Smart Headphone Design and Development

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Abstract

The aim of this project was to develop a headphone concept combine with smart functions by focusing on the user needs and using industrial design methodology. It was intended to be easy to use, comfortable to wearing and provide the most necessary smart functions.

Industrial design methods used include design brief, work breakdown structure, functional analysis, design research, mind map, ideation sketching and modeling, among others. From the information gathered during the research phase, some areas of exploring were defined to conduct the ideation phase and then combine and narrow down the ideas in the final development part.

The final result presented in this report is a single smart headphone made by 3D printer the earmuff covered by PU some parts build with form and metal.
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1 Introduction

This project aims at developing a new headphone concept combine smart functions.

1.1 Background

As the smart phone become popular and wireless network become available everywhere, people start to try to get information from every object they use.

Start with the most common and mostly used stuff around us, people start to focus on the things we wear everyday. Recent years more and more smart bracelet and smart watch appear. Even apple released their first smart wearable device last year.

But, some people question about this situation: Do we really need these kind of smart bracelet devices? Truth is people who brought smart bracelet, they just use them when they just got them and quit to use after couple of months.

So, I think if a device people need to use every day like headphone, combine with smart function, that will make people easier to stick on the device, is more like the smart functions is a attachment to the device, not the device just create for smart functions, which is the most common in the market.

Then, I talked to Lenny Lin who works for Propeller Design about my idea and they wiling to give me help on the design part because they have a lot experiences on the headphone design especially recent.

About Propeller Design

Propeller is a design agency based in Stockholm Sweden.

Propeller help their clients’ businesses grow through cunning use of consumer insight, create meaningful output and deliver actionable results. Think of them as a 'hands-on’ filter between client and customer. Propeller root in Scandinavian thinking and feel it's important to realize that the creativity they bring to the table is not some exotic alchemy.

Right now, Propeller will provide not only industrial design but also strategy and interaction design to their customers to make the all output as a whole and more value to their customers.

www.propeller.se


1.2 Objectives
The purpose of this project is to design a smart headphone focused on user requirements. Like I said above, right now, there have more and more smart devices pop up on the market, people are becoming interesting and willing to buy them and improve their life quality through these devices. But the hard part for the productions is how to make users keep using these smart devices?

Then I thought deeper on this question. Like you can see, the smart devices now on the market now is more like a accessories like band, watch and so on. But they have no other functions but collect data from your daily activities. So, the important thing that people use them or not is decided by the how willing the users need the smart functions. Nothing else.

How to make these devices have more value then just the smart functions?
I found out if we add smart functions into a device that people will use every day what ever they have a smart functions or not. Then is more like the smart functions is a attachment for the users not the only value the will get.

So, I decide to follow up this path to design a smart headphone. Next thing is the real design questions.
What smart functions users need now on the market?
What are the problems that traditional headphone have and could be solved by the smart function?
What are the features users really care about for a headphone?

1.3 Delimitations
The product development process for this project was completed within 20 weeks, meaning that the end result is intended as a concept to illustrate a possible direction for a new product, as opposed to a product ready for market release. The project is meant to give PROPELLER a new impressions, ideas and materials to work on and inspire their further headphone projects. The idea is that the project must also demonstrate that it is possible to combine the development of packs with the Design for All headphone projects in the future.

And I will not working on the sound effects solution on soon as well. Because that is a totally new industry and it needs a lot of professional knowledge about it.

1.4 Disposition
Chapter 1 introduces the background, objectives and delimitations of the project. Chapter 2 describes some theories in which this project is based; an overview of the design thinking, why industrial design is used, the product development process, background on aesthetics, rheumatism, packaging and some technical specifications from the company materials.
Chapter 3 describes some of the various industrial design methods used in this project, such as design brief, work breakdown structure, functional analysis, personas, mood boards, mind map, ideation sketching and modeling, among others.

Chapter 4 describes the implementation of the methods, findings during the design process and decisions taken as a result of these findings. It is organized to describe the phases of the design process: discover, define, develop and deliver.

Chapter 5 describes the result – a product family of paperboard and fiber packages in form of ready meal trays for elderly use. The features, materials, dimensions and graphics of the final concept are described.

Chapter 6 summarizes how the result has met the objectives. The chapter is divided into three different areas: a method discussion, a personal reflection over the work completed in this project and some recommendations for further work.
2 Theoretical Background

The aim of this chapter is to get know about the concept of design, design and the focus on the user, design thinking, the design problem and the design process. This chapter describes and discusses the process in general terms and leaves the theoretical description and discussion on specific design tools and design methodologies to the next chapter.

2.1 what is design

The definition of design was changed through time.

The word “design” means a “plan,” a “pattern,” a “composition,” or an “intention.” It originally came from the French word “desinare,” which was derived from the Latin word, “signum.” Words in several other languages are also used in a way that is similar to the English word “design” (Ulrich, 2011)

The latest definition is design as being the process of composing a desirable figure toward the future (Nagai, 2010).

2.2 what is industrial design

It is fair to say that we live in an almost completely designed world. We are surrounded by a multitude of designed products, spaces, systems, services, and experiences that have been created in response to some physical, emotional, social, cultural, or economic need.

In its simplest definition, product design is the design of products, but it also has a wider meaning that includes the generation of ideas, the development of concepts, product testing, and manufacturing or the implementation of a physical object, system, or service.

The role of a product designer encompasses many disciplines, such as marketing, management, design, and engineering, and also combines art, science and commerce in the goal of producing tangible artifacts. (Milton & Rodgers, 2011)

2.3 Design thinking

Design thinking is the most powerful weapon of designers and relevant people compare to businessman and engineer. It means the way of designers thinking and innovation.

“We believe great innovators and leaders need to be great design thinkers. We believe design thinking is a catalyst for innovation and bringing new things into the world. We believe high impact teams work at the intersection of technology, business, and human values. We believe collaborative communities create dynamic relationships that lead to breakthroughs.” These are the visions of the first two schools of Design Thinking, the design School at Stanford University in the Californian Silicon Valley and the D-School of the Hasso-Plattner-Institute in Potsdam, Germany. With overwhelming success these schools educate young innovators from different disciplines like engineering, medicine,
business, the humanities, and education to work together to solve big problems in a human centered way. (Milton & Rodgers, 2011)

Design thinking is a word that hard to find out a common definition among designers, they will have their own understanding which is deferent from each other.

From “Simon’s big idea—that design is always linked to an improved future—has continued to shape the practice in every direction” (Buchanan, 1987) to “Design thinking is the search for a magical balance between business and art, structure and chaos, intuition and logic, concept and execution, playfulness and formality, and control and empowerment.” (Mootee, 2013)

Design Thinking Is Action-Oriented; Design Thinking Is Comfortable with Change; design Thinking Is Human – Centric; Design Thinking Integrates Foresight; Design Thinking Is a Dynamic Constructive Process; Design Thinking Promotes Empathy; Design Thinking Reduces Risks; Design Thinking Can Create Meaning; Design Thinking Can Bring Enterprise Creativity to Next Level; Design Thinking Is the New “Competitive Logic of Business Strategy”. (Mootee, 2013)

2.4 Method and Process

2.4.1 Design method

Design method the methods designer used in different design projects. Designers have their different way to make their design match the final goals.

The relations between design methods and product development is shown in Fig1(Cristofolino, 2010)
2.4.1 Mood board

Mood board is a tool we used all through the whole process. It’s a fast way to graphic designer's mind and feeling of the whole project and the different period of the project. Mood boarding is a technique used by creative to show their visual interpretation of what the client is aiming for a particular project or concept, it’s a collage of images, text, fonts, shapes, colors, icons (the list is endless) offering visual direction. (Jones, 2013)

2.4.1.2 Design research

Design Research can help designers to find out the real goals of the projects. Designers using Design Research to define the design questions and the answers of these questions.

2.4.2 Design Process

Here have a lot different design process as well, but mainly goal is to reach the project purpose. So I will introduce some process to help readers to understand more about design process.

2.4.2.1 4Ds process

Discover—Define—Development —Deliver

So in this process, designers need to be discovering the problems with the stakeholders together. Then they need to define the problems correctly to find out the right path to the solution. Next step is to find out the best solution for all the stakeholders. Last step is to implement the concept into a real product.
Theoretical Background

You can find more details from the pictures below (Stone, 2010)
Theoretical Background

5 Develop

- Based on client-approved concept ideas, designer further develops the design concept(s).
- These further iterations of the concept(s) will be provided as tighter representations of the design:
  - Comprehensive layouts
  - Animatics
  - Typical pages or spreads
  - Preliminary Prototypes
- These will incorporate preliminary, often placeholder
  - Copy/Messaging
  - Imagery
  - Motion
  - Audio
- Designer presents the above to client for discussion, input, and approval
- Client provides insights and validation that the design direction will meet the project’s stated goals and objectives
- Typically, the client will approve one design direction that will then be refined by the designer

6 Refinement

- With a client-approved design direction, designer further refines the design.
- Typically, the changes/modifications are based specifically on client requests
- Minor in nature
- Finishing of aesthetic elements
- Designer presents the above to client for discussion, input, and approval
- Testing of the design may occur, and this may lead to another round of refinements. Testing may include:
  - Validation
  - Usability testing
- Designer would then present these additional refinements to client for approval
- Designer initiates preproduction meeting with additional team members, if needed. These might include:
  - Printer, Fabricator, Manufacturer, Photographer, Illustrator, Audio engineer, Programmer

7 Production

- With an approved design, the designer begins implementation of the design across all the required deliverables. This may include:
  - Print: mechanical/key lines, finished art, digital files, camera ready art, all elements final
  - Web: modeling phase, detailed flowchart, art content, finished art for pages and graphic elements, programming, testing
  - Motion: creating all project elements, animation making moves, shooting live action, editing, final rendering, mastering
- Environment: specifications, final prototyping, 3-D digital models, testing in preparation for production, coordinate/manage technical team
  - Packaging: high-resolution file prep, specifications, color correction, structural prototyping

8 Manufacture/Launch

- Depending on the project and delivery media, the production materials are often handed over by the designer to others. Although other professionals outside the design firm actually do the work in most instances, the designer must supervise these suppliers and their work. This can include:
  - Pre-Press/Separator
  - Printer, Fabricator/Manufacturer
  - Engineer/Programmer
  - Media outlet/broadcast/on-air
- Designer may be engaged in the supervision or management of any or all of the above suppliers or it may be the client’s responsibility
- Ongoing maintenance, especially in the case of Web design, may be an aspect of the project, or it will be determined under a separate agreement

9 Project Completion

- Designer and client have a project debriefing (exit interviews) to review
- Project procedures
- Customer success or failure
- Feedback loops
- Additional opportunities
- Designer archives project files. Also, writes up a case study while the project details are fresh. This is preparation for the project as a self-promotional tool
- Designer clears out and-invoices project
- Client pays designer

Goal of this phase:
- Further Develop Ideas
- Select a Design Direction

Goal of this phase:
- Final Design Approved
- Materials for Release

Goal of this phase:
- Design Materials
- Completed and in Use

Goal of this phase:
- Relationship building
- Sales opportunity for designer
- Begin new project

Execute
2.4.2.2 Circular Process

During the real design project, it is very often that you have to start over some part all over because you are always changing your mind. Especially in the design part. So 4Ds, looks like not that good from this point of view, so, some Circular process looked more reality for 4Ds. You can see Fig 2 (Richardson, 2013) below.

Fig 2 (by Jeff Smith from D3)
3 Method

The Design Method is a framework you can implement in every design project to achieve appropriate results. This blueprint helps you gain understanding, craft a plan, develop ideas, and ultimately produce and apply them. (Karjaluoto, 2013)

Fig 3

Design method could separate into 4 parts. Research and Define (Discovery), Planning, Ideation (Creative) and implementation (Application), the relations like the Fig 3 above (Karjaluoto, 2013)

So, I will introduce the methods I used in this project by each part.

3.1 Research and Define (Discovery) part

The Design research method is almost the same as the normal research method used in other industry.

Research is an inquiry process that has clearly defined parameters and has as its aim, the:

- Discovery or creation of knowledge, or theory building;
- Testing, confirmation, revision, refutation of knowledge and theory; and/or
- Investigation of a problem for local decision making. (Hernon, 1991)

3.1.1 Qualitative Research

Qualitative for my personal view is a method used when you need to solve a problem or support your hypothesis with massive data from the market and the stakeholders.
Like the definition I found “In natural sciences and social sciences, quantitative research is the systematic empirical investigation of observable phenomena via statistical, mathematical or computational techniques.” And, “The objective of quantitative research is to develop and employ mathematical models, theories and/or hypotheses pertaining to phenomena. The process of measurement is central to quantitative research because it provides the fundamental connection between empirical observation and mathematical expression of quantitative relationships. Quantitative data is any data that is in numerical form such as statistics, percentages, etc.” (Given, 2008)

3.1.1.1 Survey
Survey is a very useful and efficient method to find out the requirement or prove your assuming requirements. Then what is survey particular?

Survey research involves the collection of primary data from all or part of a population, in order to determine the incidence, distribution, and interrelationships of certain variables within the population. (Williamson, 2002)

3.1.1.2 Market Research
Market Research is based on a massive survey data from specific market, then find out the market trends through analysis. It can help the stakeholders to understand the trends in the future to make decisions for their next moves. Designers need to make moves through the Market Researches as well.

3.1.1.3 Interview
An interview is a conversation between two or more people where questions are asked by the interviewer to elicit facts or statements from the interviewee. (Marriam-Webster online dictionary)

Some requirement or questions is hard to get from survey. Normally we combine interview with survey together to get all the data and requirements. Another advantage of interview is the percentages of valid data from interview are a lot bigger then the survey.

3.1.2 Quantitative Research
Quantitative research is a method of inquiry employed in many different academic disciplines, traditionally in the social sciences, but also in market research by the business sector and further contexts including research and service demonstrations by the non-profit sectors. (Lincoln, 2005)

So, for us, some problems could find answers from quantitative research. For instance what’s the feel like when you drink water using a mug compare to using a bottle? For this kind of problem we need to use other method to get the answer. Like you can try it by yourself or a group of people and then ask them about their feelings.
3.1.2.1  Competitor research
In now time, more and more products on the market are almost same from each other. How to make your products different from others? Why users choose your products instead of others? To figure out these kinds of questions, the fastest way is you study from your competitors on the market. What is the functions they added to their products? Why customers buy their products? What is the core value they provide to the users?

Study from your competitor can help you to face to the core issues you need to think about.

3.1.2.2  case study
Case study is “In the social sciences and life sciences, a case study is a research method involving an up-close, in-depth, and detailed examination of a subject of study (the case), as well as its related contextual conditions. Although no single definition of the case study exists, case-study research has long had a prominent place in many disciplines and professions, ranging from psychology, anthropology, sociology, and political science to education, clinical science, social work, and administrative science.” (Mills, 2010)

So, I using case study as part of user study, this way can help me to understand some details about using problem.

3.1.3  Data Analysis
Data from fieldwork need to be recorded, analyzed and interpreted. The way this happens differs according to whether the research is quantitative or qualitative. (williamson, 2002)

This part is very important during the whole research section. It is a conclusion from the researches before and the rest research and design will follow the result of data analysis. So, how to find out the correct result from research data becomes very important.

3.1.4  Design question
Design question is a very interesting method that you need to make the user requirement and the questions from other stakeholders become some core questions related to design section. And it will be another key pointe or a guideline for the rest part of design process.

3.2 Implementation (Plan) part

3.2.1  Schedule
3.3 Creative Part

3.3.1 Brain Storming

Brainstorming is a very powerful way of ideation in design processing now. To do the brainstorming, we gathered some people (more than one) to discuss a project or a problem together. And every possibility allowed discussing during brainstorming. All members should open their mind and willing to accept all the ideas at beginning. As the discussion moves on, we should start to filet the solutions or the ideas and try to judge them objectively. After find out the best solutions, and we should think deeper.

A group people’s power is a lot stronger than one man. “Brainstorming was more effective than individuals working alone in generating ideas, although more recent research has questioned this conclusion.”(Stroebe, 1991) So, brainstorming is widely used in design industry.

3.3.2 Fast sketching

Sketching is the most effective tool in design process. Designer could use sketching visualize their idea in a very short time and it is understandable for others as well.

So, I create some rough sketching during brainstorming to discuss with other designers to exchange each other ideas.

3.3.3 Function analysis

After research and analysis, we will have a lot results relate to the functions. But considered welfare and cost we need to find the most important functions. How to find them? Function analysis is the most common way to do that.

The way of function analysis is make a function list first, and evaluate the importance piece by piece for all the stakeholders. Afterwards, we make a function analysis list to evaluate all the functions and find the most important ones.

3.3.4 Ergonomic study

All products is designed to use by human. Understand the relations between human and products are the main goal of ergonomics. So, ergonomics study is a very important during a product design process.

Normally we can find out the ergonomics data from some professional website or articles. Then, we pick the data through the project purpose.
4 Approach and Implementation

In this project, I need to understand the real requirement of smart functions and headphones. The markets So that I could find out which part I need to focus during the next steps.

4.1 Why smart headphone

Although, I explained way I pick smart headphone as my thesis, but I want to explain the process of it in this chapter.

First, I feel interesting about smart wearable devices which is the most hit industry recently years. I tried some wearable devices as well, So, I have some experiences of using it. For, my feeling, I think users are not that satisfied for them. First reason is, these devices mostly are braches, more like a accessory, not everyone like wear a accessory. Then, the smart function is more challenged users habit, because most of them are helping users to keep doing physical exercises to be healthy.

But for catch the goal these devices have to be annoy some times, like your personal coach in a gym. Of course the body health fans will love it, but the problem is you think they really need to use a Bracelet to warning or noticing them to keep practicing? But, for other users who not that willing to go practice, how to make them keep using the smart functions without leave the devices? It becomes the key problem these smart wearable devices need to be faced.

To solve this problem, I thought from 2 different angles. One is combine smart functions into some wearable devices that users really need what ever it have smart functions or not. Another angle is making smart functions more like record not forcing users to do some thing. Is more like a light function, not a heavy function, so that people will not feel the pressure mentally from the devices.

So, for the first angle, I draw a mind map about wearable devices. You can check the fig.4 below.
Through this map, I find out some options, belt, glasses and headphone. Based this result, I decide to follow with headphone. The reason is first, for the belt, is it more belong to a clothing design area, I’m not very familiar with it. Then, the glasses, I think now there still have a lot technic problems need to be solve and there already have Google Glasses in the market which I think is very interesting and I don’t have other interesting idea for glasses. I think it is more close to replace the cellphone is more like a terminal device, not smart device. So, that’s why I decide to choose smart headphone for my thesis.

4.2 Research

4.2.1 Qualitative research

4.2.1.1 Headphone research

I started with the basic requirement of a headphone. Headphones separate into 3 kinds based on the structure.

Different structure will create different sound effect and different sound conduction. For full open headphone it can bring the best quality of the music which most close to the sound effects of Live music. But the disadvantage of full open headphone is the noise reduction is very bad because of the sound unite is completely open. So, this kind headphones fit for the Hi-Fi fans to enjoy the music at home. We can see almost the most flag

Closed headphones have the best sound reduction. But relatively it have a special sound effects which is weird for some people caused by the closed structure. So, this kind of headphones fit for people who want to listen music in outdoor, or plane and so on. They want to listen music to kill time in a noisy environment. So, for them the most priority thing is the sound conduction the sound effect is not so important.

Semi-open headphones it is a compromise solution compare to other two kinds of headphone. It has neither the best sound effect nor the best noise reduction. So, it fits some professional users like DJs, sound record studio. Those users need a not bad sound effect but some time they need to hear the sound from the environment at the same time. So, Semi-open headphones are their best choice.

4.2.1.2 Target group

According to above study, we can find out different headphone have their own target group. Hi-Fi users; Professional users and normal users. Among these groups, normal user group undoubtedly is the biggest group on the market. For find out the features of this the groups, I need to find out the characteristic of the 3 groups above. The graphic below each group is to show the requirement for a headphone.
**Full open headphone users** should be: Hi-Fi fan, above average income, have a strong requirement for the sound performance of the headphone.

![Full open headphone users](image)

**Close headphone users**: love music, need to kill the time during travel and so on, have requirement for the sound reduction, have requirement for the style of the headphone.

![Close headphone users](image)

**Semi-open headphone users**: professional users, have requirement for the sound performance, some users (like DJ) have the requirement for the style.

![Semi-open headphone users](image)

To find out my target group more accurate. I decide to study the features of smart wearable device users. As we all know, smart devices should connect with a smart cell phone to sync and share the data. So, actually the user group of smart wearable devices is highly covered with the users of smart phone. What’s most interesting about the data from Nielsen is the age-based segmentation they do. For those under 44 years old, smartphone penetration has now crossed the 50 percent threshold (54 percent). In fact for those in the 25-34 age category it stands at 62 percent. (Sterling, 2011)
So, we can find out, the target group of smart headphone is highly possible is the people age under 45.
Finally I cross compared two different target groups to decide my target group for this project: normal headphone users under age 45.

4.2.1.3 Competitor research
I studied competitor’s product on the market to understand their features. The results is shown below.

The Dash (Bragi, 2015)

Headphone features: built in Mp3 player, 4GB storage, water resistant, wireless, passive noise isolation, audio, ear bone microphone.
Smart functions: track performance recording(speed distance time cadence),track body (heart rate, Oxygen saturation ,energy spent)

Glyph (Avegant, 2014)
Headphone feature: wireless, closed headphone
  Smart functions: built-in screen on the headphone band to allowed users to watch video through it.

**MUZIK Headphone** (Muzik, 2014)

![MUZIK Headphone](image)

Headphone features: wireless, closed headphone, Foldable.
  Smart functions: 4-hotkeys customized by a user and motion sensors for controlling (like turn off the headphone when you put it off from your head), an open source platform for cellphone apps, memory foam ear cups.

**Jabra Intelligent Headset** (Jabra, 2014)

![Jabra Intelligent Headset](image)

Headphone features: Wireless, closed headphone, foldable.
  Smart functions: 3-D sound experiences, touch key.

Above headphones are the mainly lunched smart headphones on the market. I found out all of them is a closed headphone and wireless. Three of them is very portable. For the smart functions, they all focused on new interaction experiences, body performance and share except Glyph.
4.2.1.4 Function analysis

Function analysis is a way to find out the importance of all the related functions. Function analyses normally evaluate the functions in general level. Is more like focus on the problem need to solve not the technology level.

I find out I need to focused on these angles:

- What data need to be recorded from user’s activity?
- Storage while user goes out.
- How to prevent the environment noise?
- Comfort.
- How to make sure user’s safety while using it?
- How to keep user health while using it?
- How to make user stick on it?
- Iconic
- User friendly

### Smart Headphone function analysis

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<th>Verb</th>
<th>Noun</th>
<th>Type</th>
<th>Performance Limit</th>
</tr>
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<tbody>
<tr>
<td>Listen</td>
<td>Audio</td>
<td>MF</td>
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<td>Be</td>
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<tr>
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<td>Portable</td>
<td>DF</td>
<td>Muff size/Comfortable</td>
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<tr>
<td>Be</td>
<td>Smart</td>
<td>NF</td>
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### Smart Function

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<tbody>
<tr>
<td>Provide</td>
<td>Information</td>
<td>MF</td>
<td></td>
</tr>
<tr>
<td>Be</td>
<td>Friendly</td>
<td>DF</td>
<td></td>
</tr>
<tr>
<td>Resist</td>
<td>Weather</td>
<td>NF</td>
<td>Rain drops</td>
</tr>
<tr>
<td>Be</td>
<td>Accurate</td>
<td>DF</td>
<td></td>
</tr>
<tr>
<td>Be</td>
<td>Reliable</td>
<td>DF</td>
<td></td>
</tr>
<tr>
<td>Be</td>
<td>Useful</td>
<td>NF</td>
<td>Requirement</td>
</tr>
</tbody>
</table>

### Head phone function

<table>
<thead>
<tr>
<th>Verb</th>
<th>Noun</th>
<th>Type</th>
<th>Performance Limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Be</td>
<td>Comfort</td>
<td>DF</td>
<td>Size/ heavy weight</td>
</tr>
<tr>
<td>Listen</td>
<td>Audio</td>
<td>MF</td>
<td></td>
</tr>
</tbody>
</table>
Approach and Implementation

<table>
<thead>
<tr>
<th>Be</th>
<th>Lightweight</th>
<th>DF</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Through list above, I choose some functions I need to continue analysis in the next steps. Track recording</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body performance recording</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wireless</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interaction experience</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gesture control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smart warning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Choose the music for you</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume smart control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connect to electronics at home</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4.2.1.5 Stakeholder study
I studied the stakeholder of a headphone. Stakeholder means all the parts related to the product from production to user.
For a headphone, the stakeholders are:
Producers: who produced the headphone from raw material to the final product?
Retail channel: including the distributors and the stores.
Final Users: people who will buy and use the headphone.
So, as a designer, I need to consider these different parts and try my best to guarantee all these stakeholders could achieve their profit for design level.

4.2.1.6 Persona
Persona is a way that help designer understand the features of the final users.
I set a scenario to simulate the whole process and environment to understand the whole process of the using.
For instance, Peter is a product manager of a finance company in Stockholm Sweden. He normally goes to work by subway because of the traffic situation in Stockholm and the parking fee is very expensive in down town of Stockholm. So, in the subway, he always listen some music or watch movies to kill the boring time. In the train they’re always full of the noise from the railway. So, Perter have to use the headphone, which have a very good noise isolation function. Since during the different environment the Nosie level always changing, he has to adjust the volume several times. As product manager, Peter always needs to go different branch to let everyone understand their new product and related policies from head court. So, he travels a lot in Scandinavia area. He likes to watch some movies in the plane.
Persona is a very useful tool during the design process and it helps designers to understand the whole processing of user using the product.
From this project, I understand users will have a lot requirement for the noise isolate and portability for a headphone. And the interaction is very important as well.

4.2.2 Quantitative research

4.2.2.1 Market research
For get a big picture of the market. I need to find some market data and predicting.
4.2.2.1.1 Smart wearable devices

According to a research released by Juniper Research in 2013, the market of smart wearable devices had grown to 0.8 billion US dollar by the end of 2013, and Juniper Research had predicted till 2014, the market will arrive 1.5 billion USD. Till 2017, the whole sailing amount of smart devices will increase to 70 million pieces even we say the average price of a smart device is 100 USD, then the whole market will be 7 billion USD or more by the end of 2017. (Research, 2013)

![Graph showing growth in smart wearable device market](image)

4.2.2.1.2 Headphone market

Headphone market driven by the mobile or mp3 player and so on markets. Don’t expect hot technologies in headphones specifically. But headphone purchases will continue to be driven by sales of other high-tech portable devices such as MP3 players, iPads, iPhones, Droids or other MP3-enabled cell phones. Buyers will be looking for headphones that meet their needs for style and application, or for headphones that take advantage of features offered by the device they are using the headphone with: for example, A/V control or call-answering devices. (Klosek, 2011)

4.2.2.2 Survey

I did my survey through Survey Monkey platform to collect the data from people in both Europe and China.
The survey is shown below.

<table>
<thead>
<tr>
<th>Basic info</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What is your gender?</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>2. What is your approximate yearly income? (currency below is USD)</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>3. What is your age?</td>
</tr>
<tr>
<td></td>
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<td></td>
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<td></td>
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<td></td>
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<tr>
<td></td>
</tr>
</tbody>
</table>
Your attitude for smart wearable devices

4. How often you use headphone normally?
   - very often (at least once a day)
   - normal (2-3 times a week)
   - not often (once a week)
   - very less (once a month)
   - never

5. Are you willing to try the latest smart wearable devices?
   - Yes, of course
   - No, I hate these devices
   - ah......what is smart wearable devices?
   - Other (please specify)

6. How much money you can accept maximum for a smart headphone? (All options in USD)
   - 100-200
   - 200-300
   - 300-400
   - 400-500
   - 500-no limits

how you use headphone normally?

7. What situation you use headphone normally?
   - During the way to school/ work/ ....
   - During long distance travel.
   - at home
   - at office/ at school
   - Other (please specify)

8. What kind of situation you think your headphone necessary to reduce the noise from environment?
   - in a transportation tools (like bus, train, plane and so on)
   - on the street.
   - in office/classroom
   - Other (please specify)

9. For you, what is the most important element for a headphone?
   - Style (my headphone must be the coolest)
   - Sound performance
   - Be comfortable to wearing
   - intelligent (like your smart phone)
   - portability
   - Other (please specify)

For a smart headphone's functions

10. order the functions below by importance for you.
   - track recording.
   - performance recording.
   - 100% wireless
   - gesture control (play/pause/rewind/volume +/-)
   - smart warning (when you on the street, to warn you when a car or a bike coming)
   - choose the music for you depends on your body situation.
   - Volume smart control (control volume to guaranty same volume, make sure the volume would not hurt your hearing)
   - Connect to the electronics in your home and control them by your headphone (like TV, stereo, air condition and so on)
The key feature of this survey is the Q10. This question is to let people pick the order of the functions importance for them. The results will cross compare with the function analysis to find out which are the most important functions and which are not. This step could make the research results more reliable.

4.2.3 Analysis

The data from survey is:

<table>
<thead>
<tr>
<th>FUNCTIONS</th>
<th>NUMBERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>male</td>
<td>61</td>
</tr>
<tr>
<td>female</td>
<td>55</td>
</tr>
</tbody>
</table>

![Gender Distribution Chart]

![Functions Analysis Table]
2. Yearly income (USD)

<table>
<thead>
<tr>
<th>Functions</th>
<th>Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-12,000</td>
<td>55</td>
</tr>
<tr>
<td>12,000-18,000</td>
<td>53</td>
</tr>
<tr>
<td>18,000-22,000</td>
<td>18</td>
</tr>
<tr>
<td>22,000-26,000</td>
<td>11</td>
</tr>
<tr>
<td>26,000-32,000</td>
<td>7</td>
</tr>
<tr>
<td>32,000-42,000</td>
<td>11</td>
</tr>
<tr>
<td>42,000-50,000</td>
<td></td>
</tr>
<tr>
<td>50,000+ and limits</td>
<td>7</td>
</tr>
</tbody>
</table>

3. Age

<table>
<thead>
<tr>
<th>Functions</th>
<th>Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-24</td>
<td>59</td>
</tr>
<tr>
<td>25-34</td>
<td>67</td>
</tr>
<tr>
<td>35-44</td>
<td>6</td>
</tr>
<tr>
<td>45-54</td>
<td>7</td>
</tr>
<tr>
<td>55-64</td>
<td>8</td>
</tr>
</tbody>
</table>

4. Frequency for using headphoe

<table>
<thead>
<tr>
<th>Functions</th>
<th>Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every day</td>
<td>54</td>
</tr>
<tr>
<td>More than twice a week</td>
<td>25</td>
</tr>
<tr>
<td>Around once a week</td>
<td>13</td>
</tr>
<tr>
<td>Around once a month</td>
<td>15</td>
</tr>
<tr>
<td>Barely use</td>
<td>18</td>
</tr>
</tbody>
</table>
5. Are you willing to try the latest smart wearable devices?

- Yes, sure: 80
- Not, I hate them: 8
- What are smart wearable devices?: 2
- Other: 2

6. How much money you can accept maximum for a smart headphone? (All options in USD)

- 100-200: 59
- 200-300: 54
- 300-400: 14
- 400-600: 11
- Above 600: 7

7. What situation you use headphone normally?

- Way to school/work: 69
- At office/school: 72
- Long distance travel: 49
- At home: 58
- Other: 4
8. What kind of situation do you think your headphone necessary to reduce the noise from environment?

- In a transportation tool: 72%
- On the street: 17%
- At office/class room: 8%
- Other: 3%

9. For you, what is the most important element for a headphone?

- Style: 32%
- Sound performance: 50%
- Comfortable to wear: 8%
- Intelligent: 5%
- Portability: 5%
Through these data, the results of survey is:

The people who did this survey is mainly under age 45 (88%), yearly income is mainly under 32,000 USD (76%), half male and half female.

People who used headphone more than once a week is 73%, and among them more than half of them use headphone everyday (58.7%). So the people who did this survey is highly Consistent my target group.

Who very interesting to use a smart wearable devices is 63%, refuse to use is only 5%. So, I think my target group is very willing to use smart devices.

49% people could accept the price of a smart headphone is under 200USD and 37% people could accept the price is under 300USD.

60% people use headphone during the urban transportation and long distance travel.

And more then 73% people use headphone on a public transportation tool.

The most important thing of a headphone for targets is its sound performance (50%), secondly is its confortable or not (37%).

The Q10 is very equal compared to other questions. Because this question is more complex than others. And maybe people not that familiar with the terms. But I still can find out the top4 important and unimportant functions for the users.

Top4 important: Body performance recording; wireless; touch control and track recording.

Top2 unimportant: choose music for users; connect electronics at home.

For the rest, I think same of them is still important, but it depends on the target group. For instance people above 35 think the auto volume control is more important.
I cross the answer and decide the main function of my smart headphone is: **Body performance recording; Track recording; new interaction experience; wireless and auto volume control.**

Another important thing I need to focus on is **ergonomics** part. Because comfortable is a very important issue for users.

### 4.3 Ideation

After the research, I start the ideation stage follow with the conclusions of the research stage. Use brain storming and sketching to find 3 better solutions as the mid-proposal.

Then, refine them to find out the final concept.

#### 4.3.1 Brain Storming

First, I worked on the headphones on the market and conclude 3 directions. First is focus on the new possibilities on the portable solutions. Second direction is try to use a new professional design language to create a new concept. Finally is focus on the new interaction experiences.

So, I did a sketch brain storming with Propeller’s help. As the sketch below, I conclude 11 directions to continue.
4.3.2 Sketching

Then I sketch more details of the concepts above.

The new portable solutions

This concepts is enlarge the distance of the sliding to make the headphone have smaller volume after it slide up. This way could save more space when you go out and put the headphone into your bag.

This concept is to make the headphone could stable with a hook, then users can hang the headphone on your bag and so on.

This concept create a new solutions for bring the headphone with you.
Approach and Implementation

This concept is focus on the way of the ear muff fold, to make the headphone more protable.

Professional language

After I study the high-end headphones on the market, I find out they all have their own shape or features to create their own design langue.

So, the concepts below are try to create a new form design langue to make the headphone different.

This concept is to focus on the combination part of headband and earmuff.

This concept is focus on the head band, I tried to use a different shape of headband to make the headphone special.
New interaction experience direction

This concept is to use a physical rotation button which used a lot by the stereo equipment before.

This concept is to built in a touch pad on the outside of the earmuff to let users use gesture control like which used on ipad to make a new experience on headphone.

This Concept is using gesture control as well, but the area of touch pad is larger then it will create a better experience of gesture control.
4.4 Concept Refine
After the sketching part, I made another brainstorm to find out the interesting features and concepts I can continue with.

Then after the brainstorm, I use AI software to make the vector drawing of the side view to compare the concepts I conclude.

Then I continue with these concepts to conclude 6 proposal for mid-presentation.
4.5 Concept proposal

Proposal 1
This concept is using leather and metal material to create interesting feeling, which is combine old fashion and high-tech. then new interaction is another key point.
Proposal 2

This proposal is use long distance sliding headphone band to reduce the volume and increase the portability of the headphone.
Proposal 3

this proposal is using metal frame on the headband to reduce the weight of the whole headphone and professional design language.

After the mid-presentation, I talked with my thesis tutor and Propeller. We all think the first proposal is more interesting compare to the others. So I decide to refine the proposal 1 to create final concept.
4.6 Ergonomic study
For finding suitable data for the headband and earmuff, I checked some material about anthropometry of human body to find out the data. In this project, I choose the max data of the head to fit more than 85% people.

Fig. 6 (Technology, 2014)
Through data above, I conclude the dimensions for my headphone.
4.7 Concept refine

4.7.1 Prototype

To test the ergonomic dimensions I build some prototype.
Since I decide to Refine the proposal 1, I think about the final concept. I decide to keep the physical rotation button create a interesting interaction experience. Use the headband for concept 2 in proposal 1. Which is could bring a iconic feature for the whole shape.
5 Result

5.1 final concept

This is my final concept. Use the leather and physical button to create a classical feeling for the users, and the metal surface in the middle of the physical button is a touch pad allowed user to tap on it to control the playing.
The shape of the headband is follow the gesture when user wear it. It save more space compare to the round headband.

The headphone is foldable, it a lot more increase the portable.
5.2 Details

Part of the cable is exposed outside to reduce the thickness of the connection part for headband and earmuff.

The switch button is on the left earmuff.

The hinge is hiding from the headband. Then cable go through hinge to the upper headband.
5.3 Exposed view and section view

The exploded view shows how many parts included and what is the connection between them.

Section view shows how the parts the structure of the whole headphone. You can find out the placement of the PCB, battery and ports.
Dimensions of the final concept. Is come from the ergonomic study.

5.4 Interface Design

This interface design is allowed users to use it both on the screen of smart phone and the buttons on the headphone.

Users have to use this application to check the data collected by headphone and share them on social network.
5.5 Prototype
I want to use leather to cover the whole earmuff to follow my language, but I never work with leather before, So, I did some prototype to test the way I to cutting the leather.

5.6 physical model
Physical model is a very important way to test the whole design in real dimensions. There have a lot different way to make a physical model in different material. Normally use milling machine and 3D printer to built the main shape and the material will be foam or plastic. This physical model is built by 3d printer mainly. Because the headband and earmuff are hollow, so milling machine can’t make it.

After print the parts, next step is to fix the finish surfaces by sand the surfaces after print filler on them. When the surface are arrive the requirements. Then I start to paint real color on them.

Then clue the leather outside the earmuff. This is the hardest step because of the leather is a soft and highly flexible material but my concept need it to be follow the shape of the earmuff strictly. Please see the detail pictures in attachments.
6 Conclusion and discussion

6.1 Smart functions
Smart functions of this concepts, is include body performance recording, track recording, auto volume control. These functions are come from the survey analysis which are most needed smart functions for the users.

The auto volume control is what I think necessary for a smart headphone. This function will make users feel the headphone is smart because it can change the volume and reduce the noise by the environment noise. Is like the headphone is a living thing that could judge the situation by itself.

6.2 Headphone functions
The headphone function part is very important as well because this part is the main function of the whole product. As I mentioned before, smart function is more a additional function for this project, and people use this product mainly as a headphone. So, for headphone function, is a closed active noise reduction headphone. Built in 35 mm speakers to create a beautiful sound effect. The sound effect should be a Hi-Fi trend sound. Which means the sound should be very closed to the live music. No extreme sound dyes.

6.3 Engineering design
For engineering part, there have some main problem need to focus on. Firstly, foldable parts like hinge and its connection. Secondly the placement of the inner parts, like the PCB, battery and so on. Finally, the placement of the cable.

These problems I already showed my solution in previously sections. The key rule of my solutions is to reduce the volume and weight to make the headphone as slim and light as I can. Try to keep the headphone as a whole and make it less design as possible.

6.4 Conclusions
The whole project is different direction of thinking about smart wearable devices. Built in smart functions into a devices we used a lot in routine live. So that will make users no need to pay any other extra energy on using the smart functions.

Headphone is more and more necessary for the users(Schmidt, 2010) as a important accessory of smart phone. So, add smart functions into a headphone is a very good solution.

Keep the headphone function perfectly is a basic requirement for smart headphone as well.
6.5 Discussions
Some point need to be continue discussed in the future.

Are there any other better smart functions fit to add in smart headphone?

What is the most important functions are really required by the users? And so on.
7 References

Hernon, P. (1991). the elusive nature of research in LIS. In library and information science research: Perspectives and strategies for improvement (C. R. M. P. H. Ablex Ed.): Norwood,NJ.
8 Attachments

Physical model pictures
9 Reflection

My thesis is a smart headphone design. The main subject I need to focus with is the interface and user experience. Since smart devices becoming more and more common, users need to connect with the devices more often then before. The latest interface is the touch screen. Which is very rare before. But after a while, people start to get tired for touch screen, almost all the devices built-in a touch screen and people have to finish most tasks through it.

Like the article said “UX is about arranging the elements of a product or service to optimize how people will interact with it.” (Schmidt, 2010) So, we can figure out that user experience is one of the most important features. So, I decide to focus on create some different UX for my smart headphone concept. Not just touch screen and gesture control. Make be I can combine these kinds of experiences with some traditional experiences.

UX design is a very popular design area in recent years. But in people’s mind UX design should be only deal with the software and the interface of the applications. But the article mentioned “User experience design is a broad field that draws from many disciplines including but not limited to interaction design, information architecture, and visual design. Other aspects of UX, including architecture and sound design (story time in digital surround sound, anyone?), are also important. Over” I totally agree with this point, UX design not just for website and mobile applications. Every design area should have their own UX design part.

So, after I read this article I find out that UX design is more like a “glue” to stick users and the products or services. It decided the products’ soul and personality. Industrial Designers should to pay lot more attention on this area in future work.