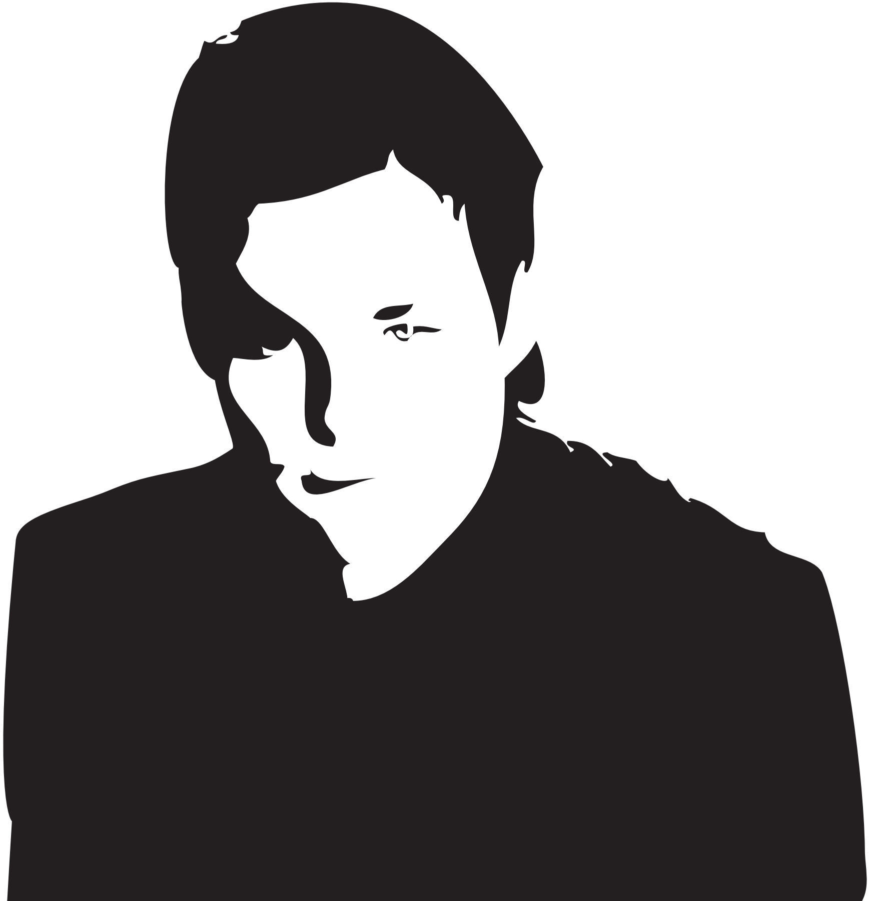


MUSE

PORTABLE AUDIO PLAYER FOR THE BLIND

IBP DAP VAN GENNIP

CONTENTS

Industrial Design Bachelor Project @ TU Eindhoven

Student Doménique van Gennip

Domain Home

Coach Bert Pompe

Committee R.F.E. de Torbal / ir. W. Smeenk

Final report

June 2008

INTRODUCTION

CORE

EXTRA

INTRODUCTION

In Greek mythology the Muses were both the embodiments and sponsors of performed metrical speech: music. In the archaic period, before wide-spread availability of books, this included nearly all of learning. Draw a parallel to the world of blind people for whom speech and other audio constitute the main channel of learning and knowing. In this world they could use the help of a muse - guiding them in their audio world.

Sound, be it noise on the street, talk, music or audiobooks, plays a large role in the daily life of blind and sight impaired people. They have to rely mostly on audio for getting information from various sources. It makes sense to think that a portable audio player, such as an MP3-player, is a valuable tool to them. It is, but there are issues. For visually impaired people the use of a portable audio player is problematic due to the average product's emphasis and reliance on visual feedback for interacting and insufficient feedback via other senses. Navigating the possibilities and contents of such devices is often guesswork instead of the user being in control.

The goal for this project is to have a good design for a portable audio player that provides the necessary functionality for this target group with appropriate interaction in form and feedback. A well-designed product empowers its user. The focus is on the most problematic and challenging part; the non-visual interaction. The emphasis will be on designing the human-product interaction for a portable device that holds various and potentially large amounts of content. I'm interested in the question of how people will be able to find and use what they are looking for.

The Muse project started in October and has delivered research into the subject, benchmarking of current devices on the market, concept studies and several discussions with end users. At this moment, the intended final, a final concept direction has been motivated and elaborated on.

Committee feedback on the first interim aimed at better involvement of users in the process; to take them as a starting point both in evaluating work and in gathering more substantial research on the topic of blind users. The latter is the reason the text on research has been revamped and extended. Vital feedback from end users has motivated decisions. Feedback on the second interim pressed on the necessity of realisation and whether I'd see a chance to make the interaction more intuitive and less of the straight-on approach to give it an edge.

Pitifully the project is not finished. There's still some work on the design and quite a few challenges for the tech prototyping and user testing with this prototype.

Enjoy your reading!

PROBLEM STATEMENT

For visually impaired people the use of a portable audio player is problematic due to the average product's emphasis and reliance on visual feedback for interacting and insufficient feedback via other senses. Navigating the audio contents of such devices is often guesswork instead of the user being in control. Current products targeted at this user group do not solve these issues in a complete and satisfying manor.

PROBLEM STATEMENT

This project is about designing a music playing device for blind and visually handicapped people. The point is that for these people modern human-product interaction is often hampered because of the emphasis on the visual aspects. Many products and systems work with menu's and visual data to deal with often complex functionality. Visually impaired people can get no clue of this without tools such as voice-overs that read out the visual data. If such tools are not available they may be unable to use the product and are thus reliant on others to help them. This disempowers them by taking away their ability to be self-sustained. These problems can be found at any scale. From computer software to mailed letters, from ATM's to DVD-players and on. The problems are largely the same; the visual interface is dominant and there's usually no alternative for people who have trouble with this visual way of interaction.

These problems cannot be solved easily. This project focuses on one product: the portable music player. Such a device provides entertainment and relaxation by playing their personal choice of music. Because blind people cannot read from paper audio is also a popular and necessary way of getting information. Audiobooks, podcasts and weekly selections of spoken newspaper articles are ideally suited to be listened to on a portable player. It implies such a device is important in their daily life and should work nicely.

Ideally a product puts the user in control and treats the user appropriately, that is according to their capabilities. Because of a disability on the user's side this situation may change for the average product. The alternatives go too far in catering towards a broader impaired audience of a usually elderly signature. I believe there's room here for improvement by designing for a more focused audience. A target group that is only visually impaired, not hindered in any other way. On first glance this group, only a visual handicap and relatively young, seems small. But when looked at from a worldwide scale it is a significant group of millions who deserve a well designed product.

The focus is on the most problematic and challenging part of the problems identified; the non-visual interaction with a product. The emphasis is on designing the human-product interaction for a portable device that holds various and potentially large amounts of content. I'm interested in the question of how people will be able to find what they are looking for. Thus there's a strong focus on interaction here; looking at navigation, overall form and tactile quality and content. The project should have a holistic view on the product, where all elements work together to create the product experience.

PROJECT GOALS

A human being has nine senses: sight, hearing, taste, smell, touch, temperature, pain, balance & acceleration and body awareness. Sight is only one of them. A very important one indeed, but it leaves enough 'channels' open. I plan to look into interaction that is a combination of hearing and touch.

MAIN GOAL

THE DESIGN OF INTERACTION (OF A DEVICE) FOR BLIND PEOPLE TO ENJOY AUDIO WITH FOCUS ON BROWSING AND FINDING CONTENT.

SUBGOALS

The user should feel in control of the usage experience.

The interaction should explore the multi-modality possibilities of audio and haptic feedback.

Designing the complete functionality is not a goal, only things relevant for the primary goal should be implemented.

The design should fit the context of use.

Validate the design decisions through research and user evaluation.

CHALLENGES

The main challenge of this project is to overcome the apparent limitations set by crossing out the visual part in interacting with the world and thus this device. It implies the average interaction paradigm does not hold up or should be applied differently. I believe this is especially a challenge for designers, who tend to be visual people. The question I'm most pressed to answer within this project is how can my design help the blind person to find what he or she wants (music, spoken word).

The challenge set out above implies the search for a good combination of audio and haptic interaction for this purpose. While these senses are often seen as augmentary in user-product interaction mechanisms the challenge is to find a way to make these carry the main functionality in accordance with each other and most importantly in accordance with user expectations.

To make sure this individual bachelor project serves as proof of my design and academic qualities the results have to be evaluated as scientifically sound as possible. Thus there's a need to design a method for evaluating. This will come at a later point in the project when design samples are available.

METHODOLOGY

My intended methodology is a constant cycle of research, design and feedback. This will help me do make steps through doing and evaluating. It is different from previous work which can be helpful for personal evaluation and hopefully this works better for me.

INTENDED PROJECT OUTCOME

In its final form this project should deliver decent user research, an integrated design process and as a result a prototype that's able to convincingly demonstrate the concept, accompanied by a user test to back up the project results.

The user group that will be designed for are blind people and people with visual impairment. The thing that binds these people in relation to this project is their inability to rely on visual cues in daily life and interacting with products. This section gives more in-depth information on the target group and the experiences they have with current portable audio players.

THE RAW NUMBERS

According to the World Health Organisation "more than 161 million people worldwide are visually impaired; among them 124 million have low vision and 37 million are blind." [1] The majority of them (90%) live in low- and middle-income countries. Reasons for visual impairment are both congenital and due to illnesses or accidents in life [4]. While in highly developed countries medical treatment helps the majority of these people, these places see a higher number of visual impairment due to diabetes and an ageing population.

Numbers vary on how many people are visually impaired. It depends on the definition of what is visual impairment and blindness. The common rule is that people who have less then 1/3rd of sight in their best eye are said to have low vision. A sight of less then 3/60th is considered as blind. Thus being practically blind doesn't mean someone is actually completely blind. For the Netherlands estimations run between 200.000 and 300.000 people with visual impairment (1,3 to 1,9 percent of the total Dutch population). [2] Approximately 10% of this group is considered blind; thus a group of 20.000 to 30.000 people. For the whole of Europe the WHO counts 12,8 million people with low vision and 2,7 million are blind (1,4% and 0,003% of a total population of 877,9 million in 2004) [3]. When extrapolating this WHO data [2, 3] to the Netherlands 220.000 people would have low vision, 50.000 can be considered blind.

RELATED FACTS

Estimates show the Netherlands have a population of 2000 people actively using Braille. Braille is the tactile representation of the alphabet, used for books and et-cetera. These people learned using Braille mostly in early stages of their life (58% before the age of 12, only 14% after the age of 35) [2]. The people using Braille consider it an important asset and way of getting information. Because it's a writing and reading tool it helps them develop their understanding of words. According to an earlier study in Germany [5] 52% of the people who would benefit from using Braille (and age < 66) are able to read braille. Overall, given the low number of active users (likely 10% to 20% or less of the people for whom it could prove valuable) Braille is a very narrow and specific way of communication.

Ninety percent of respondents to a survey [2] among visually impaired users of specialised libraries said to own a DAISY player. Such a device allows the user to listen to and browse spoken word such as audiobooks and newspaper articles; which are available in a structured format named DAISY.

GRAPHICAL INTERPRETATION

The numbers above indicate that the total population of visually handicapped people for the Netherlands is small. This is obvious looking at the graphs here. The target group is definitely small since the focus is on people with little to no visual sense, but with no significant disability in other senses (fig.1).

The graph below (fig.2) is based on data from England in 2003. Numbers for other North European countries are roughly the same. It plots the amount of blind and visually impaired people based on age. The biggest group is in the 75+ region, while the younger groups show a more or less steady number. This indicates blindness is to a large extend a disability that develops during life. Only a small number of people are born blind. A slightly larger group of people become blind during teenage years due to the growth phases one experiences, but the majority loses vision gradually at higher age.

It seems likely though that younger people are more willing to buy portable music players. The second figure confirms this. It shows the percentage of people owning a portable MP3 player by age groups. This data is for all people, not just for people with visual disabilities. The line displays a peak in the teenage group while declining from there on with older groups. MP3 players can be considered devices for a young market.

When these two sets of data are combined it gives an idea of the market potential. It's done by multiplying the data in the two graphs with each other. Thus a large percentage of elderly blind people who own a very tiny percentage of the total amount of MP3 players gives a low market potential. It does show the most potential is found in the age groups between 5 and 50 years. It proofs the best target group is between 12-50 years.

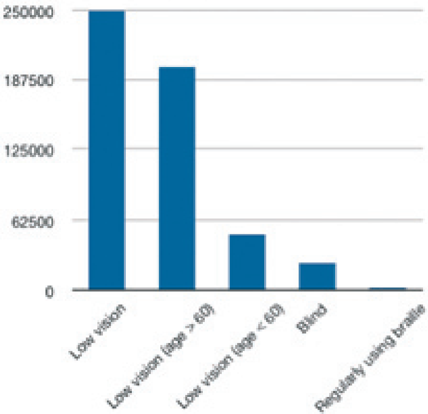


Fig. 1 - Population with visual impairment

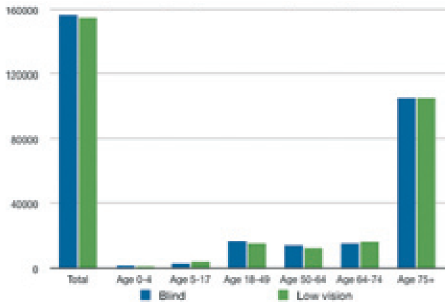


Fig.2 - Visually impaired people by age

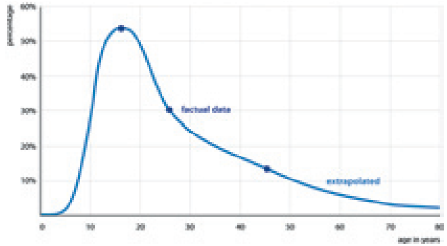


Fig.3 - People owning an MP3 player

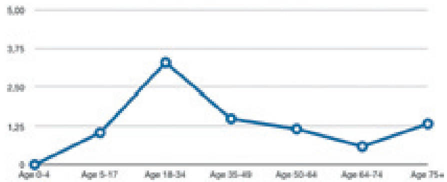


Fig.4 - Market potential in percentages

PROJECT TARGET GROUP

This project's focus is on designing for blind people. This implies the group that's seen as medically blind, thus no or no useful vision. People with low vision are not the target group. This distinction has been made largely based on the argument that people with low vision still try to get as much out of their visual sense as possible which is in stark contrast with people who have no vision to use. It's also my personal challenge to work on something without any visual interaction.

The numbers and graphs mentioned earlier indicate that the majority of blind users is at least seventy years of age. But given the fact that the majority of interest in a portable audio player lies within the less than fifty years of age group, the 12 to 50 years of age group will be my primary target group. The elderly may have additional issues such as hearing impairment and generally less 'feeling' for technology. This comes at a cost to younger people with only visual disabilities. This younger group is a large group in terms of age differences, but the real numbers are small while the group should be reasonably large in terms of marketability. This argument is also the reason why the older generations and people with low vision should not be forgotten entirely, though they will not receive my primary focus.

As a spin-off of the discussion on defining a target group it's interesting to note that this design could be of interest to a wider audience. If the design has a practicality as a non-visual device even sighted people may be interested, for example because they are 'visually occupied' for safety reasons (think driving a car or operating a machine). And if the design sports a certain 'coolness' in the use and looks sighted people may show interest as well. It would certainly pull the object out of the dark corner of 'tools for disabled people'.

THE BLIND AS USER

So what does the target group think of this project? Is there actually a need out there? How do they feel about current audio players? To answer these very relevant questions several blind and visually disabled people were contacted. In short, the initial response to this project has been very positive. They seem to bump into problems using all kinds of products and are glad to hear someone is willing to change this.

But is there a real need to have an audio player that's promising to make the audio easier to access and find? I believe the answer is yes. This is for two reasons. First, the people who replied all used audio players that are in the bottom of what's available on the market nowadays. They use those devices because - for cost reasons - there's no display thus they're not at a disadvantage. The choice for these devices implies a smaller amount of memory available to story music. Here's the real issue: it's very hard to find something if there are a lot of similar things. Think the classic 'pin in a heyfield' example. Thus when faced with more storage space, you're faced with the question how to retrieve items. The second reason is that blind people tend to think in lists and this shows in their navigation through the contents of a medium. It's very sequential - try and if it's not what's looked for go on to the next one. Because of this phenomenon blind people seem to be very adapt at learning such sequences. They often know it's the 14th item in the list and thus quickly go there by pressing a 'next'-button this many times. In itself effective but hardly truly pleasant. Nowadays the interaction doesn't tap into this mental image of knowing where something is.

USER EXPERIENCE & PROBLEMS

Via quantitative methods (such as mail and internet newsgroups) feedback on experiences and problems has been gathered to get an overview of current issues with products. These results are the result of asking more than ten people for their experiences with portable audio players, be it a normal device or a 'made for low vision' device. The problems as indicated by the user group are categorised to make the larger issues surface.

NAVIGATING THE DEVICE

Navigation is troublesome. No overview of what's going on. This is a major put-off for people, since it makes them feel lost.

Menu's and files have to be learned by heart since these cannot be seen.

Button functionality has to be learned by heart, because of similarity in feel (and often, orientation).

Buttons lack tactile and distinctive feel. It troubles easy use.

It's hard to find a specific item or 'place' within a song / book. Trial and error (to see if the current selection is the right one) is common now. Even with special VI devices this gives trouble.

If lost, turning the device on and off doesn't reset it to the starting position in the menu. At this point help from sighted people is necessary.

Modern touchscreens have no tactical feel, thus no feedback and are therefore inaccessible.

Most devices have a 'soft' on/off functionality, so it's impossible to see or feel whether it's on or not. It might lead to empty batteries.

Battery indication is mostly only visual.

Bottomline: Navigation is only doable with the visual menu as an mental image. The interface relies purely on visual feedback, tactile and auditory qualities come second. Since functionality and navigation through these require the device to have different states blind people cannot use them with only visual feedback. Thus navigating through the device's contents and finding something is cumbersome if not impossible.

GETTING THE CONTENT

Loading the music/books/news onto the player can be difficult if using a proprietary method.

Filing the files in the right way is difficult and cumbersome (music together, audiobooks together, and etcetera).

Bottomline: Blind people have different kinds of content (music, articles, audiobooks) and getting these on the device in the right place (where it can be found) could be better.

ENVIRONMENT

Due to noise or lack of concentration a short piece of audio might be missed. This is mostly a problem with books and articles.

Usage in public spaces is impossible since the audio blocks the environmental sounds necessary for location and safe movement.

Usage is only possible when they're sure no one could interrupt them for they would not hear this person.

Bottomline: People who rely on their hearing and feeling senses cannot distract themselves by adding another layer of sound. A possible direction would be to have earphones that do not block environment sound.

MARKET

Specialised devices are often really expensive compared to similarly featured normal players. This is to some extend due to the fact that certified devices for disabled people are subsidised by healthcare insurance companies which will pay the artificially high prices.

The specialised devices often have clunky looks, which feels stigmatising.

Speech interfaces are frequently only available in English, German or French, since those markets are bigger / Dutch market is too small.

Bottomline: Blind and visually impaired people are a small market and within this market most devices go for the biggest group; the elderly.

BENCHMARKING

The earlier parts of this report show typical audio players pose serious challenges for visually disabled users. There are devices on the market that tailor to these people. Benchmarking has been done to find the pros and cons of both normal and specialised portable players. It served to identify where the omissions are and thus where this project finds its niche.

The figure gives an overview of the products considered. The images are not on scale. From top left to right: Apple iPod Classic, Apple iPod Shuffle, Creative Zen Stone Plus, Sony NWD-B105. The bottom row is for the specialised products: BookPort (US market only), VI Player (to be released on UK market soon), Humanware VictorReader Stream, Bones Milestone 311D.

In order to keep this document compact and comprehensible the full benchmarking has not been included but rather the things to be taken away from this. In short: the conclusions are in line with the experiences and problems the target group indicated. For example the iPod Classic is a very visual device with menu navigation which proves inaccessible, just as the transfer software (iTunes) is inaccessible. It's the least accessible to non-visual people for each 'button' effects the visual menu and feedback and from here it results in audio feedback. Its little brother, the iPod Shuffle, is the most accessible normal player since it does away with all visual feedback (except for the battery indicator). The visual feedback is doubled in tactile feedback, such as the on/off switch position which can be seen and felt. The point is these devices are aimed at an average market and the difference between the two models is cost more than it's that one of the two aims for the visually disabled market.

The products aimed at this specific target group try to alleviate the problem by either simplifying the menu-structure and/or adding more 'one button per function'-controls which have to be learned by heart. The keypads on two of these devices serve to jump to certain content or places within content quickly. But the overload of buttons complicates the use and experience. Another thing is the linearity of menu's and etcetera. Since all feedback is in audio things have to go in a linear fashion; one after one after one. This can be seem on websites for blind people as well. Everything seems like a long list. There's generally a lack of overview since information density is low and things cannot be comprehended at a glance, like seeing people can with visual interfaces. An interesting thing which sets the Milestone apart from all the other products is its curved form. This helps to get the orientation in the user's hand right; it suggests top & bottom and front & back. It may feel better as well.

PROJECT VISION

The earlier parts of this report hint at a really large and complex project. There are sides to the total picture which are impossible to fulfil in an IBP or simply not in line with this study. Thus a fully implemented product is not a reality, it'd be too much. Most importantly a pure focus on functionality isn't reasonable, plus it foregoes an interest in how blind people actually put such a device to use. Though I see the non-visual interaction as a personal challenge the blind user shouldn't be seen as an 'excuse' for my work. They rather be the cause and reason behind the project. At this point the project focus has been defined as developing ways of appropriate interaction with a portable audio player through audio and haptic control, with the ultimate goal to find a way blind people can find their wanted content in a possible large pool of files. It means both interaction and form are important parts to explore. The idea is to create a design that is fun to use and works for this kind of user. It must try to balance efficiency and joy of use. Within this focus area the requirements were set and consequently similar research investigated.

REQUIREMENTS

The requirements are based upon the user-product investigation discussed earlier. All the things listed here are based on the principle of what the resulting device must do to be useful. These requirements show what is deemed important and relevant from a functionality point of view. What's truly relevant in this project is conveyed through the blue texts. The additional black requirements are to give a broader sense of what would be required for the full-fledged product design. The blue ones are what counts in this project. All of the blue requirements are selected based on the project goal and are within the focus area of interaction and form. These requirements serve as a guideline for the design and research exploration.

It must be small enough in size to be at least pocktable. It must not give electric shocks if handled inappropriately. It must indicate its power state. It must handle a large amount of files. It must be manufactured at reasonable cost as not to curb demand. It must support both headphone use as well as without. Preferably it is operated using one hand only. It must fit the context of use. It must not be too small to use. It must not fall apart after an accidental drop on the floor. It must not be hard to orient it for proper use. It must be able to play music and spoken word file formats. It must not rely on visual cues or affordances for meaningfull operation. It must last long enough for daily use. It must have its contents easily findable. It must not give insufficient information on content. It must not put off and disempower the user. It must be able to bookmark listening positions and retrieve these. It must not look stigmatising. It must be able to change playback speed for spoken word. It must not make difficult the transfering of content onto or from its memory. It must be able to record audioclips. It must not require help from sighted people. It must not require an extensive mental image of its controls (and menu navigation). Preferably it is usable for people with less haptic and/or hearing abilities. It must not have controls which cannot be found by touch.

During my visit to Beleyes, a non-profit organisation by visually impaired people in Amsterdam, I noticed a curtain of beads hanging in the entrance to the kitchen. When walking through the beads make noise and thus help the blind people there to keep track of your whereabouts. A similar thing can be seen when a blind person hands something to another: they ask the recipient to snap with their fingers so they can locate and move towards their hand.

The introducing text shows the challenge of audio compared to vision. Compared to seeing hearing is less layered and more linear. Inherently, time is an important dimension of the audio perception. Hearing is mostly not as instant as is sight, because it takes time to listen and then recognise something. The state of who and where is inherently fluent. If not kept up-to-date blind people lose sight of the situation. Thus the mental image of the situation is fluent and deteriorating. Compare it to seeing in the dark. Only when there's light you'll be able to recognise things and gather an image of the situation. When there's no light the situation may change without you knowing it. This example proves why it's so important to have a good feedback mechanism in designing interaction.

SENSE PERCEPTION

Since the visual sense is not available for the design a choice has to be made for other senses. It leaves eight other senses [7] and combinations thereof open for exploration. I want to focus on only two; hearing and touch. The table here gives an overview of the senses of a human being.

SENSE	CONSCIOUS	SPECIFIC	DIRECT	EXTERNAL
SIGHT	X	X	X	X
HEARING	X	X	X	X
TOUCH	X	X	X	X
SMELL	X	X		X
TASTE	X	X	X	X
TEMPERTURE				X
PAIN		X	X	X
BALANCE & ACCELERATION			X	
BODY AWARENESS		X	X	

Table 1 - Senses and perception
Conscious: the ability to be aware of this sense, opposite to unconscious.
Specific: the sense gives specific information that can be interpreted, opposite to relative info.
Direct: the sensed is directly interpretable, opposite to something that's interpretable over time.
External: the sensed is (a result of) an external, physical property, opposite to internal.

To be useful as a modality in interaction the sense should be perceived conscious, specific, direct and be based on external factors. This leaves sight, hearing, touch and taste. For obvious reasons sight is out the question. Taste is a very difficult sense to be used as modality for interaction. It would require the design to be partially placed near the user's tongue. As a result talking will be difficult, penalising a very important method of dealing with the world for these people. It would be a far cry from pleasant; it's too intrusive to be considered. Thus the focus will be on hearing and touch.

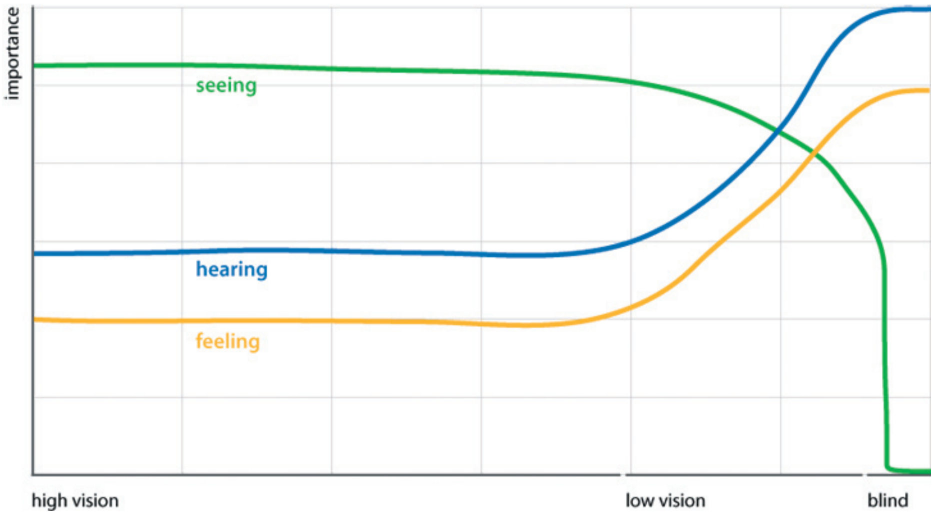


Fig. 6 - Importance of senses compared to level of vision (assumed)

The graph on this page shows an assumption of the importance of the three common senses found in human-product interaction set against the level of sight. It gives my personal assumption thus it may be wrong, especially on the importance of feeling and hearing for blind people. It seems very likely though that blind people value sight as near zero since it's no use to them. People with low vision try to get as much out of their remaining vision thus it still has importance to them. At the least this graph argues that people with low vision and blind people are different groups considering their needs in a product.

SIMILAR PROJECTS OR RESEARCH

WEBPAGE BROWSING VIA KEYBOARD ADDITIONS

I had an interview with Philomena Athanasiadou about her IBP. She designed a tool to ease the browsing of webpages. This was implemented as part of a standard keyboard. It provides direct access to navigational tools such as a list of headers (as found above the paragraphs on the particular webpage), which help to jump through the page without losing track. She had come to a set of interesting conclusions which are relevant to my project.

For blind people the mental image of a website is a vertical menu. They identify and assess a website by its headers. These headers form the grips in their navigation [9]. It shows the main difference between sighted and blind people in the way they explore and navigate products and/or content. Sighted people use a quick scanning of what they see which is very parallel and non-sequential. They often skip through various parts until they find what they're looking for. Blind people are more likely to follow a sequential approach. Confirmation (i.e. via cues) and keeping track of where they are in the interface is essential. This hampers the skipping of lists or parts of a webpage. This is no different with normal interface menu's. It's seen as a list of options, which are only called out one by one (for example by screen reading software). Building a mental image of the interface and structure requires cognitive effort. Thus large menus with lots of options are cognitive overload. My design should find a way to avoid or work around this 'limitation' because it has to deal with possibly large amounts of audio files.

Because of the cognitive effort one function per button is appreciated. The product should be self-explanatory, e.g. by calling its functions (audio). This can be disabled when the user has more experience. When it comes to buttons and other interaction elements grouping can help to orient and thus remove clutter and mental effort.

Her experience is that user testing with a prototype or Wizard of Oz-quality mock-up is much more fruitful than just a paper of foam mock-up because you need to trigger the non-visual imagination. This is valuable in future contact with users for design evaluations.

RESEARCH ON INTERACTION

This part of the report is dedicated to finding answers in research for questions relevant for the design problem. This text is meant as grounding for later design opportunities and decisions. These questions were chosen to reflect the issues faced when designing an interactive product or service for the non-visual user.

HOW CAN I PROVIDE UI STRUCTURE?

Reducing the cognitive effort necessary to operate a product can be done in several ways. First of all, recognition is important. What you recognise is what you don't have to remember. It argues for consistency. A strong coupling between input and output helps as well. This is explored in TUI's where "the action itself is usually the feedback as well, both visually and haptically. This makes it action driven effort instead of cognitive."

WHAT HELP COULD BE A METAPHOR?

It often helps to communicate a function using a metaphor, which helps the user make parallels from the known metaphor to this current interface. Think the trashcan in desktop-like interfaces. Over time such things become convention. Usage no longer requires the effort it did on the first encounter. So consistency and convention reduce effort.

Instant usability is an important aspect for products which people are likely to use without ever consulting any help (be it a manual or an expert person). "Consistency of operation, minimality of features, the small use of control elements and the use of a conceptual metaphor for interaction are methods to design for instant usability." [24]

Key to designing multi-modal interaction is to see the interaction model, framework or metaphor separate from the actual interactive implementation. Thus functionality and possible information (feedback) should be designed first, after which the optimum modality should be sought for each kind of information. [15] The idea is to conceptualise elements in a larger whole, not isolated. [7]

WHEN TO USE A MENU, WHEN NOT?

In other words: what is the raison-de-être for menu's? Menu's are meant to provide a place for functionality that has to no place upfront on the main interface. Basically all main functionality should be available at any moment, while functionality that doesn't pass this scrutiny should be moved to a menu. Because menu's provide a lot of functionality at once it means the options should be as explanatory as possible to avoids errors or excessive cognitive effort for decision making. The average human's short term memory holds seven items. Especially auditory interfaces need take this into account when providing menu options. Auditory interfaces don't have the affordances that visual and tangible interfaces often profit from. [22] It argues for menu's that keep the amount of options small. But introducing extra, each on its own smaller steps has a downside: the longer it will take because more decisions have to be made, as well as the process becomes more error prone. [23]

WHAT IS COMMON IN A SEARCH ACTION?

Within the digital realm search functionality can be seen as applying constraints on a known body of data, whatever this data may entail. For example a music library gives us the ability to search for a string of text such as 'beatles' and apply constraints like 'only within artists' and 'before 1966'. The resulting list may give all known songs by The Beatles released before 1966. In short it means the digital search consists of explicit constraints (input) that filter known data and gives us the data that passed these filters in return. This contrasts with real life search, because the principle of knowing all data isn't valid here (at least not at a fundamental level). Still, for the person who is searching for something this does not really matter. What counts are results. If the search action yields no results a different action needs be taken. It indicates the feedback of results should be well implemented to allow for this evaluation. In short, there should be a recap of the input given and an overview of the results with the ability to explore these. Are these the results I'm looking for? If not, can I retry? The interface should provide these handles, especially when the process itself takes time to gather results.

WHAT IS DESIRABLE: QUICK ACCESS, DIRECT ACCESS OR STRUCTURE?

Let's use a metaphor. When you go to the supermarket it would be very easy to ask an employee to get your desired items. He knows the place and can retrieve the items quicker than you ever could navigating the aisles and finding the right product among all alternatives. It would be slightly easier if there were no aisles but just a kiosk-like display of goods. You would have direct access to all items in one view and need not ask someone else. The first shop example can be translated to quick access via a search engine and other methods that bridge between user and result. So what is desirable? If you know what to get it may be the quick access. If you don't have a good clue the aisles are best for exploration.

HOW TO GIVE FEEDBACK ON THE STATE OF THE INTERACTION?

The state of the interface informs the user of where he is. It means the user is aware of how he got here and what the possibilities are. Based on this feedback and subsequently the knowledge of other states, the user builds a mental model.

Because this design exploration seeks to apply both audio feedback and tactile methods of interaction there's the issue

"HE STANDS IN THE MIDDLE OF THE FIELD. THE WIND BRINGS THE SURROUNDINGS TO LIFE. AFTERNOON SUN WARMS HIS SKIN. THE SCENT OF FLOWERS ENTERING HIS NOSE. SPRING BLOSSOM. HE FEELS THE SLIGHT SLOPE UNDER HIS FEET, THE WIND TRYING TO GET GRIP ON THE FOREST FURTHER AWAY, EVENTUALLY FLEEING OFF INTO THE VALLEY AHEAD."

- HOW A BLIND PERSON WOULD EXPERIENCE A SCENE IN A FLOWERFIELD of multi-modality in interaction. It means that a device uses interaction and feedback mechanism in different modalities, in this particular project it will be auditory and tactile modalities. Here the quality of interaction depends on the level of integration between each modality [20].

No matter how the current state is interfaced, the ways leading away from this state are just as important. After all, a user wants to get somewhere. So an 'undo' option would be nice if gone wrong. Plus the further options should be available in a consistent format so he can easily continue towards his goal.

The user mental model may go against the designer (intended) model [23]. Users do not have the complete image, rather they start to explore from one point. If it's illogical they won't be able to determine the complete image. This is key to assess with users.

HOW COULD AUDIO BE APPLIED?

The use of auditory feedback in interaction can be split in two parts; speech and non-speech sounds. Non-speech sounds are often neglected but can communicate much useful information to a listener. With non-speech sounds the messages can short and therefore rapidly recognised. Such sound icons do have a downside; it's based on agreed meaning and thus have to be learned. Basically there are two kinds of auditory icons. First, iconic and representational with an intuitive link to its meaning. Second, symbolic and more abstract sounds that are not intuitive, but rather have an agreed meaning. Key advantage of non-speech sounds is that they are good for giving status information, for representing simple hierarchical structures and grabbing attention [10]. Interpretation of these individual sounds is dependent on the context of use.

Speech as a feedback mechanism is less common, but blind people are reliant on it for use of computers and reading texts (if not opting for Braille). On a computer they can use screen-reading software that speaks out all options and elements. Though it's the only method to acquire specific information such as the title of a document on your computer it's rather slow. It takes time to listen, recognise and take action. It can tell the user only one thing at a time. Compared to other feedback methods there's no layered or parallel streams of feedback. Hearing has a low spatial resolution versus high spatial resolution for the visual sense. This implies audio requires a single focus (more sequential) versus the visual parallel processing [1].

HOW COULD HAPTICS BE APPLIED?

"Much of haptic perception relies on active exploration." [15] We touch something because we intend to do something. Thought and physical response are close coupled. We assess, verify and build a model of our world through touch. [15] Haptic interaction is most valuable for continuous manual control versus discrete control (steps). "Feeling a virtual representation of an electronic system's operational model can help a user understand how it works. Haptic feedback can offer clues as to what a user's options are, through constraints and gentle guidance."

Haptic feedback is important for the visual impaired people to form a mental understanding. [6] In fact, tactility is the only dimension through which blind people can perceive affordance, an important concept in human-product interaction. "... haptic feedback can serve as a substitute for the visual mode (...) visually impaired people can orient themselves." [6] A serious drawback of tactile feedback in devices is that a vibrating movement (simplest virtual tactile feedback) can move the user away from the target due to a small reflexive muscle response. Secondly the vibration may disturb the own sense, causing further trouble. [20] It argues for subtle use of tactile feedback, not to overpower and distract the user.

As a side effect it should be known that modalities bias other modalities used at the same time. [5]

HOW TO COMMUNICATE NATURAL AND ARTIFICIAL CONSTRAINTS FOR THE INTERACTION?

This question is strongly related to the state of interaction. Where am I? When using a vertical or horizontal menu users might not know at which level they are and thus have trouble navigating up and down. [2] This seems a minor problem if the menu system works with dedicated 'level up' and 'level down' buttons. The extreme ends could be incorporated in the interaction by providing a clear maximum or (if impossible) add virtual barriers by applying audio and/or haptic feedback.

HOW USEFUL CAN SPEECH RECOGNITION BE IN MOBILE PRODUCT INTERACTION?

With speech recognition the roles of human and product are reversed. Normally it's the user that initiates, gets feedback and reacts to the product, gets new feedback and so on. With speech recognition the product has to interpret and react to the user. For the user it implies he or she doesn't have to navigate the device towards her goal but have it go there at once. Speech recognition can be very direct and thus reduce effort and errors, apart from recognition errors on the device's side. It reduces steps and menu's in the interaction with the device, though it requires the user to know which functionality is 'on call'.

Generally it can be said people build relations with others primarily through speech. [22] People are cognitively wired for speech. Our brain equates voices with people and acts quickly on that. "Speech is intrinsically social," up to the point that the brain makes no distinction between talking to a human or a machine. This implies that similarity between the voice and its message is important. Extrovert content with an introvert speaker cause a mismatch for which people are very sensitive. Often such a mismatch causes distrust in the speaker or system.

The quality of interaction should be consistent with its functional quality. If speech recognition is error prone the voice quality shouldn't set a high standard that's inconsistent with the actual - lower - standard. [22] Recognition accuracy is ± 90% on the high end of speaker independent voice-input systems available today. There are ways to improve the accuracy. If the system speaks slowly and well enunciated the user tends to do so as well, since people tend to mirror their communication partner. Because the system might not understand everything it's wise to have the system repeat the user's request. It's a way of confirmation and error probing for the user. [22]

All requirements set, user data gathered and research studied helped in the conceptual exploration for designing a portable audio player that is a joy to use for blind people. The next pages will be about this exploration and lead up to the concepts discussed later on.

TASK SCENARIOS

In order to shape the conceptual process from a user point of view a set of tasks was created. This set was to help the idea generation by giving handles for brainstorming possible concepts. Basically the list can be seen the requirements the persona Tommy would have for his portable audio player. It results in actions Tommy would have this device to perform, such as telling him whether he needs to recharge the device before he goes out. Despite this set of tasks being derived from the requirements shown earlier, this is meant as a more user focused effort for its focus is how the user would use it instead of what it can do.

However this set of tasks was made to be a tool for brainstorming and thinking of usage scenarios. It's not a hard list of requirements all concepts have to adhere to. For example the task 'Tommy wants to find the device' was conjured to trigger thoughts about what would happen if Tommy lost it in his home. He can't see it lying at a different place than where he thought he put it so how could the design help him find it? Possible answers include the device making noise when it hears its name called out, a kind of compass or a very distinctive shape making it is easy to recognise.

SEQUENTIAL SELECTION

Quite some attention was paid to the question how the user would find a certain piece of audio in a large list of such items. How would it schematically happen? What

Tommy

Tommy wants to ...

blind since birth
30 years old - lives alone
likes music, not obsessed
works at customer service

... find the device
... turn on the device
... turn off the device
... know whether the device is on
... know whether he needs to recharge
... put the device away

... play the song 'Eleanor Rigby' by The Beatles
... play songs in a random order
... skip the currently playing song

... listen to yesterday's newspaper column
... stop listening this column
... resume listening to a book
... know where he is in a story
... increase the reading speed

... put new audio on the device
... record a short memo

steps would be necessary to take by the user? So what is the actual problem here? As discussed before the process is very much a sequential one. Figure 8 illustrates this. It gives an example of how the menu structure could be. For example, if looking for the song 'Eleanor Rigby' by The Beatles the user would choose to go into music (step 1). Next, he would select artists which gives a list of all the artists available (step 2). He selects The Beatles, now resulting in a list with all songs by this band (step 3). Now he can select the song he wants (step 4). With this song selected the user can choose to play the song (step 5). This method has five steps to be taken. It does not even include additional steps to actually select The Beatles in the artists lists and similar actions. That issue itself forms a big problem as well. Especially on mobile devices there's no place to add a complete keyboard or such solutions.

In short it can be concluded that there's no way around the sequence shown here, but taking out steps by providing shortcuts or other improvements is a good way to go. This would also alleviate the burden and mental effort of all these menu options.

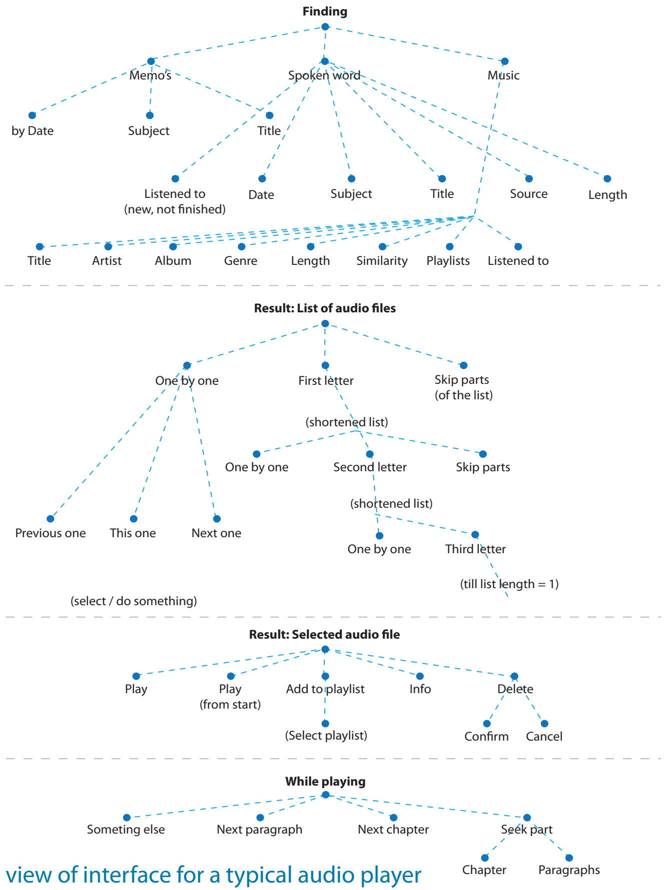
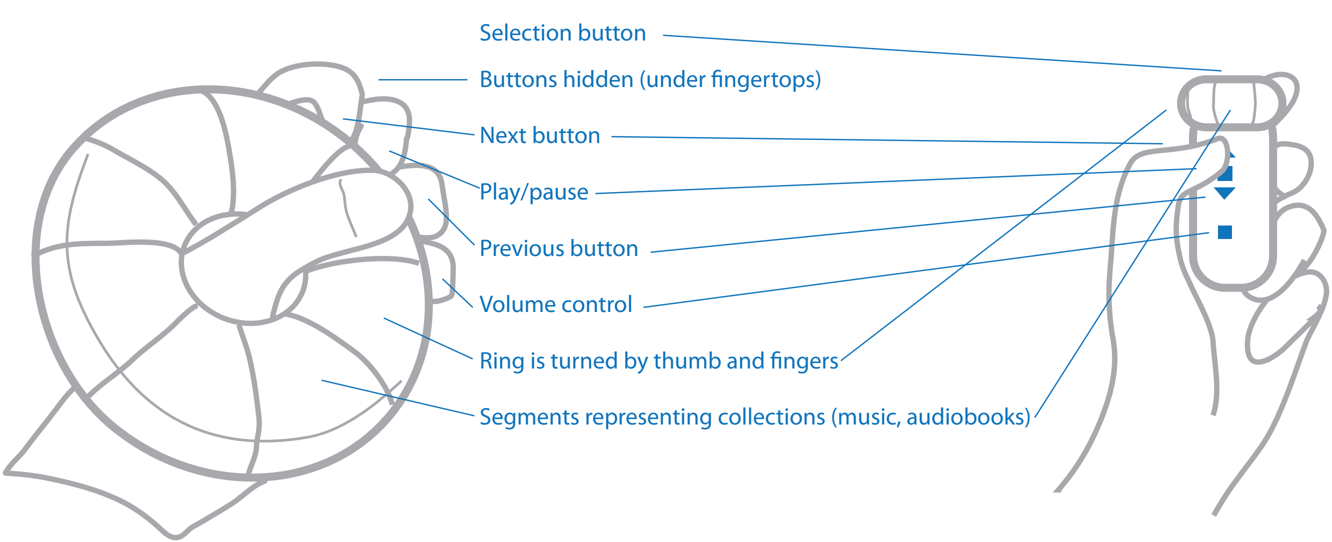


Fig.8 - Schematic view of interface for a typical audio player

CONCEPT 1


Selection button
Buttons hidden (under fingertops)
Next button
Play/pause
Previous button
Volume control
Ring is turned by thumb and fingers
Segments representing collections (music, audiobooks)

CONCEPT 1 - RING

This concept is baed on the idea of a ring that can be used to rotate and scroll through a list of content. What makes it unique is that this ring offers a segmentation, recognisable by touch. Each part represents a collection of content, for example audiobooks, favourite music and other music. By pressing you'll be taken directly to this collection. As you'll scroll through the list the audio files are called out in synthesised speech. Buttons next to the ring are for play, stop, next and previous and volume controls.

POSITIVES

+ Offers collections directly upfront
+ Does not require spatial orientation
+ Separates the conventional controls (play, volume, etcetera) from searching and finding
+ One handed operation
+ Interesting form
+ (Small cylinder) Fits nicely in hand
+ (Small cylinder) Feels ok, could be hanger?
+ (Small cylinder) Button layout is easy to understand

NEGATIVES

- Categorisation has to be done in advance
- Scrolling movement isn't easy using the thumb
- Interaction is very conventional
- If the ring has a double function (segments and scrolling) it's confusing
- (Big ring, small ring) Large, hardly pocketable
- Scrolling action might too much one by one
- Questionable how it would represent a deeper folder structure

CONCEPT 2 - PEBBLE

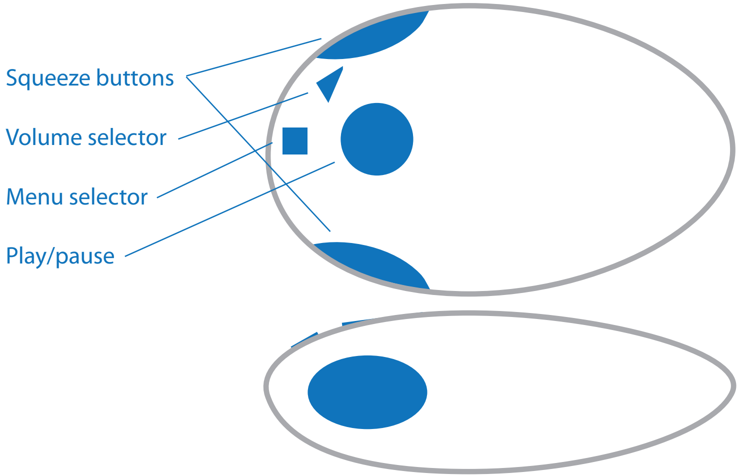
The pebble is meant to be held in one hand. It features a limited set of buttons. It's secret is the tilting. A menu is spatially presented by it's first option tilted left, last option when tilted right. It's an absolute and spatial mapping which in time can be learnt, significantly speeding up browsing.Each item is spoken out using synthesised speech. Selecting an item is done by squeezing the side buttons. The selector is used to decide what will be browsed through, i.e. this audiobook, this playlist or even the whole collection.

POSITIVES

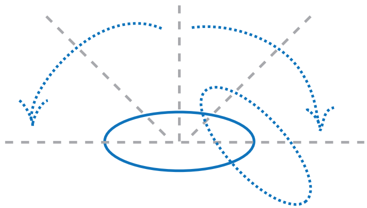
+ Usable for people that have trouble with large numbers of buttons
+ Unique and interesting interaction
+ One handed operation, same for both hands
+ No special hierarchy/ordering necessary
+ Nice form, fits nicely in hand
+ Buttons are fine in form and texture
+ Taps into mental image and body awareness (perceptual motor skills)

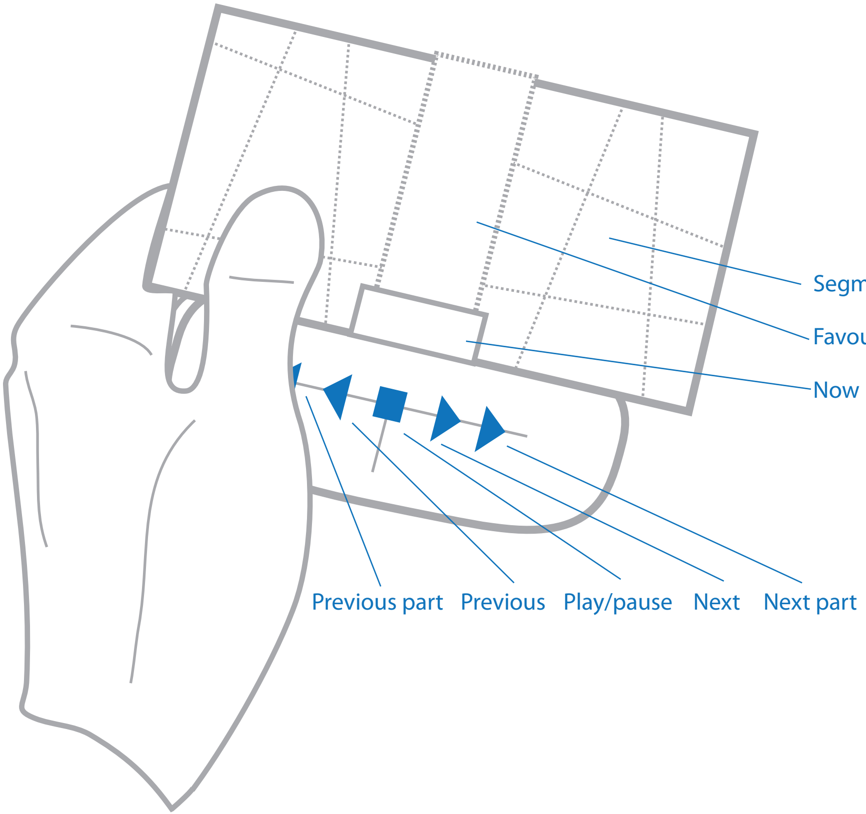
NEGATIVES

- Low tangibility (less buttons)
- Less direct shortcuts
- Absolute position issues (what is left and right when lying in bed)
- Tilting may be troublesome when mobile (think walking on a street)
- In evaluation users had trouble grasping the idea of tilting, it felt impractical



Tilt device to scroll through lists etc.
Squeeze to select




Segments for collections (music, audiobooks, podcasts)
Favourites & Bookmarks segment
Now playing touchfield
Previous part
Previous
Play/pause
Next
Next part

CONCEPT 3 - BOARD

This shape relies on two-dimensional spatial orientation. It's board consists of various segments that represent collections the user has made. Items can be selected using a finger, like a touch display. Items are called out using synthesised speech. So when the user has learned where a certain piece of audio is he can retrieve it by trying the area he remembers. If desired so items can be moved around making the board really a personal collage of music.

POSITIVES

+ Direct access, no weeding through lists and menu's
+ Spatial mapping helps building a mental image of where things can be found
+ Concept taps into current model of storing things in folders, places
+ Separates controls and content
+ Users like the rounded form
+ Button layout is fine according to users

NEGATIVES

- Two handed operation
- Probably large, hardly pocketable
- Requires spatial mental image, otherwise very hard to use
- Users see the segments as strips that represent lists, for example the content of a folder
- Users think of it as a grid (in itself ok), but difficult to represent extra/other folders

USER EVALUATION

The concepts explained above are all translated to foam mock-ups to be able to discuss them with potential users. This user evaluation is considered an important aspect of the project. The goal in this particular discussion was to find the need for such a design, find the preference for a conceptual direction by evaluating the positives, negatives and other comments given by the users. Most of the comments directed towards one of the concepts are incorporated into the lists of pro's and cons.

First, a short introduction to the two people talked to. Ben and Patricia are a couple living in Eindhoven. Both are in their 30's and blind since birth. Patricia works as an administrative officer at a local police office, while Ben is temporarily employed by a social workplace. Next to their normal work they try to become professionally involved with audio. For this they're in the process of building a sound studio in their home. Occasionally they perform as dj's for parties and such things, using a computer holding their collection of music. They digitalised all of their CD collections for easy retrieval. These people are seriously involved in audio, which sets them apart in my intended user group.

They agreed in the finding that it's currently hard to navigate audio players. They also resort in getting to what they want by remembering the order. Going through the files one by one and listening to the first few seconds is the current way. Maybe because of this they use no special ordering into categories, though they'd like to separate different types of audio like music and kinds of spoken text.

Each concept relies on items spoken out using synthesised speech. Having items spoken out loud (if selected) is fine with them and not considered annoying. For blind people it is very critical feedback, now lacking on portable players. It's not even considered a problem when music is already playing, although I believe it's more a necessity than preference.

They seemed most enthusiastic about the board concept, which was surprising since they argued spatial orientation is more difficult for blind people. It appears closest to what they experience using a computer with a folder based structure, although it wasn't intended that way but rather their interpretation. The freedom in ordering things the way you'd like, combined with a more or less familiar folder structure made this concept a favourite. For reasons of unfamiliarity the pebble concept was considered the most awkward and impractical. They couldn't imagine how it would work (well). While its form and feeling were praised the rest of the concept was too far off. The ring concept mock-ups got differing feedback with the big one coming in last. It was deemed too large and impractical. The smaller ring was ok, but didn't elicit any strong reactions. The cylinder was a favourite for its nice feel and easy to understand interaction.

CONCLUSIONS

Taking all comments together the two people spoken to were enthusiastic about the concepts and looked forward to new results. This new result will be a mix of the concepts shown here. There's no clear winner for both these users and me. Each has positive characteristics and negative ones. I believe for the blind people I've talked to the board concept seems most promising, probably because it fits their kind of ordering best. They see it differently though from my initial stance which means a more list oriented view. Just having the various audio collections displayed as lists isn't the kind of innovative idea looked for in this project. The same argument goes for the more conventional ring concepts that revolve around a big scrollwheel. In its current incarnation this concept cannot be a truly innovative design and thus needs its core principles reworked. It leaves us with the pebble shaped design. The users called it possibly impractical, I think there untapped potential in this device. It's more innovative and new, thus unknown to everyone. It might work or not. Interesting enough to find out.

The requirements and tasks set out earlier were helpful in coming up with these concepts and should be helpful in refining concepts in the future. All of these three concepts could be made to fit within these constraints, though the ring would need most change for it is somewhat unhandy in control and orientation. The board concept has a big negative on its own; it's too large to be really pocketable which breaks with the original idea and requirement. On the positive side, it does break the most with the dreaded sequential selection process.

All in all these concepts differ in approach, philosophy and positive and negative points. It implies a better or more promising concept can be found at the points where they overlap. In that sense it's most interesting to look at the board and pebble concepts for these are the most interesting conceptually. The ring concepts are too conventional to be very promising.

PROGRESS AFTER FIRST INTERIM

Just before the interim report and presentation weeks the first user evaluation of three concepts had been done. Those concepts were pretty basic but none the less gave valuable feedback when turned into foam mock-ups. This method of gathering user feedback proved to give adequate results. But as indicated this session with only two people cannot be held for a robust decision making tool. Of course this shouldn't be due to the small 'sample' number but the lack of a clear favourite counts as much. Therefore the only viable decision to make at this point was to get other people involved and deepen the knowledge of this subject. The latter can be reviewed in the research section.

During several discussions with o.a. my coach I decided to strive for a more focused user group. Instead of the 18 - 50 age band it was narrowed to 18 - 25 years of age. This decision to go for a younger audience is based on the idea that a younger audience is more involved with portable audio players and more open to new ideas. While the larger group is absolutely not abandoned the main focus is from here on channelled to a smaller group. In fact, this group in the Netherlands alone is so small (a few thousand at most) it turned out to be rather hard to get in contact with them.

Eventually I got in contact with younger users and was able to discuss the improved and new concepts with them. Their feedback has been used to evaluate these concepts and helpful in choosing one. These concepts and user evaluation will be discussed from here on.

Figure 9 - Logo of Sensis who were so kind to arrange time to discuss this project.

SECOND USER MEETING

Next important stop for this project was at Sensis education in Grave. Sensis is a non-profit organisation which does consulting for visually impaired people and running a school specifically for visually impaired people. They were willing to co-operate and let me talk to two students on this first occasion; Niels, who's 17 years old and Marjoke, 16 years old. Both are enrolled in the VMBO-T level education. With them the old concepts were discussed along with an interview. This interview aimed at getting a better understanding of the role music (listening) has in their lives. It focused on how they wish to deal with a music collection and how they go about it now. See Appendix 1 for the questions (only available in Dutch). Since this user meeting involved no more then two people it cannot be used for decision making per se. The reason to go was to be able to review and set up criteria and arguments for the actual decision. These meetings have helped to shape a program of demands. Actual conclusions about each concept have been transferred to the eventual evaluation.

There are however a few conclusions worth mentioning here. Currently none of them uses any kind of integrated digital system for their collection such as a library used by popular software like iTunes and Windows Media Player. Rather they stick with a file system ordering, having a folder for each artist and album that contain the songs. They prefer a fairly standard alphabetical ordering for their music that is consistent and predictable. This way they're able to remember and browse there without guesswork and errors. If they use a portable audio player it's often stuck to having it play songs at random or in strict alphabetical order because they feel not at ease deviating. It was argued this is due to inaccessibility issues. They feel that a clear order is important, especially when the browsing process is difficult without sufficient feedback. Inverted this means that if the browsing experience is good you could let go of the 'forced' order and deviate. This conclusion is in line with things seen earlier and is basically what this project strives for. Another thing was slightly surprising to me: for them, aesthetics seem to be mostly a thing of feeling and product size, especially the latter. This seems rather weird and likely faulty as a viable conclusion. It's considered that aesthetic value is something which is experienced more or less unconscious and hard to get by rationally. On the whole it argues for an exploration that allows people to judge the aesthetic value relative to other objects.

DESIGN CRITERIA

Considerable time has been spent during this project getting the desired requirements to surface. These requirements can be categorised and prioritised. Now it's these requirements that form the criteria for concept selection. The prevailing concept will be developed further. The evaluation and selection process has been documented in a Design Specifications document ("Programma van Eisen", see Appendix 2). This document provides a guide for converging the design process at this point, which was the primary reason employing it. The criteria on which the concepts will be compared are derived from the subject research, user meetings and evaluation of earlier conceptual states.

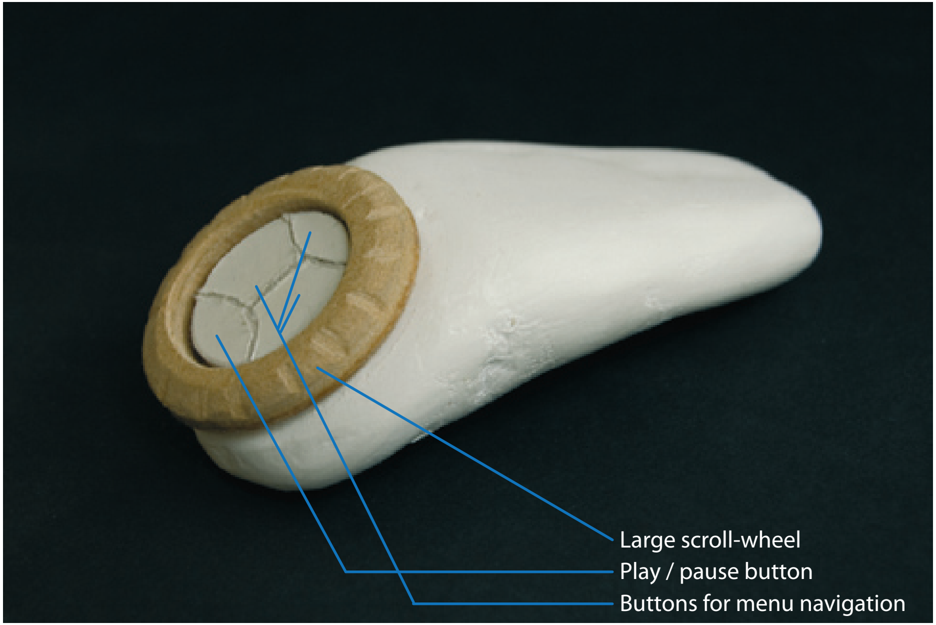
Regarding the functionality of the device two kinds of criteria are determined. So-called hard criteria which are demands absolutely needing fulfilment in the proposed alternatives (except when conflicting criteria are discussed) and soft criteria that describe desirable functions (wishes) which are not necessary though do improve the perceived value and experience of the alternative.

HARD CRITERIA

1. Playback music
2. Playback spoken word
3. Retrieve specific song or spoken word file
4. Browse collection
5. User is in control
6. Playback control (o.a. Play / Pause)
7. Random playback
8. Adjustable volume
9. Structured browsing (e.g. via menu's)
10. Auditory feedback on status / selection
11. Tactile feedback on status (where appropriate)
12. Feedback on location within audio file (especially for long articles and books)
13. Feedback must not overwhelm
14. Interaction has tactile quality
15. Tactile guidance on how to hold product
16. Resume spoken word files
17. Design does not stigmatise
18. Size is in line with mobile use
19. Last for at least one day of use
20. Indicates power status
21. On/Off functionality
22. Sustain external impact
23. Safe in use
24. Technologically feasible

SOFT CRITERIA

25. Record spoken memo's (nicety)
26. Speech rate variable
27. Usable without external speakers
28. Diversity in audio contents (large collection, changeable)
30. Pleasant use experience
31. Usable while in motion
32. Intuitive control
33. Limit cognitive effort
34. Fits nicely in hand
35. One-handed operation
36. Design shows positive aesthetics
37. Efficient energy usage
38. No small or weak external elements



A. HANDHELD WHEEL

This alternative takes a no frills approach by providing only the necessary controls and leaving all else to scroll-and-click. Main interaction goes via large wheel on top that allows to scroll through options. Browsing is done via a structured menu that navigating the collection by artist, album and songs. At the highest level a distinction is made between music and spoken word as not to clutter these two.

Main control of navigation goes via buttons within the wheel which takes it a menu level lower, another button takes it a level up (hereby it works much like a 'back' button). The Ok / Back buttons double as Play / Pause when toggled via a Menu button. Below in this circle is a Volume button which allows to change the volume using the scroll-wheel. Feedback is given by Synthesised Speech which speaks out the current selection.

Shape is reminiscent of a electric shaver with a 'fit to the hand' design with the scroll-wheel to be operated by the thumb as are the buttons within the wheel.

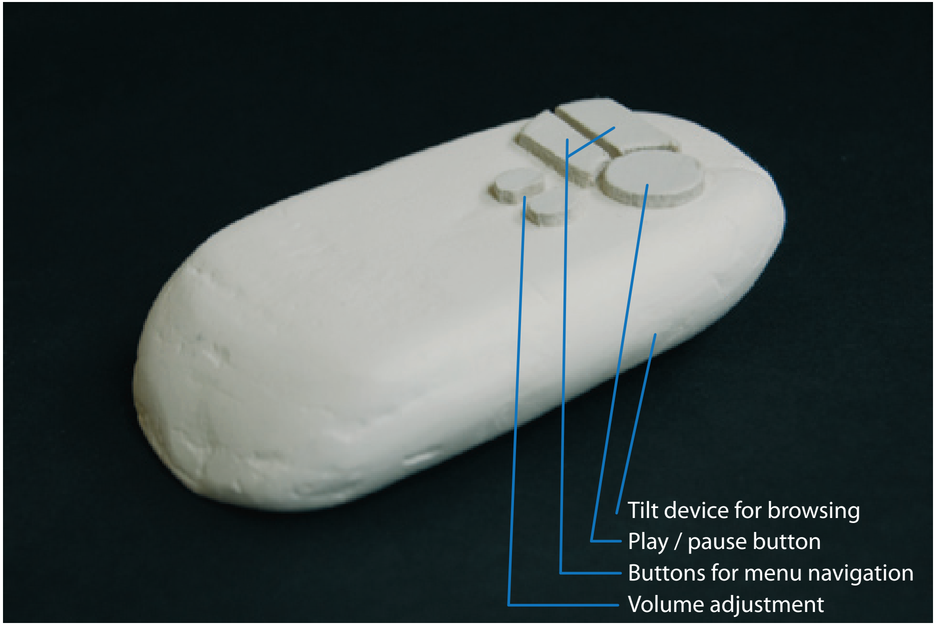
B. PEBBLE

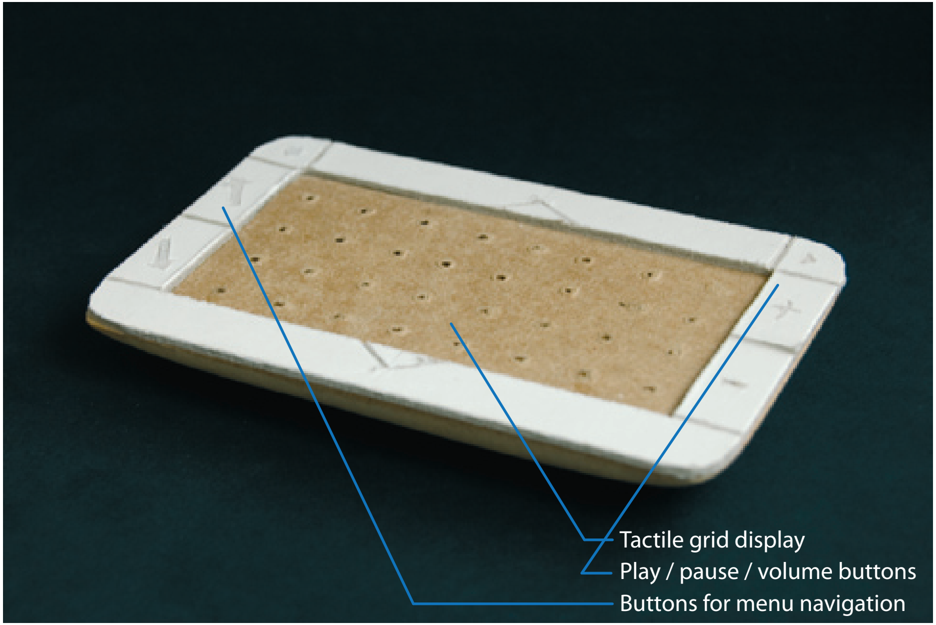
This alternative seeks out the unconventional by applying tilt movement for scrolling which is the main method of interacting with this zen stone-like product. Interaction relies on tilt movement of the device. The physical movement effectively constructs absolute boundaries for the scrolling.

Shape resembles the form of a zen stone. Buttons on the outside are limited to only the absolutely necessary; Play / Pause, Up or Down menu level and Volume control. Feedback is given by Synthesised Speech which speaks out the current selection. Additional feedback is given via subtle vibration, e.g. to mark the end of the scroll movement or acknowledging a command.

Browsing is done via a structured menu that navigating the collection by genre, artist, album and songs. At the highest level a distinction is made between music and spoken word as not to clutter these two.

This alternative employs an accelerometer to sense the tilt movement.





C. TACTILE DISPLAY

Alternative C aims for bringing out the contents via a spatial and tactile grid, allowing to access audio more directly. The grid of tactile dots is surrounded by controls that influence the content to be displayed.

Each dot represents one item ; a song or spoken word article. The grid, to be felt by slightly raised dots, resembles items which the user can select using a finger. Large amount of choice on a two-dimensional grid improves browsing by providing freedom to jump from dot to any other dot. More choices than dots is accommodated for by splitting all choices to several 'pages' of choices which can be scrolled through. High level browsing is done via a structured menu that navigating the collection by genre, artist, album and songs. C.5 Feedback is given by Synthesised Speech which tells out the current selection.

Shape follows the two-dimensional grid, with the flat rectangle form with slightly curved edges. It aims at two-handed usage. This grid is a touch sensitive 'display' and synthesised speech to provide auditory feedback.

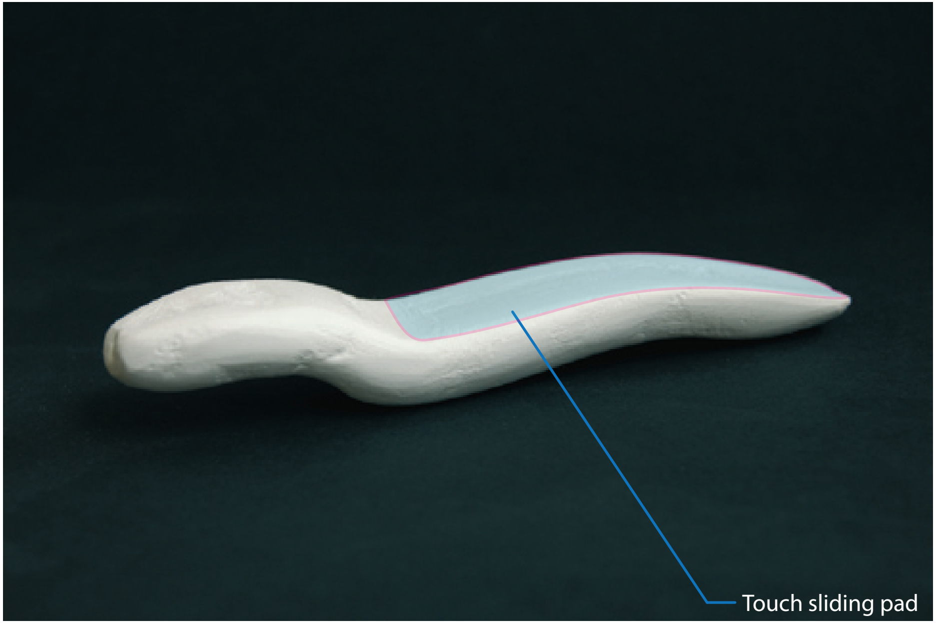
D. SLIDER

Alternative D employs a multi-touch strip which allows for button-less control using a set of finger gestures.

At the heart of this device is a small multi-touch sensitive display that accepts specific finger gestures.

There are no dedicated buttons beside the top that has a ring to lock the touch strip from / have it accept input. Using one finger to slide over the strip is the scroll gesture. A tap with the finger acknowledges a choice thus functioning as Ok or Play. A two-finger tap means Pause or a menu level Back. Quickly sliding over the strip with two fingers works to skip to the Previous or Next song, depending on sliding direction. Volume is changed using two fingers that move towards or way from each other (lower and higher volume).

Feedback is given by Synthesised Speech which speaks out the current selection. Shape is like a short rounded pencil with a large flat area for the strip.



USER EVALUATION

The alternative concepts have been evaluated with five potential users (age 16-19) in a third user meeting. This was done with students of Sensis' school in Grave. Earlier versions have been discussed with four other people (age 16,17 and ± 35). Again, the method used was an interview on music listening behaviour and audio player usage, combined with discussion of provided mock-ups. Later these mock-ups were used to compare the alternatives. What follows here are the users' findings and conclusions per alternative. These are thus not necessarily 'true' but rather hold their opinions.

ALTERNATIVE A

Low amount of buttons is regarded positive for sake of simplicity.
Tactile quality of buttons can be improved.
Ergonomics are fine and fits in hand nicely.
Not that compact, but overall a nice form.
Scroll-wheel should have tactile feedback, e.g. with little clicks to be convincing.
Position within a list can be a problem due to wheel's infinite range.
Shoot-through with wheel might an issue.
Text-to-speech cannot finish talking if going quickly from item to item.

ALTERNATIVE B

Would require getting used to.
Possible undesired wobbling is a problem.
Shoot-through the list is very likely.
Can be quick if you know 'where to go'.
Buttons are very clear, might be more subtle.
Form has the right size, but is somewhat without character.

ALTERNATIVE C

Requires two-handed use, it is less 'mobile'.
Buttons don't have enough relief, though a large number which is overwhelming.
Probably needs a learning curve, not only of the operating methods but of the underlying music library as well.
Lots of tactile info which is just too much
Offers possibilities for casual browsing
Size is considered too big, not pocketable.
Form is regarded as not beautiful.

ALTERNATIVE D

Requires a learning period and cognitive effort, at least at first.
There's no tactile response or grip which helps to inform the user.
Seems not that easy or quick in use because the user has to wait for the audio feedback (given the lack of other feedback).
Omitting real buttons is not a real problem.
Gestures can be learned and after a while may become second nature.
Form is handy given its small size, feels nice.
Thin shape could be vulnerable.

EVALUATION CONCLUSIONS

Alternative A is clearly favoured by the users. It's likely that this is due to its more conventional interaction while other alternatives require a learning period. Both in terms of interaction and shape this one got most positive response. People attach more positive values to it because they can understand it instantly. A negative is the infinite loop of the scroll-wheel.

Alternative B follows A closely on the heels. This isn't surprising given the fact both share the concept of a single dimension scroll movement. A gives this a different shape and uses an infinite relative scrolling movement (wheel). With the latter comes the drawback that inherent (body awareness or tactile) feedback is troublesome since the user cannot feel directly at what position he/she is.

Alternative B sees its major strength and pitfall in the idea that most of the functionality is controlled via the one-dimensional tilt/ scroll movement. It needs active physically manipulating the device. Much relies on the intuitiveness and feedback quality of this tilting, because the directly available controls are basic. However, alternative B didn't spark much interest from the user group though this could be due to its unfamiliar workings.

The results for alternative C can be related to the inherent concept. The idea of a fixed tactile two-dimensional display is less fit to provide ease of use and moderate (non-overwhelming) feedback. Because the whole concept revolves around this, its size and tactile proportions have to follow, making it a less likely candidate for mobile and one-handed usage.

Alternative D got mixed response, but generally less favourable. Users hinged on two thoughts; the gestures could be learned, but until that moment it seems unhandy. Inherent to a touch panel is the lack of tactile quality which is regarded as a negative because blind people rely on it much more than non-visually impaired people.

When looking at the overall 'score' alternative A comes out on top, followed by B. D and C do not seem viable alternatives. It's been pointed at earlier that A and B are similar apart from the method used to scroll through a list (scroll-wheel versus tilt movement). Users indicated preference for the more tactile wheel and shape of A.

PROPOSED DIRECTION

Given the results of the evaluation and comparative matrix (see Appendix 2) alternative A should be taken further. Alternatives C and D should no longer be considered for the user response has been meagre. Alternative B shows similarities with A, though the better tactility and recognisable principle of the scroll-wheel favour the latter.

The key distinctive of A is the tactility of the scroll-wheel which should be paid special attention. The menu structure and accompanying button structure will be developed in detail - at least with enough depth to be able to prototype and evaluate the concept. What's important to keep in mind is the quality of interaction. This relies on appropriate and qualitative feedback which needs designing and evaluation. Because the concept is based on auditory and tactile feedback these elements need designing. The audio feedback is (partially) based on spoken text. It should be decided how this is implemented. Tactile quality and aesthetics will be reflected in development.

Technical considerations should inform this development of interaction and form, but are not the main drivers of design work. For this project I see technology as a helper and not the focus of attention. Of course the concept needs realism and thus an outlook on what materials and technologies to use. And as has been stressed before a working prototype to evaluate with users is high on the list and this will require technology to make it happen.

STRONG POINTS

Strong points that favour this concept are the 'instant usability' due to a more conventional method of control compared to the others and its form that fits well in the hand. These strong points should be retained above all since these are crucial to the users' choice.

The scroll-wheel has potential to give quality tactile feedback. The small number of buttons and details are hailed for its simplicity. It was regarded the most aesthetic shape.

WEAK POINTS

On the whole users were positive about this concept but there are a few remarks. The scroll-wheel is equally a weak point as well. Its scale is by definition infinite which makes guessing position within a virtual list hard if not impossible. This could lead to overshooting of the intended position. The tactile quality of the buttons is adequate for most, but not a winner.

The spoken menu items are likely not to have finished before a user decides to move on. Messy feedback should be avoided.

STRONG POINTS IN ALTERNATIVES

Some of the strong elements of the other concepts that were evaluated can prove positive addition to this concept. These are gathered here.

The tilting pebble can be very quick in getting where you want to, if you get the hang of it. Due to the relative versus the absolute positioning issues between these concepts it will be hard to incorporate this. Its buttons are very clear and distinct (on the brink of stigmatising). This is easily translated to the scroll-wheel concept. This goes as well for the tactile display concept. Though alternative C had too much of it, the tactile feel of buttons is good.

The slide concept has several easy gestures that can become second nature after some learning period. If done right, omitting real buttons is not a problem. One of the immediate advantages is a simple sleek shape which gets positive remarks. This seems not the best route to take now, but the idea of gestures - movements with meaning - is interesting to consider.

UNIQUENESS OF CONCEPT

From a market perspective it's important to know that this concept has enough to be unique and set itself apart from the competition (if any) in form, interaction and accessibility. A second benchmark was done to get argument on the table. See Appendix 3 for more details. This overview - a benchmark by no means complete - shows a couple of things going for this concept in comparison to its market space. Most forms are very rectangular in comparison to the smoother, round shape of this concept. Though audio players with scroll-wheels exist - even in large numbers - these do not resemble the form proposed here. Thus it can be concluded that a unique (and appreciated) point is the form that is more organic and less boxy. When considering the box-deviant products and concepts shown here, such as the iPod Shuffle, Tactile player and Freestyle player it has to be concluded these devices pay the price in lessened functionality. This is likely due to the idea that a display is a necessity to convey more complexity, thus one without cannot be complex but it can deviate from the rectangular shape. Sony Rolly and the B&O remote are an exception but these are not made to be portable in the manner of 'to be able to taken everywhere' like the intended concept is. In terms of tactility most devices keep this at a simple level like a distinct button response, while this concept seeks out slightly more from its wheel in the sense that it should guide where possible. A similar argument can be made for auditory feedback. It makes sense that most devices on the market use this modality only for the end result: music. The Sony device uses short sounds to inform on operation and comes close to what is intended here. Still, this concept remains a thing apart because it's operation relies on audio in various forms; of course the music itself, spoken text in menu's and taunts to inform on status. Overall can be said that this concept holds enough uniqueness over the competitors reviewed here. Partially this is due to the niche this project seeks out; that of the visually impaired user who likes control over his/her portable audio experience.

AREAS OF DEVELOPMENT

In its current form this concept isn't fully developed and has many omissions or 'white space' so to say. These gaps need filling in on many levels, not all of which are possible within the scope of this individual project. The focus is on interaction and form development. This implies I will spend time developing the user control and feedback cycle, including menu structure. I consider the feel and tactile quality important which implies material and form are also considered.

Project work has until now focused on the design of the device itself. Since this device is going to connect to at least a battery recharger and a computer to get content, this world around the device needs attention. It must be mentioned that the Muse itself is the focus but extra work can lift up the design to a more holistic level, providing an overall better experience. Thus the final concept will have an answer on how this device interacts with its world and gets its content and energy. It is already mentioned elsewhere but the technological factors need consideration and will receive attention in the future.

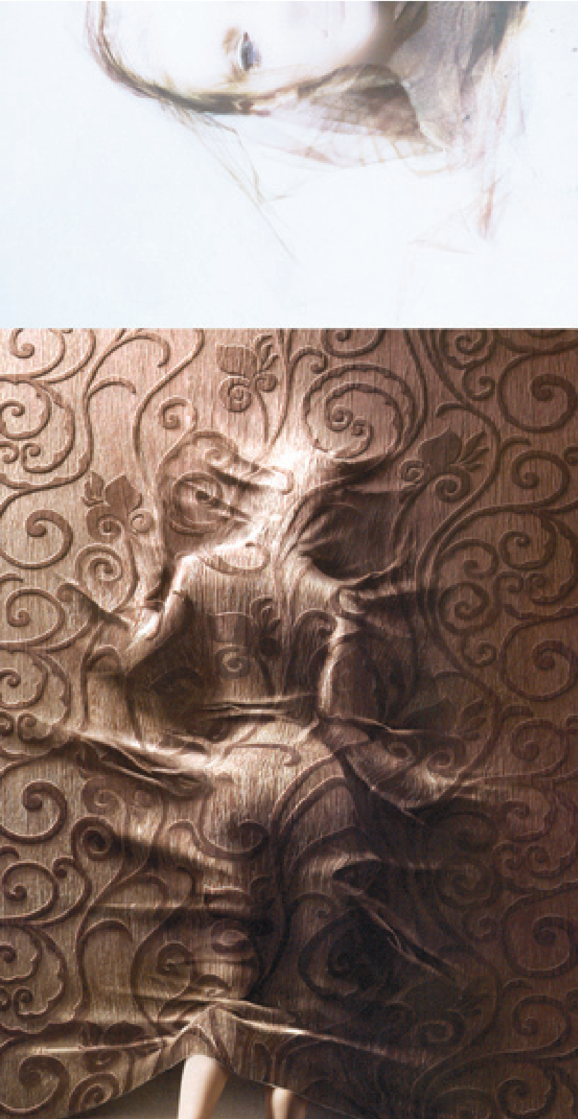
SEMANTIC MESSAGE

Appearance, material, form, function, control, tactile feedback and audio feedback; these elements together make the experience of the device. Since these should be developed more or less dependent on each other it's valuable to have a singular character for the concept. This single character helps to keep development consistent among the bigger picture and the details. So its form shouldn't tell a different message from the audio feedback, semantically speaking.

So how could this character be defined? The introduction of this report mentions: "A muse is a kind of angel (...) The muses can take you by the hand and inspire by their works, artfully aiding one's life. (...) before the wide-spread availability of books, arts / music included nearly all of learning. Here we can draw a parallel to the current world of blind people for whom speech and other forms of audio constitute the main channel of learning and knowing their world. In this world they could use the help of a muse - guiding them in their audio world."

At this moment the character is still in a very early stadium thus cannot be discussed here. It is worth mentioning though that the intended characteristics of this device (think the manner of feedback given) will be based on this exploration.

Figure 10 - Moodboard for sense and desired emotive meaning. Purposedly abstract.



INTERACTION AND FORM

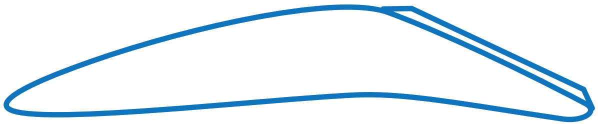
Currently a first draft of the intended interaction and feedback cycle is ready. At this point this draft resides mostly in sketches and schemes that live strictly in a visual world. See the figures 11 & 12 that try to illustrate the main menu structure and feedback cycle.

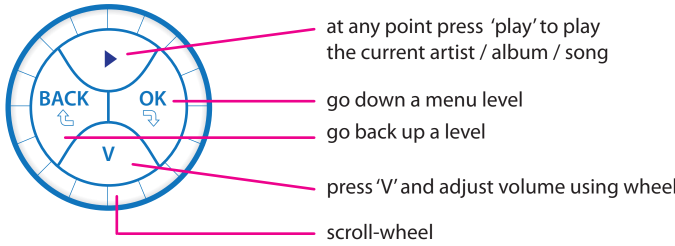
In short, the most important thing when considering an interactive device for non-visual people is status. What can be done now? What is it actually doing now? Imagine yourself walking down a road. You'll see where you're heading and where you're supposed to walk. If you are not sure there are basically two options: walk around and explore or get info from a map. In a way a map gives you information ahead of time and tells what's going to happen, what could be chosen and so on. Generally people can now find out what's the best thing to do.

This principle is important because this device will tell the user via synthesised speech what the currently selected option is. But it also need to tell you how many there are so you can get a grip of where you are and where you want to be (within this menu). This is why Muse will tell upon entering any menu how many options there are.

WHY NOT SPEECH RECOGNITION?

Menu's require steps, options, scanning these options and so on. So why could speech recognition not be used to take away the burden? It's a good question and the answer isn't so simple. First of all, there's a practical issue. Modern speech recognition systems are not error free. Actually, they get it wrong about 10% of the time. Plus these systems require processing capacity though this is nowadays a smaller problem. The reason why it was decided not to include speech recognition is that it cannot be a viable solution all the time. People do not want to talk to an inanimate thing and less so if other people are around. Answers from the user group reflected this. "Hmm, could be handy. In public? No way, I don't wanna look silly!" Concluding it's not a complete solution and needs a 'backup method' which has to be there anyway. Therefore Muse will not use speech recognition.





Menu structure (draft)

|| Music | Podcasts | Articles | Books | New & unfinished | Settings ||

|| Artists | Songs | Albums| Genres||

|| Source | Title | Date | Subject ||

|| Authors | Books | Genres ||

|| Battery status | Voice | Sound | Vibration ||

|| A | B | C | D | ... | Z ||

the alphabet preselection is only used when options > 200 (to avoid endless scrolling)

(similar structure as with music)

gathering of all new or unfinished spoken word to be listened to (helps to keep track of new items)

|| Songs | Album 1 | Album 2 | ... | Album n ||

the most likely options come first & can be clicked through when known

|| Song 1 | Song 2 | Song 3 | ... | Song n ||

alphabetical order where it's possible and makes sense

|| Play | Info ||

|| Play / Resume | Play from start | Info | Mark listened

tells artist - song (from album), length

Figure 11 - Interactive elements & menu structure

Menu navigation	Audio feedback	Tactile feedback
Enter menu -> press OK	♫ short taunt - into menu mode 〃 Menu, 6 options	◉ click feel from button
Choose type -> scroll if necessary	〃 Tells current selection -> i.e. Music	○ slight ticks from wheel
Select -> press OK	♫ short taunt - menu level deeper 〃 Music menu, 4 options	◉ click feel from button
Select option by scrolling -> Artist	〃 Tells current selection -> i.e. Artist	○ slight ticks from wheel
Select -> press OK	♫ short taunt - menu level deeper 〃 Artist alphabet, 27 options	◉ click feel from button
Scroll to -> R	〃 Tells current selection -> i.e. R	○ slight ticks from wheel
Select -> press OK	♫ short taunt - menu level deeper 〃 Artist R, 23 options	◉ click feel from button
Scroll to -> Rolling Stones	〃 Tells current selection -> i.e. Rolling Stones	○ slight ticks from wheel
Select -> press OK	♫ short taunt - menu level deeper 〃 Rolling Stones, 5 options	◉ click feel from button
Scroll to -> Angie	〃 Tells current selection -> i.e. Angie	○ slight ticks from wheel
Play this song -> press ▶	♪♬♩ (plays music)	◉ click feel from button

Figure 12 - Intended variety of feedback, illustrated in this scenario of selection the song 'Angie' by the Rolling Stones.

PROGRESS AFTER LAST INTERIM

The second interim left me with one concept, one road ahead. Committee feedback largely agreed on the chosen direction. There was a question as to I would able to demonstrate the technical challenges of this form. After this non-squared thing with not that much volume would have to house all electronics and such. More on that further on. Another thought expressed was aimed at the overall experience. Could it be more intuitive and less of the straight-on (possibly annoying) spoken word interfacing? I wholeheartedly agree with this argument. Together with examining the weak elements of the concept, plus the strong elements of the other concepts, this led to changes in the concept's interaction.

However, when it comes to the progress it must be said this progress has not been enough. The project should have been finished by now and it isn't. I have to point at myself for being indecisive and generally not delivering this period. That's in short the conclusion.

Back to the work actually done. After the initial concept shown on the previous pages the development went on. This development focuses on making the concept realistic. The changes made are more subtle. In the next paragraphs these decisions are motivated, grouped by subject.

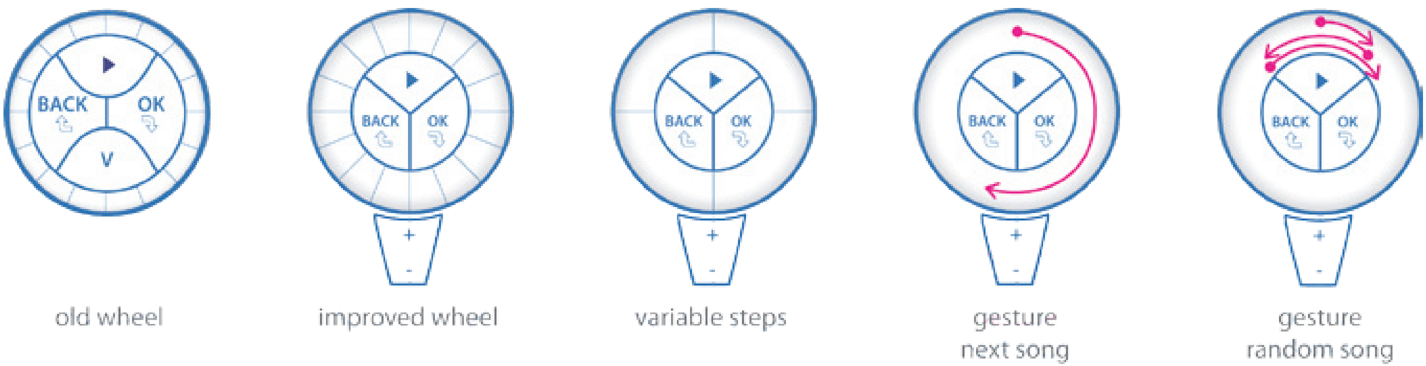


Figure 13 - Scroll wheel redesign, including possible gestures.

INTERACTION

The draft interaction as illustrated in figures 11, 12 shows a couple of issues. First off, there's the volume button. Volume would now be altered by first pressed the 'V' in the middle and then turning the wheel to set the volume to your liking. If you'd like to return to normal operation press 'V' again. This three-step process is cumbersome. Thus it was chosen to decouple the volume control from the wheel. This means that the element 'volume' has to move out of the ring entirely since there's no space within the ring to have a 'volume up' and 'down' control. The result is that just below the ring, towards the palm of the hand, a short strip is placed that acts as a touch-based slider. Going up/forwards moves the volume level up and vice versa. In figure 13 the result can be seen. It's obvious that the three remaining button controls in the middle take up the space, though the inner circle was made smaller.

The wheel is originally a very tangible thing. It's real and it physically moves. This has advantages, especially for the blind, given its tangible quality. But it can be argued that this tangibility is a combination of your thumb moving and (plus) a ring following this movement. However, the effective result of this interaction is always received in another form (audio). The position of the wheel itself has no absolute relation to its meaning. A scroll wheel is inherently relative. If you scroll ten 'notches' you'll go ten items down a list. Scrolling your thumb to the left, right or bottom position has no meaning. What if in a menu with only 4 options each quarter of the ring would relate to one of the options? So what if the notches themselves could be flexible, based on the scrollable content? What if these notches could be spread based on scrolling speed (quick scrolling, short spaced). This can have advantages since it better relates the content and input. This happens at the trade-off of having different behaviours at the same physical scroll distance, implying the need to learn and anticipation (through indicating beforehand what kind of behaviour the user can expect, for example when announcing the menu).

It was decided to incorporate at least a few of these advantages. But this cannot be done with a physical wheel thus a touch wheel was chosen instead. This means the user does not move a ring, but makes the same circular movement which is detected and translated to the appropriate feedback. This is the reason why the ring is bigger: to accommodate touch surface for a thumb. While bigger the ring is lowered, now slightly below the inner buttons, to ease the access to those.It sets them apart and reduces confusion.

Initially the wheel would incorporate clicks at each step. With variable steps this isn't possible to do in a fixed form. So a small vibrating motor will be placed below the ring to generate the desired subtle 'tick' feeling.

MENU SOUNDS

The change towards a less straight and obvious interaction comes at the cost of instant usability, but could be rewarding after an initial learning process. The same goes for menu sounds. The idea is that at each step the user is given an indication that a new menu is entered and what this menu is about (see fig. 12). From there on the user knows its state and can browse the options which are called out using synthesised speech. The idea is to replace the calling of menu's with

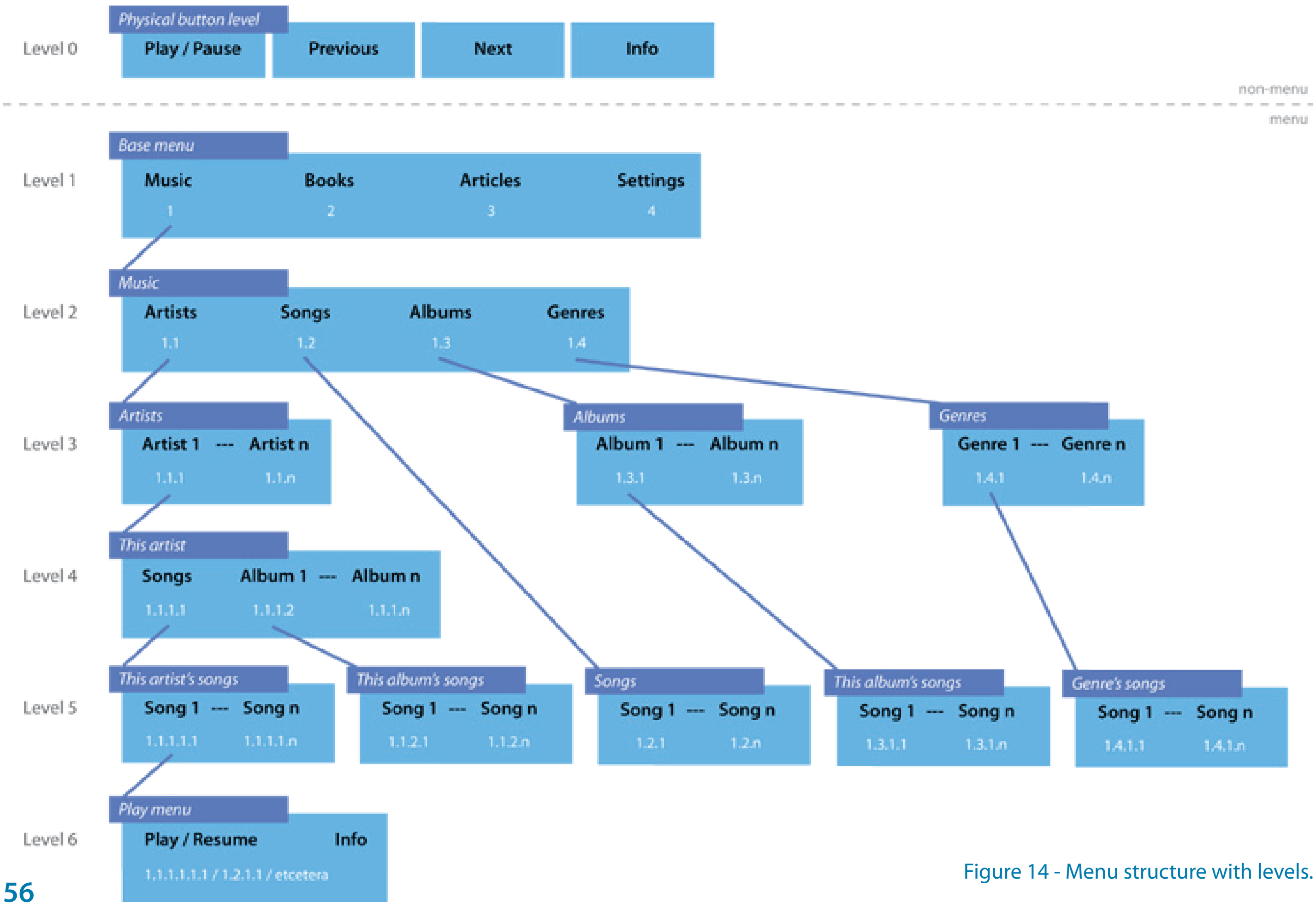


Figure 14 - Menu structure with levels.

non-speech sound. The main issue with the interaction for blind people is providing grip on what's going on (the state of operation) since there's no use for visual info and sound is temporal (so has to be remembered or repeated). However, the abundant usage of synthesised speech, as in the NOW situation (fig. 15), is functional but quite busy. It relies on very careful listening, because nothing should be missed. Apart from having to listen to things already known, waiting for the complete utterance to have finished might be another annoyance for people who have grown acquainted with the product.

Because the menu deals with selecting music it could be an option to skip synthesised speech entirely and play snippets of the music itself. For now this is just an idea 'to go all the way'. There might be a learning period after which the speech is slowly taken away for the menu sounds and possibly the songs.

The design of these menu sounds was done in assignment DA617 on Sound Design. Therefore the process and results are only broadly covered. Earcons [25] were chosen for the purpose of providing structure. Earcons

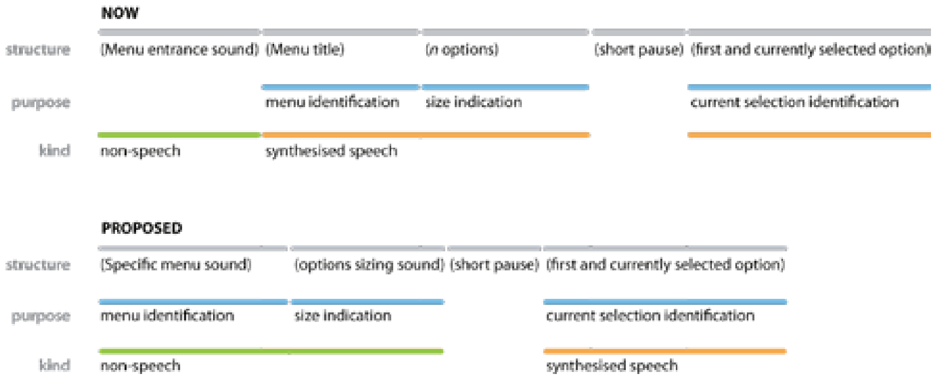


Figure 15 - Scheme of sounds at entering a menu.

are short musical pieces, thus basically consisting of a few notes. The arrangement of the notes, rhythm, pitch and timbre are what group them and distinguish them.

Testing the sounds with the demo application there are a couple of interesting conclusions and suggestions for improvement. The most notable is length. The sounds are quite long, somewhere between 2 to 3 seconds. In sequence this means 6 seconds at least. This is long, especially since the user has to wait for all this to finish because he or she cannot see the options available. Therefore a good direction is to try shorten these sound to 1 second or 1,5 second each. Another thing found during testing is the slow rate at which some sounds reveal their uniqueness (e.g. the first few notes are the same overall).

WHAT IS LEFT TO BE DONE?

The intended scrolling behaviours need be implemented in the software. By putting it into reality it can be experienced and tweaked (or abandoned altogether). The earcons are implemented in the current form, but need tweaking to shorten them considerably.

TECHNOLOGY

Up to this period it has been a deliberate choice not to focus on technology. I believe technology is a result and enabler of the design effort in this project, thus first it needs the user and design partially covered. This period the project has come to a point where the application of technology is necessary to help it move forward. As pointed out earlier it's very helpful to approach users with a working prototype, because they can then evaluate an actual thing instead of having to rely on their imagination. Thus I wanted to use technology to enable a working prototype in this phase of the project.

Given the nature of the concept this asked for something that can gather input from a handheld form (the device) and translate it to a non-visual interface using auditory and haptic output. Since we're talking about an audio player at the very least it has to play music and most likely use synthesised speech to help navigate the interface. The solution is to use a microcontroller (Arduino) for relaying input to a computer that generates the necessary output using like Adobe Flash. It means the complexity is handled by a computer, not the device form itself. It implies the desired prototype at the end of the project will not without be wires and a real standalone thing.

The figure illustrates what's happening between input and output. I've chosen not to include the software source code for it is not finished nor very interesting to read fifteen pages of code. Currently the software is implemented up to menu navigation, play controls and generation of menu sounds, but lacks synthesised speech feedback, as well as the special scrolling behaviours and related haptic feedback. I'd say it's 70% done. The hardware setup exist only in theory and the components need all wiring and soldering.

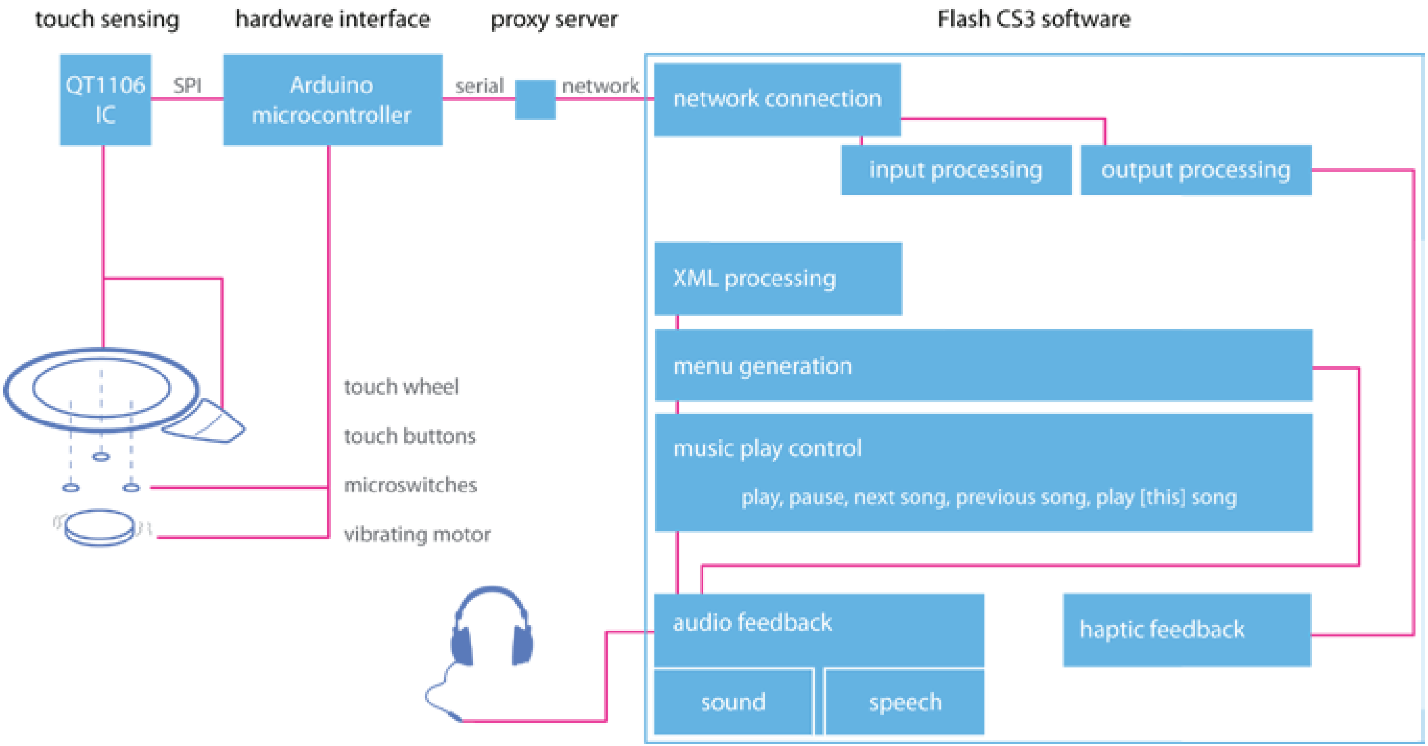


Figure 16 - Scheme of input, output and related hardware and software.

PARTS

Here follows a list of components that the real device would need to operate such a logic board, battery, microswitches for the buttons and etcetera. Firstly, it helps to convey that my design efforts are not made out of thin air and could not prove possible. Secondly it helps the design of form and aesthetics because the underlying parts of technology that make it happen do have dimensions and requirements which guide or prohibit certain shapes. A quick 'n dirty render shows the main elements.

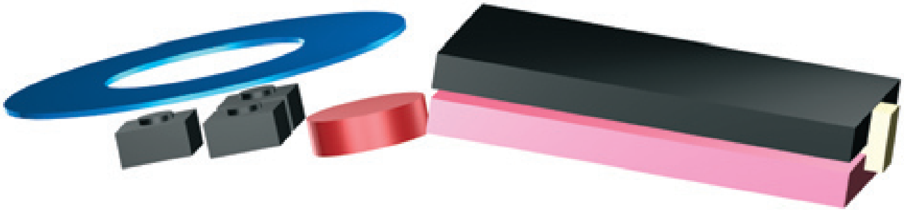


Figure 17 - Quick render to portray parts in their position. Touch wheel, three buttons below, vibrating motor in red, battery in pink, logic board in black, with standard 3,5 mm audiojack.

Buttons need a good, clear tactile click. A microswitch like the Omron B3F used here (3x yellow) measures 6 x 6 x 5 mm with a click travel of 0,5 mm. The vibration motor (red) measures 10 (dia) x 3 mm. It delivers only little power, but subtlety is required anyway. On top is the ring which actually consists of three segments each making up one third of the ring (not pictured here). Since the touch wheel uses capacitive sensing each segment needs be conductive, but can be thin like aluminum foil. The sensing IC (QProx QT1106) is mounted on the PCB.

The headphone connector will be placed on the bottom and measures 15 x 4,5 x 5 mm. It may protrude a bit further downwards than shown here. This connector can be mounted onto the logic board (white). The requirements for the logic board are processing of all input, audio decoding, generating a menu, generating audio feedback and holding memory. The sizes listed here are based on reviewing the logic boards of current audio players [26] that feature similar requirements, such as the iPod Shuffle or Nano. The size is flexible as is the layout. Thickness is 2 to 3 mm. The board area should be at the very least 850 mm2 and maximum 1300 mm2, with a minimum width of 22 mm. Here a size of 35,5 x 24 was chosen. The battery would be placed below the logic board and follow its size, albeit slightly thicker at 3 or 4 mm minimum.

WHAT IS LEFT TO BE DONE?

All the necessary parts are known and available, but need be applied to get a working prototype. This means soldering, tinkering and programming. The other part of the prototype, Flash software, has seen more advancement and could be finished within a day.

DESIGN

The design changes in interaction and technology have an effect on the form of the device. Together with these changes I've looked to improve the ergonomics. This was done via an exploration in clay and foam. These models also helped to find a form that is in line with the aesthetic criteria set up for this device.

Like it has been explained earlier on this device should foster confidence and not stand out as a tool for the disabled. The design should express this. Desirably the design follows modern trends with clean and sleek lines, rather minimal but not introvert. Desirably the form shows unique character within the boundaries set. Of course there should be room for the necessary tactile details but overall the appearance should be uncluttered as if the thing says 'I'm easy! I'm confident!'

The photos (next page) illustrate a few of the steps in the design process, starting with the old design towards more ergonomic and aesthetic models. The last one is now considered the final shape, but the technical side of things could change it a little. This form is preferred because of the appearance and feel in the hand. The strong edge that seems to draw a line around the sides gives character, while the smooth curves are pleasing to hold.

MATERIALS AND COLOURS

In line with the aesthetics aimed for some materials have been identified to suit. This is based on the idea that the form is constructed of a shell with two parts. These parts are most likely injection moulded because this design would be more or less mass-produced. The top part should be left sleek (a slight grain is welcome to provide grip), but the bottom can be more rubbery and providing a nice feel. Possible materials are polycarbonate (sleek, rather sturdy, injection mouldable), santoprene (rubbery / plastics, overmould, 2K injection mouldable, sturdy, but with a good tactile feel, feels real nice) and the odd one out: aluminum, which can be pressed or moulded into this form, has sleek appearance, adds quality feel, might interfere with touch wheel (conductive material) and is quite receptive to finger stains. For the bottom part it could work.

The intended has been undecided though it should be in sync with the overall appearance. Actually these colours could be changed to go along with the current trend. So the product can be produced in a series of colours, like many other things on the market. It's a personal item, although it should be noted that the owner doesn't see this. So the colour is really a thing for the rest of the world. Because this design aims at the blind there's no reason to use high contrast for buttons, but this could be helpful to appeal to a larger visually impaired market.

WHAT IS LEFT TO BE DONE?

While a final form has been found, this shape needs some tweaking in order to get the last details right, as well as the technical inside shapes. This needs be done mostly via CAD drawings. The plan is to design the final shape in CAD and have it send to a rapid prototyping firm. This translates the design back into a physical object. This object can be used for the technical prototyping and user testing I intend to do.

Figure 18 - Clay and foam, form exploration.

USER

Development on the user part has been low since last interim. This is due to the wish to test something that actually works rather than foam or clay models. But this actually working thing isn't here to test with, so I've not ventured into getting user feedback. I believe that getting the feedback and validation of blind people is very important to make good judgement on my design. Thus I really need to get something to take to these people. I've done several user interviews and review sessions in previous stages, which indicate this direction was the best one. But there have been small changes, some bigger such as the touch wheel which lack verification with my user group.

TEST PLAN

One of the project objectives is a proof of concept evaluation via a prototype. Will people understand it? Will it perform as intended? Especially the second question is important because earlier benchmarking shows there are competitors in this market arena. The project doesn't involve a super innovative solution to a problem nobody saw before. So what counts is the experience. Do people actually have a good experience (i.e. high satisfaction level)?

At this point the test plan is no more than a draft. The general hypothesis is that this concept will enable a non-visual user to perform better in tasks compared to a normal audio player. Such tasks could be selecting a specific song, resuming an audiobook or adjusting specific settings to their liking. The user will acquire a good understanding of the procedural working of the device and rates the use experience as satisfactory. To be able to test these hypotheses a user test has to be developed. This test should comprise of a comparative task completion test and afterwards a questionnaire to get feedback on the perceived experience. The user test itself will involve a normal audio player, such as an Apple iPod Shuffle which is popular with blind users, pitted against the prototype.

This is the general outline and needs further development to deal with possible issues. For example, to get comparable results both devices need to work with a similar music collection but experience gathering during the tests with the first device helps to get better results with the second device. This argues for swapping testing order and a possibly larger required sample to be able to get viable interpretation of the results.

The test idea outlined here is very broad and aims at the whole experience. It could be a smart idea to go for smaller tests first to get the basics straight: do people understand specific items like the menu sounds or the variable scrolling? If these work, then we can focus on the bigger picture.

MUSIC PLAYLIST

An important part of the prototyping is the actual music. To be able to navigate content, there has to be content first! So I've compiled a playlist of 247 songs (would fit on a standard MP3 player for comparative testing). These songs all have artist, title and album info available. The Flash software reads in this data via a XML file that acts as library. See an example below. The songs are chosen based on likely familiarity with the user group. Thus the list consists of mostly very well known artists such as the Beatles, Bryan Adams, Snow Patrol and etcetera. This is done to curb any problems when for example asking a user to go to 'I Love You But I've Chosen Darkness' which is actually a band, but I guess not a lot of people know them. Thus familiar names to reduce confusion.

```
<library>
 <songs>
  <song id="902">
   <title>All I Need</title>
   <artist>Air</artist>
   <album>Moon Safari</album>
   <genre>Electronic</genre>
   <year>1998</year>
   <url>Air-AllINeed.mp3</url>
  </song>
 <songs>
</library>
```

Figure 19 - Example of the XML code used.

FUTURE OUTLOOK

Next week's presentation will review the past period and illustrate what the project has been about. As indicated, though this presentation is marked as final, it really isn't. Currently, the design is in its near-final state, but the technology is not. This will improve before the presentation, but not to a satisfactory level. The lack of a decent technology prototype means no feedback can be gathered from users, leaving that part of

the process blank for the final phases.

The omissions given need filling in. Because the project has seen a delay in the past period there's no specific planning for the upcoming period at this moment. There are however steps and milestones defined for reaching the end deliverables. These deliverables consist of a final design (to be build or rapid prototyped), a working prototype showcasing the designed interaction and a good user evaluation of the final design. The first two deliverables are necessary to be able to reach the third. This information will be part of the presentation.

My initial proposal started out by thinking 'how could I design something that helps me to listen to music while not watching the actual thing?'. From there the question became 'how would blind people do this?', eventually leading up to this project in which I've asked myself 'how could they use such an audio player?' and 'how can they get to the audio they want to hear?'.

The project is now in its final phase. A good amount of time has been spent on learning the user context and problems. This has revealed blind people cannot enjoy the same level of human-product interaction as sighted people do which can hamper their self-sustainment in operating products. By and large they feel the same needs in terms of desired functionality and joy of use. The benchmarking done shows there's a gap between what's available and what's desired.

It has been argued that most issues encountered are related to navigating the interface. In our world there's a predominance of visual (or derived from visual) interfaces and resulting interaction. The main question set out to answer in this project is how this interaction can be done different and better catered to the possibilities of these users. The project takes into account the fact that blind people are often music lovers and very much adept of spoken word, such as audiobooks and podcasts. It's easy to argue that this affection with audio results in a desire to be able to carry this info and entertainment with them, for easy retrieval when in the position to listen. The question that has guided a large part of the design process is how this 'easy retrieval' could take form. Feedback from various users proves that the current method of sequencing through long lists of files is becoming unwieldy, inefficient and rather unpleasant. Which is why they tend to avoid it all along.

From the data gathered can be concluded the main market for a portable audio player is found in the younger age groups, though the majority of (nearly) blind people is of high age. This implies the design is targeted at a small group and should thus keep awareness of secondary groups.

The design work has been inspired by what the user might actually want the product to do and accomplish rather than a problem solving process. The motivation is to create a design which goes beyond pure functionality. Desirably it will have extra quality that makes someone like the thing beyond merely using it. I believe this is important in design.

The second phase of the project has seen a less then desirable progress, partially due to difficulties in getting external feedback from younger users. This time has been spent on deepening understanding of the problem through analysis of research and scrutinising the conceptual possibilities. Eventually the efforts led to four concepts which were discussed and evaluated. One of them stood the test and has been developed since.

Muse, the concept, has been taken to a higher level and grown into a viable design. So I believe, but there are still questions. Too much actually to call this project finished. It needs extra work. Muse requires a good amount of work to be done in design, interaction prototyping and user evaluation. It's hardly easy listening...

LITERATURE AND WEBSITES

[1] Facts on blindness. World Health Organisation. (http://www.who.int/topics/blindness/en/#) Internet; quoted on 17-10-2007.

[2] Lectuurvoorziening Braillelezers, final report. Ipso Facto BV. 2005. Internet (PDF), quoted on 16-10-2007.

[3] Factsheet on blindness. World Health Organisation. (http://www.who.int/mediacentre/factsheets/fs282/en/) Internet; quoted on 17-10-2007.

[4] Blindness. Wikipedia article. (http://en.wikipedia.org/wiki/Blindness) Internet; quoted on 17-10-2007.

[5] New Changes to establish MOON by the Use of Converting Software and a Computer-driven Braille-printer. Nator, P. 1990. Infovisie Magazine, Leuven, Belgium.

[6] Visualising Graphical User Interfaces for Blind Users. Poll, L.H.D. 1996. PhD Thesis, TU Eindhoven. ISBN 90-386-0437-8.

[7] Senses. Wikipedia article. (http://en.wikipedia.org/wiki/Senses) Internet; quoted on 02-11-2007.

[8] Modality. Wikipedia article. (http://en.wikipedia.org/wiki/Modality_(human-computer_interaction)) Internet; quoted on 02-01-2008.

[9] NavAccess: An Auditory Based Navigation Tool For The Blind. Hillen, H. Short paper. Internet; quoted on 15-11-2007.

[10] The Effective Combination of Haptic and Auditory Textural Information. McGee, M.R. Gray, P. Brewster, S.A. 2000. Proceedings of Haptic HCI 2000.

[11] Multimodal Interaction and Proactive Computing. Brewster, S.A. 2005. Paper. Internet, quoted on 16-11-2007.

[12] The Vicinity Sensor: Exploring the use of Hapticons in Everyday Appliances. Molen, K.v.d. 2005. Master thesis, Mechanical Engineering TU Eindhoven.

[13] Interaction Patterns for Auditory User Interfaces. Frauenberger, C. Putz, V. Höldrich, R. Stockman, T. 2005. In Proceedings of ICAD 05.

[14] A Spatial Audio User Interface for Generating Music Playlists. Hiipakka, J. Lorho, G. 2003. In Proceedings of ICAD 03.

[15] Designing with Haptic Feedback. MacLean, K.E. 2000. In Proceedings of ICRA 2000.

[16] A novel multimodal interface for improving visually impaired people's web accessibility. Yu, W. Kuber, R. Murphy, E. Strain, P. McAllister, G. 2005.

[17] Designing Haptic Feedback for Touch Display: Experimental Study of Perceived Intensity and Integration of Haptic and Audio. Tikka, V. Laitinen, P. 2006. In Proceedings of HAID 2006.

[18] Navigation and Control in Haptic Application Shared by Blind and Sighted Users. Sallnäs, E.L. Bjerstedt-Blom, K. Winberg, F. Severinson Eklundh, K. 2006. In Proceedings of HAID 2006.

[19] A Semiotic Approach to the Design of Non-speech Sounds. Murphy, E. Pirhonen, A. McAllister, G. Yu, W. 2006. In Proceedings of HAID 2006.

[20] Multimodal Feedback for the Acquisition of Small Targets. Cockburn, A. Brewster, S.A. 2005. In Journal on Ergonomics, volume 48, no. 9.

[21] Music Mood Wheel: Improving Browsing Experience On Digital Content Through An Audio Interface. Andric, A. Xech, P.L. Fantasia, A. 2006. In Proceeding of AXMEDIS '06. ISBN 0-7695-2625-X

[22] Wired for Speech: how voice activates and advances the human-computer relationship. Nass, C. Brave, S. 2005. MIT Press, Cambridge. ISBN 0-262-14092-6

[23] The Design of Everyday Things. Norman, D.A. 1990. Basic Books, New York.

[24] Programming and Enjoying Music with Your Eyes Closed. Pauws, S.C. Bouwhuis, D.G. Eggen, B.H. 2000. In Proceedings of SIGCHI 2000. ISBN:1-58113-216-6

[25] An Evaluation of Earcons for Use in Auditory Human-Computer Interfaces. Brewster, S.A. Wright, P.C. Edwards, A.D.N. 1993. Proceedings of InterCHI 93.

[26] Guide to repair Ipod. iFixit. (http://www.ifixit.com/) Internet; quoted on 24-04-2008.

EXPERTS

Stichting Beleyes, a.o. spoken to Wolter Kramer (tools and consultancy for visually impaired people, Amsterdam)

Slechtziend.nl, spoken to Han de Waard on business perspective of aids for the blind.

Berry Eggen (UCE, sound design)

RELEVANT BUT NOT YET CONTACTED

DQI capacity group (interaction design)

Harm van Essen (UCE, haptic interfaces)

Loy Rovers (haptic interfaces)

Stephan Brewster (non-visual mobile interfaces, University of Glasgow)

Berry den Brinker (low vision ergonomics, Vrije Universiteit Amsterdam)

Hans Hillen (Universiteit van Amsterdam)

Bartiméus Accessibility (experience in user design for visually impaired people)

This section provides extra content which is referred to in the main text, but is considered too detailed, in depth or off-topic from the main thread to be placed there.

APPENDIX 1

VRAGEN GEBRUIKERSONDERZOEK

ALGEMENE VRAGEN

Naam / Leeftijd / Geslacht / Opleiding / Mate van visuele beperking?

Hoe ervaren beschouw je jezelf op het gebied van computers, audiospelers e.d.?

Gebruik je op dit moment een audiospeler en zo ja, waarom dit type?

Welke rol speelt muziek in je leven?

Is een mobiele audiospeler daarin belangrijk?

Heeft het voor jou een bepaalde waarde die je anders zou moeten missen?

MUZIEKCOLLECTIE

Hoe ga je nu om met je muziekcollectie (bv. digitaal)?

Is dit georganiseerd en zo ja, op welke manier?

Hoe kom je aan je muziek en wat zet je vervolgens op een audiospeler?

Is je indeling op je mobiele audiospeler anders dan op je computer? Zo ja, waarom?

Hoe wijkt je digitale indeling af van collecties die je ‘in het echt’ maakt?

Wat zijn voor jou bij je collecties de grootste struikelblokken? (denk aan problemen met de indeling, afspelen)

Wat zou je zelf het liefste willen veranderen en hoe?

Hoe werkt je ideale speler? Wat zou die doen? (voorbeelden?)

Hoe zou je je collectie in willen delen als je helemaal vrij zou zijn?

Stel, je moet je collectie indelen op een ruimtelijke manier. Hoe zou je dat doen?

Stel, je bent muziek aan het luisteren. Je wilt nu naar een (specifiek) ander nummer luisteren. Hoe zou je dit het liefste willen doen?

Zou je willen dat het huidige nummer doorspeelt totdat een nieuwe gevonden is?

Wat is meestal je motivatie om naar een bepaald nummer te luisteren?

Gebruik je bepaalde waarderingen voor bepaalde nummers, zoals een lijstje met favorieten of sterren?

GESPROKEN WOORD

Hoe gebruik je en beleef je audioboeken?

Wanneer en waarvoor gebruik je daarvoor een draagbare speler?

Is er bij de indeling of groepering van audioboeken en gesproken artikelen een verschil met je muziek? Zo ja, hoe wijkt dit af?

Wat zijn de redenen om het anders te doen?

Heb je een idee hoe je het zou willen?

MEMO'S

Hoe belangrijk is het voor jou om memo's op te kunnen nemen?

Op welke momenten gebruik je het? Wanneer juist niet?

Wanneer en hoe luister je je opgenomen memo's terug? Wat doe je er dan mee?

SPRAAK

Heb je ervaring met producten of software die gebruik maken van spraakherkenning?

Wat denk je ervan om het te gebruiken voor een audiospeler, bijvoorbeeld om snel dat ene nummer te kunnen luisteren (zonder door menu's heen te moeten gaan)?

Zou je het een bezwaar vinden als anderen je kunnen horen? (denk aan in de trein e.d.)

Hoe is je ervaring met spraaksynthese? Welke problemen kom je tegen, bijvoorbeeld bij verschillende talen?

Wat vind je van het gebruik van gesproken menu opties?

Is dit prettig, duidelijk of juist vermoeiend en onwenselijk?

Hoe zou je het liever willen?

Hoe wenselijk is het wanneer je naar muziek luistert?

VORMGEVING

Hoe belangrijk is het uiterlijk en gevoel van een product voor jou?

Zou je een omschrijving kunnen geven van dat wat je mooi vindt qua vormen en materiaal? (in het algemeen)

Heb je voorbeelden van producten die je mooi vindt? (mag ook zijn qua gebruik)

(wellicht enkele modellen of voorwerpen geven ter vergelijking)

CONCEPT MODELLEN

Er zijn hier geen vastomlijnde vragen of kaders. Wel is het belangrijk dat de gebruiker een beeld kan vormen over de werking en hier dan ook een reactie op geeft. Enkele punten voor mogelijke feedback:

Interactie (al dan niet een inschatting)

Juiste mapping van functies (indien aanwezig)

Vormgeving en gevoel

Denk je dat je dit kan / zou gebruiken?

Wat lijkt je positief?

Welke problemen verwacht je?

(Algemeen) Welk model lijkt jou de beste keus?

(Algemeen) Welk model vind je het prettigste qua vorm en waarom?

APPENDIX 2 - DESIGN SPECS

DOCUMENT OVERVIEW

1. Introduction
2. Task description
3. Target group
4. Criteria (usability, functionality)
5. Technical considerations
6. Aesthetics
7. Context
8. Proposed alternatives
9. Evaluation
10. Proposed direction

INTRODUCTION

1.1 The design effort aims at a product that enables blind people to operate an audio player without disabilities.

1.2 The target group agrees it's a worthwhile effort to come up with a new view for this market.

1.3 Focus is on interaction design, not innovative functionality per-se.

2. TASK DESCRIPTION

2.1 The main goal is to enable the target group to efficiently retrieve and playback audio files.

2.2 Playback of music and spoken word such as newspaper articles

2.3 Interaction will be designed in tune with the capabilities of the target group in order to create a crucial distinctive element of this device over competitive products. This is directed specifically at browsing and retrieving the audio contents.

2.4 Design efforts are aimed at developing a device which could enter the market in the near future.

2.5 Necessary technology has to be available in the very near future and applicable within the constraints of a compact, battery driven electronics product.

3. TARGET GROUP

3.1 The device is primarily targeted at visually impaired people who are unable to use vision for common everyday functioning, such as interacting with products and environments.

3.2 The primary target group is young blind people between 18-25 years of age, who are found to have the strongest interest in a mobile audio player.

3.3 The secondary target group is all people between 12 to 50 years of age who have full auditory and tactile sensory capabilities.

3.4 Worldwide there are 3,7 million blind people in developed countries.

3.5 Sighted people may show interest if the design useful in situations of visual cognitive effort such as driving a car.

4. CRITERIA

(included in main text, therefore not repeated here - see also § 9.B for the list)

5. TECHNICAL CONSIDERATIONS

5.1 Necessary technology has to be available in the very near future and applicable within the constraints of a compact, battery driven electronics product.

5.2 The product is intended for availability in a competitive consumer market which restrains technology in terms of cost. The cost of applicable technology should not place the product out of competition.

6. AESTHETICS

6.1 Given the blind target group pure visual aesthetics are less relevant compared to tactile and interactive qualities.

6.2 The visual impression this product makes on sighted people is relevant to avoid the stigma of 'an aid for the disabled'.

6.3 In terms of style I aim for a contemporary design, in line with current trends. This means a simple, minimalist approach to form and surface treatment. This may be in conflict with 6.5.

6.4 Colour follows the style set out in 6.3; specifications need research on this topic. For people having low vision featuring strong contrasts between control elements enhances usability.

6.5 Because the design cannot bear any visual guidance on how to operate and hold the product the shape will be influenced by the interaction design and vice versa. Form and interaction have to be a unity.

7. CONTEXT

7.1 Intended use of the product is not restricted to any specific environment due to its mobile nature. It must therefore be expected the product will be taken around a lot.

7.2 The target group relies on auditory and tactile sensations which interferes with the intended feedback modalities of this product, so in noisy and unknown environments this product isn't likely used.

7.3 The blind person is frequently surrounded by others while likely using this product which implies this product must refrain from interfering their relationship (whatever this may be), for example by created irritating noise or eliciting awkward behaviour that compromises dignity or fosters stigma.

8. PROPOSED ALTERNATIVES

(included in main text)

9.A USER GROUP EVALUATION

(included in main text)

9.B COMPARATIVE ANALYSIS

A matrix is shown here to illustrate how well the alternatives validate with the hard and soft criteria. In theory the hard criteria are qualitative, implying a yes/no compliance of the alternatives. An alternative that does not comply with all hard criteria is not a viable solution. In effect the best alternative meets all hard criteria and scores best on the soft criteria.

These alternatives have been evaluated with five potential users (age 16-19). The + and - signs indicate which alternative is regarded best and worse for each criteria. Other criteria have been evaluated with yes/no statements or I,II,III rankings. Some criteria could not be evaluated at this point.

9.C & 10. PROPOSED DIRECTION

(included in main text)

9.B Soft criteria	A	B	C	D
4.25 Record spoken memo’s				
4.26 Speech rate variable	II	II	II	II
4.27 Usable without external speakers	I	I	III	I
4.28 Diversity in audio contents (changeable)	II	II	II	II
4.30 Pleasant use experience	+++++		---	--
4.31 Usable while in motion	+++++	----	-	
4.32 Intuitive control	+++	++	----	-
4.33 Limit cognitive effort	++++		----	+-
4.34 Fit nicely in hand	+++	+	-----	+
4.35 One-handed operation	+++	++	-----	
4.36 Design shows positive aesthetics	+++		-----	++
4.37 Efficient energy usage				
4.38 No small or weak external elements	++	+	++-	----
4.B Totals	**5 / + 28 / - 0**	**5 / + 6 / - 4**	**7 / + 2 / - 28**	**5 / + 4 / - 7**

9.A Hard criteria	A	B	C	D
4.1 Playback music	y	y	y	y
4.2 Playback spoken word	y	y	y	y
4.3 Retrieve specific song or spoken word file	++	++	+-	----
4.4 Browse collection	++	++	+-	----
4.5 User is in control	++	+	++-	----
4.6 Playback control (play / pause / prev / next)	++-	++-	--	+-
4.7 Random playback	y	y	n	y
4.8 Adjustable volume	y	y	y	y
4.9 Structured browsing (e.g. via menu's)	+++	+	+-	----
4.10 Auditory feedback on status / selection	y	y	y	y
4.11 Tactile feedback on status (if appropriate)	+++	+	+--	---
4.12 Feedback on location within audio file	y	y	n	n

4.13 Feedback must not overwhelm	++++		---	+--
4.14 Interaction has tactile quality	+++	+	+--	---
4.15 Tactile guidance on how to hold product	++++	+	---	--
4.16 Resume spoken word files (another time)	y	y	y	y
4.17 Design does not stigmatise				
4.18 Size is in line with mobile usage	++	++	-----	+
4.19 Last for at least one day of use				
4.20 Indicates power status				
4.21 On/Off functionality				
4.22 Sustain external impact				
4.23 Safe in use				
4.24 Technologically feasible	y	y	y	y
4.A Totals	**y 8 / n 0 / + 27 / - 1**	**y 8 / n 0 / + 13 / - 1**	**y 6 / n 2 / + 7 / - 21**	**y 7 / n 1 / + 2 / - 27**

APPENDIX 3 - BENCHMARKING

APPLE IPOD CLASSIC

Sets standard for most of the competition. Uses a round touchpad acting as scrollwheel.

+ Nice finish
+ Interface is straightforward

- No tactile feel
- All interaction feedback is done via display

APPLE IPOD TOUCH

Same as the classic iPod except for the multi-touch display interaction, which discards butons in favour of acting with your fingers.

+ More tactile interaction (apart from feedback)

- Absolutely no tactile feel
- All interaction feedback is done via display
- Not really compact
- Interface has lots of features, playing music is only one of them

APPLE IPOD SHUFFLE

Goes for the basics. Plays music and let you only go forward or backward. Uses limited number of buttons and switches.

+ No visual feedback necessary to operate
+ Tactile feel
+ Nice finish
+ Really pocketable
+ Integrated clip for attachment to clothing

- Hard to navigate thus discouraging

BONES MILESTONE 311D

Audio player designed for the visually impaired uses distinctive buttons and

+ No visual feedback necessary to operate
+ Distinctive tactile feel
+ Integrated speaker
+ Pocketable plus keycord

- No true auditory navigation (calls only five prerecorded folder names)
- Requires usage of small memorycards that are indistinctive (tactility wise)

BANG & OLUFSEN BEO5 REMOTE

Home entertainment remote control that uses a combination of display, buttons and a scroll-wheel in a form that is remarkably distinctive.

+ Tactile feel of buttons and wheel
+ Made to fit the hand
+ Nice finish
+ Generic functionality always available

- Relies on visual feedback (partially)
- Given its size and form not pocketable

SONY ROLLY

Home audio player that focuses on physical gestures to interact with. Meant to be placed on a table or similar surface. Automatically deploys flaps that hide integrated speakers.

+ No visual feedback necessary to operate
+ Emphasis on physical interaction (though requires flat surface to roll on)
+ Integrated speakers

- Limited to home use given its hefty size
- No navigation beyond forward, backward & random

TACTILE AUDIO PLAYER (CONCEPT)

Goes for the basics. Plays music and let you only go forward or backward. Uses braille-like buttons creating a tactile experience.

+ No visual feedback necessary to operate
+ Distinctive tactile feel
+ Nice finish
+ Really pocketable

- Hard to navigate thus discouraging

DIMPLE PLAYER (CONCEPT)

Stroking the dimple gives you “a sensual experience for the human senses, to create a personal connection to mobile music technology.”

+ Tactile feel
+ No confusing elements

- No indication of how to operate (learning curve)
- No navigation structure (i.e. a menu)

FREESTYLE AUDIO SPORT

Simple but durable player that caters to sports enthusiastics who cannot devote attention to operate a full-fletched player. Does only on/off, other song and volume adjustments.

+ No visual attention necessary to operate
+ Clear tactile buttons
+ Really pocketable and durable

- No navigation possibilities at all