in other domains. For example, a clapping sound could trigger a light to switch on or speech can be translated into text speech recognizing algorithms.

Conclusion

Sound has different characteristics and can be adjusted in different ways. In a public space people are exposed to and dependent on many context factors. People with Usher are dependent on the sound in their environment, ability to anticipate what they hear by seeing, as well as on their hearing abilities and help offered by hearing devices as opposed to normal hearing that is able to adjust to various sound situations.

Definition

Sound is a wave of pressure traveling through a medium (ANSI, 1994). In human contexts this medium is usually air. The frequency range of audible sound/acoustic sound (for humans) lies between 20 and 20.000 Hz. Sound is produced by a sound source, which can be any vibrating object. For example in music, strings are plucked to create vibrations at a desired pitch.

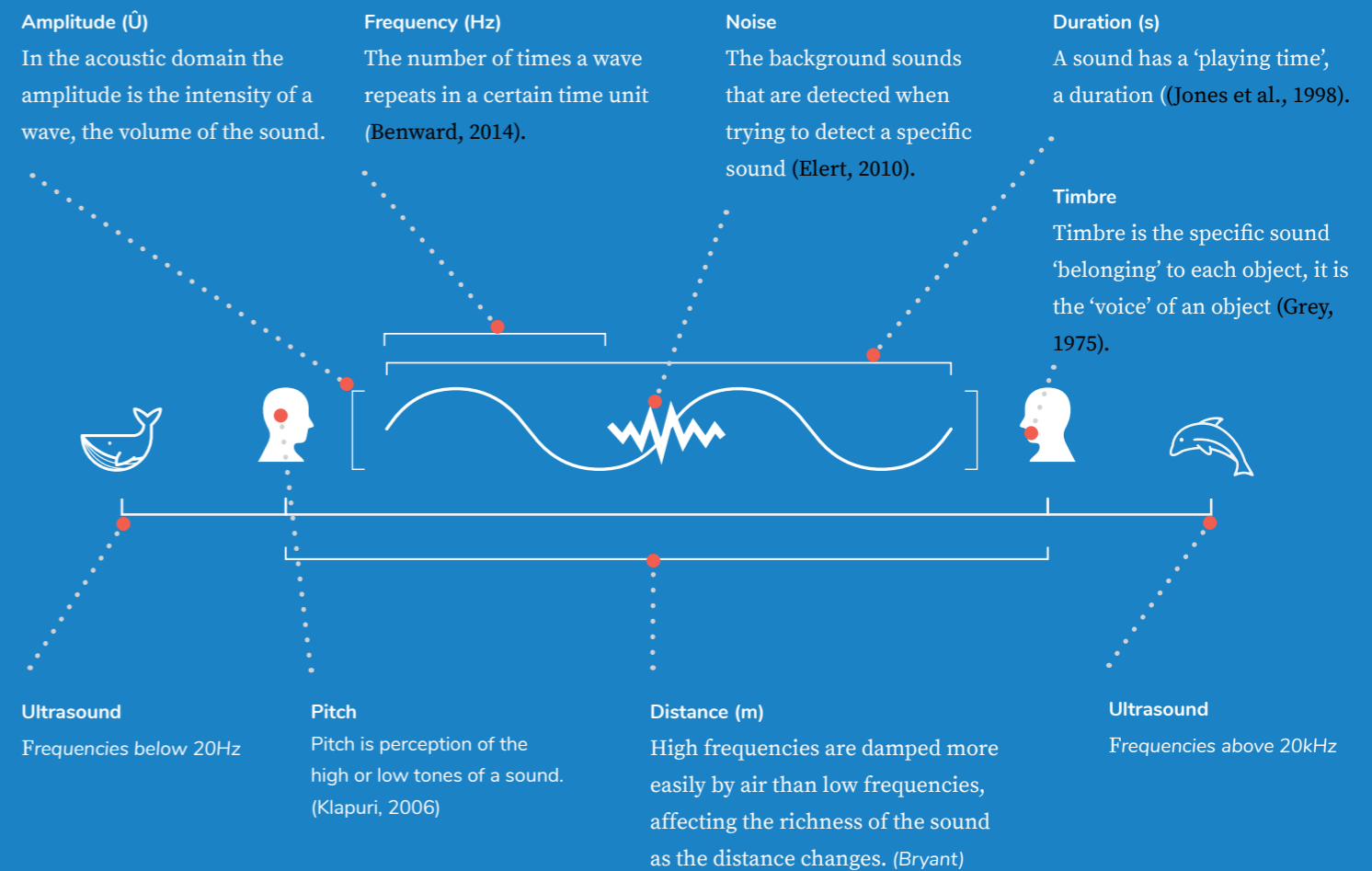




















Figure 15
Main acoustic characteristics of sound.






Appendix D:

Light and sound principles

- **Switching On/off**
A conventional light switch can switch a light on or off by flicking a physical switch.
- **Dimming**
Built-in dimmers can be used to gradually increase or decrease light intensity from no light (off-state) to fully lit-up.
- **Programming**
Using a built-in timer or placing timer hardware in between the light plug and the power net a light can be switched on/off at set times.
- **Motion switch / occupancy**
Using infrared or ultrasonic waves, motion detectors can switch a light on or off when detecting motion.
- **Sound switch**
Built-in microphones can be used to pickup sound and so switching on lights or, when combined with a dimmer, can vary the light output in relation to the sensed sound.
- **Gravity switch**
A switch can be flicked on/off by the use of gravity, for example when a product is flipped upside down. Piezoelectric sensors can also be used to sense a variable weight pressed on a product, varying the light output.
- **Blocking**
By covering light with a non-permeable object, light is blocked. These could be shades, curtains, blinds, blocking panels or caps.
- **Damping**
By covering light with a semi-permeable material, light is damped / partially blocked. This creates a softer hue and less intense light. This is not energy-efficient since not all the emitted light is useful light.

- **Overruling / over exposing**
Human focus is triggered by the brightest light source. Brighter lights will over-expose less bright lights and so shift focus.
- **Amplifying**
By adding more lights or increasing a light's power a greater light source is created.
- **Light sensing**
By using light sensors the intensity of a light source can be measured (related to the distance of the sensor to the light source). After analysing the values, corresponding behaviour can be automated or be communicated to the user.
- **Smart controlling**
By using a smart system of for example a smartphone, bluetooth connection and smart light bulb, one is able to control a light over a distance using a smart phone. Using the sensors found in smart phones, a light can respond to different variables as light, sound and movement. Digital timers can also be used to trigger light at set times.

- **Absorbing**
Absorbing sound is a form of passive noise control. Using the natural damping features of a material or shape it is 'passively' present in a room and absorbing the incoming sound waves. These could be, for example, acoustic panels placed against walls and ceilings, but also rugs and couches, bodies of liquid or even human bodies.
- **Blocking**
Sound can be blocked by means of materials that bounce of sound and not necessarily absorb them, like floors, panels or ceilings. The layout of these elements can 'guide' the sound in a certain direction, blocking it from areas the sound should not reach.
- **Diffusing**
Sound diffusing lowers the intensity of the sound by 'breaking' it and spread it over a bigger area, as opposed to eliminating it in the case of absorption.
- **Active noise-cancellation (ANC)**
Hereby a microphone picks up a surrounding sound, runs it through an algorithm and produces a sound with an inverted wave-shape, to cancel out the noise. The direction-specific nature of ANC makes applications to a more dynamic sound environment hard.
- **Altering Amplitude (volume)**
A microphone can be used to pickup and linearly amplify sounds to the hearing-impaired person. The downside is that also other sounds such as ambient noises and sudden sound-peaks are being amplified, causing discomfort. By using a digital signal processor (DSP), soft sounds can be amplified louder and (relatively) loud sounds can be amplified less.
- **Altering Frequency**
A device uses a microphone to pickup sounds e.g. during a conversation, and then applies the right filters to the sound (high-pass, low-pass, etc) to get the frequencies that are useful for the human ear (speech banana).

- **Sound effects**
Often seen in the music scene, different effects are used to generate different sounds and create a different mood of tone. Essentially this is tweaking the audio signal, changing its waveform. This can be done by applying filters, algorithms or change bass and treble with an equalizer.
- **Overruling principles / covering up**
Here, ambient noise is sensed and analysed. Then, a more pleasant sound is played at a louder decibel level than the ambient noise. This overrules the ambient noise and covers it with a louder but more pleasant and constant sound. The downside is that it does not get rid of the noise in its totality, it only helps the mind to focus on one kind of sound instead of a mix of different sounds.
- **Noise-mapping**
Noise-mapping can be used to get an idea of the nature of different sounds in the environment. In a home for example, a number of sounds are specific and easily recognizable (running dish washer, buzzing lights, closing doors, etc). By mapping them the user gets an insight in which sound is caused by which sound source.
- **Focusing**
By focusing sound in a specific direction using directional speakers, one can target a specific area to expose to sound. This technique is used in museums for example, where audio about a painting is only useful to the person standing in front of the painting and not to surrounding people watching other art works.
- **Vibration isolation**
By damping unwanted vibrations noise can be stopped before it is generated. For example, one could add a weight to a vibrating object to change it's natural frequency or suspend the object on springs/ dampers to absorb the vibrations.

Appendix E:

Context description

Figure X
Bar / pub collage



General context description

An analysis of traditional European bars and pubs (both on the web and in the Netherlands) lead to the following insights. The insights are described in the way they are sensed; both to give a full description of the experience and to put it in the perspective of the sense-themed project.

Looks

Traditional bars/pubs are primarily build up from wood (floors, tables, chairs, ceiling, bars), lights (usually traditional candescent light bulbs, neon tubes, candles, LEDs in semi-permeable covers) are dimmed and range from warm white to candlelight-orange. Next to wooden materials, there is made use of bronze, copper, stainless steel and glass. Dependent on the popularity and visiting times, it can be crowded up to a point that moving from a-b can be a challenge. Tables are positioned close together, there is few space for chairs to be moved back when sitting/standing up. On the tables there are a variety of things ranging from drinks to coasters, (artificial) flowers, table lights, candles, snacks, menus, playing cards. Walls are usually covered with paintings, photos and other decorative items. Lights are suspended from the ceiling as well as decoration depending on the season. Windows become foggy when it is crowded. At the bar there are always stools positioned, behind the bar a classic chaotic personnel scene is playing, be it waiting, pouring, running, mixing. Behind the personnel is an array of drinks, lit up in specially designed cupboards. Blackboards often display beers that are on draft. People are dressed casually and look relaxed. Coat hanging space is limited, and are often stored in a back corner or suspended on chairs.

Smell

There is a smell of alcoholic beverages, a smell of smoke in older pubs and sometimes a whiff of perfume of people dressed up for going out. Depending on the age of the pub it can smell a little dusty, muffled or moist. People's breaths are noticed when having to converse close-up.

Touch

Since there is a lot of objects consistent of wood or metals, most objects that are touches convey these natural feelings. This goes from the handle of the pub

door, to leaning on the bar and sliding chairs backwards. Glass is touched as well, as is the condensation on the glass. Cardboard coaster underneath the glass has its distinctive soft and foamy touch. The menus often have a plastic laminate, which feels smooth and artificial.

Taste

The taste of drinks is the most primary one, ranging from water to beer to wine to coke. Next to drinks, snacks and nuts are consumed. Sometimes there are mints at the bar to refresh a unpleasant taste.

Sound

Depending on the number of people it can be relatively quiet to very noisy. This noise consists of background music, talking people, cheering glasses, dropping tableware, coughing, laughing, cash machines, doors slamming, moving chairs and squeaky floors. As the night is progressing, more people are entering, music is getting louder and people start to talk louder.

Feel

Although feel is very subjective, in general it can be said that bars have a cozy, social and relaxed environment, and at the same time can be chaotic and overwhelming when there is too many people or when the noise is too loud. It can feel intimate when talking with someone close-up, or awkward when it is not the right company.

4.1.6: Conclusion

According to people with Usher, the bar/pub context is the most difficult to operate in. Main reasons are the background noise and low-light settings, which appear to be true from context observations. No solutions have been recalled to specifically account for operating in the challenging 9 contexts.

Appendix F

HA / CI Connection means, interfaces and signals

Induction loop

An induction loop system is traditionally used for speech-purposes used in for example churches or lectures. In this system, sound of the speaking person is captured by a microphone, is sent to a special amplifier which translates the audio into electromagnetic signal through a wire that runs around the listening crowd, creating an electromagnetic field. Coils in the hearing aids / CIs pickup this field and translate it back to audio for the ear to hear. Important is that the aids are switched to T-mode (telecoil-mode) in order for it to work. (O Bengtsson & B Brunved, n.d.) The perceived sound works well for speech but has no nuances in the low and high frequencies. Also, the sound is mono and moving the head changes the position of the coils in relation to the wire, influencing the volume of the incoming signals (Van de Weijer, 2018).

FM

FM-systems makes use of a sender who is speaking into a microphone, the audio is modulated to a radio frequency signal transmitted through an antenna. On the receiver-end a receiver is tuned to the same radio frequency and the signal is de-modulated back to sound. This is then sent to the aids by an electromagnetic field or by wire directly attached to the aid. Advantages are possibility to power by battery, stereo sound, steady and high quality sound. (O Bengtsson & B Brunved, n.d.)

Wifi / Bluetooth

Similar to FM systems is that the source audio is first converted to a wifi or bluetooth signal, which is sent to a wifi/bluetooth receiver found in either a smart phone or in a body-worn receiver. With a body-worn receiver it is sent through a magnetic field or wire to the aids, with a smart phone it is sent by bluetooth directly to the aid. Both the body-worn devices and smartphones function as an interface to control the signal. The signal over wifi is a little slower than bluetooth but is easier to have multiple connections with, for example in a concert hall. (Van de Weijer, 2018) The greatest advantage is that modern devices such as laptops and smartphones make use of these connections and can thus be used dynamically, for example in listening to Spotify or Netflix.

Infrared radiation

Infrared uses similar principles as FM as well. Differences are that it requires high energy consumption and there is a blockage of signal when there is an object between sender and receiver. Moreover, it has a limited range and portability caused by the need of a main infrared outlet. The sound quality is high.

Direct connection

A direct connection with the aids is also possible, by having a wire attached directly from the sound source to the aids. Here, every sound source has a type of amplifier to either

amplify the sound of a microphone or music input from for example a cd-player. (O Bengtsson & B Brunved, n.d.)

Other means

Ear hooks / speakers

In cases, ear hooks are used as means in between the smartphone or body-worn device interfaces. Ear hooks are small coils positioned behind the HAs / CIs, enabling for a more steady signal reception since the magnetic fields of the hooks remain parallel to that of the aids regardless of the movements of the head.

In other cases, smartphones or body-worn devices send signals to small speakers (e.g. headphones) which, in turn, play the audio to the HAs / CIs. It is a local representation of the sound source.

Appendix G1

Lighting products and trends

Introduction

This sub-chapter describes lighting products and trends on the market; to explore, inspire and posing possibilities for a future product. Here, there is a focus on products that are portable, as this is a main criterion of the product. A definition is given as well as a description about products and trends on the market.

Lighting products and trends

Definition

By a lighting product a product is meant that emits light, with heat as a by-product. Heat is desirable in heating products as infrared lamps or terrace heaters, but in the scope of this project light products are aimed at products that primarily emit light.

Products

All kinds of commercial products are present on the market, from indoors to outdoors, from suspended to portable. However, the lighting market is too broad to analyse every light available. To the right, a visual overview is shown, showing the different varieties of products offered in the lighting market, ordered in different categories.

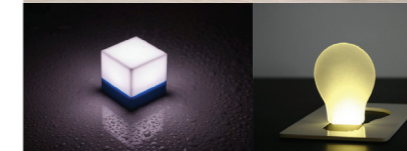
Trends

Trends that are observed here are the popularity of portable lights; carrying a beautiful and functional product can offer convenience and allow people to express themselves. There are a lot of applications of smart lights; from controlling lights without a light switch on the wall, to set a certain mood or set timers when on a holiday. Users are more

focused on an individualised (customized) and convenient experience. Voice control becomes more apparent as speech technology is getting more advanced and shows fewer flaws over the years. Combined with artificial intelligence, lighting can learn the user's behaviour and adjust lights accordingly. Lighting innovation is seen with for example light that responds to touch or in lighting that gets more flexible and flat, like OLED lights. Light armatures usually have a high-design appearance, which is seen all throughout the light market segment.

Light gadgets

Gadgets vary from phone accessories to lit bank cards and portable light cubes. It is often a combination of a fun but functional product.



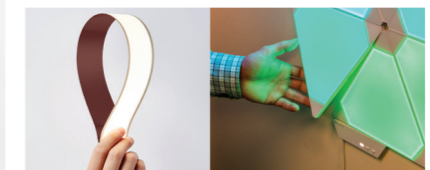
Portable desk lights

Portable desk lights enable users to bring a light with them, to light their table top wherever it is needed.



Portable mood lights

Portable mood lights enable users to bring atmosphere to wherever it is desired. Here, there is special focus on materials, finish and color use-case (e.g. during dinner or in the bedroom).



Wearables

Wearing lights adds extra functionality by not having to actively hold the light. Wearing lights can also be a means of expressing identity or emotions.

New technologies

OLED shows a promising future with its high efficiency, uniform lighting and flat and flexible form factors. In other products, touch and light is combined.

Interactive lights

An extra dimension is given to lights because of its interaction; unconventional ways of lighting up spark a different user experience. This could be for example rubbing, tilting, connecting or twisting.

Torches

Torches may be old fashioned, but new approaches are found in the light crispness, modern embodiments and high end performance combined with compact size.

Appendix G2

Sound products and trends

Introduction

This sub-chapter describes sound products on the market. There is a focus on products that are portable and that have a focus on speech, as these are main criteria of the product. A definition is given, as well as description of products and the trends on the market.

Sound products and trends

Definition

Sound products in the context of this project are products that either emit sound and/or help in alternating the sound for the ear. A sound emitter would be a speaker for example, and a sound 'helper' would be an active noise canceling headphone or sound absorption panels.

Products

With a focus on the target group, products that are analysed in this segment have been selected for their portability and way of improving intelligibility of conversations. For example, products like bulky and non-portable audio systems are therefore not analysed. To the right, an overview of different products is displayed, ordered in different categories.

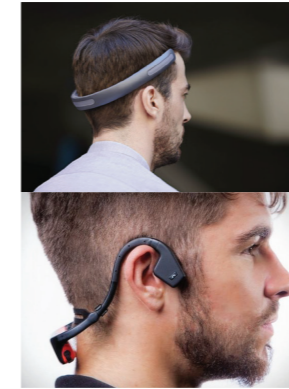
Trends

Just like lighting trends, portability is also a trend for audio products. There is a need to carry along a speaker to any context, for convenience and self-expression. Directional

portable speakers take this to the next level, where music can be enjoyed in the open without disturbing surrounding people. When it comes to headphones and ear-buds, active noise canceling and bluetooth connection are the way to go. The smart trend is also applicable to the sound domain, where virtual assistants are integrated in speakers, to talk with the user. This is done in for example Alexa and Google home, which are both operated by voice control instead of through a haptic interaction. People's behavior is learned (artificial intelligence, deep learning) and devices adapt correspondingly. When it concerns sound dampening there is a trend in where offices are more often equipped with sound absorbing panels, creating personal work spaces.

Bone conducting headphones

Sound is sent through the skull, avoiding any blockage of the hearing canal and so leaving the ear open to receive sounds from the environment. Now, sound can be enjoyed without having to close oneself off from the environment.



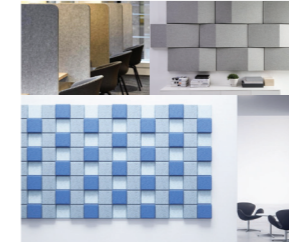
Volume earplugs

These earplugs enable the user to change the level of dampening by twisting a button on the outside. The user is now able to use the plugs in different contexts, where noise levels vary from context to context.



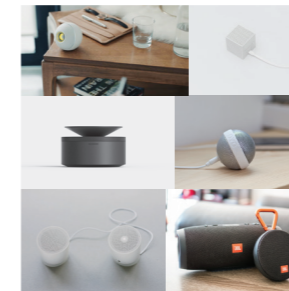
Sound absorbing panels

Due to shape, geometry and materials these panels absorb sound waves, creating a more quiet environment and a more comfortable space to have a conversation in.



Portable (bluetooth) speakers

These speakers are small, portable and convenient in use. Connect them through bluetooth or audio cables to with a sound source to play music. The size compromises on sound quality however. Some are made as wearables, to listen to music hands-free or on the go.



Psycho-control

A system developed by Columbia University can use brain wave scans to determine which person someone is talking to, and amplifies the sound of that person specifically, for the receiver to hear more clearly.



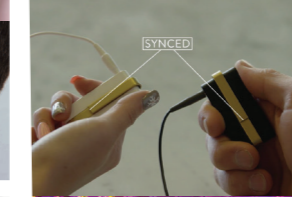
Active noise canceling in spaces

Different products claim to noise-cancel environmental noise in spaces, however reviews show that these products to be working in theory only.



Soundscape products

By analysing sounds in the environment people can be made aware of their soundscape (Chapter 3.3) and be advised on how to act upon it accordingly.



Active Noise Canceling headphones

By sensing, processing and ultimately playing reversed-phased audio signals, external noise is canceled. Some products are specialized to, for example, motorcyclists or drummers.

FM-systems

The concept of FM-systems is that there is one audio source that is connected to a group of different receivers, or different audio sources that are connected to one receiver. It is often used specifically in public spaces as churches, theaters and silent discos. Wireless connections could be done through specific radio frequencies, wifi or bluetooth.

Portable Digital Audio Converters

These devices amplify a digital audio signal with high quality, delivering a more detailed sound to the ear, improving the intelligibility of the sound source.

Noise over-rulers

These devices play an audio signal (e.g. the sound of rain) which is louder than the present ambient noise, lowering their distractions.

Directional speakers

These speakers are able to direct sound in one specific direction, only audible inside this specific area. One step outside of this area and sound is not perceived anymore. This relatively new technology is also available in a portable version.

Smart speakers

These products combine a speaker (sometimes including a screen) with artificial intelligence. The user is able to communicate with the system to, for example, discuss the schedule of the day, talk about the weather or lookup facts on the internet.

Appendix G3

Assistive technologies for the visually and hearing-impaired

Introduction

Numerous solutions to aid visually and hearing-impaired people are available on the market, a grasp of these products are described in this paragraph, organised in several categories. Next to an overview of examples of products in these categories, trends in the assistive technology market are described.

Assistive technologies

According to the 1998 Technology Related Assistance for Individuals with Disabilities Act (Yell., 1998), an assistive technology (AT) device is “any item, piece of equipment, or product system whether acquired off the shelf, modified or customized that is used to increase, maintain or improve functional capabilities of individuals with disabilities”. Such products that make people’s lives easier can be organised - amongst others - in the following categories: Writing, reading, communication and electronic aids for living, mobility and leisure (Seok e.d., 2010).

Since People with Usher have a double sensory deficit, both visually and hearing-impaired products are included in these categories. Notice here that in a lot of cases other senses are used to complement the hearing and seeing deficits.

Reading / Writing

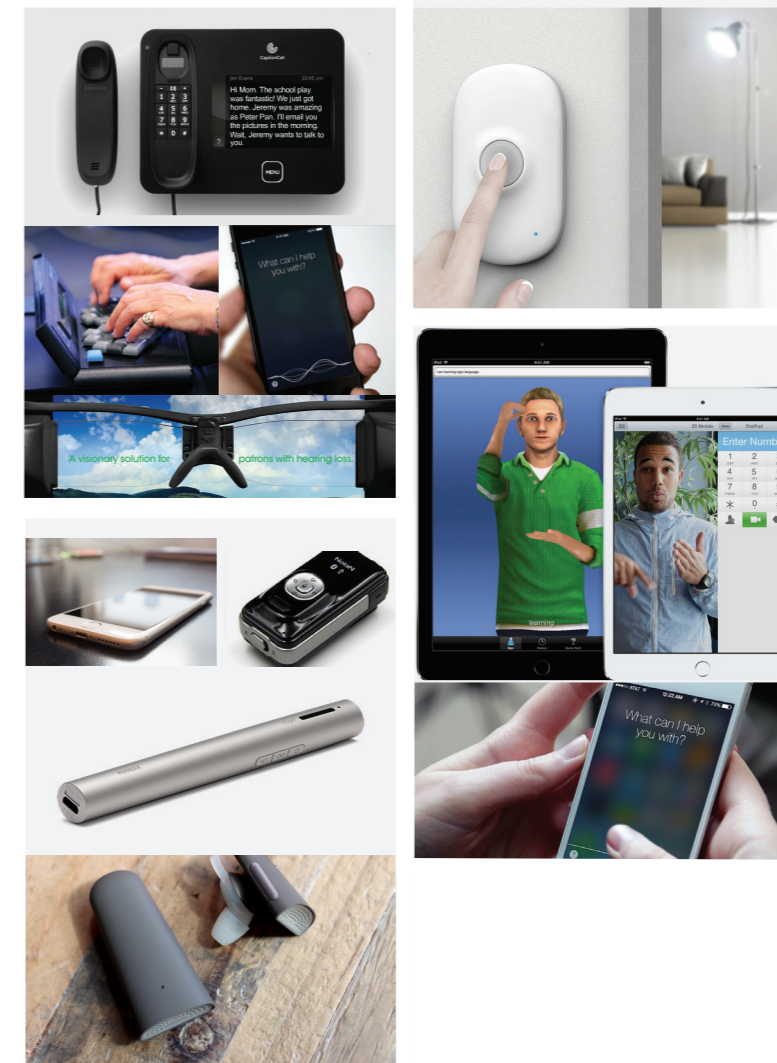
The obvious reading ‘technology’ would be braille language. This tactile lettering system could be realized in print, but also mechanically using small actuators and pins. These products can ‘refresh’ the braille pins to then shape the next letter. Speech-to-text reporters can display spoken text on a screen, so hearing-impaired can read what is said. Text scanners can pronounce written text so visually impaired people hear what is written. Lamps, smartphone lights and torches are used as reading lights in low-light settings.

Communication

Communication between people is assisted first and foremost by HAs and CIs, which enhance sound that is offered to the ear. Other sound devices that improve the way sound enhanced is through (wireless) microphone systems, where speech is separated from other sounds, ‘highlighted’ specifically to the receiver. Smartphones communicate messages through sound notifications, tactile vibrations or spoken language. Camera-apps can translate photos into spoken text, making the world accessible for the visually impaired. Other apps that translate and teach sign language apps that have speech recognition touch input, vibrations feedback

Electronic aids for living, mobility and leisure

face recognition to login
Temperature changing temperature to indicate stuff
Door bells that light up through a lamp
smell can indicate dangers (fire, gas)
Taste can complement sight to indicate that something is not recommended to eat
Audio cues like ‘mind your step’ help in orientation
A few examples of products are found that enhance the biological sense of sight. These are for example night goggles which act as a retina with light sensitive cells. Fish-eye lenses that act as a wide-angle lens and put more information in the same field of view. Magnifiers enlarge images, something a natural eye is not capable of. Mirrors enhance the field of view and can redirect light to light up a space. Different from the sense of hearing is that there are no ‘seeing-aids’ or ‘eye-implants’, so a visually impaired person is dependent on external devices for help.



Ultrasonic way-finders to find the way

Trends

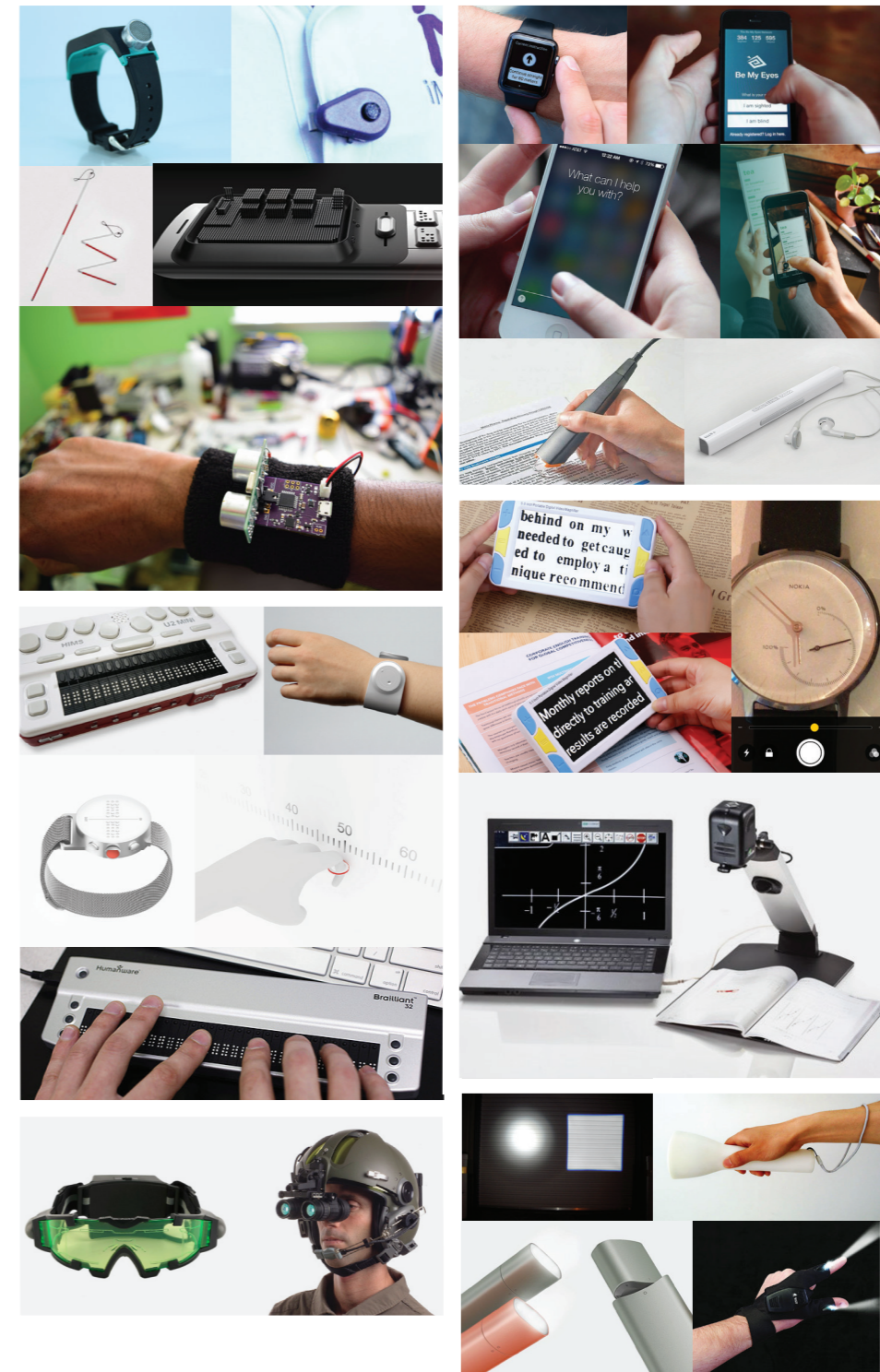
Hearing aids and CIs are getting more advanced; sizes decrease, audio conversion software and hardware get quicker, more accurate and reliable. Bluetooth connection possibilities to both hearing aids and CIs offer specialized uses for this target group; something that is convenient in the age of connected devices. The use of iPhones and its apps is popular.

Trends that are spotted is the very expensive market price on visually impaired products, because of their specified functions and relatively small target group. However, a number of products is found on crowd-funding web-pages as Kickstarter and Indigogo, enabling manufacturers to produce these specialized products when a need for it is indicated and proven directly at the consumer-level. The use of apps is popular and convenient. Most people use an iPhone, for its clear and constant interface throughout its various versions. Moreover, it is a product that everyone owns worldwide, and therefore not stigmatising to vips only. Siri is used abundantly to read and write texts and to control apps in general. Amongst these apps are tools that allow vips to understand content in photos they take, or brings them in touch with people throughout the world, to receive help and also to share stories. The use of technology binds people together. The use of braille is specific to only a few people, as it requires dedication and training to master this tactile language. Because of this reason, modern technology (like Siri) is often preferred over braille.

Conclusion

The variety of products in the audio, lighting, visually impaired and hearing-impaired domains show a wide variety of technologies used, different applications, embodiments and trends. These technologies develop further over time, making them faster, smaller and more convenient in use. The convenience and versatility and non-stigmatising factors of smartphones make this the number one product for visually and hearing-impaired people.

Other human senses are used to complement the sensory deficits, by translating information across sensory domains. The use of crowd-funding platforms allows for a specialized product to be offered to end-consumers directly, and can be funded and developed when the need is apparent. This increases the odds for a product to make it onto the market.



Appendix H

Informed consent: Micall test

Introductie

Beste deelnemer,

Bedankt dat u heeft aangegeven uw medewerking te willen verlenen ten behoeve van de verdere ontwikkeling van het afstudeerproject voor Stichting Ushersyndroom en TU Delft. De betreffende test is onderdeel van het afstudeerproject van onderzoeker/student Job van Dongen met betrekking tot de werking van, en uw mening over het ontworpen concept: Micall. Het doel van de test is het testen van Micall op de functionaliteit en op wat u van het concept vindt.

Testprocedure

Vanuit Stichting Ushersyndroom is de behoefte geuit een product te ontwikkelen om mensen met Usher beter in staat te stellen zich te kunnen omgeven in sociale settings als een kroeg, restaurant of verjaardag.

Als resultaat van het ontwerpproces dat hierop is uitgevoerd is er een concept gevormd: Micall. Micall is een microfoon-systeem waarin het meebrengen, opladen, en gebruik van draadloze microfoontjes is geoptimaliseerd. Vrienden en familie kunnen deze microfoontjes eenvoudig opspelden/clippen, en spaak van de microfoontjes wordt vervolgens via een smartphone-app naar het hoortoestel en/of cochlear implantaat gestuurd. De persoon met Usher heeft hierbij de controle om onder meer het volume per microfoon naar behoefte aan te passen en zo beter in staat zijn een (groeps-) gesprek te volgen.

Om een gedeelte van de werking van Micall te testen is er

van Micall een functioneel prototype gemaakt, om van de eindgebruiker (u) feedback te ontvangen met als doel de werking van het ontwerp te bevestigen en verbeteren. De testopstelling zal er uitzien als een tafel in een kroeg of restaurant. U wordt gevraagd plaats te nemen, waarna u uitleg krijgt over het ontwerp en waarbij een zichtmodel van Micall wordt getoond. Daarna wordt het functioneel prototype geïntroduceerd en uitgelegd. Deze bestaat uit een set microfoontjes, een geluidsmixer en koptelefoon. De persoon met Usher wordt gevraagd de koptelefoon op te zetten, de vrienden/familie wordt gevraagd de microfoontjes op te spelden/clippen (Eventueel is het ook mogelijk bluetooth-streamers te gebruiken in plaats van de koptelefoon). Hierna wordt een gesprek tussen de persoon met Usher en vrienden/familie geïnitieerd, waarin de persoon met Usher de mogelijkheid heeft de geluidsmixer uit te proberen om zo het volume van het geluid van de microfoontjes te regelen. Zodra het voor u duidelijk is hoe het werkt zal er in de achtergrond kroeg-geluid worden afgespeeld (langzaam van zacht naar wat harder), om de setting van een kroeg na te bootsen. Ook zal de vrienden/familie gevraagd worden te spreken met de hand voor de mond, om te testen in hoeverre lippen benodigd is voor het verstaan van spraak wanneer er gebruikt wordt gemaakt van de microfoontjes. Daarnaast wordt de persoon met Usher gevraagd de ogen te sluiten, om te testen in hoeverre lichaamstaal bijdraagt aan het verstaan van spraak wanneer er gebruik wordt gemaakt van

de microfoontjes. Na een gesprek van +- 15 minuten is de test voorbij. Na de test zal een open discussie plaatsvinden over de ervaringen met het prototype. Daarna wordt u gevraagd een korte vragenlijst in te vullen. Het geheel zal ongeveer een uur tot anderhalf uur in beslag nemen. Tijdens de test zullen er een geluidsopname en foto's gemaakt worden. Deze opnamen en foto's zullen enkel gebruikt worden door Job van Dongen, Stichting Ushersyndroom en TU Delft, voor onderzoeksdoeleinden. Hierin wordt er zorgvuldig omgegaan met de anonimiteit van de deelnemers. Tijdens de test heeft u ten alle tijde het recht te stoppen, zonder reden.

Uitgangspunten

Als onderdeel van het testen van het prototype gelden de volgende uitgangspunten waarmee u zich door ondertekening van dit document bekend en akkoord mee verklaart:

1. Door deelname aan dit onderzoek, heeft u toegang tot het gebruik van het prototype.
2. U doet mee aan dit onderzoek op eigen risico. Het enige risico binnen dit onderzoek is dat het uitgangsvolume van de mixer luid zou kunnen klinken door de koptelefoon, wanneer testpersonen luid in de microfoons praten en/of de volumeknop (te) ver is open gedraaid.
3. Aan het eind van de test zal u gevraagd worden een vragenlijst te beantwoorden. U geeft Stichting

Ushersyndroom, TU Delft en Job van Dongen het recht om al uw feedback te gebruiken voor de verdere ontwikkeling van Micall.

4. U bent niet verplicht deel te nemen aan het onderzoek en u kunt zich op ieder moment en zonder reden terugtrekken uit het onderzoek.
5. Uw gegevens blijven vertrouwelijk, alleen onderzoeker/student Job van Dongen heeft weet van welke informatie bij welke deelnemer hoort.

Voorwaarden

Door ondertekening van dit document en met deelname aan de Micall-test, gaat u akkoord met de bepalingen en voorwaarden die hieronder uiteengezet zijn.

1. Uw feedback

Door deelname aan de Micall Test gaat u ermee akkoord dat al uw feedback eigendom van Stichting Ushersyndroom en TU Delft wordt. De door u gegeven feedback is origineel van u. U gaat ermee akkoord dat Stichting Ushersyndroom en TU Delft deze feedback mag gebruiken. Dit kan alle feedback of een deel van uw feedback of een afgeleide daarvan zijn op welke manier of media dan ook, zonder enige verdere beloning, vergoeding of vermelding van uw naam. Tijdens de test zullen foto's van uw gebruik met het

werkend prototype en zichtmodel worden gemaakt. Geeft u Job van Dongen, Stichting Ushersyndroom en TU Delft toestemming om deze foto's te gebruiken voor educatie/promotiedoeleinden (verslaglegging/website/nieuwsbrief/etc.)?

- Ja, ik geef hiervoor toestemming
- Ja, mits ik onherkenbaar ben op de foto('s)
- Nee, ik geef geen toestemming

2. Beperking van aansprakelijkheid

U bent akkoord dat uw deelname aan de Micall-test op eigen risico is. U verklaart Job van Dongen, Stichting Ushersyndroom en TU Delft (alsmede hun werknemers, agenten, advocaten, consultants, of aannemers) op geen enkele manier aansprakelijk te zullen stellen voor enige schade veroorzaakt door of tijdens de Micall-test.

3. Bevoegdheid

U verklaart en garandeert dat u bevoegd bent om deze overeenkomst aan te gaan en verleent de rechten en aanvaardt de verplichtingen zoals met deze overeenkomst overeen gekomen.

Voor ontvangst en akkoord met het voorgaande:

Deelnemer Naam:

Datum:

Plaats :

Handtekening deelnemer:

Hartelijk dank voor uw medewerking!


Met vriendelijke groet,

Job van Dongen

J.vanDongen-1@student.tudelft.nl

+31642459000

Handtekening onderzoeker:



Appendix I:

Context decision questionnaire

Productontwerp voor Usher - het positief versterken van zicht en gehoor

Hallo! Super dat u deelneemt aan deze enquête (±15-20min),

Mijn naam is Job (foto beneden), ik ben masterstudent Industrieel Ontwerpen aan de TU Delft en ben momenteel bezig met mijn afstudeeropdracht voor Stichting Ushersyndroom.

Voor iemand met Usher ligt behoefte voor licht en geluid anders dan voor iemand zonder Usher. Het licht kan te sterk of te zwak zijn, het geluid te luid of onduidelijk, of een combinatie van beide.

Er vanuitgaande dat licht en geluid in een thuisituatie constant en juist afgesteld zijn, wil dat niet zeggen dat dit ook geldt voor alle scenario's buitenshuis. Sterker nog: het kan voor iemand met Usher juist heel lastig en vermoeiend zijn te functioneren in een (sociale) omgeving waar deze licht en geluidssituatie niet zoals thuis is (denk aan een restaurant, in een kroeg, etc).

Hier gaat mijn afstudeeropdracht over: hoe kan ik door middel van een product de specifieke licht en geluids-behoefte van iemand met Usher faciliteren in een sociale context buitenshuis?

Mijn doel met deze enquête is een specifieke sociale context (op het terras, bij een barbecue, op een verjaardag) te vinden waarin er met name behoefte is aan een specifieke licht en geluid-oplossing. Er zijn meerdere contexten te bedenken maar niet elke context is misschien altijd relevant voor de meeste mensen met Usher en/of hun familie of vrienden. Vandaar deze enquête: om een focus te kunnen leggen op een specifiek scenario om voor te kunnen ontwerpen.

De enquête kan worden ingevuld door zowel mensen met Usher als gerelateerde vrienden of familie: beide hebben unieke inzichten en ervaringen die voor mij waardevol kunnen zijn. U kunt het dus invullen vanuit uw eigen oogpunt.

Bij voorbaat dank voor uw tijd, moeite, en inzichten! Er wordt vertrouwelijk omgegaan met alle verzamelde informatie.

Job.



Productontwerp voor Usher - het positief versterken van zicht en gehoor

Kennismaking

Het lijkt me leuk u iets beter te leren kennen.

Geslacht

- Vrouw
- Man
- Transgender Vrouw
- Transgender Man
- Anders: _____

Leeftijd

Jouw antwoord _____

Uw relatie / connectie met Usher

Jouw antwoord _____

Welke hulpmiddelen gebruikt u / degene met Usher in uw gezelschap?

Hoortoestellen

1 CI en 1 hoortoestel

2 CI's

Anders: _____

Hoe is uw zicht (als u Usher heeft) / van degene met Usher in uw gezelschap?

De kokersvisus is groter dan 10 graden

De kokersvisus is kleiner dan 10 graden

De scherpte van het zicht is (eventueel met bril of contactlenzen) nog 80% of meer

De scherpte van het zicht is (eventueel met bril of contactlenzen) minder dan 80%

Anders: _____

Hoe is u gehoor (als u Usher heeft) / van degene met Usher in uw gezelschap?

Slechthorend

Hyperacusis en/of tinnitus

Anders: _____

Productontwerp voor Usher - het positief versterken van zicht en gehoor

Eigen ervaringen in sociale contexten

Zou u (vanuit uw eigen standpunt) iets kunnen vertellen over enige moeilijkheid die u ervaart of hebt ervaren in een sociale context met oog op Usher? (bijvoorbeeld een afgesloten gevoel van uw gezelschap door een slecht belicht restaurant, hard moeten spreken door omgevingsgeluid in een café, verwarrende interacties in een treincoep, etc)

Jouw antwoord _____

Productontwerp voor Usher - het positief versterken van zicht en gehoor

Sociale contexten

Hieronder ziet u 9 sociale contexten. Hoe lastig is de sociale interactie (het met elkaar omgaan/ in gesprek zijn) in deze context voor u op een schaal van 1-5? Daaronder is er ruimte voor een korte motivatie van dit cijfer.

Bijvoorbeeld: Context 1: de moeilijkheid is een 5. Motivatie: vanwege de hoeveelheid mensen, de zeer drukke gesprekken, achtergrondmuziek en verschillende lichtbronnen door het huis heen, etc.

9 contexten



	1 (makkelijk)	2 (redelijk makkelijk)	3 (normaal)	4 (redelijk moeilijk)	5 (moeilijk)
Context 1: Etenje bij vrienden of familie thuis	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Context 2: Barbecue / tuinfeest	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Context 3: Koffiebar / lunchroom	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Context 4: Restaurant	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Context 5: School / werk / sport-kantine	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Context 6: Verjaardag	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Context 7: Terras (overdag / 's avonds)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Context 8: Bar / kroeg	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Context 9: Sport(veld)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Zou u per context kort uw motivatie voor het gekozen cijfer kunnen toelichten?

Context 1: Etenje bij vrienden of familie thuis

Jouw antwoord _____

Context 2: Barbecue / tuinfeest

Jouw antwoord _____

Context 3: Koffiebar / lunchroom

Jouw antwoord _____

Context 4: Restaurant

Jouw antwoord _____

Context 5: School / werk / sport-kantine

Jouw antwoord _____

Context 6: Verjaardag

Jouw antwoord _____

Context 7: Terras (overdag / 's avonds)

Jouw antwoord _____

Context 8: Bar / kroeg

Jouw antwoord _____

Context 9: Sport(veld)

Jouw antwoord _____

Productontwerp voor Usher - het positief versterken van zicht en gehoor

Producten in deze contexten

Uiteraard zijn er producten die gehoor en zicht kunnen ondersteunen (schrijftolk, mic, solo-apparatuur, etc), echter dat wil niet zeggen dat een product altijd goed werkt, prettig in gebruik of mooi is in de situatie waarin het gebruikt wordt.

Welke ondersteunende producten gebruikt u in deze contexten?

Jouw antwoord _____

Hoe ervaart u het gebruik van deze producten?

Jouw antwoord _____

Productontwerp voor Usher - het positief versterken van zicht en gehoor

Andere ervaringen?

Mochten er nog een of meerdere contexten of ervaringen binnen te zijn geschoten die niet in het rijtje van 9 voorkwam maar die u wel wilt delen, dan is daar hier de ruimte voor (Denk bijvoorbeeld aan een winkelcentrum, op straat, kerk, markt, begrafenisreceptie, museum, dagje naar het strand, etc).

Jouw antwoord _____

Eind van de enquête

Bedankt voor uw tijd en moeite, super!

Als vervolg op deze enquête zal ik in de komende tijd nog een aantal kleine onderzoekjes doen (creatieve sessies, context ervaring sessies). Mocht u het eventueel leuk vinden daar aan mee te doen, kunt u uw e-mailadres hieronder achterlaten. Ik neem dan t.z.t. vanzelf contact met u op.

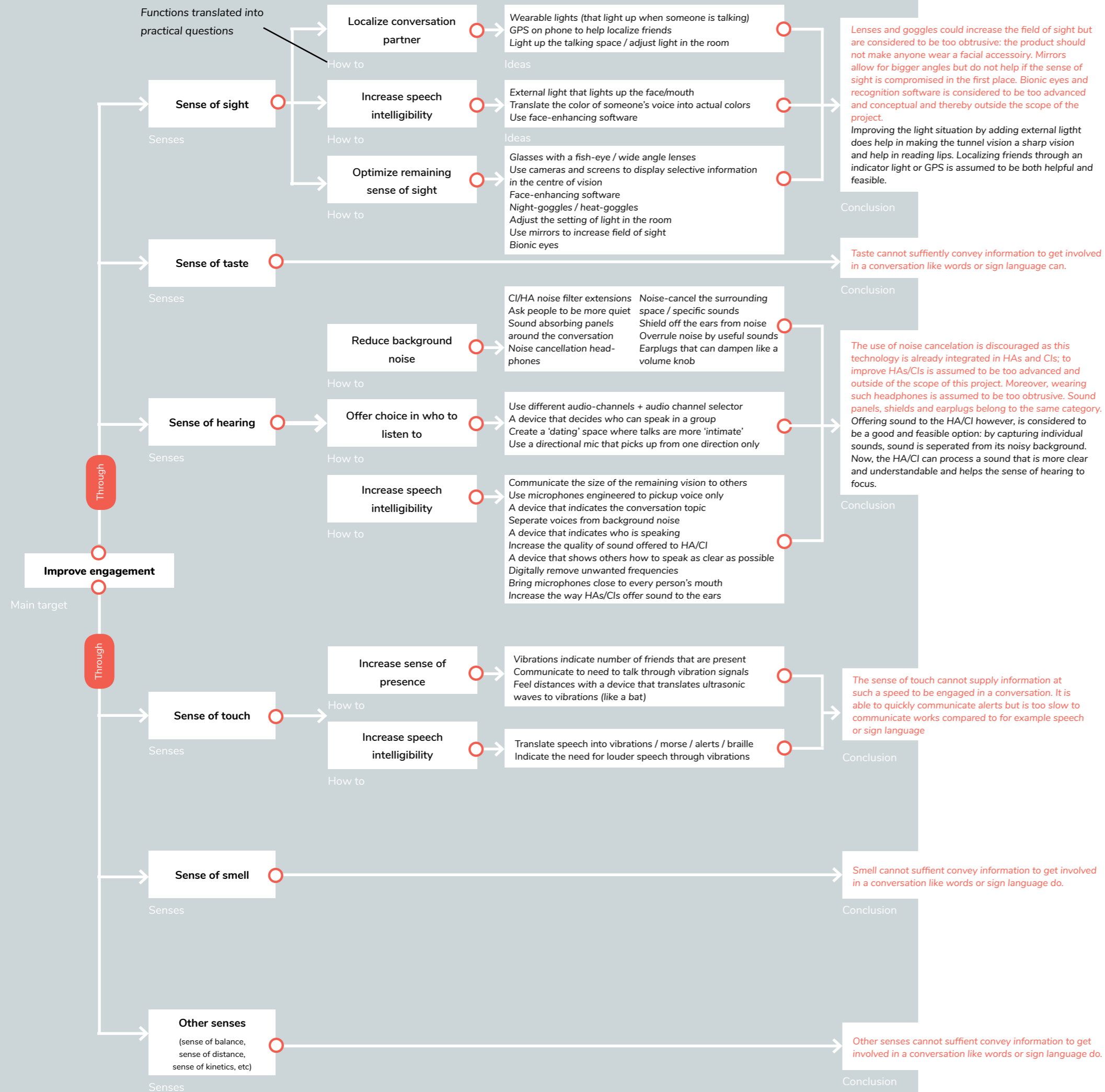
Nogmaals dank,

Job.

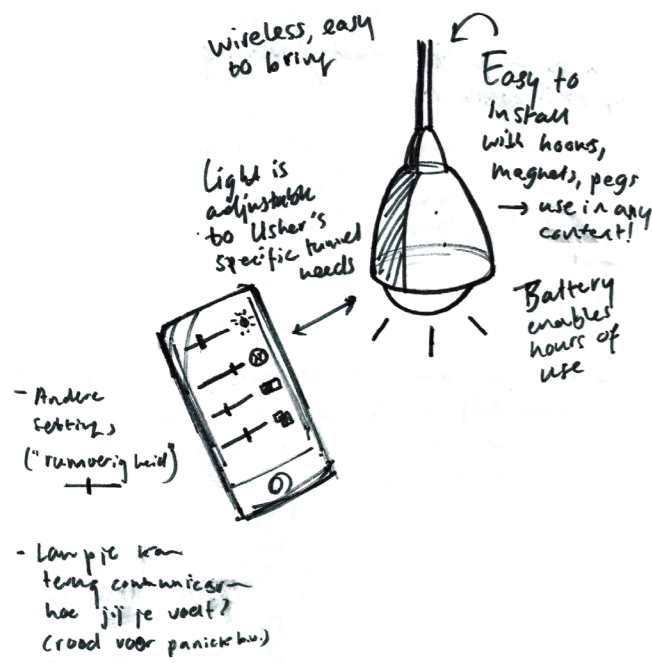
E-mail adres:

Jouw antwoord _____

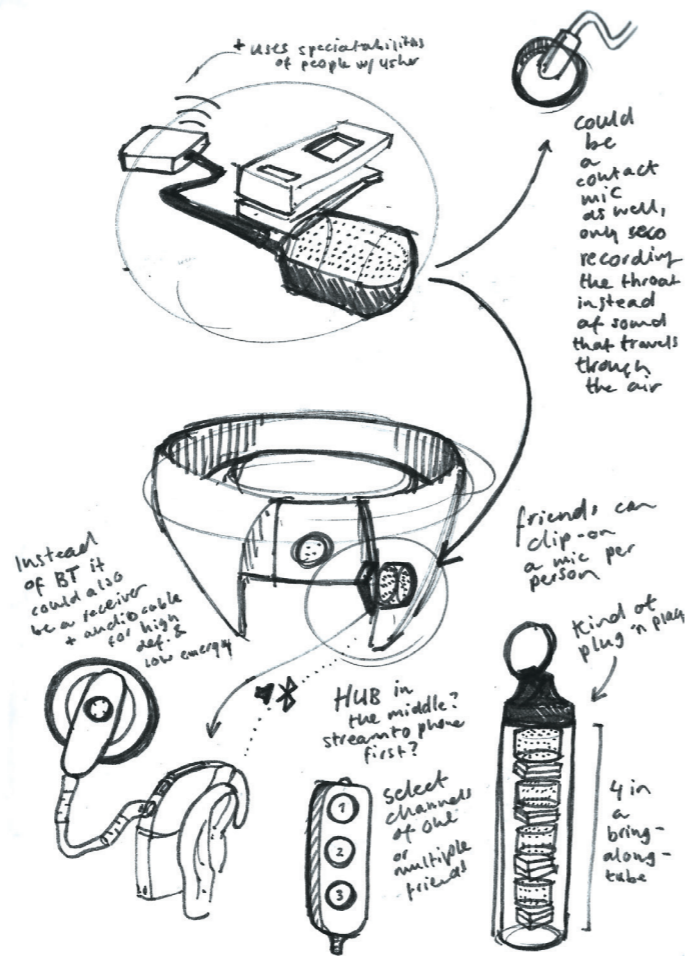
Appendix J1: Ideation flow chart



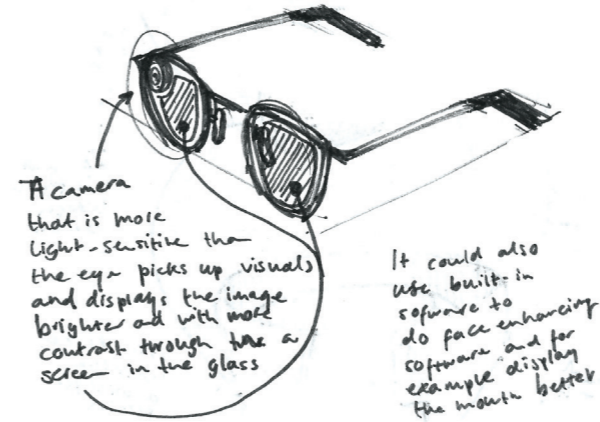
Appendix J2: 8 best ideas sketches



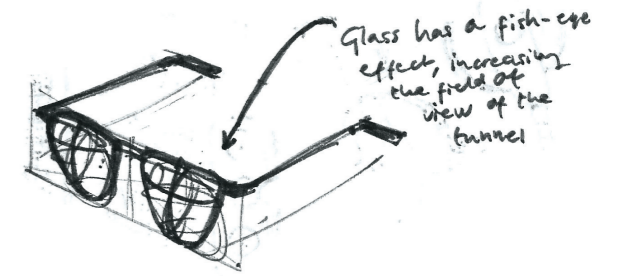
Idea 1
Multi-purpose lamp



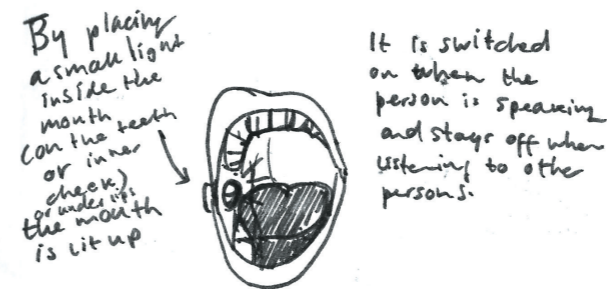
Idea 2
Clip-on family



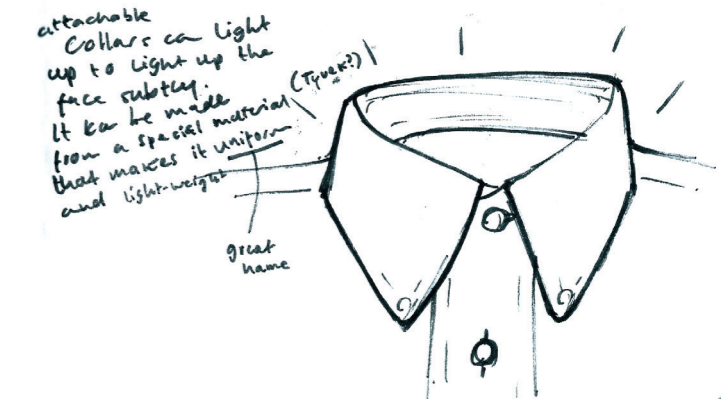
Idea 3
Night goggles



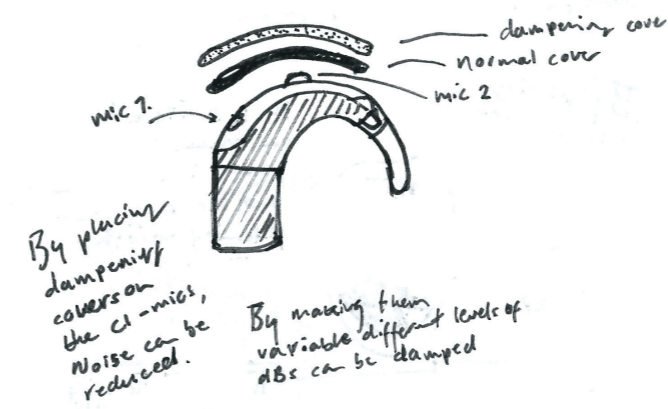
Idea 4
Fish-eye goggles



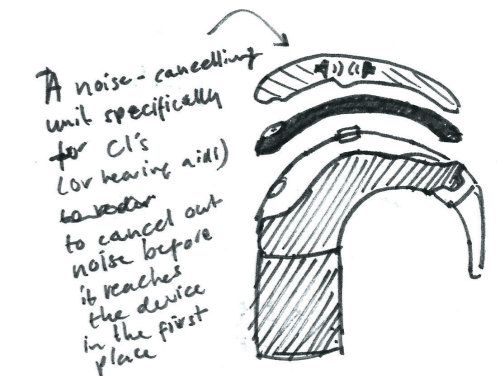
Idea 5
Chewing light



Idea 6
Collar light



Idea 7
CI variable noise filters



Idea 8
CI noise cancelling unit

Appendix J3

Ideas vs functions

Introduction

To the right, the 8 best ideas have been ranked according to the functions defined in Paragraph 2.1. Functions that weigh the most heavy are 1,2,3 and 8, as these are considered to make or break the product. The most-right column shows the ranking of the final design proposal of the project.

		1	2	3	4	5	6	7	8	Final design proposal
1	1a. Enable control over light power	++		++	--	+	+			
	1b. Enable control over what area is being illuminated	+		+	--	+	+			
	1c. Offer control in color temperature	++		++	--	+	+			
2	2a. Enable volume control of the target message		++					-	-	++
	2b. Enable reduction of background noise		++					+	+	++
	2c. Enable connection with hearing aid(s) and/or cochlear implant(s)		++					++	++	++
	2d. Reduce distance between sound source and person with Usher		++					--	--	++
3	3a. Enable independent use	++	+	++	++	--	--	++	++	+
	3b. Enable non-obtrusive use	-	+	-	-	--	--	++	++	+
4	4a. Reduce amount of steps needed to operate the product	++	+	+	++	++	++	++	++	++
	4b. Do not disturb other people	-	++	++	++	-	-	++	++	++
	4c. Be intuitive to operate	++	+	+	++	+	+	++	++	++
	4d. Have readable interfaces	++	++	++	+	+	+	++	++	++
5	5a. Have compact dimensions	+	++	++	++	++	+	++	++	++
	5b. Be light-weight	+	++	+	++	++	++	++	++	++
6	6a. Have a reduced amount of parts	?	?	?	++	++	++	++	++	++
	6b. Have a material which has a high quality/price-ratio	?	?	?	?	?	?	?	?	?
	6c. Have a cost-effective way of manufacturing	?	?	--	?	?	-	?	?	+
7	7a. Have beautiful looks	?	?	?	?	?	?	?	?	++
8	8a. Make use of available technology	++	++	--	++	++	+	+	+	++

Appendix K:

Embodiment design process

Introduction

This paragraph describes the embodiment process of Micall. The embodiment is separated in the disciplines of technology/functions, aesthetics and interaction and is divided in a number of stages. Every stage has an iterative connection with the previous and next stage where finally, all design decisions are distilled in one design, ready for validation. This will then result in a final design proposal.

Stage 1: Inspiration

Technology/functions

Current microphone products teach a lot about technology which is used, their size and way of assembling. In this case, different ways of clipping on a small product, size of batteries and microphone components are aspects taken from current products.

Aesthetics

Looking at other products inspires shapes, use of materials, colors and texture, and also how not to do it. Subtle fillets, bright colors, use of fabric and high build quality were aspects that were taken from these images.

Interaction

The way a microphone can be stored, used and enjoyed can be inspired by similar products. For example, by making it easy to hand-out, use interesting use-cues and make links with traditional products like clothespins.

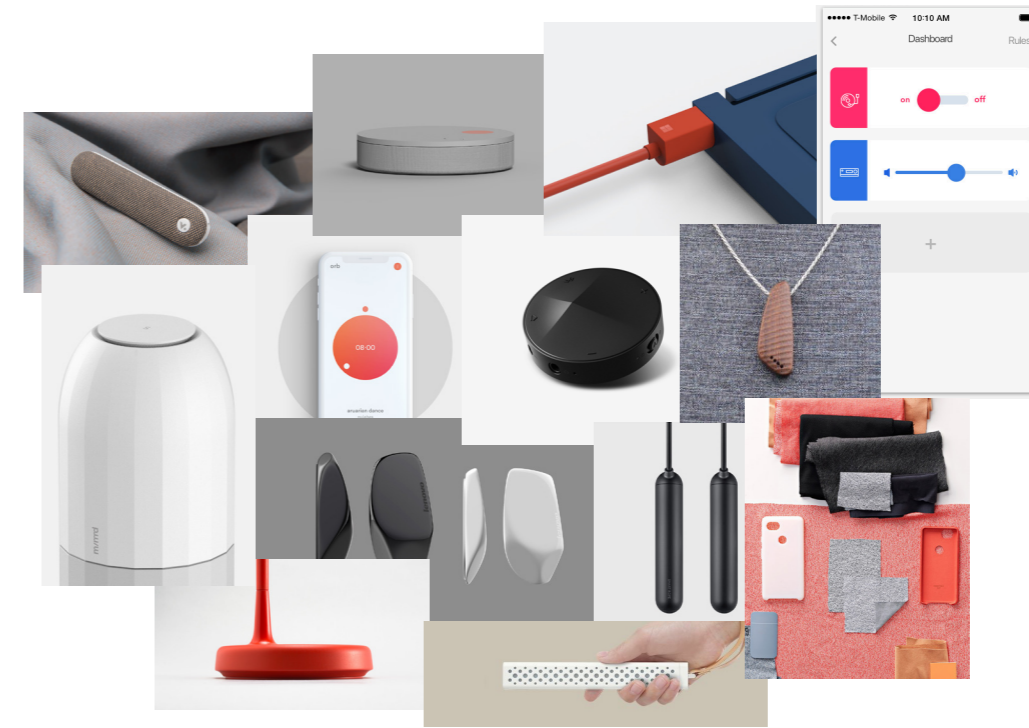


Figure X
Aesthetic inspiration



Figure X
Interaction inspiration



Figure X
Technology/function inspiration

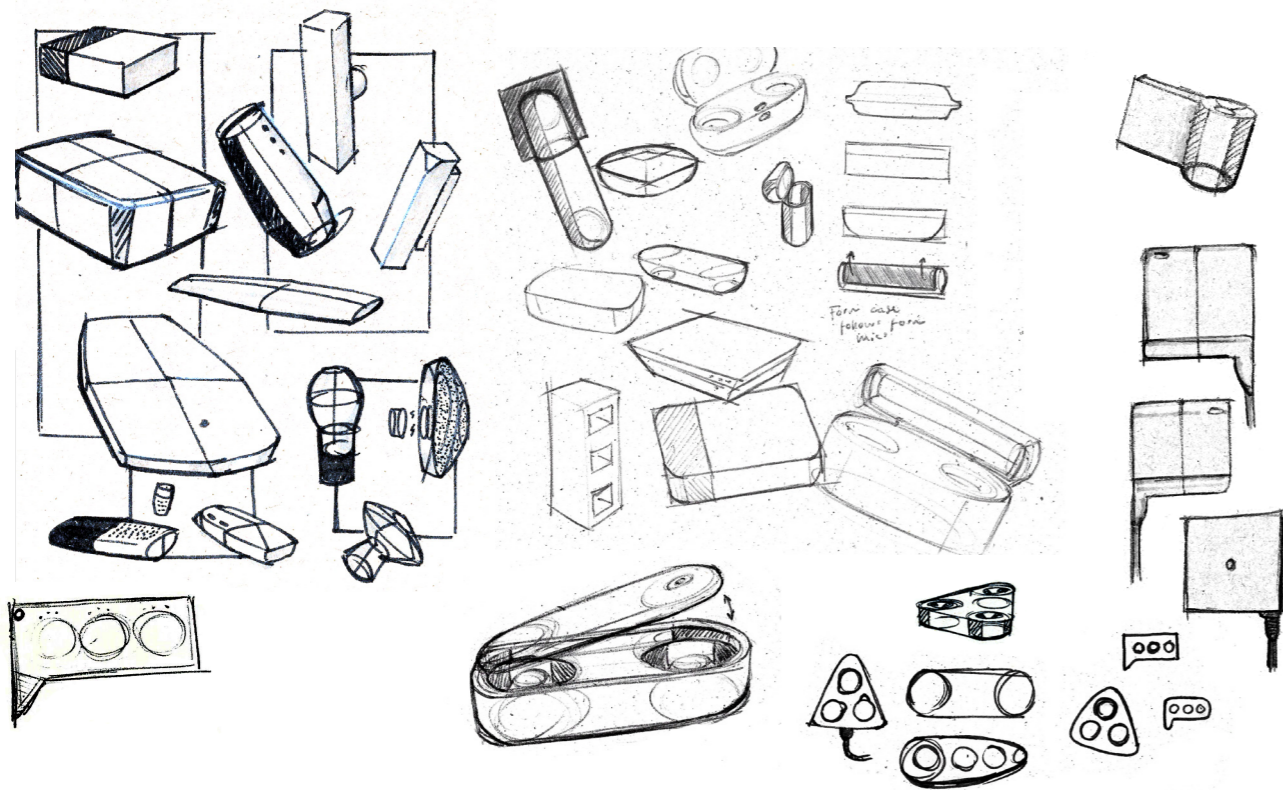


Figure X
Aesthetic sketches

Stage 2: Sketching

Technology/functions

Inspired by the collages from stage 1, ideas are put on paper. Form follows function, and thus its functions should be defined first. This is important to make sure technology would actually fit inside the housing of the product, and that it can be manufactured in the end. The functional overview of micall (compared to the table of requirements) is shown in appendix L2.

Aesthetics

Early knowledge about to-be-used components define the minimum dimensions and main shape of the product. One of the goals here is to deviate from standard shapes for both microphones and corresponding charging cases. Different shapes of cases and mics have been tried out, but ultimately this goal is achieved by adding symbolism to the design: the shape of a speech bubble. Since the product is all about communication, this is a convenient touch to make the product stand out from the rest and add meaning to the embodiment. Extending on the conversation-symbolism, the round mics placed in the case represent the periods (dots) often seen in speech bubbles. Moreover, a round-shaped mic makes sense since it is efficient volume-wise, as the envisioned battery is a rechargeable cell battery. Especially in the case where a product is worn 'in the open', aesthetics play a significant role. Even more so, because

other people are involved in the use of the product (friends/family) and not only the primary user (Person with Usher).

Aesthetic requirements can be described as follows:

- Charging case: rather long than wide
- Mics should be wireless
- Mics should not look like mics
- Mics and case: portable
- Design should be unisex to fit all
- Form case follows form mics
- App should be looking coherent with case and mics
- Turning on/off should be easy: button on the front
- App should be designed for people with RP
- Mics should be compact
- Mics should blend in with clothing
- Mics should clip-on easily
- Mics should include light

Interaction

The interactions with Micall are tried to be the most convenient and fun with every step of the way, from charging the product to bringing it, opening the case, connecting it in the app, wearing the mics, putting the mics back into the case and so on.

Simultaneously sketches of the app are made. Information is centred and contrast is maximized. Interaction-wise it is important to offer maximum functionality with minimum effort to increase the convenience of use.

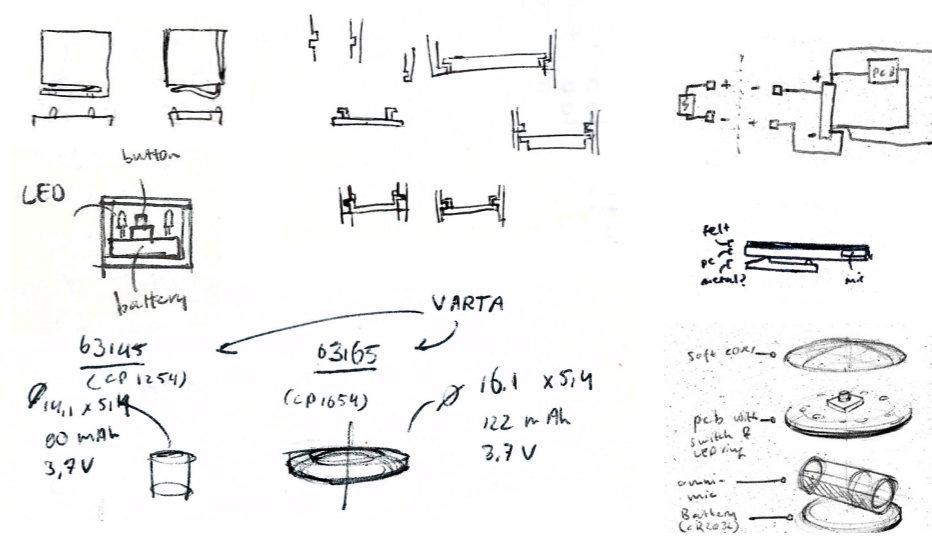


Figure X
Technology/function sketches

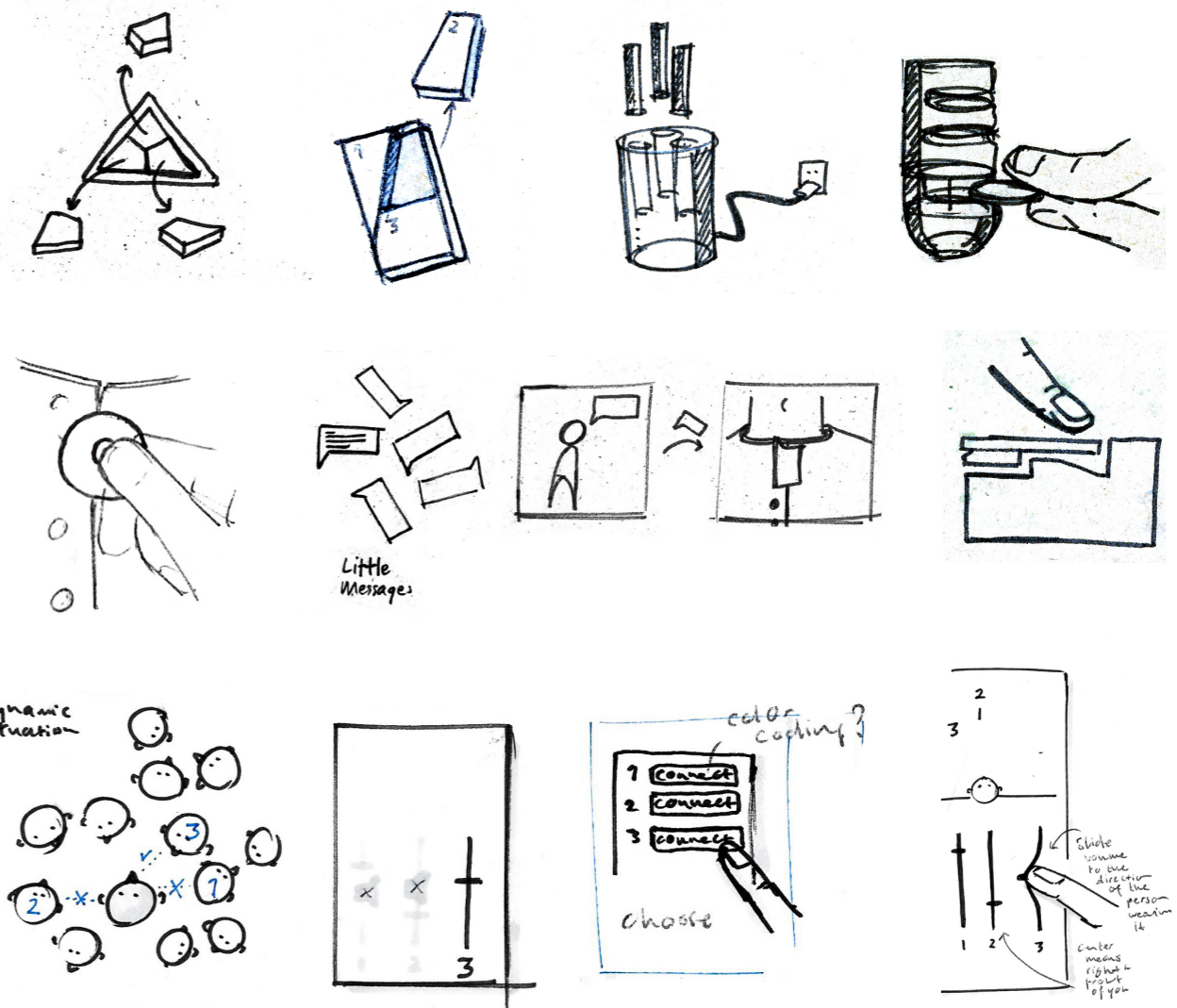


Figure X
Interaction sketches

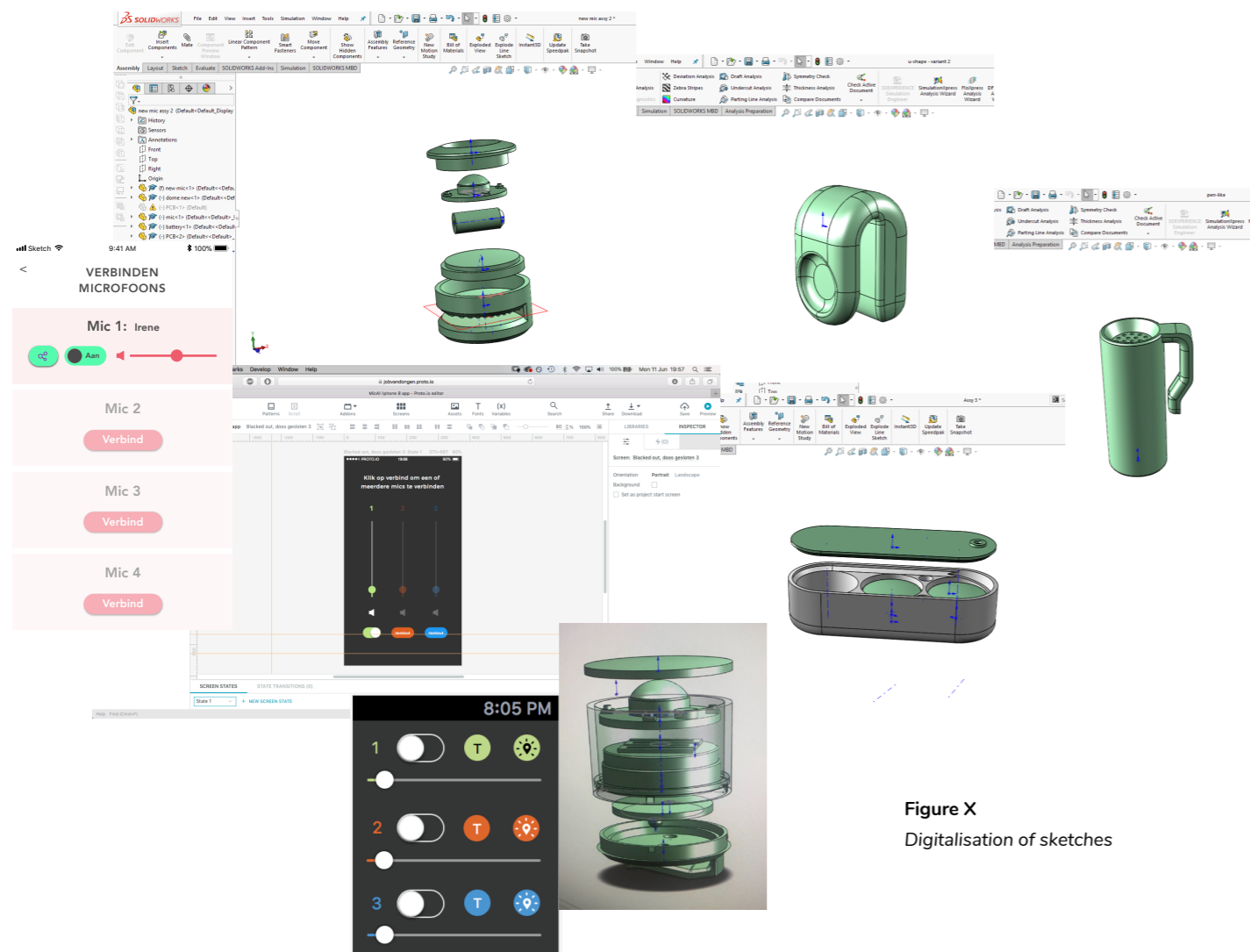


Figure X
Digitalisation of sketches

Stage 3: Digitalizing

Technology/functions

Micall components are defined and researched. SolidWorks is used to transform the sketches into 3D. Here, dimensions of micall can be adjusted to the components it should house.

Aesthetics

As this is the first 3D model of Micall, the main function is about the look and feel, its proportions and size. How well fit the mics and case together and what are the bottlenecks? Here, app sketches are also made digital.

Interaction

Here, a focus is on its portability, the way the case opens and closes and how mics can be taken in and out of the case. The digitalized app is made interactive.

Stage 4: 3D-printing (PLA)

Technology/functions

The component leading for the size of both case and mics is the battery. Having a physical model of both case and mics,

the fitting of the battery can be tried out.

Aesthetics

With the first printed models, the look and feel can be assessed, and decisions can be made about which models should be developed further. Here, multiple tryouts of mics and cases can be seen. In this iterative process the idea of the text-cloud symbolism was found.

Interaction

With the physical models, the opening and closing of the case and taking the mics in and out of the case can be tried out. With magnets, magnetic locking mechanisms are made. Ways of clipping on the mics are explored to find the most convenient manner. For example, first the clip was centred to divide the weight of the Mics equally to the front and back. This was later switched to a bottom-clip because this enabled for improved housing of the components on the inside. Magnets seemed promising as a clipping option but were not used because a risk of losing the product if a magnet would slip off.



Figure X
Overview of different 3D print tryouts.

Figure X
Trying out different ways of wearing a mic

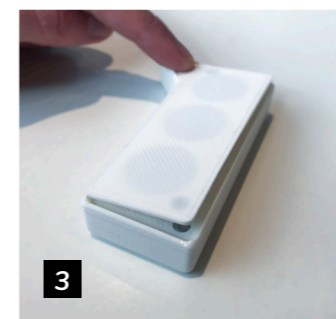
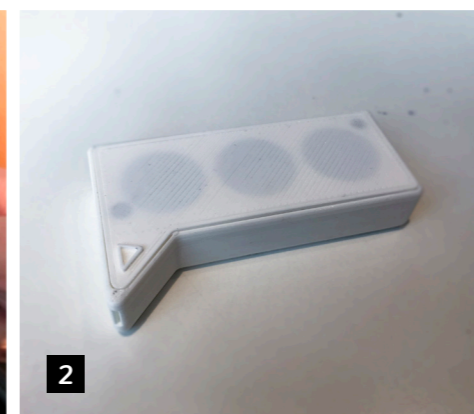
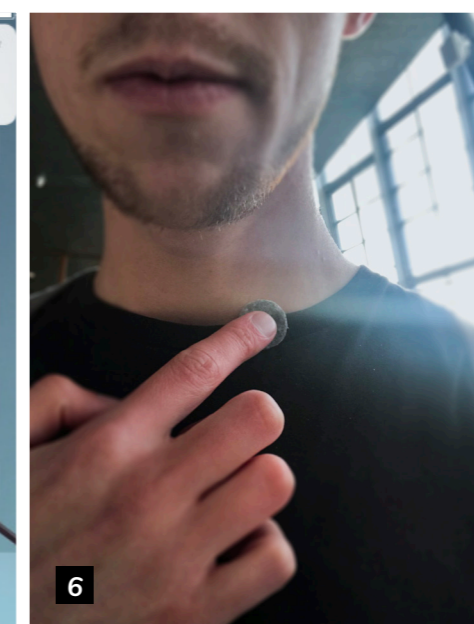
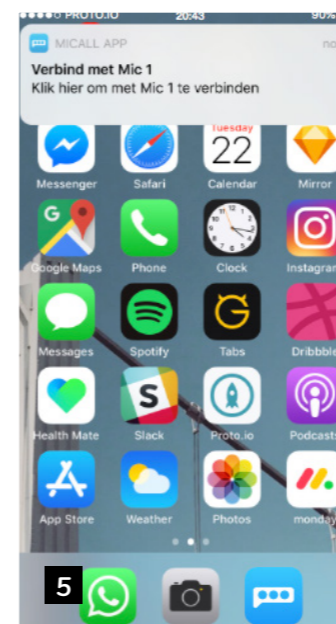


Figure X
Overview of the interaction with Micall

1. Bring Micall along and get it out of your pocket or bag
2. Place Micall on the table
3. Open the case by pressing on the triangle in the speech bubble corner
4. Take out one mic
5. An automatic message comes through on the phone, asking for connection with the mic
6. Clip-on the mic and everything is set. Press on the front for silent-mode, if the person who is wearing the mic does not want to be heard (toilet, private conversations, etc)



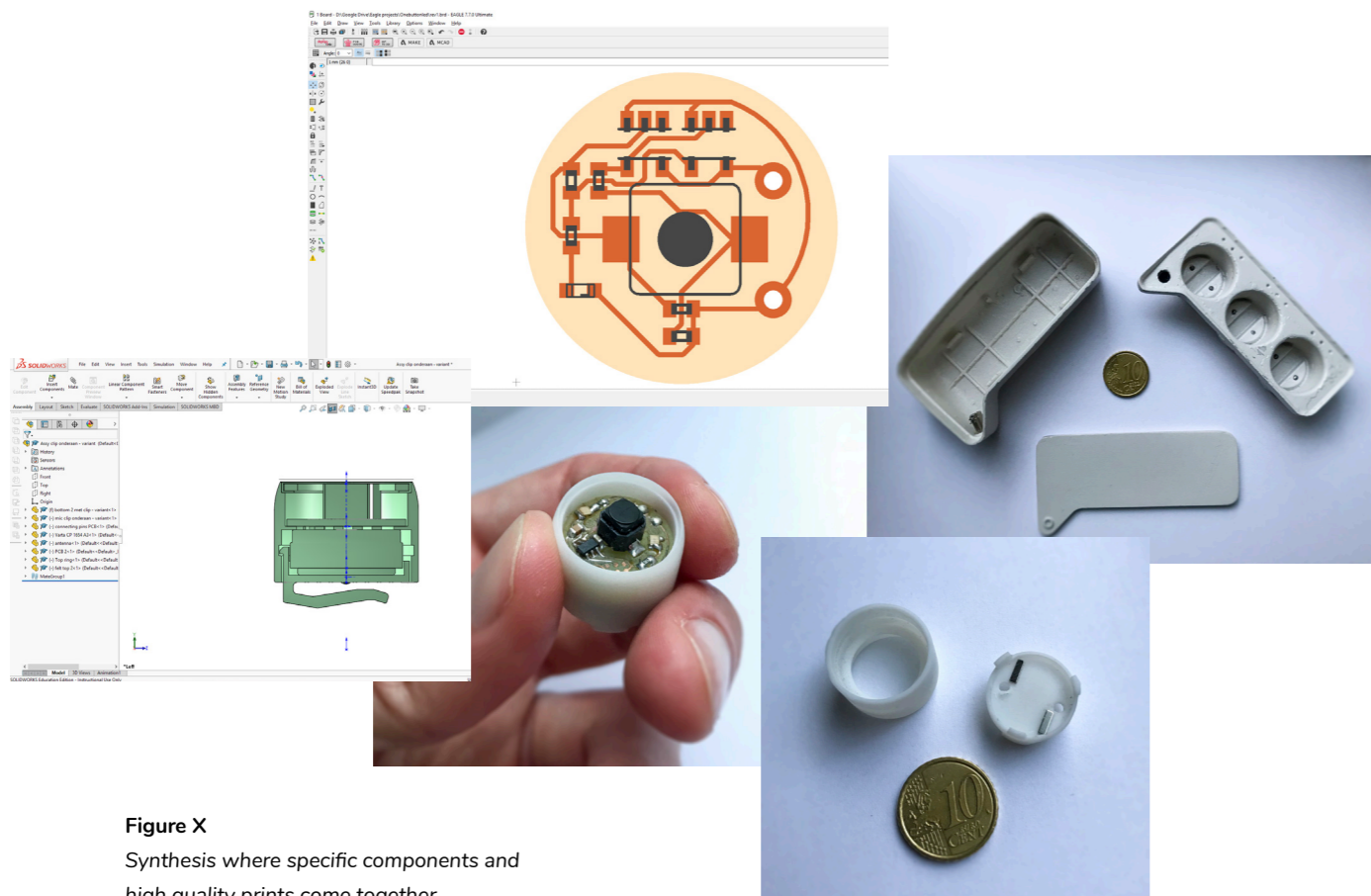


Figure X
Synthesis where specific components and high quality prints come together

Stage 5: Synthesis

Technology/functions

In this stage, the choice for technical components is defined, and so the 3D model is refined to specific dimensions. This is then 3D printed using a high quality SLA-printer. Together with an electrical engineer, a PCB is designed and assembled to fit into the mics.

Aesthetics

Having defined components means that from this point aesthetic details can be applied. The use of a high quality 3D-printer allows for these details to be realized.

Interaction

At this stage, the interaction has not changed, since validation is needed to test if the envisioned interactions work for the target group. High quality prints allow for using smaller magnets, although these snap less well than previously used magnets.

Stage 6: Validation

This stage is described in its entirety in paragraph 3.2.

Technology/functions

Since Micall is not fully functional with for example bluetooth connections or volume control through the app, a prototype has been assembled to represent these functions. This is done through a sound mixer, 3 microphones, an amplifier and a pair of headphones. Testing such a setup can give a proof of concept of the envisioned design.

Aesthetics

During the validation tests, the aesthetic model of Micall is presented, along with the functional prototype described above. The app is also shown. This one is not functional but visual elements like sliders and fading screens are made interactive to mimick the functions.

Interaction

Users can test interaction elements with the aesthetic prototype and give feedback on it subsequently.

Stage 7: Final proposal

This stage is described in its entirety in paragraph 3.3. Renders are also displayed there.



Figure X
Testing the aesthetic and functional prototypes with end-users

Technology/functions

As a result of the validation tests, it has become clear what functions should be kept and which should be omitted, to get a desired product for the end-user. Important functions to keep are volume control and having wireless connections. Functions to omit are the use of LEDs to indicate the wearer's location. Functionalities of the mics and the volume control was perceived as very useful and fun.

Aesthetics

Important aesthetics to keep is the color coding of mics. This should be changed to more primary and contrasting colors however. Remarks have been to try to keep everything as small as possible.

Interaction

Participants with Usher had fun with the way they were able to adjust volume per mic and so control the sound that was offered to them. Moreover, interactions with the aesthetic model was perceived positively. The interaction with the app could be improved by making buttons and text even bigger. Bluetooth functionality should be expanded with distance-tracking, where the Mics are put on stand-by when they are too far away from the person with Usher, to offer a more real experience (you would not be able to have a conversation 10 meters away in real life either).

Appendix L1

Table of functions and requirements:

elaborations

Introduction

In this paragraph, findings from the analysis are translated into design functions and requirements: what functions should the product contain (and with which requirements) to be a successful product for people with Usher in its context of use? By taking these functions into account when designing the product, it is assumed to answer the project assignment.

1a. Enable control over light power

Light power (lumen) is one of the characteristics that determines the sharpness of the remaining vision of someone with Usher (the difference between a blurry and a sharp tunnel vision). Because this remaining vision varies for every person with Usher, the amount of lumen should be variable as well.

1b. Enable control over what area is being illuminated

Lighting up the table allows people with Usher to see what is in front of them (food / drinks) and prevents for example knocking over glasses or having to ask where snacks are positioned on the table. On the other hand, by lighting up people's faces, people with Usher are enabled to read lips and so increase intelligibility.

There is a trade-off however, as the desired brightness be disturbing to the people they are with and surrounding people.

1c. Offer control in color temperature

Just like the variable amount of lumen is important, so is the color temperature: every person with Usher has a different preference in color temperature because of the difference in altering nature of the disorder. Important here is that a

changing color temperature should not negatively influence its context of use.

Wish: Have a light with a high color rendering index

The closer to natural daylight a light source can get, the more information is contained in light that is refracted from an object lit by the light source. Hence, this rendering index should be maximized.

2a. Enable volume control of the target message

Sound can contain a lot of information, but not all information is useful. For example, in a cacophony of background music, surrounding talking people and your own conversation (1-to-1 or in a group), only the latter could be of use. The clearer the input sound, the clearer the sound after the processing or linear amplification by CIs/HAs. Since 'meaningful' is different for each person with Usher, this selection should be controllable.

As sound is processed differently by every person with Usher due to the disorder but also because of different types of HAs and/or CIs, persons with Usher should be in control of how loud the sound is heard by them.

Note: There is no focus on how CIs/HAs process or amplify incoming sounds, this is the responsibility on the aid's manufacturing side.

2b. Enable reduction of background noise

By reducing background noise, the hearing nerve is less distracted by different sound inputs. Less noise means that the remaining sense of hearing can focus on the target message. Since 'acceptable' is different for each person with Usher, this reduction should be controllable.

2c. Enable connection with hearing aid(s) and/or cochlear implant(s)

Since all person with Usher make use of hearing devices like hearing aids or CIs, any sound solution that will be designed should include a way to deliver sound to the HAs/CIs by for example a hearing loop, wire or bluetooth connection.

2d. Enable reduction of distance between sound source and person with Usher

As sound decreases its intensity over distance logarithmically, the distance from the sound source and ear of the person with Usher should be minimized to enable them to process sound that has not been weakened by distance (or absorbed by elements in the area for that matter). In the decreasing of distance it is encouraged to limit this to a face-to-face distance, to allow for lip reading.

3a. Enable independent to use

The less help one needs from other people, the more independent a product can be to its user. A feeling of independence helps in gaining confidence in use of the product.

3b. Enable non-obtrusive use

To encourage people with Usher to use the product, it is a prerequisite that the use of the product does not label them as being disabled. By making a product look discreet, it is less likely to stigmatise and obtrusive to both the user and the context of use.

4b. Does not disturb other people

It is important for both the user and their environment (secondary users) not to be disturbed by the product. Users

should not feel like they are disturbing other's 'privacy'.

4c. Be intuitive to operate

The use of the product should not be difficult to understand, as this discourages the use of the product and the user's opinion towards it. Intuitiveness creates a sense of relief and confidence rather than stress and confusion.

The fewer the operating steps, the more discreet and easy its use. Any extra attention on the use would underline a person with Usher's reliance on aids. Moreover, the quicker the product can be used, the better.

4d. Have readable interfaces

People that have tunnel vision (RP) benefit from information that is centered, as well as the use of contrasting colors and text size. These an other layout guidelines should be incorporated when designing (product) interfaces (Fulton, 2018).

5a. Have compact dimensions

As people with Usher are already carrying a number of aids and products, it is a prerequisite that the product is easy to carry along. This in turn helps in making the product less obtrusive and outstanding.

5b. Be light-weight

Heavy products are inconvenient to carry around. Therefore, the product should be made light-weight to encourage portability.

6a) Have a reduced amount of parts

The fewer the amount of parts, the cheaper a product can be made and the more convenient its assembly.

6b. Have a material which has a high quality/price-ratio

By giving value for money, a product is realized that is both affordable and durable.

6c. Have a cost-effective way of manufacturing

Important is for the product to be affordable, given that most impaired-products have skyrocketing prices. The product should not add to this stigma but rather be affordable and encouraging to buy and be used.

7. Be aesthetically pleasing

A beautiful looking product is encouraged since this makes people wanting to buy and use the product. It does not make it more functional, but it helps in making the use more pleasant.

8a. Should be feasible on the short term

The desire is to offer help to people with Usher as soon as possible. Because of this, any idea should be feasible to work out on the short term.

Appendix L2

Micall functions overview

Functions, components and requirements

To the right, an overview is given of the functions Micall entails, before having done the validation sessions with end-users described in paragraph 3.3. Below the figure, the sub-functions set in paragraph 2.1. are listed down, which are linked to each function in the figure. Some functions in the figure are named 'extra', since they were not originally included in the table of functions and requirements.

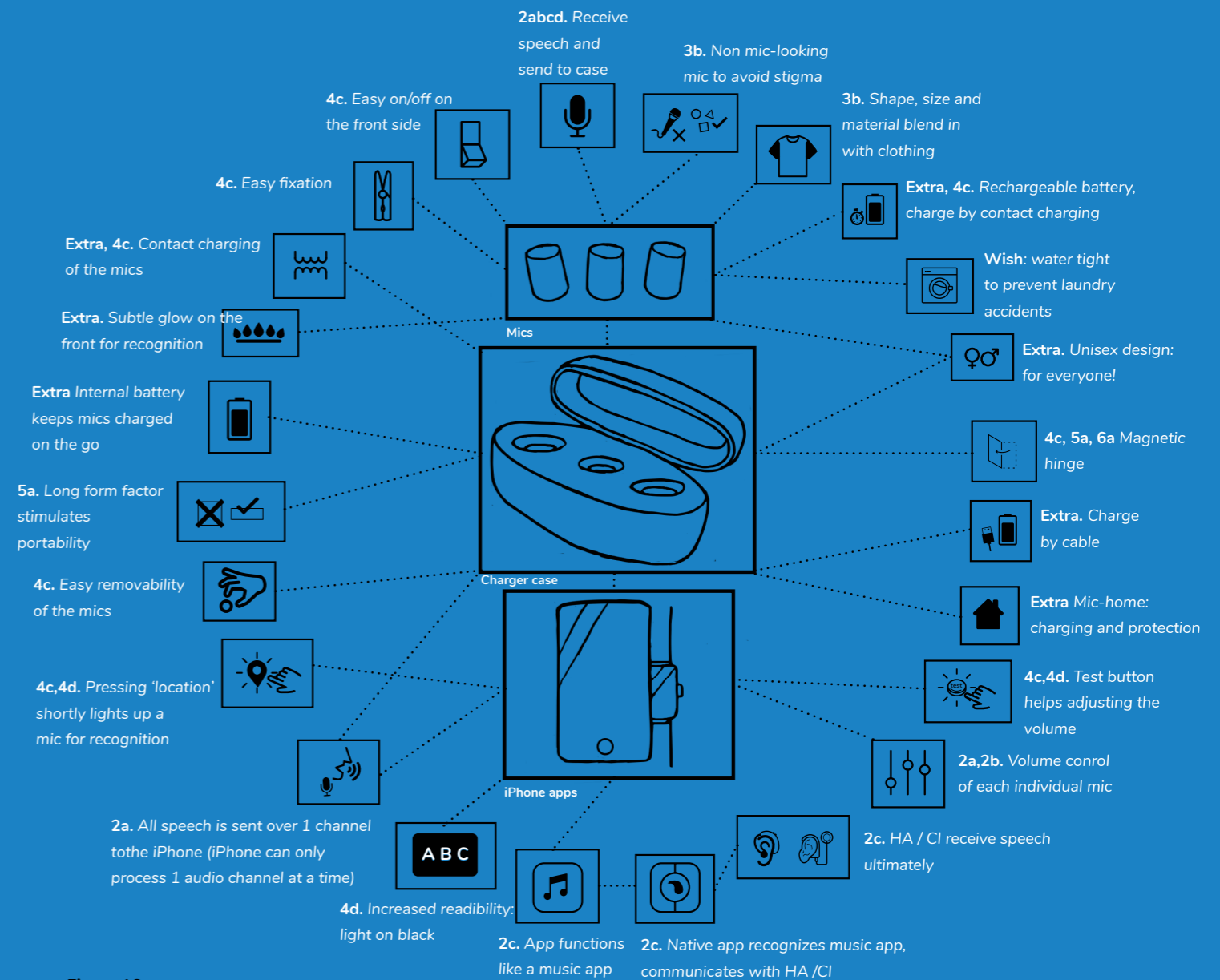


Figure 16
Functional overview of Micall

- 1a. Enable control over light power
- 1b. Enable control over what area is being illuminated
- 1c. Offer control in color temperature
- 2a. Enable volume control of the target message
- 2b. Enable reduction of background noise
- 2c. Enable connection with hearing aid(s) and/or cochlear implant(s)
- 2d. Reduce distance between sound source and person with Usher
- 3a. Enable independent use
- 3b. Enable non-obtrusive use
- 4a. Reduce amount of steps needed to operate the product
- 4b. Do not disturb other people
- 4c. Be intuitive to operate
- 4d. Have readable interfaces
- 5a. Have compact dimensions
- 5b. Be light-weight
- 6a. Have a reduced amount of parts
- 6b. Have a material which has a high quality/price-ratio
- 6c. Have a cost-effective way of manufacturing
- 7a. Have beautiful looks
- 8a. Make use of available technology

	Part	Quantity	Function	Details
1	Tricot cover	1	Closing off Mic from the top, recognition by color	Tricot, die-cutting
2	Cover ring	1	Holding down the felt top	Off-the-shelf
3	Mic-PCB	1	Contains all the tech to make the Mic work	Omni-directional microphone, pre-amplifier, micro-controller, bluetooth transmitter, button, LED, program-header, LiPo-cell (In-house PCB design)
4	Mic shell	1	Housing the parts of the Mic	ABS/PC, injection molding
5	Antenna	1	Send audio over bluetooth	2.4GHz PCB antenna
6	Battery	1	Powering the components in the Mic	Rechargeable coin cell, 3.7V - 4.2V, 120 mAh
7	Metal contact charging plate	1	Enabling contact-charging	Off the shelf, RVS disk
8	Bottom shell	1	Closing off the Mic from the bottom and houses the clip	ABS/PC, injection molding
9	Cover of the charger-case	1	Closes off the charger-case from the top	ABS/PC, injection molding
10	Inner-housing of the charger-case	1	Houses the Mics, light guides, pogo pins, button	ABS/PC, injection molding
11	Pogo pins	6	Enables contact charging of the Mics	Off-the-shelf pogo-pins
12	Light guides	9	Indicate the battery status of the Mics	PMMA (Acrylic), injection molding
13	Pushbutton	1	Switches the charger-case on/off	Off-the-shelf pushbutton
14	PCB of the charger-case	1	Houses indicator LEDs, Sound card, amplifier, bluetooth transmitter and receiver, battery protectors	LiPo-cell, USB-C connector, reverse-current protector, charge-IC, triple external LiPo-chargers, pogo pins, button, charge indication LEDs, bluetooth receiver (in-house PCB design)
15	Frontal light guide	1	Indicates charging status of charger-case	PMMA (Acrylic), injection molding
16	Battery	2	Charges the Mics	Li-ion 3.7V - 4.2V (rechargeable) 370mAh
17	USB-C female	1	Enables charging of the charger-case	Off-the-shelf, USB-Female connector
18	Shell of the charger-case	1	Houses all the charge-case components	ABS/PC, injection molding

Appendix M

Bill of materials



Appendix N

Functional prototyping process

Introduction

This appendix describes the process of getting a functional prototype working, to ultimately use for user validations.

Process

First, functionalities are drawn in a schematic way, to show the functions and the relations of different components to each other (Figure 16). This houses the main functionalities of the prototype:

- Capture speech and send it to a central place
- Control volume per microphone
- Send audio over one channel to the output

To figure out what type of microphone would be good to use, two types have been selected: Cardioid and omni-directional lavalier mics. Cardioid mics have a heart-shaped polar pattern (hence the name), which pickup sound from the front only. Omni-directional mics have a polar pattern that picks up - as the name suggests - sound from all directions.

Audio configurations are tried out as they are drawn in the schematics, however this did not work because of technical details such as voltages and impedances. A digital version was then tried using an online server and multiple smartphones. This did not work out because of a latency in the speech between different persons: the audio of incoming speech was significantly later than the the vision of seeing

people speak. Also, there was no ability to control volume per smartphone, from the listener's side. Back to the drawing board it was decided to try the first approach again, but with more robust hardware. This turned out to be succesful, and a functional prototype was obtained.

Figure 16:
Drawing of a schematic of how to prototype the concept

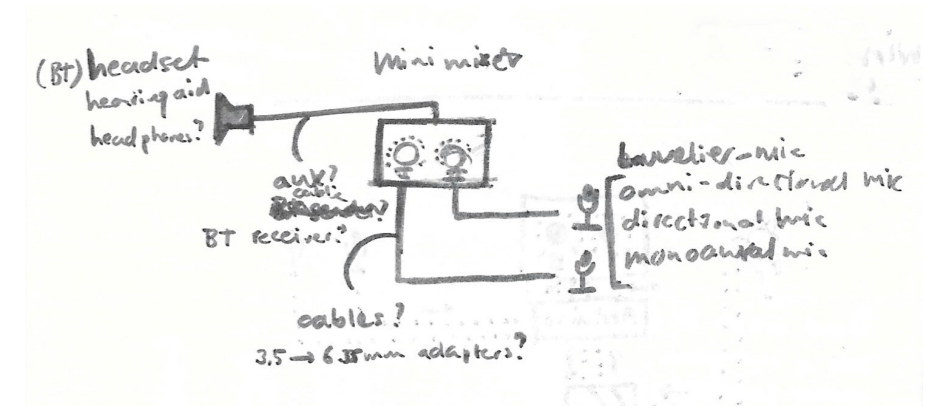


Figure 17:
Trying out different audio configurations to make a crude prototype for testing

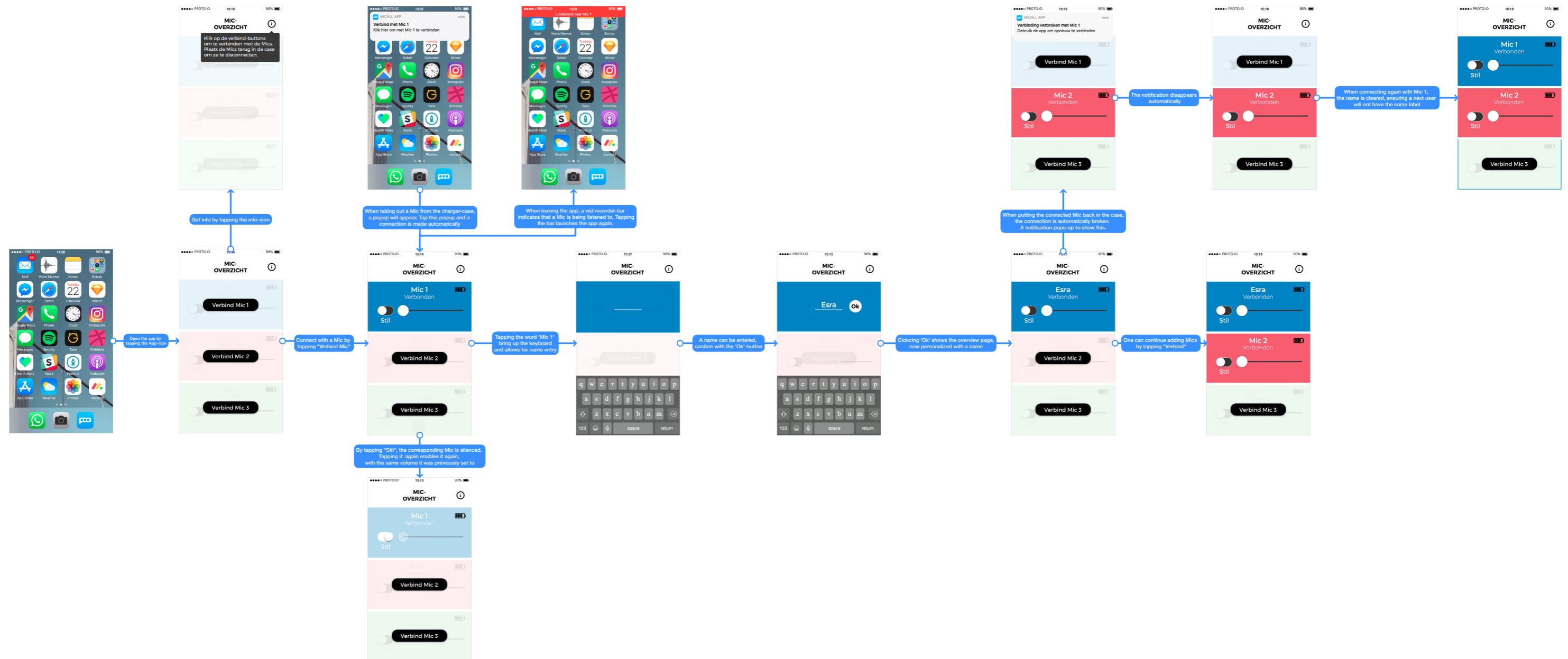


Figure 18:
Trying to mimic the concept by using a digital conversation platform



Appendix O

Flow-chart iPhone application



Thank you for your time.

DESIGN FOR USHER AND BEYOND

A master thesis by Job van Dongen

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