Wearable payment for young women

Utilizing rapid prototyping in iterative conceptual design

Verna Kaipainen | Master`s Thesis | Aalto-University | 2015

Abstract

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Master`s Thesis

"Wearable payment for young women -
utilizing rapid prototyping in iterative conceptual design"

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This is a production-based thesis work made aside my work as a 3d-printing specialist in Microsoft Mobile`s Design Department`s 3d-lab. The topic is designing a jewelry-like payment device for young women. A production-based thesis work was made to discover the process of designing for wearable technology and the practical issues related to it. The main process-guiding assumption in this thesis is that familiar, jewelry-like form would be more acceptable for young women in context of everyday wearable device. Important goal for 3d-lab is to knit rapid prototyping as an integral part of design process, so I utilized rapid prototyping as my main methodology for studying the subject.

The goals for thesis work were to learn more about wearable devices field and practical design issues relevant to it. For author the goal was to improve my skills both in iterative design concept -creation and prototyping. The goal for the concept-creation was to prototype an idea for acceptable, wearable, contactless alternative for traditional debit card in small everyday purchases, targeting to young women.

The methods used in this thesis work are literature research, benchmarking, rapid prototyping, expert interview and user-centered design methods. The process consisted of background research, making re-brief, technical concept creation, making several product design ideas, testing and reviewing the ideas, selecting one design for further development and finally testing and reviewing the appearance model and interaction prototype with potential end users.

The project`s end result is a design concept depicted by prototypes and pictures, and a written thesis report about the design process and philosophy behind the design work. The main focus of this written report is in product design, the minor focus areas are designing interaction and concept creation. Concentrating deeply to all product development areas was not purposeful in thesis framework, so I decided to put most effort on describing the product design development.

Keywords: Wearable technology, digital jewelry, contactless payment, user acceptance

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1. Introduction

1.1 About the topic

As a starting point for my thesis work, my manager Heikki Hakamäki from Microsoft Mobile`s Design Department`s 3d-lab team, suggested that I would do something around wearable technology and tactile feedback. By tactile feedback I mean simple eccentric-mass-actuator that can be found for instance from smart phones and game consoles. I was given free hands to re-focus the work as I wanted. We decided not to tie my thesis to any existing program, as the Phones unit was undergoing transformation from Nokia to Microsoft and the programs were constantly changing and many of them were killed as well. My work was considered more as a possible inspirational source. I was also taking care of 3d-printing process at the same time, so I was able to utilize team`s resources and skills for my rather free exploration for thesis work.

From different wearable technology functions I decided to focus on authentication and more specifically on payments. In my opinion, "wearability" could add value to this area. I reframed the topic as "wearable payment for young women". In wearable technology, the most interesting point for me was the demobilization of wearable technology. In other words how to make wearable technology acceptable, and even better desirable for consumer, and what role design plays in that. Wearable technology is an exciting field for product designer because it is constantly ongoing a change and there is no established convention of how these devices should be designed.

I wanted to target my concept to young women because the wearable technology devices on market at the moment are mainly for technology-enthusiastic men, and therefore I saw it more interesting to focus on some other user group. I was especially interested in knowing how to design wearable technology device for people who are not the earliest adopters of new IT-devices or wearable technology. As I am myself a young woman, it was rather easy to relate to at least part of this group.

I wanted to focus on smart accessories rather than smart clothing because my main interest is in product design. As my target group were young women, I decided to make a piece of digital jewelry meaning a jewelry-like wearable technology device that contains electronics for payment. The result, from my point of view, is a wearable technology device that utilizes jewelry design features.

I decided to make a concept that would be feasible now or in near future, rather than to focus on more futuristic ideas. The reason behind that decision was that I wanted to make the prototyping and testing the acceptability of concept and design easier for myself. I also see that kind of work more natural for myself. I decided to create rather simple technical solution to be able to concentrate on design-aspects. I delimited tactile feedback as an only feedback method in order to simplify the concept, so for instance use of display was out-scoped. When I started to make my thesis the scope of 3d-lab was to support the early prototyping of non-display devices, so this effected on my decision as well. Limiting input and output medias gave me more freedom in my design work, since there was small amount of technical restrictions effecting on the look of the device.

1.2 Goals, Methodology

Goals:

My personal goal for this project was to improve my skills in design concept -creation through rapid-, iterative prototyping and user-centered design methods. I also wanted to explore a little bit in interaction-design field, more specifically in physical interaction and tactile feedback.

My goal for background research was to better understand wearable technology field, and especially how to design more acceptable (screen-less) wearable technology device for young women. In productional part my goal was to get to know what kind of practical issues there is when designing a wearable technology device.

For the concept I set a goal that it should be easy to use, useful and desirable for selected target group in its main functions: making everyday small purchases and being a nice piece of jewelry. I tried to measure if I succeeded to achieve abovementioned goals by conducting two user studies with potential users.

The goal for design work was to create many design ideas and then select one to develop further. As my thesis is a conceptual work, it was not my goal to make fully functional and ready-to-be-produced product, but rather a convincing concept.

3d-lab wants to have thesis workers to improve their ways of working and communication between designers and model-makers. My work is one example of how rapid prototyping tools can be easily applied to iterative design concept creation in many levels, even until the apprearance prototype phase. As I see it, prototyping should be inseparable part of concept creation and design process, not just something that is added in the end of the project. Rapid prototyping tools force designer to take the ideas early to practical level. This can make the entire design process more productive and faster.

Methodology:

Literature research

I did literature research for constituting a theoretical context for my work and placing it in a right place in wearable technology field. Since there is no solid established form or function for wearable technology devices, I used literature research together with benchmarking to consist my own viewpoint on how I should design for more acceptable wearable device. I also researched information about technical topics such as connectivity technologies and vibrotactile feedback.

Benchmarking

I did benchmarking to understand the market context of wearable technology devices. I benchmarked interesting ideas, different new payment methods and technologies and different designs among wearable technology devices. I also benchmarked smaller details like materials, attachment mechanics and decorative elements. As I was working in a new field, I found benchmarking quite useful tool helping me to avoid copying.

User centered design methods

I was interested in the acceptability of wearable technology, so it seemed crucial to include some user-centered methods to my thesis work. The idea of having an iterative design process also required testing. I wanted to use user feedback as a source of inspiration for my design work. I did not have lot of resources for user testing, so I chose to use more lightweight qualitative testing methods and to concentrate more on concept development supported by insights from attitudinal qualitative user testing, rather than conducting heavy behavioral and quantitative user testing.

Facebook-survey:
I made a Facebook-survey for the target group to better understand their payment habits and what they value in their everyday payment methods.

Focus group interview:
I made a focus group interview to get inspiration for my design work and to find out attitudes and opinions towards the idea of using jewelry for payment and different design ideas.

Usability- and desirability study:
I made a second user study for testing the entire user experience including user interaction and design. I wanted to test if my design was acceptable for some representatives of my target group.

Expert interview

I interviewed Kirsti Saarikorpi, a goldsmith and jewelry designer, to get better insights into jewelry design. I used interview also for gathering feedback and likewise developing my concept.

Prototyping

As 3d-lab is dedicated to rapid prototyping, I wanted to utilize the tools that were available. Rapid prototyping methods mean technological solutions that are capable of directly generating physical objects from graphical computer data (Jacobs and Reid, 1992, 1). I used mainly inkjet-type 3d-printer as a prototyping tool. I used rapid prototyping for idea-creation and testing different design ideas.

Rapid prototyping included:
- 3D-modeling with first Rhino and later Catia
- 3D-printing with Objet Connex500 utilizing PolyJet technology
- Stereolithography 3d-printing
- Laser sintering stainless steel (executed by AmFinland)

Interaction prototype was implemented by Michihito Mizutani. The aim of experience prototype was to convey the idea of interaction in second user testing. My interaction prototype is so called Wizard-Of-Oz -prototype, meaning that it fakes the interaction. Part of interaction prototype was a mobile application prototype implemented by Jani Vuorinen.

Appearance prototype was made to depict the wished look and materials. It was used to convey the design idea in second user study.

Functional prototype was not made, since it would have required some electrical engineering development work, and I did not have resources for that. The main threshold for implementing this kind of product is the size of components.

1.3 My process

Eric Zimmermann, a game designer and the co-founder and CEO of Gamelab, defines iterative design as "a design methodology based on a cyclic process of prototyping, testing, analyzing, and refining a work in progress" (Zimmermann, 2003, 176). The main benefit of iterative design process, compared to traditional waterfall process, is that the fundamental problems in design are discovered in earlier phase of process, and thus they can be fixed faster. (Jacobs and Reid, 1992, 5-6.)

I had one main iteration cycle in my design process. I divided my process into three phases. Phase one included background research and technical concept-creation. In phase two I made three design ideas and gathered feedback from potential users. In phase three I made first iterarion based on gathered feedback from users and jewelry designer Kirsti Saarikorpi. After developing more detailed design concept, I tested it with potential users. The main reason for slow iteration cycle was my slow learning process and loose brief that caused many sidepaths.

Executed schedule

The topic was really open in the beginning, so the scheduling of the project was quite difficult. I had also other tasks to do simultaneously with my thesis work. The actualized weekly thesis-making hours varied between eighteen and thirty hours depending on the other workload. Luckily I was given quite free hands on scheduling my thesis. Originally I scheduled more time for this project, but after getting the focus group interview done I realized that I could finish earlier than I expected.
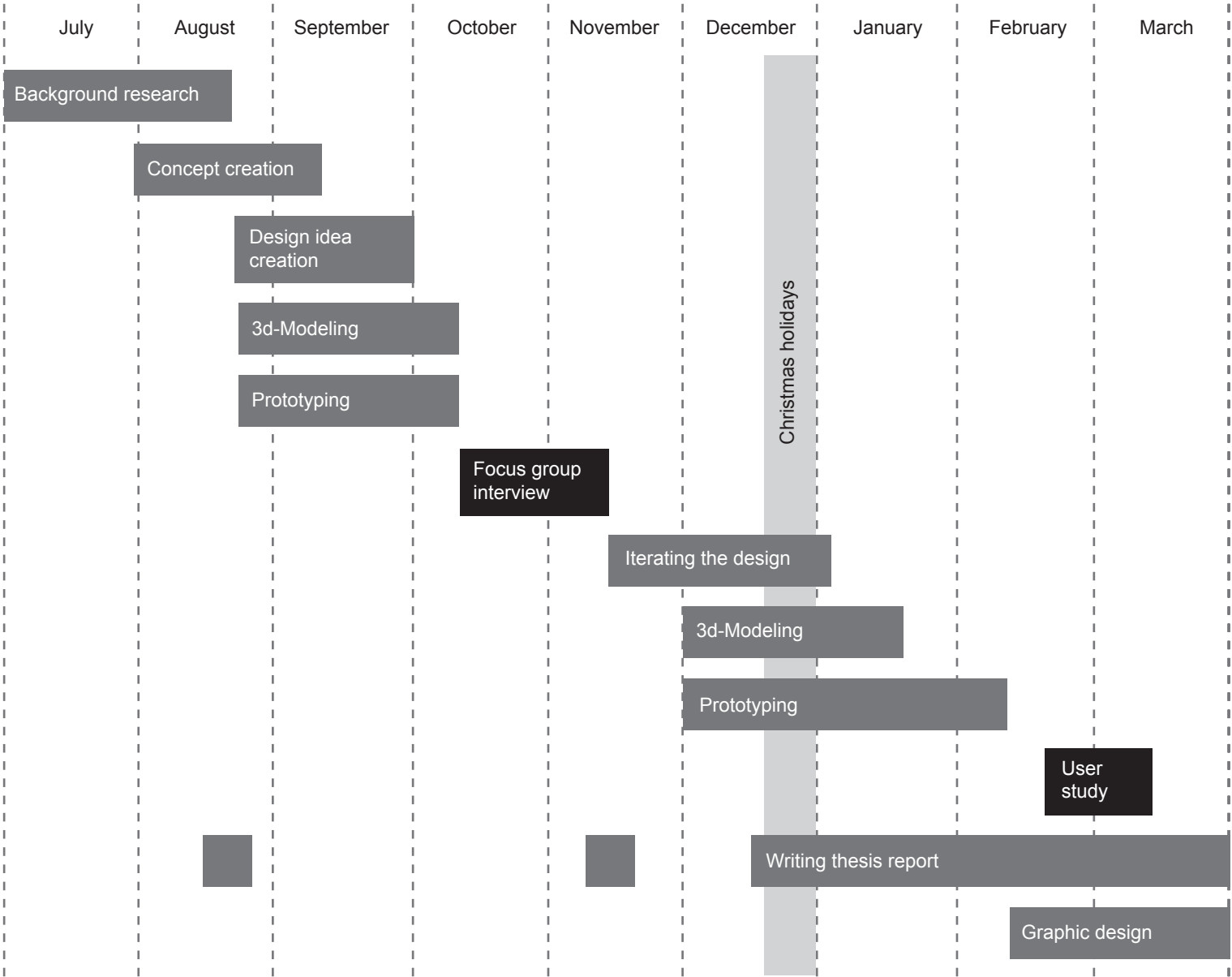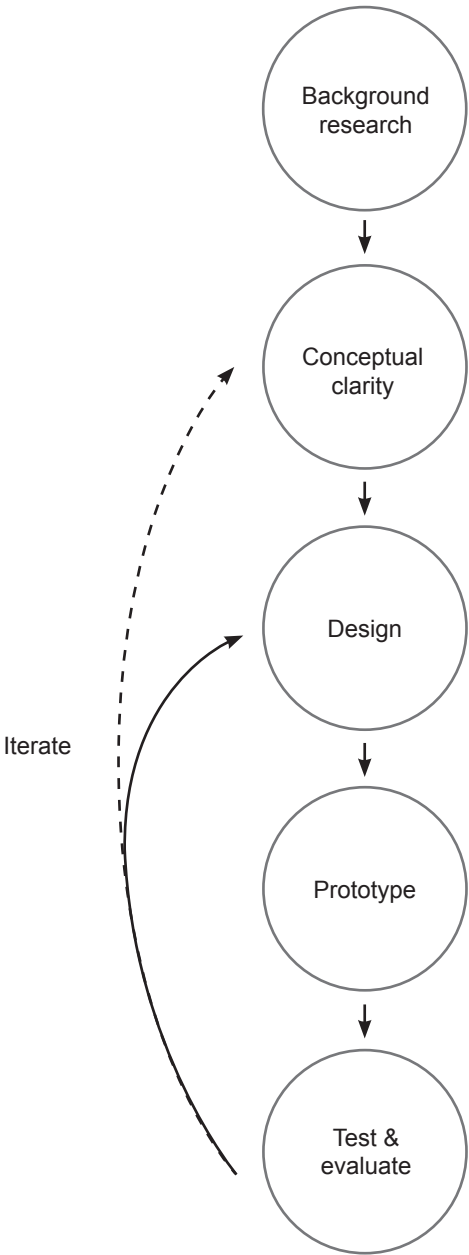
2. Backround research

2.1 Wearable technology and user acceptance

2.1.1 About wearable technology

In order to understand better wearable technology field, I made lot of benchmarking and read articles and trend research reports about the topic. I tried to form my own vision of how I could design an acceptable wearable technology device for my target group. This section aims to give some insights into wearable devices as a new product category and which things effect on the acceptability of wearable technology device from consumer`s point of view. I want to help a reader to understand how my concept is positioned in wearable technology field, and what is the theoretical framework for my design decisions.

What is wearable technology?

According to Steve Mann, a wearable technology pioneer, wearable technology is "the study or practice of inventing, designing, building, or using miniature body-borne computational and sensory devices. Wearable computers may be worn under, over, or in clothing, or may also be themselves clothes". (Mann, 2014, 23.0.)

In everyday talk, many people see wearable technology devices equivalent to smart watches or fitness trackers, as these are the most visible examples in the media. The market is fast-evolving and it is difficult to find clear product categories yet. From my point of view any wearable item containing electronic components is part of wearable technology.

Wearable technology devices categorization

To better understand this field I made several attempts to categorize wearable technology devices. One categoriza-

tion was according to the form factor: there are for instance glasses, watches, jewelries, wristbands, shoes, clothes, headbands and other kind of clips and bands. Some of the shapes are familiar from traditional wearable accessories and some are new.

One categorization could be by function: there are for instance wearable devices for healthcare, wellness/fitness, smartphone notifications, communication, military, industry, security, life logging and professional sport. Other way to categorize wearable technology device could be, whether it is an independent device or needs a smartphone for its companion. For instance Google Glass is an independent Internet-connected device and most of the activity trackers need smartphone for device control and data analysis.

Big differentiator, especially from design perspective, is whether the wearable technology device is aimed for consumer- or business-to-business market. I think that at work people are more willing to wear devices which do not represent their personal taste or style, since they are paid for doing so. Good example of that are work uniforms. On the contrary, in free time people are more selective on choosing the clothes and accessories they want to wear.

Sensors

The development of wearable technology has happened hand-in-hand with the development of sensor technology. Sensors are devices that convert a physical parameter such as temperature, pressure or speed into a signal that can be measured electrically (Sensorsweb.com, 2015). Sensors that continuously collect data from user`s body and environment are in the core of wearable technology.

2.1.2 Diffusion of Innovations

Diffusion of innovations is a theory developed by Everett Rogers. It tries to explain how new ideas and innovations spread through culture and at what rate. Rogers divides consumers into five categories according to their technology adoption rate. The groups are Innovators (2.5% of population), Early Adopters (13.5%), Early Majority (34%), Late Majority (34%) and Laggards (16%). (Rogers, 2003, p.150.) These groups have different roles, and they also effect on each other. The Innovators and Early Adopters are so called opinion leaders, who can persuade other users to adopt new technology. People who adopt technology earlier are generally younger and they have higher social status and greater financial lucidity than people who adopt technology later. (Rogers, 2003, p. 283.)

Wearable technology companies are now probably in a shift between Early Adopters and Early Majority and they seek
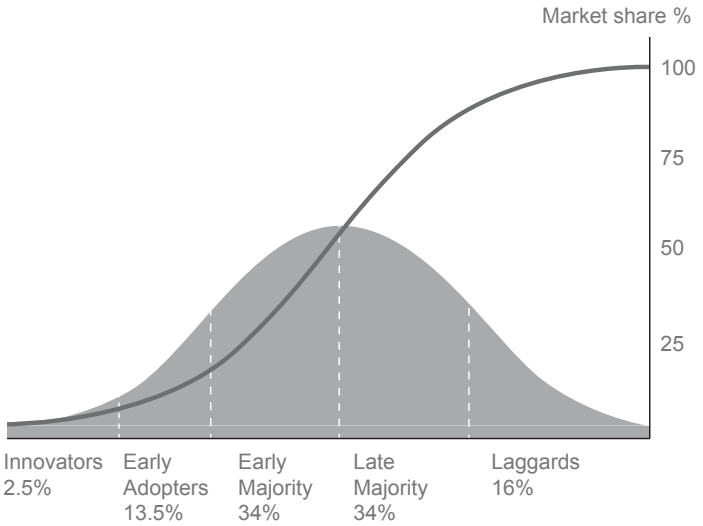
Market share %

FIG 1: Diffusion of Innovations -model (Rogers, 1983, p.243-247.)

for wider adoption rate. In this shift design can play important role, as people who are not per se enthusiastic about all new technology are in target.

2.1.3 Design guidelines for acceptable wearable technology devices

In my background research I was looking for things that make wearable technology devices acceptable and desirable for users. As a designer I found out four guidelines I was interested in:

• The design needs to appear appealing and stylish to consumer
• The device needs to be easy-to-use
• It needs to be socially acceptable to use the device. This is linked to both design and interaction: if the device makes the user appear like a fool for others, she does not want to wear it
• The device needs to feel useful for consumer

I`ll open up these aspects below.

Social acceptance

Buenaflor and Kim state in their research about human factors to acceptability of wearable computers, that the main social aspects effecting the acceptability of wearable technology device are personal privacy, social influences and culture. Most important social influences come from family, friends and colleagues. (Buenaflor and Kim, 2013, 109.)

One of the most remarkable wearable technology commercial launches in past few years, Google Glass, has been criticized to look "nerdy" or uncomfortably collecting gazes for example by The Guardian- and The Wired -magazines (Honan, 2013 and Gibbs, 2014). The interaction with Google Glass requires visible signs like talking and nodding, which can feel socially uncomfortable. Other common worry with Google Glass has been the video-recording and photographing functionalities, which made surrounding people

FIG 2 Samsung Galaxy Gear Smartwatch (Samsung, 2013)

FIG 3: Fitbit Flex activity tracker (Fitbit, 2015)

FIG 4: Ringly, connected jewelry for smartphone notifications (Ringly, 2015)

FIG 5: Wearable solar power charger (Pauline Van Dongen, 2013)

FIG 6: Steve Mann wearing computized eyewear in 1994 (R. Hughes, 1994)

FIG 7: Google Glass worn by Sergey Brin (RuhrNachrichten.de, 2013)

FIG 8: Nod, gesture-control ring (Character, 2015)

FIG 9: Modwells, wearable device that helps to improve your posture (Artefact, 2015)

fear of losing their privacy (Swearingen, 2015). We will see if people will be ready to act differently in future, but currently Google Glass seems to be too much for consumers, as Google is giving up the production of Google Glass in its present form (Woolf, 2015). Google Glass seems to need a cultural change to be accepted by wider population.

One interesting thought play I had, was about the visibility of wearable device and the interaction. Stroking your phone is socially accepted today, but when, if ever, people will be ready to talk, weave their hands in air or make weird facial expressions in order to interact with their devices? Would you like to show or hide your wearable technology device? And more interestingly: if it is visible how should it look like?

Demographic characters, such as age, gender and technical experience effect on the acceptance of wearable technology (Buenaflor and Kim, 2013, 110-111). Schaar and Ziefle evaluated the acceptance of smart shirts in men and women and found that men were more accepting of the technology than women (Schaarand and Ziefle, 2011, 601-608). Elderly people are not accustomed to use new technology devices so they might have difficulties in learning to use them. People who lack the experience of using technology have sometimes negative attitudes against starting to use new technology. (Buenaflor and Kim, 2013, 110.)

Interaction

Wearable technology devices give new challenges to interaction design as well. Depending on whether there is just output medium, or both input- and output mediums in wearable device, the challenges are different. For input medium, the small size of wearable device sets challenges for usability, especially when using screen as an interface.

According to Steve Mann: "the goal of wearable computing is to position or contextualize the computer in such a way that the human and computer are inextricably intertwined, so as to achieve Humanistic Intelligence – i.e. intelligence that arises by having the human being in the feedback loop

of the computational process" (Mann 2013, 23.3). According to Mann this leads to two features: constancy of interaction and ability to multi-task. This means that, unlike with other portable devices, you do not have to especially stop your other activities to use the wearable device. (Mann 2013, 23.3.)

If the aim of wearable device is to be an immersive part of users` mobile, everyday life, then the interaction should be extremely easy and quick without complex navigations and controls. Multimodal user interfaces could be utilized to allow truly mobile, eyes-free use of device (Lumsden and Brewster, 2003, 3). Multimodality could mean for instance utilizing sound, tactile feedback or LED-light as an output method, and for instance natural voice, gestures and touch as an input method. Especially new kind of interactions, such as gestural- and natural voice interaction have been recently researched a lot. Context-aware computing has also been seen as a solution for the problems of mobility and size (Lumsden and Brewster, 2003, 4). For instance in case of smartwatch, context-aware interface could mean that you would only see the information relevant in your current situation on the smartwatches tiny screen.

Design; style

There are some literature sources about designing for wearable technology, but most of them are focused on smart clothing. Some practitioners have also given statements on how they think wearable devices should be designed. One expert, I picked up, is Jennifer Darmour, who has been working in wearable technology -related companies like Artefact, Electricfoxy and Chrono. She has stated in her article in co-design web-magazine: "Until recently, in the technology industry the idea of aesthetic value was often considered secondary and sometimes controversial. Yet fashion and aesthetics are important when you start wearing the product on your body--it becomes a part of our identity and a mode of self-expression; it evokes certain perceptions in others and starts to define us. That is why beauty is essential to wearables" (Darmour, 2013). There are many approaches

to designing wearable technology devices: should a new design language be created for new kind of products, or should the form factors of traditional wearable accessories be utilized as people already accept to wear them?

Physical comfort is important for the wearable device to be accepted. Size and weight of the device and how it effects on body movement are main factors effecting on the comfort. (Buenaflor and Kim, 2013, 109.)

Utility

The common problem outspoken within wearable technology is that the devices on market do not answer to the customers` real needs. One signal of this is that many people have stopped wearing their fitness tracker or smartwatch after a while. According to survey that Endeavour Partners did in US in June 2014, about a third of owners of smart wearable devices abandon those after six months (Ledger and McCafrey, 2014, 4).

Utility and user needs are interesting since the perception of utility varies by user. The concept of utility can be seen from the perspective of fundamental needs meaning Maslow`s hierarchy of needs. Other manner of an approach is cognitive attitude, that emphasizes perceived usefulness and perceived ease-of-use, which effect on the users` willingness to start to use a new device. (Buenaflor and Kim, 2013, 106-107.)

One function vs. "Swiss knife"

Popular approach to making wearable devices has been making a platform, on the other words wrapping a smartphone on your wrist. This kind of product has many functions and gives possibilities to application-makers to expand the use cases. One-function wearable devices are more closed systems that answer just to one or few needs. The challenge with this kind of devices is to find a function that is needed many times during a day, if the wearable device is meant to be worn all the time. "Swiss knife"-type of wear-

able devices generally have both input and output media, whereas one-function-type of devices have sometimes just output media.

2.2 Focusing the topic

2.2.1 Positioning my topic

I positioned my concept in the smartphone companion- and one function category. The function I chose was contactless payment. To be able to prototype and test the idea, I needed to focus on some simple-enough function. I selected payments because it seemed quite simple and meaningful function for a wearable device, as Near-Field-Communication (NFC) is becoming a standard solution for contactless payments. I also got some ideas how to improve the authentication process to make the payment safer. I wanted to make a wearable device that would just have simple tactile feedback as an output method and use phone as an input method, so that I could have cheaper product and get more freedom for my design, due to small number of components and the lack of big visible components such as screen.

The main connectivity technology for contactless payments is Near-Field-Communication (NFC). NFC technology enables simple and safe two-way interactions between electronic devices, allowing users to perform contactless transactions, access digital content, and connect electronic devices with a single touch. NFC operates in a distance less than four centimeters. (NFC Forum, 2015.) NFC itself is passive, so it does not need battery, unlike for instance Bluetooth. Passive NFC-tag can have quite small size depending on the size of antenna (FIG 10).

Wearable payment and authentication have been stated to be one of future trends for wearable technology devices by Endeavour Partners (Ledger and McCafrey, 2014, 7) and PSFK-labs in co-operation with Intel (PSFK-labs in co-operation with Intel, 2014, 24-25). Mobile contactless payments have been tried to push to market for a while without great success. I thought it could make sense to explore, if in some

cases wearable payment could be more convenient and safer solution. Wearable device is always available, so there is no need to look for your phone or wallet from your purse. You could easily check whether you are having your wearable device with you so it is more difficult to loose. If the wearability becomes part of the authentication, the device would be safer, as it would not work if you were not wearing it.

Wearable payment

There are many ways to make a wearable contactless payment solution. One approach is that the wearable device is an extension to mobile wallet. In that case it is totally dependent on smartphone. Other approach is that the wearable device is like credit- or debit card, so that it is directly connected to your bank account, like AppleyPay for iWatch (FIG 13). The abovementioned business model is quite complicated and requires good networking with banks. From risk management- and technical implementation point of view it is complex as well. I decided once again to simplify things for myself, and decided to make my payment method like a prepaid debit card. There are many examples of this kind of system, for instance Oyster card in London, Octopus card in Hong Kong (FIG 11-12), BPay-band in England (FIG 14) and Elisa-Lompakko in Finland. I think the most important thing for consumer is that the system is easy-to-use, fast and safe. In prepaid system the only effort is to transfer money to prepaid card, so if I could make that easy, it would meet all abovementioned criteria.

Authentication for wearable payment

Human authentication is a security task which job is to limit access to space, product, service or computer network only to those with authorization, meaning permission to use the
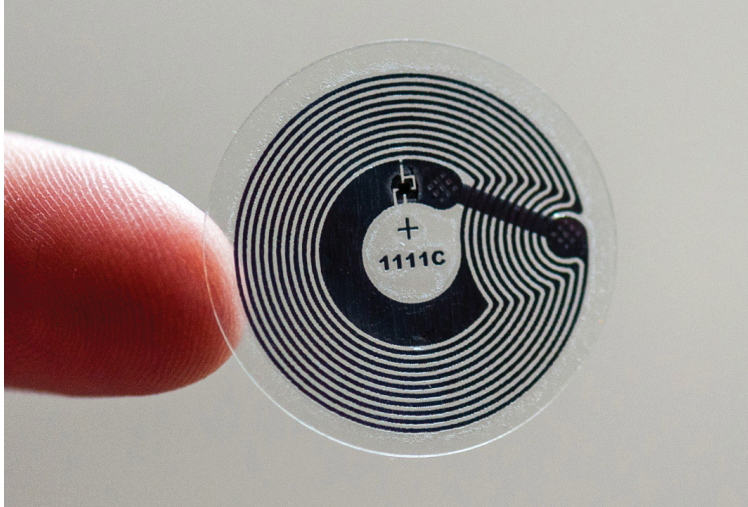
FIG 10: Typical NFC-tag (XDA-Developers, 2014)

FIG 11: Traditional Octopus card, children`s model (Desella, 2012)

FIG 12: Octopus card in decorated keychain (Clitter Gem, 2010)

FIG 13: Apple Pay for iWatch: Picture from Apple`s video (Reuters, 2014)

system. Authentication can be based on different factors: something you know (password, PIN etc.) something you have (token, for instance a key or smart card) or something you are (biometrics: fingerprint, signature, voice etc.). (Jin, Ling and Goh, 2004, 2245.) Authentication is crucial for payment devices because it protects the money in case that somebody for instance steals the payment token.

Strong authentication, also called multi-factor authentication, means that at least two distinct factors are used for authentication. For instance in case of traditional credit card, the authentication is based on what you have (the card), and what you know (your PIN). The biggest security risk in credit card is the visibility of card number in the case that card gets stolen. Currently most of the NFC-payment solutions on market in Finland do not have multi-factor authentication. Instead the risks are minimized by setting single purchasing limit to 25€.

The advantage of wearable device is that in many cases you wear it all day, so by utilizing sensor technology the device could know your identity all the time you are wearing it, and therefore other devices could know you as well. I was interested in wearable devices, which utilize the wearability in user interface by using sensors that measure for instance skin contact or pulse. One sample of wearable authentication device is Nymi, a bracelet which uses users` electrocardiogram as an authentication method and stops working if it is taken off (Nymi, 2015) (FIG 15). I wanted to use putting on and taking off as a switch. The key idea I had, was that the device would know when you`re wearing it and would then work, but it would not work after it is taken off or if someone else is trying to wear it.

Digital jewelry

After thinking of it for a while, I came to a conclusion that most acceptable form factor for wearable device aimed for young women, who are not strongly engaged with technology, would be something that resembles an existing accessory that these women are already wearing. This is the

main process-driving assumption I made about the design. It is possible that digital jewelries will be a stepping stone to other kind of designs (PSFK-labs in co-operation with Intel, 2014, 4). After getting used to use digital jewelry people might become more accepting towards new form factors.

I got interested in jewelry because it seems to be, unlike for instance eye glasses, a piece of wearable item without clear utility function, whereas ICT in my mind connects strongly with utility. Jewelry, by Merriam-Webster online dictionary definition, is "objects designed for the adornment of the body, usually made of gold, silver, or platinum, often with precious or semiprecious stones and such organic substances as pearls, coral, and amber" (Merriam-Webster online dictionary, 2015). Jewelries made with inexpensive materials or imitation gemstones are called costume jewelries (Merriam Webster online dictionary, 2015). Nowadays the value of jewelry seems to become from aesthetics and communicating user`s lifestyle, values and style to other people. Jewelry can also represents rituals and social status and bring back memories attached to it, for instance when it was given as a gift. (Ahde-Deal, 2013, 12-13.) In past, the value of jewelry was connected to the value of precious materials like gold, which meant that people in a way worn their property. In my mind this connection fitted well together with the idea of wearable payment.

2.2.2 Social media-survey about daily payment habits

I did a survey to collect some basic information about the payment habits of my target group. I shared my survey in Facebook. I was interested to know what people in my target group (women, 16-40 years old) use as their primary payment method, or if they had shared bank accounts or loyalty cards which should be included in the service. I wanted to have this information mainly to confirm my assumptions about the target group`s payment habits.
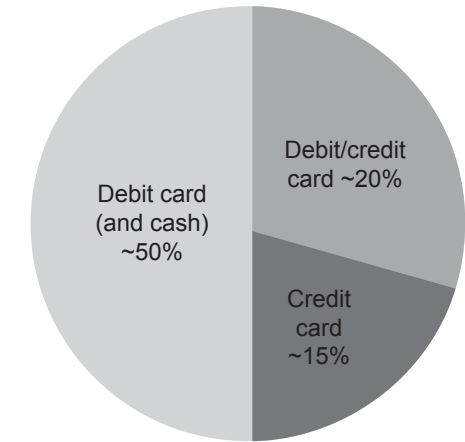
FIG 14: BPay Band, contactless payment device (Gizmondo UK, 2014)

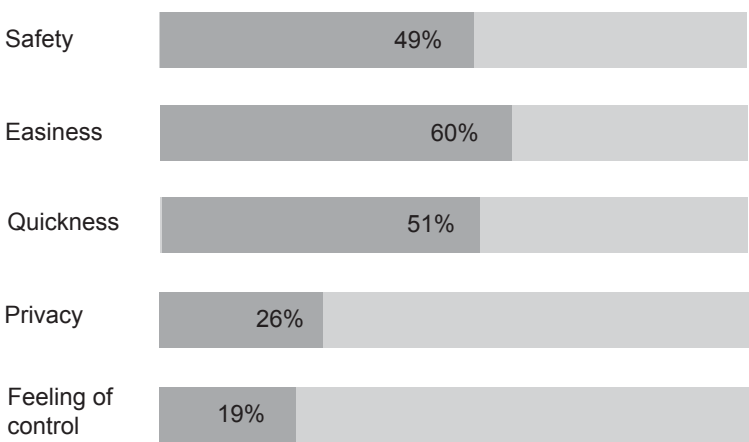FIG 15: Nymi, an authentication bracelet baced on ECG (VS, 2014)

Facebook survey results:

What is your main daily payment method?

Which of the following qualities are important for you in your daily payment method?

"This is very important for me"

The results

I made the survey using Google Forms and shared the link in Facebook in different groups and individually by sending a message. I made the survey short, because I wanted more answers. Finally I was satisfied after getting answers from 47 women aged 16-40 years old, most of them (77%) living in Finland.

The majority of answerers (92%) were 21-35 years old. The biggest occupational groups were students (55%) and junior employees (26%). This could refer to rather low income, which can explain for instance the low use of credit cards and low commitment to loyalty programs. As my selected wide age group contains people from different income groups, it should be taken account when thinking about the pricing of the payment product and for instance in the selection of materials.

The most used daily payment method was debit card (53%), combined debit- and credit card was used by 19% of answerers and only credit card was used by 17%. 51% of the answerers regularly used both cash and debit card in their daily life. 19% of answerers used just single payment method in their daily lives.

36% of answerers did not have any loyalty cards, 11% used loyalty cards every day and 28% used loyalty cards few times in a week. 85% of answerers did not have shared account with someone. This might refer to the fact that there are more singles in this age group than in older age groups.

I asked people what is important for them in their daily payment method. I asked them to rank from 1 (least important) to 5 (very important) the following options based on their preference: safety, easiness, quickness, privacy, feeling of control. The result was that easiness was the most important quality for answerers (very important for 60%). Quickness was the second important quality for answerers (very important for 51%). Safety was third important quality (very important for 49%). Feeling of control was least important

quality for answerers (very important only for 19%). I was a bit surprised that people seemed to value quickness and easiness over safety. My guess is that safety is considered as compulsory quality, and the lack of safety would lead to decision of not using certain payment method. That could be one explanation to why answerers did not want to compromise ease of use and quickness over safety.

Conclusions

This survey confirmed my idea that one simple payment method would be enough to serve the target users` everyday payment needs. I decided that it is not necessary to include loyalty cards in my concept. I got also some (quite obvious) insights into the socio-economical state of women aged ~20-35 years old: many of them are still students or in lower position in work life, so they do not have huge income and they are probably more price-conscious as well. Of course this sample isn`t very wide, and focuses on highly educated people since I shared the survey in Facebook among my friends and in student-groups. People who answered to my survey seemed to appreciate most easiness, quickness and safety in their daily payment method.

3. Forming a technical concept

3.1 Defining the basis for my design

My goal for the concept was to make a wearable, contactless alternative proposal for traditional debit card in small everyday purchases, my target user group being young women. I also had some special use cases in mind, like people who wish to better manage their consumption and travelers. I needed to improve the payment process to make a better option to debit card in some occasions.

Payment as a main function for wearable device requires that the device works really smoothly, since there is no fundamental problem in current payment methods (credit- and debit cards) which would bother people and would need to be immediately fixed. In this kind of product the appearance, ease-of-use and price should be well-balanced to make it desirable for consumer.

Technology

As NFC is becoming a standard connectivity method in contactless payments, it did not feel meaningful to explore widely other wireless connectivity technologies. A natural place for jewelry utilizing NFC was around hand, since minimum effort was needed to reach the point of sale. I decided to focus on hand-worn jewelries such as bracelets and rings. Before I settled on using NFC, I had ideas about many kinds of jewelry. One idea for instance was that it would have been more difficult to steal a jewelry which is invisible or attached to your body like an earring or naval jewel.

Business model

From conceptualization point of view, one quite important field, company strategy and business model, is practically out-scoped from this work. Main reason for this, was the transformation of Phones-unit from Nokia to Microsoft, which changed company strategy from wearable technology perspective a lot. This concept is not aimed to fit to Microsoft`s strategy, unless Microsoft would file for banking licence. The business model around banking is changing rapidly because of mobile payments. Many operators, like Elisa in Finland, have filed for banking license recently. With current business environment this wearable prepaid payment concept would be suitable for company which has a banking license and has resources for design. It could also be for instance a co-operation between bank or telecom operator and jewelry design company.

Interaction

How does it feel to wear your wallet?

In interaction design my focus was in easiness, quickness, security and feeling of control. Based on my Facebook-survey, I think security is a threshold for starting to use this kind of device, and easiness and quickness can be competitional assets together with appealing design. If the device does not appear secure or does not succeed to convince it is secure to use, people would not use it. Starting to use the device should be really easy and especially the first payment experience should be successful.

Authentication feature was added to increase security without compromising quickness and easiness. I think the 25€ purchasing limit is absolutely too low for being really usable, so the security issues needed to be solved in other way.

For increasing easiness and quickness, I decided to go with "minimum interaction and function" -principle, and add more features later in iteration if needed. Keeping price point low was also one reason to aim for simplicity.

Tactile feedback was added because I thought it would increase the feeling of control in contactless payment as user would be more aware of the progress of payment process. The idea was that there would be small vibrotactile pulses when the transaction begins and one stronger signal when it is finished.

Relationship between phone and wearable device

I had already decided to use mobile application as a main user interface for my wearable device. The further question was, whether the user should be able to use the wearable device without the phone or not. I decided that the authentication would be done with phone once in a day. The mobile application would be used for getting information about the balance and purchasing history, changing purchasing limits and adding money to wearable device. Otherwise the payment device would be independent. I think the payment should be possible to do without the smartphone, because there might be for instance battery run-out in your phone.

Comparing the payment processes

Traditional debit card:

1. Find your wallet from your pocket/ purse
2. Take the card out
3. Put the card inside reader
4. Insert your PIN
5. Wait until payment is succeeded

Nfc enabled card:

1. Find your wallet from your pocket/ purse
2. Take the card out (if there`s multiple NFC-enabled cards)
3. Reach the reader
4. Hold until payment is succeeded
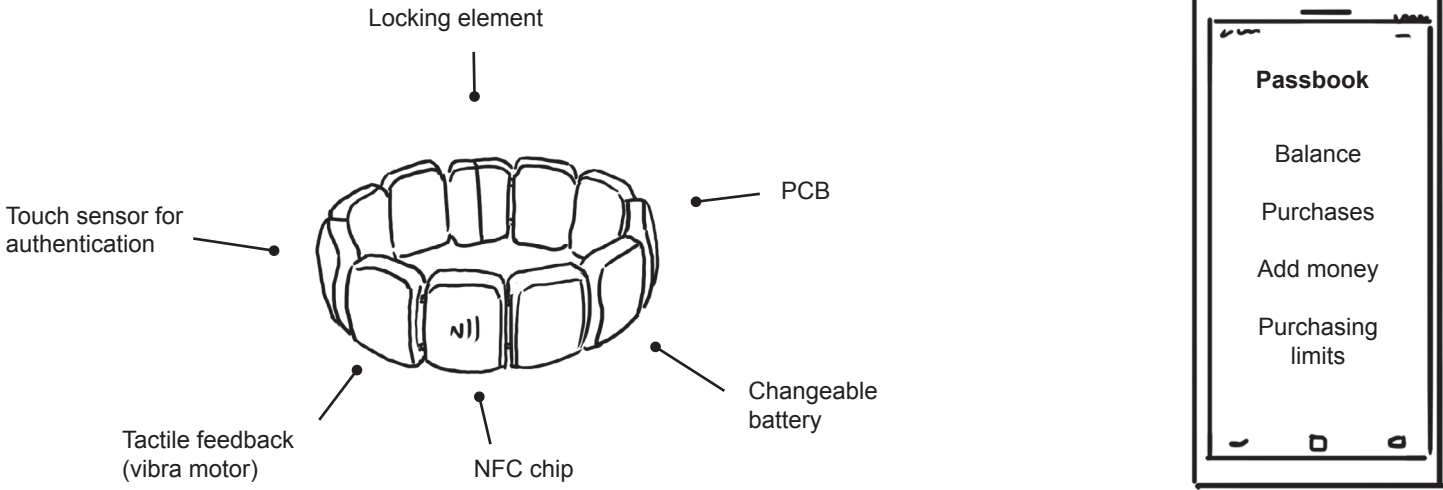
Mobile payment example process:

(Apple Pay with iPhone 6)

1. Find your phone from your pocket/ purse
2. Reach the reader
3. Touch "Touch ID" to accept the payment (repeat many times if it does not recognize your fingerprint)
4. Hold until payment is succeeded

My concept:

1. Reach the reader
2. Hold on until payment is succeeded

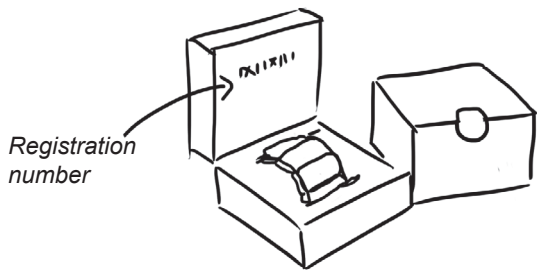# 3.2 Payment jewelry and mobile application

NFC is used for payment and discussion between jewelry and smartphone. Touch sensor measures if the jewelry is being worn when doing the authentication and after that in every fifteen minutes. If sensor detects that the item is not being worn, it cancels the authentication. All the components are quite cheap, so the starting cost for the device is low.

The application is meant for checking the balance and purchasing history, reloading money to the bracelet and setting and adjusting purchasing limits.
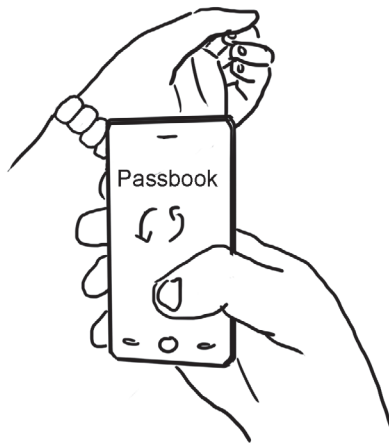
3.3 Interaction model

1) Starting to use the device

Registration number

1. Purchase the payment jewelry from authorized seller

2. Put on the jewelry first time

Passbook

Register device

3. Tap the jewelry with phone and the Passbook application starts to upload
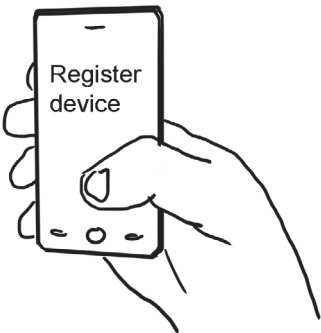
4. Register your jewelry and set a password

In the morning

In the evening

PIN

1. Put on the jewelry

2. Tap the jewery with phone and insert your password. After authentication you can make payments by tapping the payment terminal until you take off the jewelry

Taking off the jewelry cancels the authentication. Authentication is required to be able to use the device again

3) Making payment and using mobile application

Making payment

Using mobile application

+ 200€

Purchases:
S-market
ABC
Ami

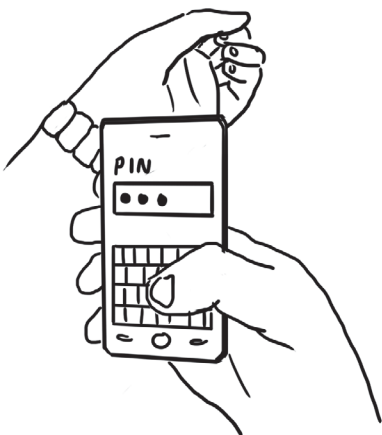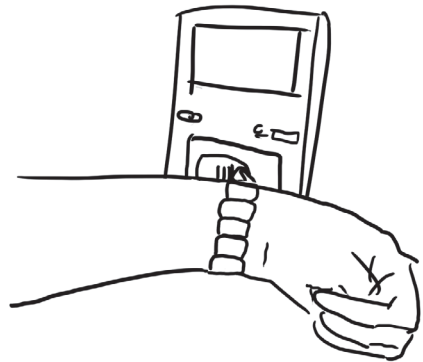Tap the payment terminal with the jewelry. A pulsatory vibration indicates when the transaction becomes and a stronger vibratory signal indicates when the payment is done and you can remove your hand
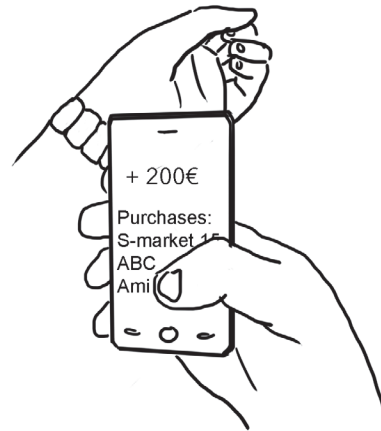
Tap the jewelry with your smartphone. When the application launches, first view is your balance and purchasing history. Other views in panorama setting are reloading money to the jewelry and adjusting purchasing limits.

4. Design process
PHASE 1

4.1 Design idea creation

Designing smart jewelry

The biggest design-related challenge was that I did not have any previous experience in jewelry design and I do not use jewelries on daily basis. I did some background research on the ways young women wear jewelries and I also got some insights into that in two user studies I conducted. First I tried to imagine what kind of jewelry my concept would be. I intended my jewelry to be used on everyday basis, so that makes a difference between this jewelry and the jewelries that are changed on day-to-day basis. The other difference between ordinary jewelry and digital jewelry is that the lifespan of digital jewelry is much shorter than the lifespan of traditional jewelries.

I set some objectives for my design work:
- Resembles a jewelry (form language, materials)
- Attachments are steady
- It is comfortable to wear (size, weight, feel)
- Adjustable for different hand sizes
- Fits to many kind of styles/ it is possible to customize
- Good contact between skin and the device is needed for vibrotactile feedback

What customization means in context of everyday jewelry?

My first expectation was that people might want to change their jewelry every now and then, like they change clothes. One approach to this problem might be to design something so universal that it fits to almost all styles. Other approach could be to try to design something that can be modified to fit the changing needs. In the beginning I was pretty convinced that my jewelry should be customizable after purchasing. After holding the focus group interview, I changed this assumption a bit.

Decorative vs. neutral design language

Some women like unisex, plain designs, but some prefer more feminine design language, which came out many times in my focus group interview. Wearing jewelry is something, that, at least in Finland, is highly gender-related which means that jewelry is used to emphasize user`s femininity. Most of the men do not wear jewelry in Finland, excluding wedding ring and wrist watch. Feminine jewelry design, based on my assumptions and findings from benchmarking and focus group interview, means smooth/curved shapes, possibly higher level of decoration, use of certain colors and gemstones such as crystals and diamonds.

In Finnish- and Scandinavian design tradition the look of product is minimalistic and pure, and as such it is not seen neither feminine or masculine. In my first ideas I searched the balance between simple and feminine design language, because I wanted to keep the jewelry pure-shaped yet aesthetically pleasurable. The need for simplicity came from both my own preference and the fact that it is more difficult to find a decorative style that pleases many people. I think in best case there would be both decorative- and simple versions of jewelry available.

One disruptive factor in jewelry design is fashion and changing trends, which effect on the acceptability of design in a way that was difficult for me to understand. I tried to cope with this by aiming for timeless and simple look.

What materials should be used?

My starting point was that there should be some metal in the product to make it look like a jewelry. Plastic is easily asso-

Costume jewelry   My target price (around 100€)   Fine jewelry

Cheap, mass-production plastic, cheap metals, short lifecycle

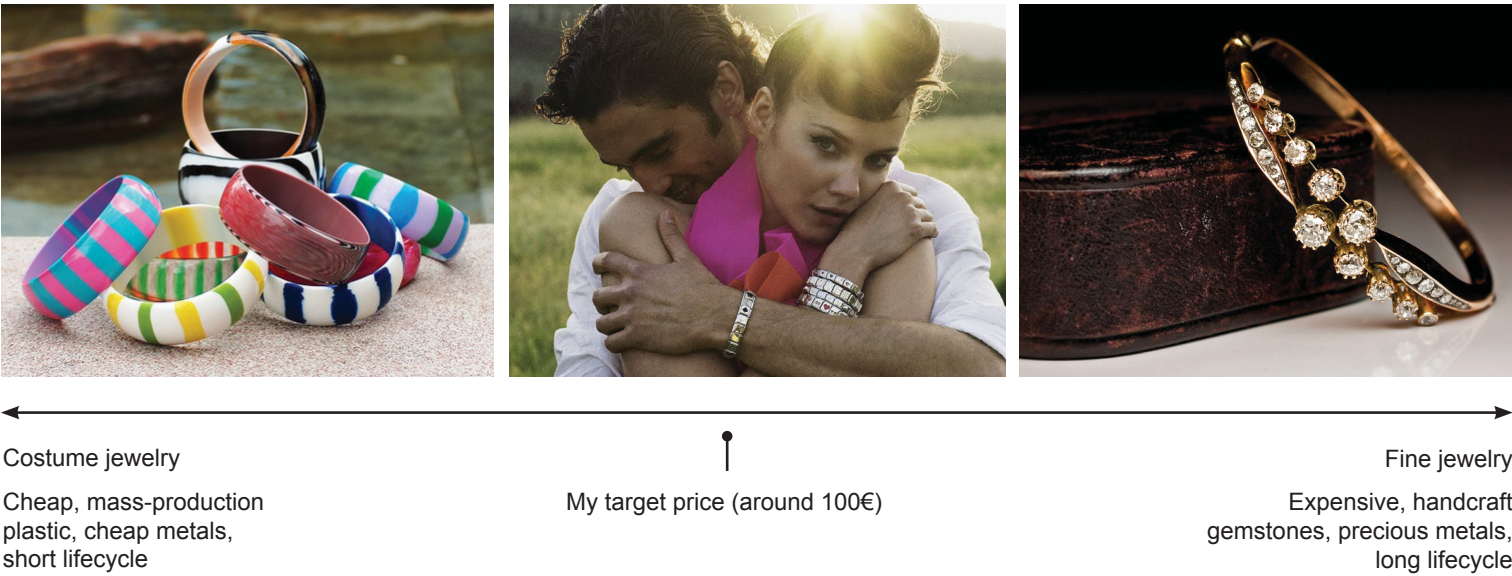Expensive, handcraft gemstones, precious metals, long lifecycle

FIG 16: Jewelries from different prize categories (Affordablegaminglaptops536.blogspot.fi, 2015), (Nominationitaly.blogspot.fi/, 2011), (Romanovrussia.com, 2015)

ciated with baubles and bad quality. I had some ideas with 3d-printing involved, so I wanted to explore if plastic could be used together with silver or steel.

In my opinion, the key aspect to materials is the intended lifetime of the product. In traditional jewelry design, the lifespan of product might be many generations, as the jewelries get inherited form mother to daughter. For wearable technology devices the lifespan might be just few years, since the technology is evolving fast. Against that, I do not see a point in using very expensive materials, such as gold or diamonds, in other than extremely luxurious products.

The interesting link between jewelry and money is the concept of value in material. In money the value has became abstract, as money today is more ones and zeroes instead of gold coins. In jewelry world the idea of precious materials is still strong, at least in Finland. It seems that the tradition is strong even though the idea of wearing your property no longer exists. Might be that younger people are more flexible on materials, as they might prefer low price over precious materials.

One debate I had in my head was, whether the payment device should be look precious or cheap. Would too expensive-looking jewelry attract pickpockets? The credit- and debit cards we use, are very neutral and does not appear expensive. If we will start to use the phone as payment method the physical standalone payment device disappears.

How the size effects on acceptability?

The sizes of electrical components are one roadblock that wearable technology developers are facing. I also encountered this issue, because I did not have proper technical development team behind me. Miniaturization of technology requires special skills which our team did not have. I benchmarked wearable technology devices with similar functionality and technical components, to get understanding what could be done now and what could be possible to do in near future. As my work was conceptual, it did not have to be fully

working or executable at the moment. My aim was to have a concept showing what kind of design could be suitable for this kind of product, not a fully functional device.

In jewelry design the sizing and mass-division is very important. The jewelry should not look bulky or sturdy. I studied the sizing of ordinary jewelries to understand how I should approach this issue. Big, showy jewelries are often called statement jewelries, and these items are generally something you do not wear every day. I aimed to do something having somehow feasible size, but being also delicate- and elegant looking.

Design process

First I sketched many kind of ideas and pretty early I started to model with Rhino and 3d-print my models to better review the designs. Later I combined many ideas into three ideas that varied by form factor and portrayed different customization possibilities.

Balancing between "feminine" and "neutral"/simple design language
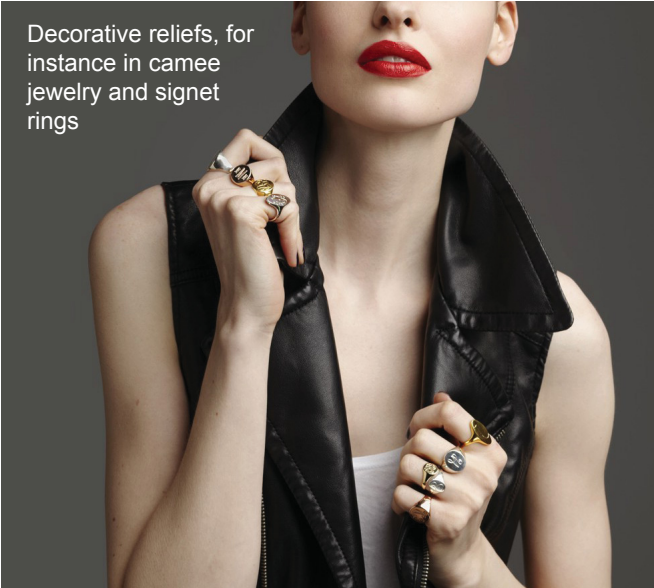
FIG 17: Moodboard: the existing jewelries and jewelry design details which I used as an inspirational source for my designs (Luttrellstudio, 2015), (Smyrniotaki, E., 2012), (Chloe, S., 2015), (Garrett, B., 2015)
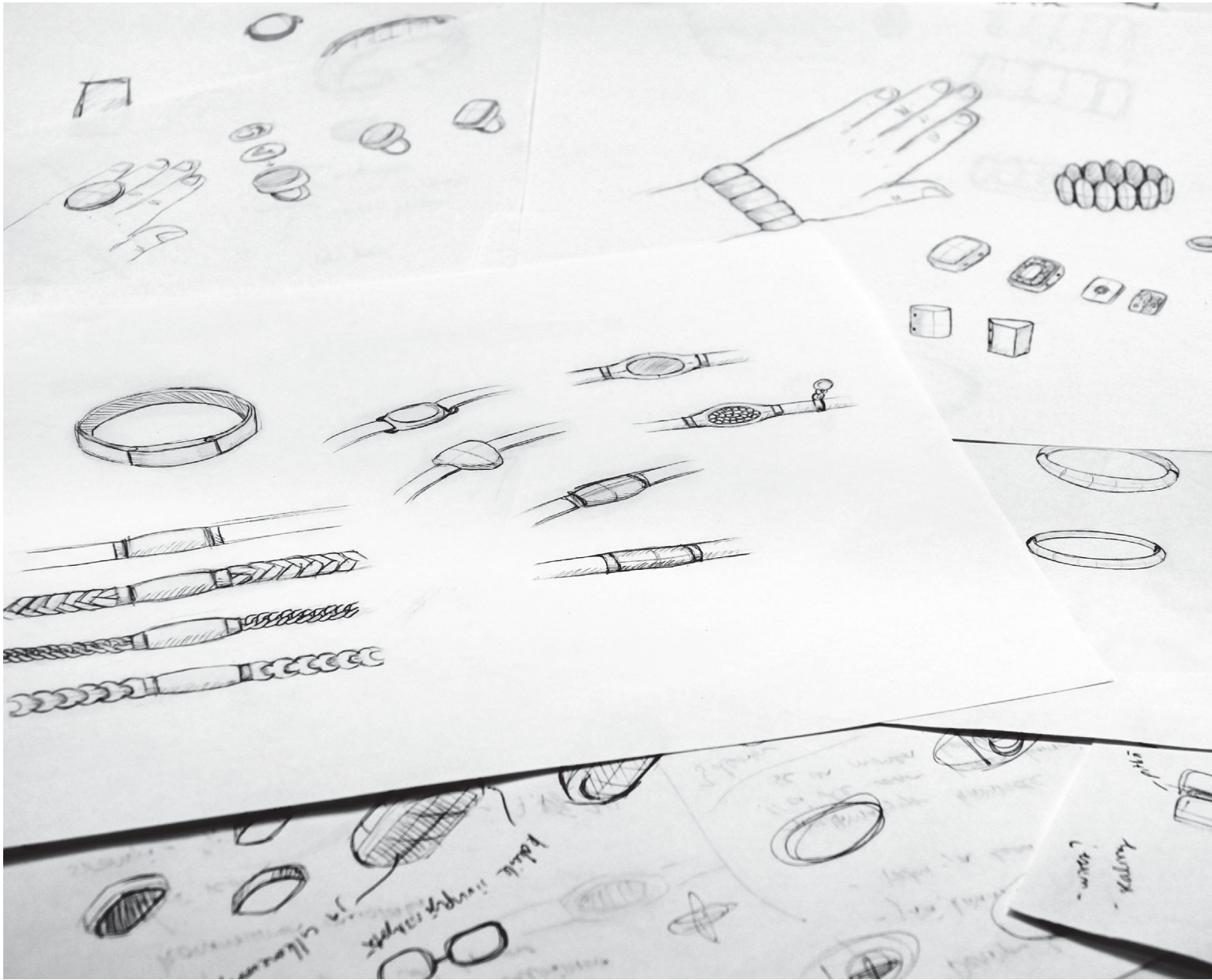
Sketches
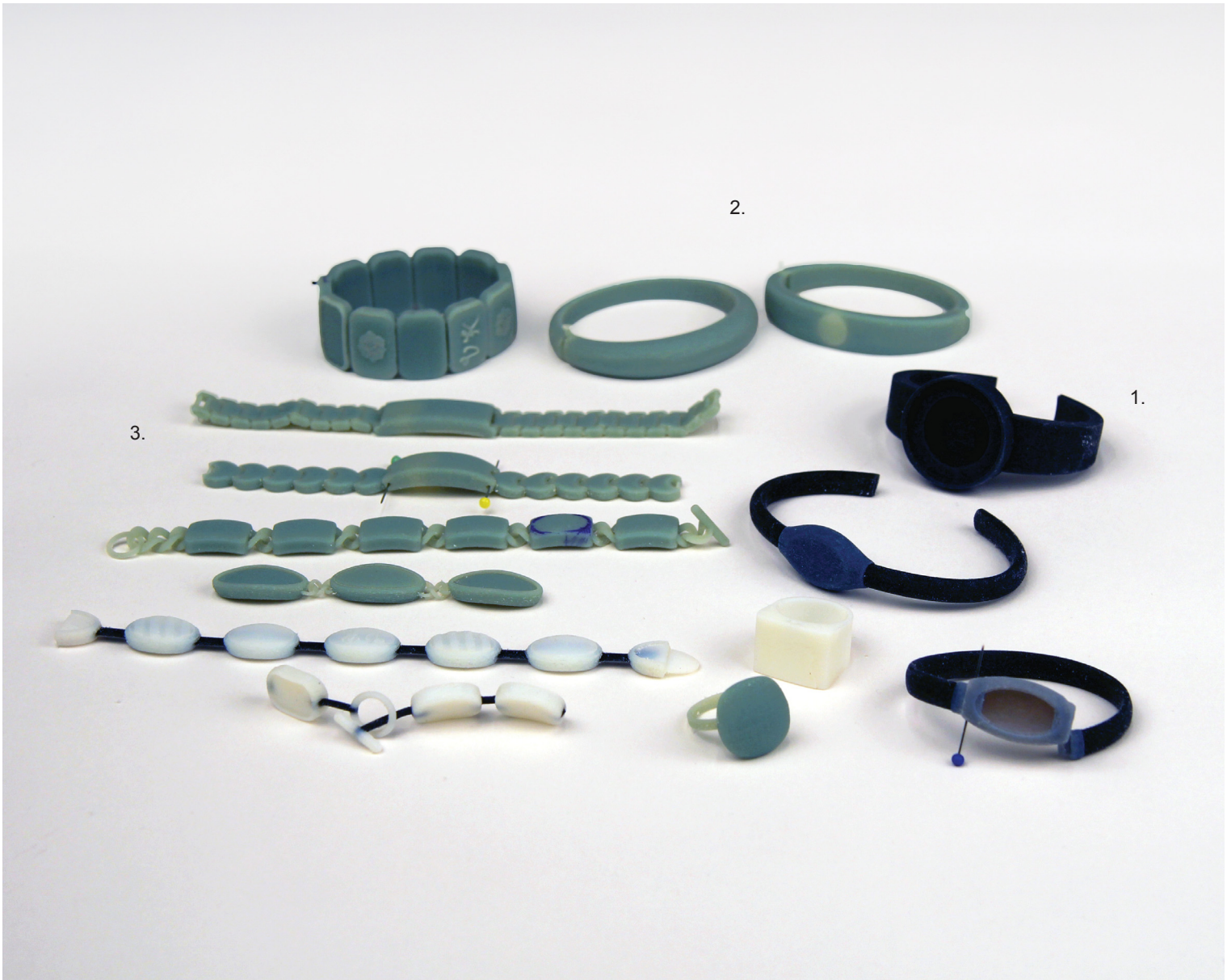
Early prototypes: 1. First prototype   2. First bangle-ideas   3. Exploring different flexible chain structures

4.2 Three design ideas

Design 1

One standard module + changeable straps in different materials and designs

My idea was that this jewelry could be modifiable to fit different styles and price categories by changing the strap-part. There would be straps made from different materials, for instance leather, metals like silver and steel, and plastic. There would be cheaper options for younger customers and premium options for quality-conscious users.

Design 2

Standard body + changeable 3d-printed "styling plate"

In this design the user could change the look of jewelry by changing the 3d-printable and customizable styling plate. My idea was that with ring-shape, it would be easy to get a good contact between skin and device. I thought that the small size would be practical. In design I aimed for more playful look.

Design 3

Standard body modules + changeable 3d-printed "styling plates"

The idea in this design was to divide the electronics into many similar-looking modules. The customization would happen by modifying the decoration plates which would be 3d-printable. The modules would be attached to each other by rubber band. This kind of design would enable a good contact between skin and device. The user could select either very simple or more decorative design for lids

4.3 Focus group interview

I wanted to interview some potential users from the target group to get qualitative feedback on how to improve my concept. I thought that the biggest weakness in the concept would be the lack of usefulness from users` perspective, which would lead to de-motivation to use the device.

Focus group interview is a qualitative research tool used for instance in marketing, social sciences and product development. It is an interviewing style based on small groups, generally from five to eight participants. Focus group interviews are guided by moderator, who focuses the discussion towards the aimed topics. Focus group interview can be used for exploring impressions and perceptions towards new product ideas, generating hypothesis for further research like questionnaires and obtaining a general background knowledge for new project. Generally focus group interviews are done in series of three or more. Focus group interview is not meant to be generalized as a representative view of target group. Advantages of this method are direct communication with (potential) users and the effectiveness per time and efforts used. Limitations can become from group dynamics like dominant individuals, withering conversation or the discussion getting out of topic. (Langford and McDonagh, 2005, 2-5.)

I discussed with User Experience -testing team in Phones Design and got some advice on how to conduct my focus group interview. They gave me a tip to collect feedback individually, in smaller groups and finally all people together in big group. This was based on the fact that people have different personalities; some people are more dominant in group conversations and there is always a risk that the quieter ones do not get their opinions through.

I wanted to collect information about participants` preferenc-

es in jewelry design and the ways they wear jewelries. I also wanted to gather feedback about my concept: general concept acceptability and specific features like interaction and customization of shape and materials.

4.3.1 Planning the workshop

The focus group interview was held in 20.10.2014 in Microsoft Talo. The recruiting of participants was made through Microsoft Campfire community. Microsoft campfire communities are secret groups on social networking sites like Facebook, they allow Microsoft employees to engage in direct dialogue with consumers and to get access to consumers` ideas and opinions. I used Campfire for recruiting users, because it was the easiest way to gather participants, as the recruiting and rewarding was done by the community itself. The selection criteria for participants was that they needed to be female aged 16-40 years old and they should wear different jewelries in their everyday lives.

The participants:

- Satu, 35 years, a real estate agent, lives in Vihti. Satu has expensive elegant jewelry for work (silver, white gold, diamonds), but she also uses big and showy costume jewelries to make different looks in free-time, especially in holidays.
- Karoliina, 30 years, secretary/ translator. Karoliina likes simple, timeless clothing and jewelries. She prefers good materials, silver, leather and gemstones. Karoliina uses different jewelries to give "a little twist" to simple look.
- Trang, 25 years, marketing coordinator, originally Vietnamese lives in Finland. Trang likes to wear simple and modern clothes and refreshes them with big, chunky necklaces. She combines costume jewelry and small pe-

tite jewelries she got as a gift in her every day clothing.
- Pirita, 31 years, student of industrial design in University of applied sciences. Pirita`s style combines feminine and "street style", she likes to use comfortable clothes like hoodies in her every day style. For parties she likes to have more feminine and showy style with special accessories.

I asked my classmate Sami Kiviharju to help me in practical arrangements of workshop. I hold the presentation and lead the discussion. Sami kept track that we keep on the schedule, took notes and facilitated discussion in one small group.

I made a pre-questionnaire for the participants to get better understanding about their styles and ways of using jewellery. I used Google Forms to create the questionnaire.

Schedule:

The workshop took totally two hours
1. Introduction to workshop, warm-up (10min)
2. Introducing the concept (slides) and prototypes, letting people test them (15min)
3. Participants make individual, written feedback for each concept (30min)
4. Discussion about the concept and design ideas in small groups (2-3 persons) (30min). The aim is to agree on common feedback when possible, and discuss on the differences between opinions. The facilitator of each group makes notes on flip board
5. Discussion all together, compare ideas and feedback between two groups (30min). The facilitators lead the discussion and make notes.

4.3.2 Summary of feedback

1) Key Findings

- Concept acceptability was good based on workshop findings

- The biggest concern was safety
- Some participants criticized the authentication being tied to phone, maybe there should be alternative ways to do it?
- Customization before buying the jewelry was seen the most valuable way to customize the jewelry
- Too many different design options can confuse users
- Materials and colors were most important elements of customization for participants
- Silver was the most popular material, also leather was liked, plastic divides opinions
- Design ranking; most liked: Design 1, least liked: Design 2

2) Summary of pre-work-questionnaire

Most of the participants had at least two different types of jewelries: everyday jewelries and party- or special occasion jewelries. The ones used every day were simplier and plain, most of the answerers used same jewelries every day, or alternatively had jewelries they used every day and bigger, more accessory-type jewelries they changed day-to-day depending on the day`s outfit. Some participants used more classy jewelries for work and "wilder" ones for free time. The jewelries used for parties and special occasions were often made from more expensive materials such as pearls and diamonds or had more showy look.

The most liked material for jewelries was silver, preferences towards colors and other materials varied. The youngest participant was interested in cheaper materials like stainless steel as well, the older ones were preferring rather expensive materials such as white gold or diamonds.

The participants had got some of their jewelries as a gift, and part of the jewelries they had bought by themselves. The gifts were liked because they were given by beloved people and therefore brought back memories. Most of the answerers said that they do not care about the brand, materials and price are more important for them.

3) Summary of workshop

Concept acceptability

All participants thought that the idea of paying with jewelry was interesting, and they liked it after the presentation. All participants thought this kind of device would be useful for them. The feedback about the idea was overall very positive, just the design options divided opinions.

It could [be useful for me], particularly when travelling and going to events (like festivals and parties) when I don`t want to carry my entire wallet (Karoliina)

Yes [it would be useful for me], definitely. I don`t use that much handbags, so my wallet is too often in car or in home when I need to get my lunch paid (Satu)

Yes [it would be useful for me], I make small purchases every day and it would be a lot quicker without the hassle of getting the cash/ money from the wallet/ pockets (Pirita)

The good sides of the concept were stated to be the combination of functionality and fashion, easy mobility (always accessible, easy to carry with you), simplicity and targeting to women.

The biggest concern the participants had, was about security. Some participants were afraid of thieves scanning your jewelry, or accidental, not-intended payments that could happen if the payment is controlled only by proximity. Some were concerned that they would lose the jewelry, as they have had that kind of habit. One participant hoped more control over payment, for instance a touch acceptance of payment. This topic divided opinions and caused debate, some participants were concerned that this kind of feature would ruin the look of the product.

One con that was mentioned, was that if you want to use this kind of payment method, you need to carry the jewelry

always with you, and sometimes you might not want to wear jewelry.

One concern, which wasn not fully agreed by all participants, was the product´s reliability on phone. Some participants thought it is s a good thing since they always carry their phone with them. Others thought it would be nice to have other authentication method, just in case the phone would be broken or they would forget phone somewhere or phone would run out of battery.

Customization

Feedback for customization-feature was asked as a part of each design idea. None of the participants got really excited about designing their own jewelry by using their own photos or sketches and 3d-printing. The idea of customizing with 3d-printing was most widely accepted in the case of design 3, a bigger modular bracelet which somehow reminded of Nomination. Even in case of design 3, most of the participants said they wouldn`t customize the design after they bought it, because it would be too much work.

[Does customization option add value for you?] Not really. A little. I like the design as it is, so I don`t really have the NEED to customize it. (Pirita)

Customizability does add value, but only during the selection process. I don`t think I would customize it much afterwards. (Karoliina)

It seemed to be more valuable for these users to customize the jewelry before they buy it. The participants wanted to have some options to choose from, but too many options could be confusing. For Design 1, all participants wanted to have different kind of straps. Most of the participants did not feel like changing the strap too often, some said they would keep the same strap for few months.

[I would like to buy] Maximum three [different straps]: 1 is fashionable silicon, 1 is silver-like bracelet, 1 is leather

bracelet. (Trang)

[I would change the strap] Maybe once every 2-3 months, unless I was going somewhere that meant changing them more often, for example if I mainly used a leather strap, I´d change it for a silver one before going to a fancy occasion/ event. (Karoliina)

The materials and colors seemed to be more important in customization and matching the jewelry to different situations and outfits than just changing the shape of product.

About design options

The first design, a simple bracelet with changeable straps, gathered most positive feedback, but it was also seen a bit boring and conventional by some of the participants. The simple look was attractive to some, but one participant said it is not enough feminine and delicate for her. Participants liked the idea of having different changeable straps and they would like to have many of them for different occasions. Different pricing options gathered positive feedback as well, this jewelry was considered to be suitable for both mother and daughter.

Ring-design was least liked from all designs. The main problems seemed to be the big size and wrong proportions (not good looking, too strong and masculine). It was mentioned that the ring remains of a medieval signet ring, or the one you can get from an eastern egg. It was seen good design for party or special occasion, but not for everyday use. In the other hand it was stated to be less likely to lose. Participants tended to wear small, precious, delicate rings and they thought this design would not fit together with other rings they had.

Third bracelet divided opinions. The style of that jewelry suites to people who like bigger jewelries. Some participants really liked the design. One participant thought it could become a nice statement accessory. The size adjusts to your wrist, which was seen as a positive thing. On the other hand

the rubber band was not liked since it was considered as too tight and easy-to-break. One participant suggested to use hinge instead of rubber band. The Vietnamese participant stated it does not fit to her style or that it is old-fashioned.

4.3.4 Conclusions and reflections

The general feedback about the idea of paying with jewelry was positive than I expected. It seemed that combining technology and jewelry was intriguing for the participants, who were wearing jewelries already in their daily lives.

I was expecting that jewelry design would be a field where more personalization would be appreciated, even in day-to-day basis. It became clear that the participants of my workshop strongly preferred choosing a ready design than customizing it by themselves. It seemed that the materials could be more important for creating different styles than changing the physical shape of the product.

The ranking of the designs was not uniform, which was result that I was expecting. The unpopularity of ring-design was a bit surprising for me, because I thought it was the most unique form factor. I think the designs that reminded some existing jewelry were more popular since they were easier to categorize. I got also feedback that the incompleteness of designs made the assessment more difficult.

Interpreting the results was quite complicated because of the small amount of participants. The people I had in my focus group were either towards simple and modern, or feminine and luxurious designs. For instance younger people might prefer different kind of designs. To get better view of the topic, I should have interviewed more people from different age-, style- and income categories. Finding and recruiting enough people from different backgrounds would have taken lot of time, so I decided to continue with my design work. Because the testing was not comprehensive, I used the results rather as an inspirational source, than a strict guideline for my design work.

5. Design process, Phase 2

5.1 Selecting one design for further development

I dealt with focus group interview feedback in a way that I picked up the things I found useful, and the things that were repeated many times. My conclusion was that the main idea and interactions, evaluated from pictures, were satisfactory. Only function that might need re-thinking was authentication with different devices, for instance home desktop computer and tablet. The design ideas needed further development and more details to be more easily evaluated. I decided that for next testing, I should have more detailed design proto-type made from proper materials, and interaction prototype to test the usability.

I decided to abandon ring-design, since there came quite many issues about the sizing and practicalities like wash-ing hands, wearing gloves in wintertime etc. The ring-design was not liked by users so it would have needed a totally new design. From interaction prototyping point of view the size of ring was challenging. I personally liked first design because of the use of different materials and scalability to different price categories and styles, but the drawback for it was con-ventional design in wearable technology field. I wanted to make the design more petite and feminine, but the mod-ularity would probably have suffered from that. The third design`s advantage was the form that was not often seen in wearable technology field. Third design had also enough space for electronics and it clearly looked like a jewelry, not like a technology product. The materials and prizing were biggest headache in this design, because I wanted to make a reasonably priced wearable device, and this design was quite big and it had complex mechanics. Finally I decided to focus on third design, because I considered it feasibly sized for electronics and it also seemed to be a new form factor from wearable technology perspective.

Design 1

Pros	Cons
By changing different straps it can fit to many types of users	"Seen look", both from the jewelry- and wearable tech-nology -perspective
Price could be rather low, possibility for many prize categories	Quite neutral or even mascu-line look

Improvements

Decrease the Fitbit-look and make it more decorative and femi-nine

Design 2

Pros	Cons
Ring is new idea compared to bracelet in wearable tech-nology field	Size of ring: components and fitting to different fingers
It is more difficult to loose	Design is not mature enough
	Washing hands is difficult

Improvements

Make it more petite and feminine, circular shape is not favourable

Design 3

Pros	Cons
The size is feasible	Design divides opinions; it is not for everybody
The adjustability and contact with skin are good	As a jewelry it is not new design
It looks like a jewelry, not like a wearable technology gadget	

Improvements

The rubber band should be replaced with something more durable, rethink attachment methods

5.2 Iterating the design

5.2.2 Discussion with Kirsti Saarikorpi

I interviewed jewelry designer Kirsti Saarikorpi to get more insights from jewelry design -field. Kirsti has worked both in Kalevala Koru and as an independent jewelry designer. The interview took place 20.11.2014 in Kalevala Koru`s premises. I introduced my concept and selected design to Kirsti and asked for feedback.

The biggest criticism Kirsti had, was about practical implication of the design. Making complicated attachments and mechanisms increases the cost together with materials such as silver. In my bracelet-idea, the price-increasing factor was the amount of modules with complex attachment methods.

Kirsti said that there has been lot of similar cuff bracelets in jewelry industry, so from jewelry design`s perspective it`s not really new idea. Kirsti stated that the size of my jewelry is quite big.

One practical challenge Kirsti mentioned is the sizing of wrist-worn jewelries. Kirsti also criticized the rubber band as an attachment mechanism. According to her it would not last in use and it should be replaced with mechanical attachment. One potential attachment mechanism Kirsti mentioned, was spring needle which is used for instance in watches.

Kirsti said that the combination of jewelry and electronics will most probably be quite common in future. According to her it will change the consumer behavior in a way that technology creates new meanings and value for jewelry. Kirsti was not convinced that people want to customize their jewelries in everyday basis, because it requires lot of effort, and

taking responsibility over the design is not something that most consumers want to do.

Kirsti told that the main manufacturing techniques they use in Kalevala Koru are pressing and casting. They use 3d-printed wax parts for casting. With pressing you can achieve really thin walls, with casting you will get thicker walls. 3d-printing for metal (laser sintering) requires a lot of hand finishing because the surface quality is not really good. One technique Kirsti adviced me to check, was electroforming, which enables really thin walls and therefore saves in material costs. Electroforming is not widely utilized in mass-manufacturing.

5.2.3 Developing the design

The idea of design process phase two, was to iterate and develop the selected design further from product design point of view. I wanted to give the design more details as they were mentioned to be important in focus group interview. The goal was not to make totally finished design, but to have a convincing prototype.

I decided to limit the customization possibilities as it did not seem to add much value to users. Probably a few color- and decoration possibilities would be enough. I also gave further attention to proportions, mass-division and decorations to make more elegant and petite design. The biggest leap was to take the idea to more realistic level. I also wanted to rethink the design of lid-parts.

Rethinking producibility

I considered mainly pressing and casting as a potential manufacturing methods for the metal body. Casting offered wider
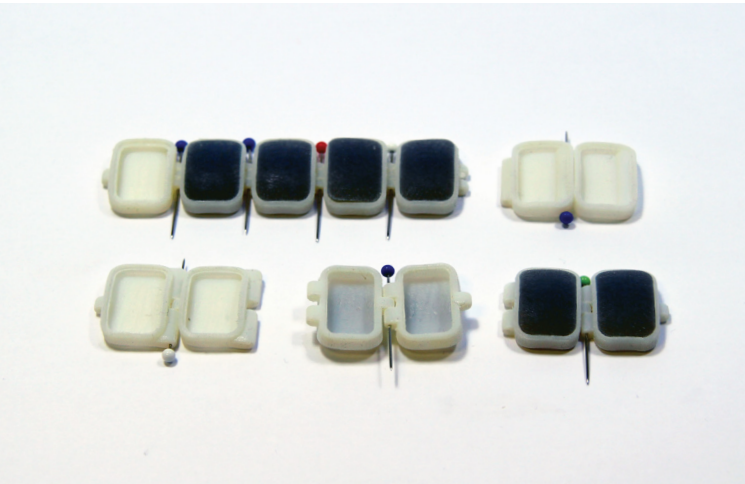
Exploring different hinge designs
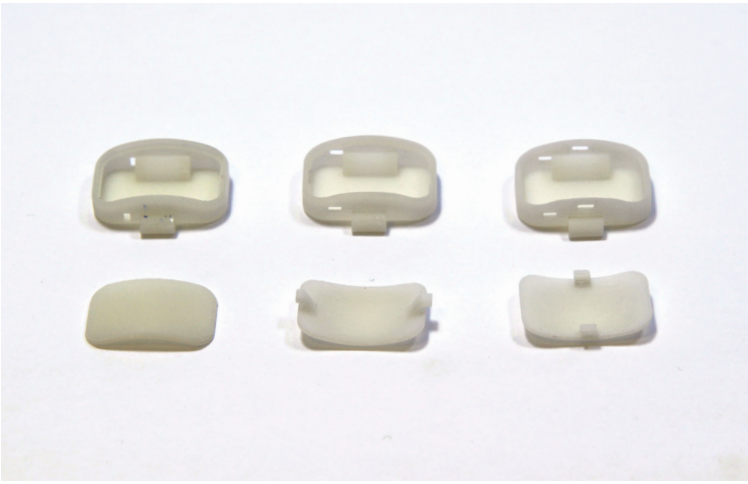
Evolution of the attacment mechanism between lid and body, SLA-3d-prints
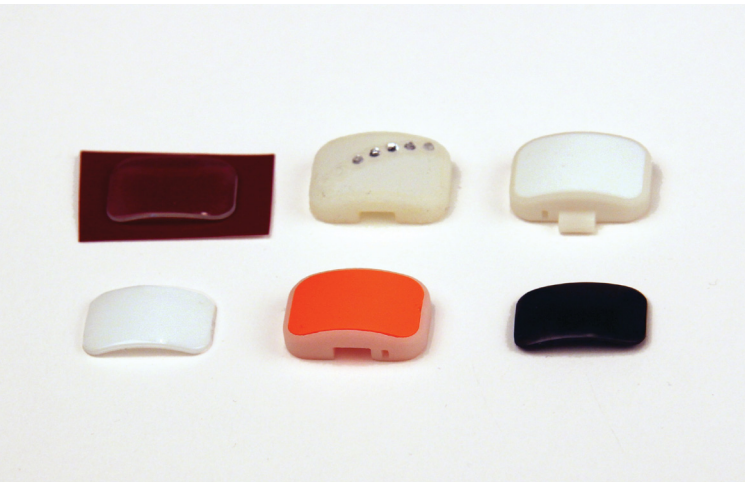
Different designs and surface finishes experiments for lid: transparent, with crystals, matte, glossy, colored matte and dyed with ink

Studying how the proportions of single module effect on overall look

possibilities for design and that is why I selected it as a main manufacturing method for body. I needed to think about the mold`s structure and thus redesign the inner shape of the module. The material of the body would be stainless steel. Silver coating would be an option for premium model. The lid would be injection molded acrylic, since the snap attachment I developed required more complicated structure.

I selected plastic and stainless steel as materials, even though in focus group interview it was stated many times that silver and other premium materials were preferred by participants. The main reasons for selecting stainless steel and acrylic were the intended prize and the short lifetime of wearable technology product.

Improving attachment methods

Attachment between modules

As rubber band did not seem to be a reliable attachment method, I decided to try to make hinges between modules. With hinges the bracelet would not be so flexible, but it would last better in use. I wanted to make as invisible attachments as possible, so I decided to use spring needles to connect the parts together. I modified one module into a locking module by dividing it into two pieces and adding a sliding-lock mechanism.

In this part of design work, high-precision models were needed for testing and reviewing different mechanical design ideas. This set higher requirements for 3d-printing in both accuracy and flexibility- and durability of the material. I used first ABS-like material for our Objet500 in my prototypes. In later stage I used stereolithography-3d-printed models for getting better accuracy when prototyping hinges and snap-attachments.

Attachment between lid and body

From producibility perspective, the most challenging detail was designing the attachment of lid, because I wanted it to

be possible to open and close again. My idea was that lid would be the customizable part. I made a snap-attachment between lid and body utilizing the flexibility of plastic. After trying different snap-mechanisms I ended up with a design in which the snap is located in the middle of the module.

Finetuning

I studied a bit different surface finishings by rendering and prototyping. I tried to give a premium and more jewelry-like look for the plastic and steel by using glossy finishing for parts. I also studied more decorative styles for lids, for instance by using crystal decorations and different colors- and patterns.

5.3 Final design

Example lid design variations

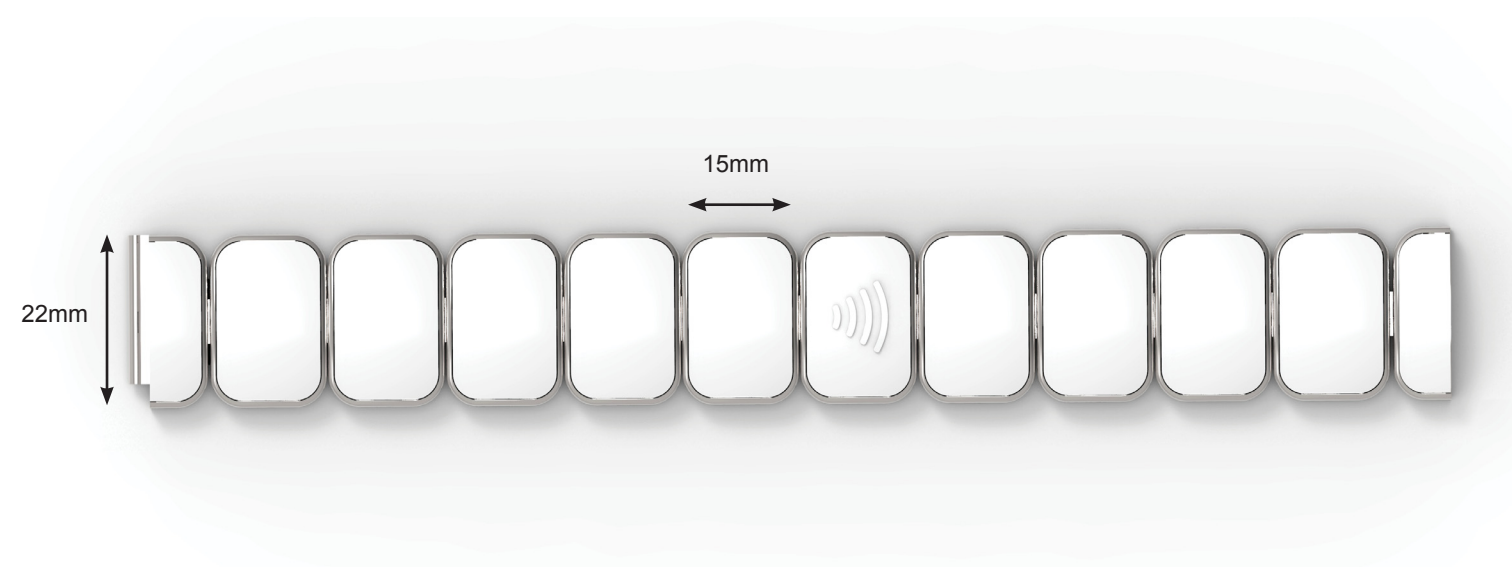*Polished acrylic with crystal decoration*

Polished colored acrylic

Transparent resin and different patterns

Module parts: spring needle, body and lid

Locking module parts: female-part, male-part and lids

15mm

22mm

5.4 Interaction prototype and appearance model

Interaction prototype

When I started prototyping I thought that my technical concept was quite simple, so I wanted to implicate it as such. I wanted to have fully functional prototype to test with users in real use contexts. The biggest threshold for implicating a functional prototype was the sizes of components like vibramotors and NFC-antenna. I would have needed custom technical solution, which was not possible due to lack of budget.

I got help for interaction prototyping from Michihito Mizutani who is responsible for interactive prototypes in our team. Together we decided that the most important function for the prototype was to depict the user interaction. That is why the implemented interaction prototype bacame so called "wizard-of-oz" -prototype which means that it looks and feels like it is working but actually it is just faking the interaction. We decided to use magnets to fake the NFC-interaction, because my prototype was quite small.
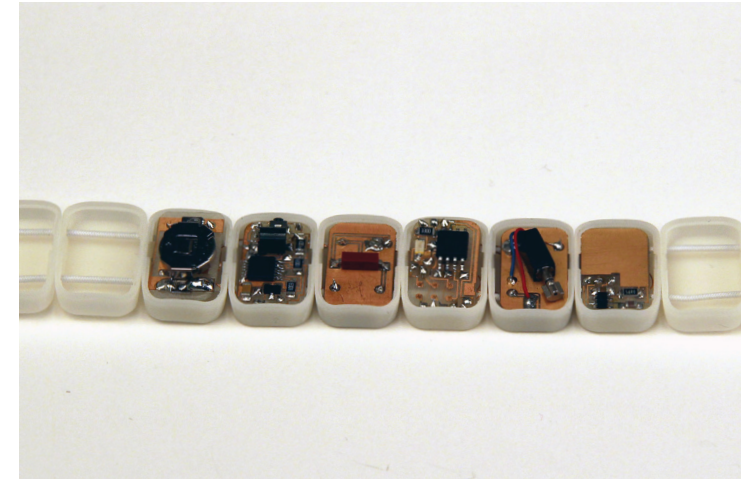
Part of the interaction prototype was a mobile application prototype, which was designed by me and implemented by Jani Vuorinen, a design technologist in Phones Design.

Appearance prototype

I wanted to make an appearance prototype as the result of my design work, because the materials seemed to be important part of user experience. The appearance prototype was manufactured by laser sintering stainless steel. In laser sintering the metal powder is fused together with laser light. Because we did not have laser sintering machine, the work was outsourced to AmFinland Oy. Laser sintering is good for prototyping for instance casted designs, or manufacturing

small custom parts or rather complicated items such as jewelries. Currently the biggest issues against using this technology in bigger scale, are relatively high price and amount of hand-finishing needed in post-processing. The most difficult and time-consuming part of prototyping appearance model, was the post-processing of laser sintered parts. I first sanded the parts, then sandblasted them, after that I applied base spray-paint and finally the silver-colored spray-paint.

For the lids I used 3d-printed models made from ABS-like material. I lightly sanded the lids and then spray-painted them first with base paint, then with black paint and finally with matte-lacquer.

Assembling the interaction prototype

Interaction prototype used in usability testing

Mobile application prototype, balance and purchasing history

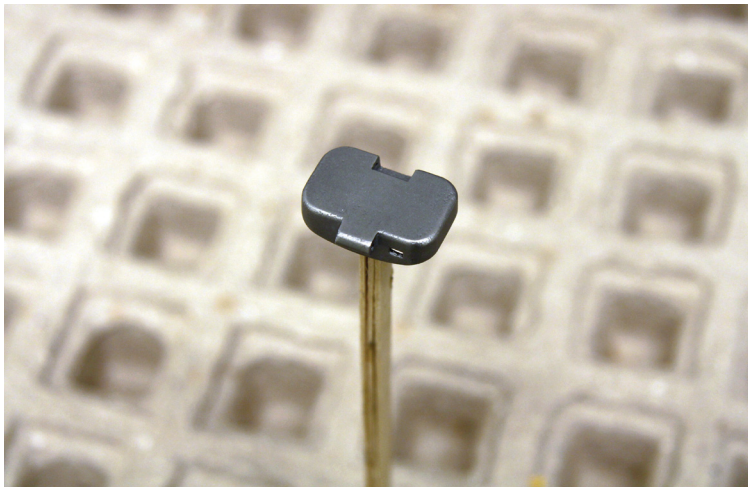*Mobile application prototype, adjusting payment limits*

First trial with laser sintering

Raw laser sintered part, sanded and sandblasted part, part painted with base coat paint, part painted with top coat paint

Painting sanded and andblasted laser sintered parts

Assembling the finished parts

Finished appearance model

FIG 18: Bracelet in use (Vaarna, 2015)

5.5 User study

5.5.1 Planning the workshop

I decided to conduct a second user study with my final prototypes. I wanted to test both usability and acceptability of design and the whole concept.

I wanted to interview potential users as individuals this time. The idea was that they could try the prototypes and give feedback, and I could observe the use and ask further questions if needed.

About methodology

For briefly testing usablity, I used standard usability lab -style method. I set up four tasks for participants that they were supposed to perform independently while I was observing. First task was to put on the device and authenticate, the second task was to make a payment with fake payment terminal. The third task was to check the balance of your account and the fourth task was to change the daily purchasing limit. Before the test I gave a brief guidance about interactions.

To collect feedback about the desirability of design and user experience, I decided to use both AttrakDiff- and Product reaction cards methods. AttrakDiff is a method developed by User Interface Design GmbH based on Marc Hassenzahl`s research. To measure the attractiveness AttrakDiff has applied an instrument of measurement in the format of semantic differentials. It consists of 28 seven-step items whose poles are opposite adjectives, like "good-bad". The aim of AttrakDiff is to measure the perceived pragmatic quality, the hedonic quality and the attractiveness of an interactive product. (AttrakDiff, 2015.) I modified AttrakDiff -platform to focus on evaluating the design. I selected the adjectives

from the AttrakDiff-platform that best described design, and I also added some adjectives to set.

Product reaction cards is a method Developed by and © 2002 Microsoft Corporation (All rights reserved). The aim of this method is to evaluate desirability aspects of product or concept in usability lab setting. It is based on 118 different word cards, which describe different qualities of product. The cards form a basis for sorting exercise, and more importantly facilitate the discussion about the product or concept. The idea is that first user picks up the cards that best describe the concept or product, and after that moderator and user have free discussion to open up the reasonings behind the selections. (Benedek and Miner, 2012, 1-9.)

Participants:

I looked for 5-6 women, aged 16-35 years, who were wearing jewelries in their everyday lives. The hiring of the participants was made through Microsoft Campfire community.

- Anna, 29 years, works as a photographer. Anna likes to wear casual style clothing with big rings and bracelets.
- Karoliina, 30 years (participated in focus group interview)
- Pirita, 29 years, works in economic reasearch group about digitalization of finance governance. Pirita wears her wrist watch and rings everyday, she uses also necklace and earrings almost daily. Pirita describes her style as simple and classical yet feminine. Pirita likes silver, white and pastel colors in her jewelry.
- Trang, 25 years (participated in focus group interview)
- Jaana, 28 years, works as a spare part sales person in car shop. Jaana wears small jewelries at work, she uses same rings daily, but changes her necklace and earrings occasionally. She has started to use Polar`s activity
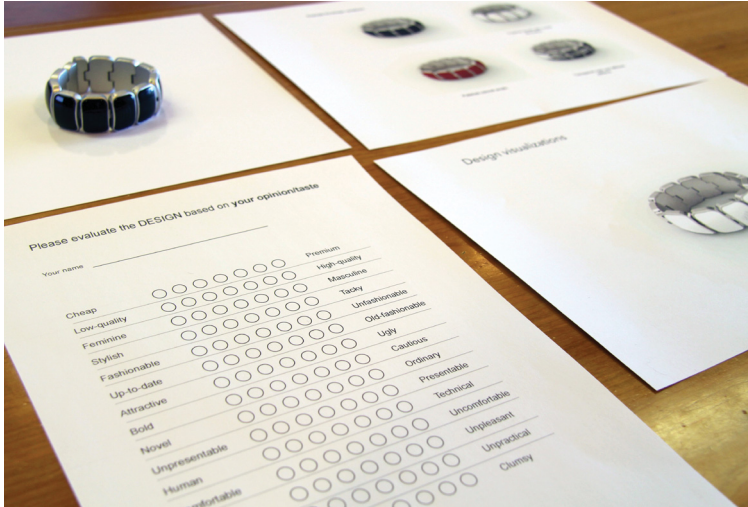
AttrakDiff

Product reaction cards

Making usability testing

Choosing product reaction cards

tracker few months ago and uses it all the time, even when she sleeps. In free time Jaana also uses bigger bracelets, necklaces and earrings. She has jewelries made from gold, silver, bronze, steel, wood, diamonds and pearls.

Schedule:

The whole interview took approximately 40-45 minutes

1) Short discussion about participant`s style, jewelries she uses and her relationship to technology, more specifically to wearable technology and contactless payment (5min)

2) Explaining the concept and main interactions (5min)

3) Brief usability study (15min)
Participant makes tasks with interaction prototype individually. I observe, and later we discuss about the experience.
Tasks:
• Make authentication with password 1234
• Make payment
• Check your balance and write it down
• Change your daily purchasing limit to 120€

Questions about the interaction:
- How did you like using the device? What was easy and what was difficult?

3) Evaluating the design from appearance prototype and renderings (10min)
User fills a modified AttrakDiff to evaluate the design, later we have a freeform discussion

Questions about the design:
- Does this design fit to your style?
- How would you change the design to fit to your preferences?

4) Assessing the whole user experience (10min)
Assessment is done via Product reaction cards: participant

selects five cards from the set of 118 cards, which best describe in her opinion the whole concept. After making the selection, participant explains why she chose certain cards.

General questions:
- Would you buy/consider buying this kind of device? Why?

5.5.2 Summary of findings

About recruited users

Wearable technology is actual topic in media and it is surrounded by exaggeration and "hype" and that might increase the desirability of concept which is part of that phenomenon. Expectations created by "hype" and real perceived usefulness after using the product for a while might sometimes not meet. That is why I wanted to know more about how people participating my user study relate to technology and ICT-trends. In focus group interview I did not ask about participants` relationship to technology, so I got lot of new information in this user study. All the Campfire group -members seemed to be very interested in technology and ICT-trends. The participants told me that they were following new technology trends and some of them had even bought products just to explore new technology. Many of participants have tried or have been using contactless payment methods or wearable technology appliances, so they were quite familiar with the topic. These consumers could probably be considered as Early Majority in Diffusion of Innovations -theory developed by Rogers. Two of the five participants (Karoliina and Trang) had already participated in my focus group interview before, so I knew their opinions about design in a general way already.

Usability test

The lock-part of bracelet clearly needs to be re-designed. Now it is almost impossible to close and it`s not possible to use it with one hand.

Most of the participants opened the application through

phone`s application catalog. People were confused because the application prototype was not fully functional so that for instance the balance and purchasing history did not change after payment. Some of the participants were asking for confirmation message after making the payment or changing the daily payment limit. The application in general gathered positive feedback due to its simplicity.

This [application] is clear, at least if it will be like this when it`ll be actualy launched. (Jaana)

The participants who were not familiar with contactless payment found making payment more confusing and said that they would need more instruction for that. The interaction prototype was not working all the time as expected, sometimes it for instance reacted to rings and other metallic parts randomly.

Desirability of design

The design of payment jewelry was most clearly dividing opinions. Some of the participants liked bigger jewelries but most of them were into smaller and more feminine and petite jewelries. Hindsight I found afterwards was that this feedback came already in focus group interview. More interviews would be needed to understand, what is the quantitative relation between people who like really small jewelries, and people who like also bigger jewelries. In this user study most of the participants considered my design as too big. Smaller and more petite jewelry would probably attract more people than bold statement jewelry. Other strategy could be to target this jewelry to smaller amount of women, who prefers bolder jewelries.

This is quite thick and masculine, not really representing my style. Maybe some more rock-styled woman could like this --- The structure is ok, but I would make this smaller. (Pirita)

My first impression was that it looks like a jewelry that I could use. It looks nice. (Anna)

There seems to be quite much dispersion in wearing bracelets, some people do not like the feeling of tight watch straps or bracelets. Also the chain-like shape feels uncomfortable for some people, since they are worried that it would pinch them. The weight of my jewelry was discussed as well and it divided opinions. One participant said that the big sizes prevents her wrist from moving. It seems that I underestimated the effect that physical comfort has on acceptability.

In general I don`t like this kind of chain structure, I`m afraid it would stitch me. (Trang)

In Attrakdiff- type questionnaire participants gave quite different assessments for design. Some considered it feminine, others thought it is masculine. Some participants considered my design up-to-date and others called it old-fashioned. Even the perception of quality varied, from premium and high-quality to cheap and poor quality.

The size and proportions might be the biggest single factors effecting on acceptability in this design. Also the surface-finishing would need more attention and exploration. The painted metal did not represent the silver coated surface well in detail.

It seems that it is difficult to find a design solution that pleases majority of users in the product category of digital jewelry. Maybe some really simple silver bangle would be most acceptable form of bracelet? In next iteration the comfort and the size of jewelry should be in focus.

Evaluating the whole concept

The feedback gathered with product reaction cards about the whole product concept was overall positive. Most of the participants considered the concept useful and many of them also mentioned that it seems to be easy to use. Summarizing the results, perceived usefulness and perceived ease-of use seemed to be good. Of course the perceived usefulness in the case of these women might be higher than in average because they are considering technology as a

positive thing per se.

I have my work, two kids, a dog, I go to gym five times a week and my kids have hobbies too --- If I for instance pick my daughter from her hobby without my wallet and then remember that I need to buy milk --- I think this could be easier to remember to carry with than a wallet. (Jaana)

Even more humanistic- than technically-oriented person could use this. (Karoliina)

The social factors effecting on acceptability of concept didnot came up in interviews. I think the reason was that no really new technology or interactions were used in this concept. Of course personal style is partly effected by social factors like friends` opinions as well.

Surprisingly many of the participants underlined the fun- and entertaining -aspects of the concept. This might tell something about the participants as well, many of them said that they really enjoy trying new technologies and products. Most of new technology-related products might be fun to use for these women.

Many participants considered the concept personal as well, due to customization possibility. I interpret this as a positive feature. Some assessed the concept as new, inventive or even innovative, which probably at least in case of these users, increases the desirability and acceptability.

5.5.3 Conclusions and reflections

This workshop combining different tasks and semi-structured interview seemed a good way to collect feedback about different areas of design. The usability-part was easier to summarize than the desirability or acceptability of design, I feel that for the desirability-part, more interviewees would be needed to have more comprehensive image of feedback, and to be able to cateorize different user groups based on their taste. The selected product reaction cards

and the feedback about usefulnss of the concept could also have been quite different if I had conducted my workshop with less-technically-oriented women.

6. Conclusions

6.1 Reflections and learnings

The goals for this thesis work were to learn more about wearable devices field and practical design issues relevant to it. I wanted to improve my skills both in iterative design concept -creation and prototyping. The goal for the concept-creation was to prototype an idea for acceptable, wearable, contactless alternative for traditional debit card in small everyday purchases, my target user group being young women.

I learned a lot about using different methodologies in design concept creation. I think my approach to selecting methodologies is more analytical after completing my thesis work. I improved my skills in prototyping and iterative development of design concept. I also learned to gather qualitative consumer insights and feedback in quite effective way. According to my own evaluation, the learning goals were successfully fulfilled in this project.

According to user feedback in second user study the design should probably still be developed to create more acceptable product. The biggest issue in the design seemed to be too big size and the unusable lock-part. More comprehensive testing with wider user group would be required to better assess the acceptability and desirability of my concept and design. At the moment the size of electrical components is the main threshold for making really small and petite digital jewelries. Looking back on process, I should have concentrated more on acceptable design and less on technical restrictions, since my goal was to make an acceptable design concept. I decided in the beginning of the thesis work, that one iteration and two user tests would be enough for my thesis work, so that is why the iteration was not continued further.

The aim was to make a concept that answers a need from customers` side. If I think about it critically, payment is not in a desperate need of improvement, as it is quite convenient already. The mobile industry is pushing NFC-payment technology aggressively to market so most probably it will become more popular in future.

I saw the thesis work as an opportunity to try new things, and that is why I ended up working in fields that were rather unfamiliar for me: jewelry design, interaction design and HCI. I have always been fascinated in mixing different fields, so in that sense this work really looks like me. I neither had ever conducted a focus group interview nor any kind of proper user testing before. Trying new things was very interesting and motivating, but created also challenges because I had to absorb lot of information.

The process was not straightforward because this was production-based thesis work, and I did not have a clear structure in my mind when I started. My main focus shifted during the process from interaction design to product design. For the sake of understandability I decided not to describe all the process in the thesis report but concentrated on the most interesting points.

The most difficult thing for me was to focus the concept from all the background research I did. I was quite critical and wanted there to be, from my point of view, a strong underlay to build on my concept. Ther fact that I was operating in new fields, increased the difficulty of choice. That is why the first two months were the most difficult part of the project. Most of times making choices between many options or designs felt difficult, because I worked so independently and there was no clear reasoning to select one of the options over the others. Afterwards it was easier to see whether the choice was successful or not. I think thesis framework made it more challenging to make choices since I felt that I had to justify

them better.

If I now look back to the process one thing I would want to make differently is making the process more iterative and faster. This would have required almost functional model in an early stage of project so that I could have tested all the ideas before confirming them. Now the iteration happened mainly in design and even there in quite limited manner.

One good learning was not to overdesign in any field. After all I think simple and easy-to-use solution is generally what most people want from their IT-devices, not dozens of features and customization possibilities. It was really educational to try to focus on one use case.

One design-related challenge was that my background is in industrial design, not in fashion or jewelry design. This can be seen both as an asset and a wekness. From jewelry design point of view this concept might not be extremely exciting or new. In the beginning I lacked lot of basic information about jewelry-design and ways of wearing jewelries, which led to many false assumptions.

As I am generally a team-player I sometimes missed engineering- and business-support. Later during the project I learned to be more independent on my work and actively gathered feedback from others. I also learned that the feedback is only supporting tool to improve my idea, the most important thing was my own vision and intuition. Everyone seemed to have their own opinion, but if I tried to follow those instead of my own vision I just got stacked.

6.2 Future development

More comprehensive user testing would be required to find out if this kind of design would really be acceptable and desirable for my target users. The biggest weakness in my user testings was small amount of participants. The participants were also more interested in new technology than my average target user. One important testing that was out-scoped from my thesis work, was testing a functional prototype in real environment. With this kind of testing the real usefulness of the concept would have been easier to assess, as it would have become clear if people actually continued to use this kind of device in their daily lives. The reason why this kind of testing was out-scoped, was the lack of resources and time. Just testing contactless payment was not enough, and making a prototype that would have had the authentication, vibrotactile feedback and right design was not possible in thesis framework.

According to feedback from the last user study the jewelry should probably be smaller to be attracktive for wider portion of my target group. More iteration would be needed to achieve more accptable design. If this was a real product development project, the strategy could also be to keep the jewelry quite big and target it to women who like bigger jewelries. Quite big area for development is the business model of this kind of wearable device.

If this was a real product development project more technical development would have been required. More detailed mechanical design would be required to make really producible and usable product. Some sealing should definitely be included to make the product waterproof and safe to use. The weight of the jewelry should be minimized, now the jewelry is probably too heavy. Using pressing as a manufacturing method would decrease the weight remarkably.

I wanted to keep the functional concept simple, so I just focused on the payment in this thesis report. Other interesting field would be using the wearable device as a ticket in public transportation. When I created ideas about the function of wearable device, I was also considering using the wearable device as a key to home or office, because NFC is widely used in access control already. One payment-related side-topic would be combining loyalty programs with this kind of payment device. Other interesting area is the analysis of consumption data which could lead to smarter consumption habits.

One fascinating aspect which was not widely discussed in my thesis report, is the loss of perception of value of money when money digitalizes. Back in times when money used to be physical coins, it was easier to understand how much money you had in your wallet and how much you had spent, as money was physically countable. Bringing physical qualities back to digital money would have been interesting exercise from interaction design point of view.

The question that was left open from design perspective, is how to match this kind of wearable device with many kind of outfits. As the feedback from focus group interview was rather negative towards day-to-day customization, I left it out from my later design work. In my opinion, the key thing in day-to-day customization is making customizing extremely easy, so that it can be done in few seconds when dressing up in a hurry. One solution could be a functional module which you could attach into different kind of jewelries. The challenge would be to design such jewelries that cover the different aesthetical needs of wide-enough user group, probably it would be done in co-operation with some jewelry design company in real life.

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