The Smartwatch: A Family's Expectations, Use and Experiences

Master's Thesis in Computer Science

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Abstract

This paper explores wearable computers in ubiquitous environments. More specifically, how smartwatches can be utilized in an ubiquitous family home. My research focuses on observing the distinctions between a family's expectations and experiences. These are distinctions towards application services and interaction styles. To gather the family's expectations, I adapted a technique inspired by participatory design called SPES (Situated and Participatory Enactment of Scenarios). Furthermore, I explore how to adapt SPES and suggestions for alternations to the technique.

SPES focuses on enactment of scenarios to envision future services and artifacts. Two sessions of SPES was performed, where the first session focused on possible applications and interaction styles. The second on focused on one service, where main observations concerning application features and interaction styles. Enactments observed in this session were later used to re-enact the scenarios in the later test phases, using the actual smartwatches.

I found that there were several similarities between the family's expectations and experiences. Within both areas of use and ways of interaction. I found that most applications were within the following categories; communication and sharing, organization, reminders and notification and remote control. While interaction styles varied between; screen interactions, gestures, speech to text and voice control.

From my experience of performing SPES in this research, I found that pilot sessions prior to the actual SPES session would be fruitful. This way the designer could note possible scenarios, which was be posed to the participants during the session. Furthermore, that big cameras placed in a family home, became a disturbance to some family members.

A task distribution application was developed to further observe whether or not the smartwatch and application would affect their daily lives. Using the smartwatch and application, proved to increase efficiency of task distribution. Further, it was the main factor of a decrease in confrontations previously caused by task allocation. As long as new technology is being brought into the family home, it will continue to affect routines and behavior, for better or worse. It could free up time or consume it, depending on your priorities.

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Chapter 1

Introduction

Imagine you are standing outside at the entrance of your home. You are about to grab the handle of your entrance door, when you realize that you are wearing a new watch. You raise your arm to get a better look at it. Suddenly, you remember that earlier that day, your entire home had been upgraded with numerous of various intelligent objects and appliances, and the house itself had become intelligent. As you realize this, your partner and children arrive in the driveway. Your pulse rise and you turn to the entrance door and grab the door handle. The door automatically unlocks and you walk inside. As you step inside, the light in the hall room turns on, and smooth jazz starts playing from your entertainment system. Short after your partner walks in, you shake your watch with a hand gesture and the music stops. Confused, your partner looks at you and shakes their watch - the television turns on. You both start walking towards the kitchen. As you walk, the light in the hallway turns off and the light in the kitchen turns on. You walk up to the refrigerator, raise your arm and a menu appears on your watch. You select "Refrigerator", then "Recipes" on your watch. Instantly, a recipe and instructions can be viewed on a display in the door of the refrigerator. While your are reading the recipe, your children sits down in the living room in front of the television. Your partner shakes their watch and the television turns off. Your oldest child shakes his watch, but nothing happens. As they reluctantly retreat to their bedrooms to do their homework, you shake your watch and the entertainment system starts playing rock music.

How would our daily lives be, if our house and every object and appliances in our home, could be controlled by a watch on our wrist? During these last months I have been researching topics for my thesis. Exploring different areas of interest, I found literature and articles related to them. After some time researching I found an interesting article. I had previously read several articles about upcoming smartwatches and their supported functionalities. However, this articles discussed what other purpose the smartwatches would have, rather than being an extension of your smartphone. This article did not specifically suggest any particular purposes, but instead discussed the upcoming smartwatches and their functionality. Nevertheless, this got me thinking. What would an interesting purpose for this intelligent watch be. Resting on your wrist, it is a highly accessible device. Given the time and technological development, could it perhaps some day supersede the smartphone completely and perhaps other devices?

My first encounter with ubiquitous computing was a year earlier in my computer graphics class. My class and I was introduced to different types of reality; virtual reality and augmented reality. We got to experience and learn about the different utilization

areas that existed. Reading the article about the purposeless smartwatch, I remembered one of my first lectures in this class. I remembered a demonstration where the lectures utilized a Kinect which recognized and mapped the different joints of the person standing in front of it. Somehow, this got me thinking about wearable computers in ubiquitous environments.

1.1 Background and Motivation

The core of this literary study was ubiquitous computing and how we could use wearable computing within this technological area. Looking closer at how users can utilize and interact with wearable computing in ubiquitous environments. New technology within wearable computing is being developed fast. Technologies like Google Glass and smartwatches are leading us into a new era of wearable computers. The idea is to smooth the lines between utilizing a computer, by moving past the desktop computer, and living.

In addition to the development of wearable computing, environments consisting of many small computers are in the light of research and development. Such environments are called ubicomp or smart environments. It is a branch of the term ubiquitous computing. The idea is to give everyday or any object, both hardware and software. Such objects have been given the name smart objects or intelligent appliances. Smart objects are regular inanimate objects given some extra functionality. Some objects may be able to let themselves reconfigure and manipulate, while others may only provide the user with gathered information.

My reason for choosing these areas were many. Ubiquitous computing I chose mainly because it presents various ways a computer can exist and be incorporated most places to support everyday activities. Imagine all the additional functionality you could add to regular objects in your e.g. home. By combining these objects, you can create environments which you can interact with in so many different ways. Environments that could learn and anticipate your needs and desires. Reminding you of small and big events. There are endless of possibilities and using wearable computers, was for me, an interesting way that we could communicate with these environments.

As mentioned, wearable computers have gotten a lot of attention these last years. The technology has been around for some time, especially wearable devices within fitness monitoring. The Fitbit is an example of many of such devices. However, the technology has taken a more particular direction. Smartwatches are in the spotlight of devices. Some have already reached the public, and others are in the final stages of development. Entrepreneurs, small businesses and several major producers like Sony, Samsung and Apple have confirmed that they are working on developing and introducing consumers to smartwatches.[9][2][10] Currently the general purpose for the developed and upcoming smartwatches, seem to only act as an extension of your smartphone. It enables the user to easily see who is calling, read SMS and emails without taking the phone out of their pocket or purse.

In my research I wanted to give the smartwatch an additional and a more extensive purpose. Since it would most of the time be attached to your wrist, it is a device which you are less likely to loose, misplace or have stolen. Furthermore, it is a device which you can quickly engage.

My supervisor presented me with a research article by Iacucci et al.[19] called "On The Move With a Magic Thing: Role Playing in Concept Design of Mobile Services

and Devices". Here a technique, inspired by participatory design, called SPES (Situated Participatory Enactment of Scenarios) is presented. It focuses on involving the end users in the design process, where they act out scenarios in real environments. I found this technique very interesting, and decided to explore it further and adopt in my research. That is how the topic for my paper was created. Adopting SPES to look at the disparities between a family's expectations and experiences, towards smartwatches in a ubiquitous family home.

1.2 Technological and Family Developments

Technology is increasingly and rapidly getting more advanced. The development of the computer has relied on various technologies the last 70 years. Going back to the early 40's, I looked at the technological developments which has enabled us to get to where we are today. Similarly, I went back just as far to look at how families have changed together with the technological developments. Specifically, how technology has developed and influenced the development and change of the typical family.

1.2.1 40's

The early computers utilized technologies like relay technology and vacuum technology. Among these computers were the relay technology based computers; Model III, IV, V and VI. These were developed by a company called Bell Laboratories. The Model V was completed in the mid 40's and was named Bell Laboratories General Purpose Relay Calculator. Mechanical computers were in the 40's already known, as the earliest ones were designed in the late 30's. In the beginning of this decade hybrid computers were also being developed. These were relay and mechanical hybrids. One of these, developed by Konrad Zuse, was called Z2. However, these hybrids had some speed limitations which lead to the utilization of vacuum tube technology. With vacuum tube technology a line of new computers were developed and released. Among these were computers like BINAC, EDVAC, UNIVAC and Whirlwind.[11]

Before the development of internal memory, computers did not have the actual computer programs stored on them. Computers were operated and obtained instructions through plug-boards with several wire connections. When memory technology became more and more advanced, it contributed to cost reductions and increased reliability within computers. Among these memory concepts was acoustic delay, electrostatic memory, paper cards and magnetic drum memory.[11]

The Family

The 1940's begun with the ongoing second world war, which had broken out in 1939. While the men fought in the war, women with and without children were at home. Most women in the 1940's were housewives. Their work was to maintain the home and care for the children, while the men were the provider in the family. Most families did not have televisions, so they gathered around the radio. They listened to news and music. As children toys were rare, they usually played by acting out scenarios. At this time more and more homes got inlaid water and electricity. This increase in prosperity brought many changes in the home, especially for the housewife.[16]

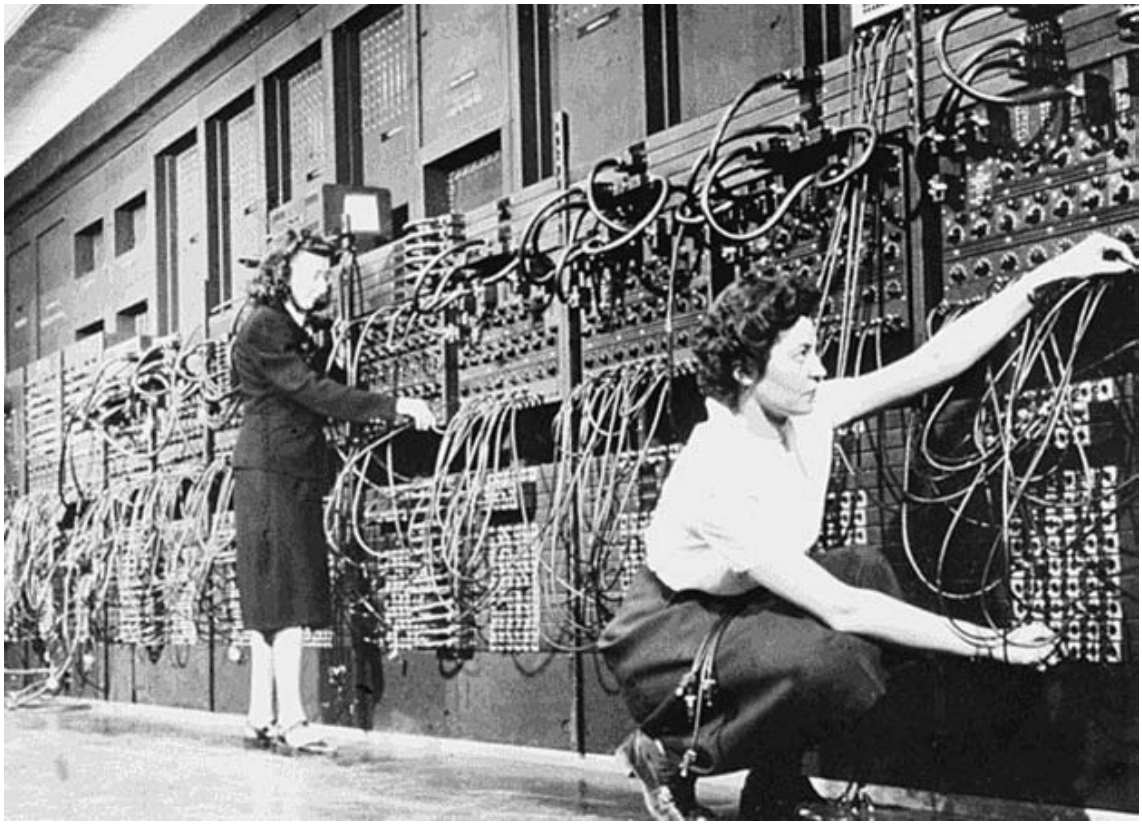

Figure 1.1: ENIAC: First Practical Electronic Computer

1.2.2 50's

Technology continued to advance from vacuum tube technology to solid state technology. TRADIC (Transistor Digital Computer) developed by Bell Laboratories was one of the first transistor computers. Furthermore, the first compiler was developed, which later in 1960 resulted to the release of the programming language, COBOL. In the late 1950's, large computers like the ones mentioned above, was firmly established. At this time the competition and interest of developing smaller computers was low. Subsequently, companies which had acquired and manufactured small computers, ended up releasing them to the public. As a result, the cost of technology decreased and started the evolution of the personal computer.[11]

Further, the development of graphics increased the research of computers and user interaction. The MIT Whirlwind was the first computer which was able to display radar information graphically. Later, games such as chess and checkers was graphically presented.[11] Visually displaying information enabled a broader comprehension of what the computer was working on. The introduction of graphics resulted in, still today, an ongoing research on user interface design. Trying to find and decide the perfect balance between presenting accurate information, and an amount of information that the user can comprehend.

Ambiguity in images and the amount of information displayed, is one aspect where developers have to find a balance. If ambiguity is present it might cause the users to

form an other mental model than what the developer intended. Furthermore, if too much information is displayed, the user will have difficulties relating their intentions to the right aspect.[27]

The Family

The nuclear family at this time included two generations, one male provider and an economical dependent woman and their children.[20] As the welfare society increased, technology was slowly introduced in the typical family home. The tasks of the housewife were lessened by technologies like the refrigerator, washing machine and the vacuum cleaner. Still, she had the solely responsibility for the children, restitution of her man's working capacity, and other social and sexual duties. Nevertheless, there was an increase of working women. Married women in America was participating in the labor market.[20] As a result of more women working, housewife schools was wider established. This was to ensure that a women, even though she was working, would still have the knowledge which the housewife role required. Housewife schools became very popular, which some used as a springboard to nursing school.[16]

1.2.3 60's

Depending on your definition of the term "personal computer", the first personal computer is argued to be the MIT LINC.[11] Considering that previous computer was huge and usually had to be operated by many user, the personal computer is the exact opposite. A computer which is smaller than its predecessors and intended for one user to operate at a time.

Small computer systems and microcomputers were also being developed for both scientific and commercial use. Several significant inventions were made in this decade. Inventions like the mouse, time sharing, the Space Wars game, BASIC programming language, computer networks and as mentioned, the personal computer.

Figure 1.2: The First Computer Mouse Invented by Douglas Englebart

The 60's was a time where the small computer market grew and assembled several competitors. Among them was HP and IBM. As the first personal computers were being developed, they got more and more sophisticated. Still, the computers did not provide a graceful way of operating them. A desire to change and better the user interaction was expressed among users. This was about to change as user interfaces improved.

The Family

In the early 60's, 9 out of 10 children was born within marriage, and 9 out of 10 women were housewives. Furthermore, it was not uncommon that a household contained three generations.[20] However, some women had started to get contracted work and it was an increasing trend. More and more attention was raised towards gender, liberation and equality. Women got married and had children in their early 20's while studying. This enabled the woman to gain contracted work after her children had become older. Because of this, several families experienced an increase in prosperity.[16]

1.2.4 70's

The 70's brought the development of microprocessors. As a result, computers like Xerox Alto, MITS Altair and the Commadore was built.[11] Since the release of the earlier small computers, cost of the technology was low which enabled a wave of hobby computing. Both professionals and amateurs were building computers. Steven Jobs and Stephen Wozniak who later founded Apple, built their own microcomputer named Apple I. As they continued developing, they later built the Apple II which had both a monitor and two disk drives. Meanwhile, Bill Gates and Paul Allan, later Microsoft, were developing a BASIC interpreter for the MITS Altair.

At the end of the decade, Apple was the main supplier of personal computers. It was also at this time that Jef Raskin introduced the concept of the "desktop appliance".[11] The "appliance" would have a screen, mouse, keyboard, storage, printer and internal software. As a result of Apple's personal computers, and the development of the spreadsheet program called VisiCalc, personal computers gained a huge interest from the general public.

The Family

From the 60's to the 70's the number of women studying tripled. Women became more free to choose between working outside or in the home. The role as the housewife was slowly loosing interest among women. Feminist movements was on the raise and fought against the housewife role. The Norwegian Gender equality act was passed in 1978, and the housewife role ceased. It was officially removed as a description in the population census at the Central Bureau of Statistics. Major changes within the Norwegian family home was set in motion, of the idea where men and women should participate in both family and community life.[16] As the motion for day-care centers was passed, 45% of married mothers with children below school age was employed.[20]

1.2.5 80's

The number of new personal computers increased rapidly throughout the 80's. IBM was one of who that thought that the personal computers, up to this point, did not meet the requirements of the small and corporate companies. They released the IBM PC trying to fill this gap in the market.[11] The computer was implemented with software from Microsoft and VisiCalc. IBM additionally created the software named DisplayWriter which possessed a graphical user interface.

Apple at this point was building computers in the Lisa and Macintosh series. They had also obtained a graphical user interface which had graphics, icons and windows. Along

Figure 1.3: The Housewife

side developing personal computers, Apple created software like the AppleWorks and the Lisa Office System. In addition, they developed their own operating system.

Wanting to enhance their corporate image, Microsoft changed the name of their products. It was at this time we got Windows, Word and the newly developed Excel. Furthermore, Microsoft obtained several software licenses from companies in their early stages and also developed their own mouse.

Both old and new competitors was established and competing throughout the decade. Among these were Compaq, Acron, Dell, Atari, HP and Toshiba. Moreover, several programming languages and databases was introduced. Programming languages like C, C++, Turbo BASIC and Pascal. Coupled with this, Oracle launched their Oracle database which was implemented in the Apple Macintosh. It was also at the end of this decade that Mark Weiser, who worked at Xerox PARC, had the idea of ubiquitous computing.[11]

The Family

The feminist movement wanted women to take part in all aspects of the society. By the late 1980's, as many as 100 000 students was registered and the majority of these were women. Furthermore, 8 of 10 thought that the division of labor should be equal for both men and women outside and in the home. Still, only 2 out of 10 put this into practice. In affiliation with the women movement, a male gender role committee was founded. Their aim was to achieve equality for both men and women.[16] In this time most families had televisions, radio and different electronic kitchen appliances. Some even had obtained the early mobile phones.

1.2.6 90's

The 90's brought the World Wide Web, which Microsoft complemented by developing Internet Explorer, the web browser. They continued developing Microsoft Windows, and ended the decade by finishing Windows 98. Furthermore, the Office package was updated and now included Word, Excel, PowerPoint, Mail and Access.[11]

Many companies, because of the tough competition, had to either terminate or liquidate. These were companies like NeXT Computer, Commadore International and Atari Corporation. Despite the termination of several companies, new technological developments were still being made. During this decade we got the Linux operating system and Sun introduced the Java programming language.[11]

The Family

By the 1990's, both men and women was very much engaged in work outside and at home. Still, there was some focus on how the get fathers to be more at home with the children. As a result, the paternity leave was inducted. Also, for parents that wanted to have one parent staying at home with the children, the cash support was introduced. As both parents were contributing at home and as providers, technology was increasingly introduced in the home.[16] This was technology like mobile phones, cordless house phones, multiple electronic kitchen appliances, entertainment systems and more.

1.2.7 21th Century

Today's personal computers come in many different shapes and sizes, from stationary to hand-held devices. Desktop computers, laptops, mobile phones, tablets and tablet PCs, have come to have a central role in our daily lives. We utilize personal computer everywhere we go; at work, in school, at home, during travel and when we have nothing to do - computers fill our time here too. Since the invention of social media, even more of our time is spent engaging a personal computer. Some sort of personal computer seem to always be with us wherever we go. Computers are even being implemented into many different objects, making houses, glasses, gloves, watches, kitchen appliances etc. more intelligent. So, with this growing implementation of computers in everyday objects, how are we going to communicate, interact and manage these objects? This is where I posed the smartwatch as a possible solution.

The Family

After the 1990's, Norway viewed itself as a country of equality. Still in the early 2000's, mothers usually worked part-time, and the fathers overtime. From the previous decade, womens working hours had increased while the mens working hours had decreased. Today, separation, change of partners and children born outside marriage is much more common. Furthermore, the majority of Norwegian mothers, fathers and preschoolers are spending more time outside the family and household.[20] Family patterns has changed a lot over the decades. Today it is not uncommon to marry people from other countries, cohabitation with and without children and single parents.[20]

1.3 Ubiquitous Computing

During the early developments of the personal computer back in the 70's, the Xerox Pablo Alto Research Center (PARC) was established. A chief technologist, working at PARC, named Mark Weiser was the first who had the idea of ubiquitous computing.[11] The research facility lead several projects within ubiquitous computing. They wanted to find

an alternative to the personal computer, which in their perspectives had some issues. Their opinion was that the personal computer had become:

> ...too complex and hard to use; too demanding of attention; too isolating from other people and activities; and too dominating as it colonized our desktops and our lives.[24]

As the desktop computer focused more on human-computer interaction, PARC wanted to enable a wider focus on human-human interaction where computers aided the expansion of this interaction. However, as research and developments were made, the media started expressing their concerns. These were concerns related to privacy and are still present in today's research on ubiquitous computing. Considering the idea behind ubiquitous computing, where a computer is supposed to be transparent to the user. Therefore, concerns were raised and some which are mentioned in Weiser's report [24] are:

- What is controlling what?
- What is connected to what?
- What information is circulating?
- How is it being used?
- How to handle errors? In case of failure, how can we debug and find the source of failure?
- What are the consequences of any given action?

1.4 Wearable Computing

Depending on how you define wearable computing, we can find wearable devices that date back to the 15th century. Pocket watches that computes time to abacus rings and necklaces.[26] However, modern perception of wearable computers are more sophisticated. Wearable computers today normally consist of both hardware and software. Technology is being developed and integrated into glasses, gloves, watches, wrist bands, headsets, shoes, rings, ear mounts, necklaces and more. As an example, we have Google Glass, various smartwatches, Glove One, electronic textiles - observed in fashion, Looxcie, Golden-i, health oriented computers like the Fitbit, Nike+ to mention some. There are even rumors about an intelligent ring being developed.[6] The technology has evolved a lot over the years and it is becoming increasingly more sophisticated.

Modern wearable computing has been given several different definitions and characteristics. However, there are characteristics which are repeatedly mentioned. Some of these are; portability during operations, which in addition limits use of hands, always "on" ability, ability to sense the context of the surrounding environment, cyborg state - a state where man and machine in some way becomes one and the interface of the wearable becomes an extension of the user.[26]

A hand-held device is less likely to become equally intertwined, compared to what a wearable computer and user has and could become further. Steve Mann, in one of his articles [25], distinguishes hand-held and wearable computers from each other by stating:

> ...the goal of wearable computing is to position or contextualize the computer in such a way that the human and computer are inextricably intertwined....

Before the computers we use today, computers were too big to carry around. As personal computers have become more portable, we are rarely without them during the day. Our portable and hand-held computers which are mostly used today are smartphones, laptops and tablets. Unlike these devices, wearable computers have an always "on" concept. This means that the computer is always interacting with the environment around the user, and is always ready for user commands and input. Because of this concept, it is quite obtainable to make the wearable computer our intelligent assistant. While interacting with the environment around us, it can provide continuous information when demanded. Wearable computers, as to hand-held devices, also have the benefit of being hands-free. This enables users to be even more mobile, and interaction with the wearable does not need to obstruct any other activities the user might be engaged in.[22]

1.5 Unexplored Niche

Even though both ubiquitous and wearable computing has been around for a while, there are still unexplored areas when we combine these technology concepts together. There are several studies about methods which can be utilized to find possible services for smart environments. However, there are fewer studies that focus on how to find services within specific environments, and how these methods are different from others. Although these other methods can be applied to some areas, they do not necessary map the services which are most fruitful within other environments. Observing the nature of an environment, contributes to more detailed information to which services are more necessary than others.

Since technology is constantly evolving, new applications and services are developed fast. As a result, consumer continue to buy them. However, these products may only become an additional activity, rather than a product which can contribute to an already existing and daily activity. These products would be more fruitful for the end users. To be able to develop products and services that the consumer wants and needs, during development the focus needs to be more on a human-centered process. A human-centered process starts with what the user needs rather than what technology we have to utilize.[28]

Proceeding with a human-centered development, we can also involve the user in the actual design process. There are studies which involves users through role playing and enactment, which proves to map user requirements more efficiently.[19] However, how can you map requirements and services for a smart environment, when the users within that environment have different preferences, which are expressed simultaneously?

A smart environment can consist of many different smart objects. Also, the environment could have a wide range of different users, especially within a family. Family members have different routines, preferences, activities, roles etc. Therefore, the services within a family home would gain from having the option to restrict or limit use of certain features, like parental control on computers.

Several types of devices have been used to interact with smart environments; computer, laptops, tablets and smartphones. However, some of these devices are not always with you, and if so they are usually located in your pocket, which does not enable efficient interaction. Interaction with an environment through a smartphone might become

too exhausting, especially if frequent interactions are required. This is where wearable computers prove to interact with the environment, in a more efficient way. Considering different aspects of wearable computers, it complements interaction with a smart environment quite seamlessly. This is because it incorporate aspects like the always "on" concept, is always with you and is ideally situated on your body, which keeps your hands free to engage in other activities.

One wearable is able to replace an item which many of us wear today. This is the smartwatch. During these last years, smartwatches have been in the light of research and development. However, some have questioned the purpose of the smartwatch, which currently seem to only be an extension of your smartphone. In my research, I wanted to look at what role this device could have in an intelligent family home. Additionally, focusing on a human-centered process and user differences, I researched how to best find services which a family might want and require. These services could aid the family in their daily routines. By incorporating different participatory design methods, I researched and observed the user interactions and behavior, to map which possibilities a smartwatch could have within a ubicomp family home.

1.6 Technological Niche

In my research I looked at how wearable computers can be utilized in an ubiquitous environment, and what services could be fruitful for a family. Furthermore, what disparities could be found between a family's expectations from using a smartwatch, and their actual experiences. This was done by involving users in the actual design process, utilizing methods which were more focused on human-centered process, than a technology-centered process. In my exploratory research, I adapted a participatory design inspired technique called SPES (Situated and Participative Enactment of Scenarios), formed by Iacucci et al..[19] Furthermore, I looked at how to best adopt this technique, and what experiences I gathered after adopting it.

This area of research was interesting because of several aspects. Firstly, human-centered design is less considered in today's product development processes.[28] By involving users and focusing on what the user needs, will aid designer in the design process to find fruitful future services ans applications. Today, family homes are filled with technological devices which are mostly being used for communication.[15]

Secondly, the smartwatches today have various but similar functionality. Acting as an extension of your smartphone, I wanted to find a more meaningful purpose for the smartwatch. Considering that it is ideally located and people are already familiar with wearing regular watches, it provides an opportunity for seamless and efficient interaction with a somewhat familiar device.

Finally, making computers invisible and simultaneously enable users to communicate with them in an unobtrusive way, was for me very motivational. If elegantly and intuitively designed, smartwatches or other type of wearable computers, could be the future replacement for smartphones and desktop computers.

1.7 Problem Statement

The problem statement for my research is as follows: Within a ubiquitous family home, what disparities could be found between the family's expectations and actual experience

from using a smartwatch. Further, I look at my experiences from adopting and performing SPES (Situated and Participative Enactment of Scenarios). I discuss the positive and negative aspects, additionally posing suggestions to the technique, based on my experiences.

Based on this problem statement, I divided it into three main research questions, with related sub-questions below each. These sub-questions focus on details about how SPES was performed and what could have been done differently, the utilization areas of the smartwatch, target group, which services to consider, and how to facilitate intuitive user interaction between the user and a service through a smartwatch.

As the ubicomp environment I chose to focus on the family home. My aim was to involve a typical family which consist of two parents with one or more children. Since there are more than one user in the home, there are further aspects to consider in the research. One of which is, how can the ubiquitous environment handle multiple users with different preferences. Should all services in the home be available for all the users within the family?

A smartwatch in such environments enables a way to interact with services in a efficient and non intrusive way. Efficient in the way that it is always with you, and non intrusive because even though it is always with you and on, you are still able to perform other tasks, considering of the hands free capability.

A service in this context is a smart object within the family home, or a stand alone service on the smartwatch. The object could be an already existing appliance in the home but made intelligent. One aspect of the problem statement, is finding these services which could aid the family in their daily routines.

1.7.1 Research Questions

In my research I wanted to explore what role a smartwatch could have in an ubiquitous family home. More specifically, which distinctions are there between the family's expectations and experience, in relation to areas of use and ways of interaction. Further, did these experiences affect their behavior or daily routines in any way. A participatory design technique called SPES (Situated and Participative Enactment of Scenarios), was the basis for my research. I look at how to adapt this technique, which results it provided, and what my experiences were with the method itself. My research questions and sub-questions are presented below.

RQ 1: How to adapt and perform SPES with a family as participants?

- What challenges were there when performing the SPES technique with a family as participants?
- Which experiences did I gather, and what could I have done differently?
- Based on my experiences from SPES, what alterations or additions to the technique would I propose?

RQ 2: Which services were found as a result of the SPES technique?

- Which of these services were realistic and which were not?
- Which interaction styles were observed?

- What type of behavior and reactions did the family express when using the dummy smartwatch?

RQ 3: How did the family's expectations differ from their experience regarding utilization areas and ways of interaction with a smartwatch?

- In relation to interaction style, what differences were there between the family using a dummy smartwatch and an actual smartwatch?
- In relation to behavior and habits, where there any differences between the family using a dummy smartwatch and an actual smartwatch?
- What reflections did the family have when observing their interactions with a dummy smartwatch and an actual smartwatch?

1.8 Report Outline

Each chapter in this report addresses different aspects of my research. Below I give an introduction to what each of these chapters contain.

Chapter 1: Introduction

Introduction chapter addresses the background and motivation for why I chose to research this topic. Further, I present an outline of how technology and the the family has developed, since the beginning of the first computers. Lastly, I give an outline to the two main areas in my research; ubiquitous and wearable computing. Lastly, I present my area of research and my relating research questions.

Chapter 2: Related Work

In the related work chapter, I present information and other work related to my research.The chapter is divided into three main parts; wearable computing, ubiquitous computing and related methodologies. In both former sections technology relating to their respective parts are presented. The latter section presents design methodologies and techniques which in some areas are similar to SPES.

Chapter 3: Methodology

The methodology chapter presents what techniques I used and why. These methods helped me gather results which I could use to answer my research questions. A large part of my research was within prototyping. Therefore, a prototype chapter was created where I describe all the techniques I used in detail, and their related results.

Chapter 4: Prototype

This chapter is divided into two parts; the exploratory phase, and development phase. Exploratory phase focuses on the techniques used to map which services that could be found within a ubiquitous family home. It described how I performed SPES and what the circumstances surrounding the different sessions were. Further in the development phase,

I describe which methods and testing techniques I used to test my prototype. Findings made from each method and technique, are presented in the order of which they were performed.

Chapter 5: Results

In the results chapter I present my most significant findings, divided among the techniques used. These findings were the most significant, and which affected the next stages of development.

Chapter 6: Discussion

In the discussion chapter I examine and reflect over my work and findings, based on my related work and research questions. The chapter is divided into different parts, where each part contain discussion on one of the research questions.

Chapter 7: Conclusion and Future Work

Here I try to answer my research questions based on my discussed findings. Lastly, I present some of my reflections surrounding what I could have done differently, and how this could have affected my results. Furthermore, which modifications I would have performed regarding the application I developed.

Chapter 2

Related Work

In my study I combine several technological areas. SPES leads me in to the world of participatory design and related research which have adapted this type of methodology. Whereas the focus on smartwatches takes me into the resurfacing area of wearable computing. Lastly, the use of smartwatches in smart environments leads me on a journey within the jungle of ubiquitous computing.

This chapter is divided into these three technological areas; Ubiquitous Computing, Wearable Computing and Related Methodologies. The ubiquitous computing section contains information about the development of smart environments. While researching this technological area, I posed questions to the papers I found. These were questions like; what environments exist and have been researched? How did they find, develop, communicate and test such environments. Did suitable interaction styles and gestures vary between different environments? Which services proved to be the most useful? Which findings during testing had the most impact on the direction of development of the device or service?

The second part of this chapter contains related research within wearable computing. This section focuses more on how people interact, and have interacted with current and previous wearable computers. Which interaction styles and gestures do the various devices support, and in which context have these devices been used to communicate with services in a smart environment? How were they tested, which methods were used to develop services and how was data analyzed.

Final section focuses on similar research which have adapted different kinds of techniques within participatory design. What is interesting to study is how they adapted the different techniques and what their findings were. Furthermore, how they thought their adaptations of different techniques might have affected their findings. Lastly, what methodology combinations and suggestion for improvements they might have for the various techniques.

2.1 Ubiquitous Computing

The term ubiquitous computing was devised by Mark Weiser in 1988. The idea behind ubiquitous computing is to evolve past desktop computers. Weiser visualized that computers could be embedded in the construction of buildings and into everyday objects.[13] The term "smart objects" was later introduced to describe these objects. By implementing both hardware and software in everyday objects, we can create an environment called a

ubicomp or smart environment. However, challenges arises when such ideas are discussed. Challenges concerning security, privacy and intuitiveness. My aim for this paper was to see how users could interact with a pervasive environment using wearable computers, by looking at existing methods for mapping and testing these environments. In addition, what kind of services would the user want or need, and how would they interact with these services. Several environments and user groups had to be considered.

2.1.1 Early Ubiquitous Inventions

Mark Weiser and his research team developed one of the first computers within ubiquitous computing. These were wall-sized screens which obtained interaction from the user through a pen. This wall was later called LiveBoard, which several schools ended up purchasing. Since the LiveBoard was such a success, various projects to develop its successors was initiated. The following research and developments lead to the realization of the ParcPad, ParcTab and the Active Badge System. The system realized the augmentation of the both devices. The implemented features in the software, enabled the system to recognize device names, location, connectivity, usage and device ownership.[24]

2.1.2 Smart Environments and Objects

Imagine that in every environment you find yourself in, there are objects connected to the internet. These objects have different technologies embedded in them, technologies like sensors, RFID tags, bacons and more. They can communicate with each other, gather information from the physical world and convey information to you. It is the collection of these objects that make up these so called smart environments and idea of IoT.[36]

> Internet of Things (IoT) is a concept and a paradigm that considers pervasive presence in the environment of a variety of thing/objects that through wireless and wired connections and unique addressing schemes are able to interact with each other and cooperate with other things/objects to create new applications/services and reach common goal.[36]

Several research studies discuss the possibilities of such environments. How to transform an environment into a smart environment, by mapping the objects that are feasible to become more intelligent. Further, which features they could implement, how they could interact with each other and the user, and how to develop an universal graphical user interface, to communicate with the different objects and the environment itself.

Within a smart environment we could have a wide range of different services for us to interact with. These services could be either stand alone services on devices or embedded in objects. By making existing objects and appliances more intelligent, enables additional functionality beyond the already tangible interaction they might have. If the object is able to connect to the internet, they can be given a more active role in the environment they are situated in. Having a connection to the internet, the object will have unlimited access to information, media and services which the user can exploit.[36]

There are also other ways for the objects to gain and communicate information than through the internet. Objects can have embedded sensors which gather information about the environment and its users. Image recognition could gather further information about who and the whereabouts of users within an environment. Implementing other technologies like NFC, RFID and Bluetooth would also increase the objects possibilities.

Figure 2.1: Internet of Things at Home

Smart object technology is being developed and deployed in products. The number of things connected to the internet is increasing. It is estimated that by 2020 there will be over 30 billion devices connected to the internet, with over 200 billion intermittent connections. The ecosystem of these devices have the ability to sense, communicate, network and produce information. This directs us into a future where storage, computation and communication services are highly pervasive.[36]

2.1.3 From Workplace to Domestic Space

Looking at the history of computers, their purpose has been to aid people in work related tasks. Even though we later brought the desktop computer home, it still has a home office related role. Now that the computer has been firmly established in our homes, it is more utilized to pass time rather than contribute in everyday activities within the home.[33]

Computer are taking new shapes, rationales and area of use. As research on pervasive computing increases, some research look to CSCW (Computer-supported-cooperative-work) related work for references. However, CSCW is a technology which have evolved from studies based on utilization of computer in office and work related tasks. In this context, computers are regarded as tools. As a tool they are utilized to be productive and resolve tasks efficiently.[33]

Therefore, considering that computers have emerged from the workplace to the domestic space, it should complement the role of the not-worker as well as the worker. That pervasive technology appeals to the not-worker is important, considering that the technology is within the home where you undertake a different role than at work. When developing pervasive computers for the home we have to reconsider the technology, the context, users and purpose.[33]

Changing Roles

As a person you have different roles depending on the environment and people around you. These roles have and require their own set of specific knowledge, skills, education, training and expectations. Similarly, the computers have different roles and purpose depending on the environment and the users current role. The work environment is set to increase efficiency and productivity, and computers are tools which are used to support this. Home, the desktop computer is less used as tools and more as a time consuming activity. These are activities like browsing the internet, online shopping, playing games and chatting. Still, we can find off desktop computers which are used to solve tasks within the home. These are computers like the microwave, washing machine, paying bills online and the remote control for the TV.[33]

However, pervasive computers at home can be developed to enable a more extensive support for everyday routines, rather than wasting time. Off desktop computers like pervasive computers, require different types of user interaction. So, for the implementation of pervasive computing in the home to become useful, the focus on users and technology has to change. Studies which seek to develop interfaces and services for pervasive environments outside of work, should focus on a more being-oriented rather than task-oriented technology.[33]

User Differences

There are noticeable differences between the different range of users, operating computers in the workplace and at home. Users within the work environment are normally within a certain age range. In addition, they are required to have the basic knowledge about desktop computers as a tool. In a home environment there is a much wider range of users present. Differences in age, knowledge, skills both cognitive and behavioral. Therefore, it is important to be aware of this when developing pervasive computers and applications. The services must accommodate these differences.[33]

2.1.4 Concerns within Ubiquitous Computing

> In the purest form of ubiquitous computing, all computation is contained in the environment rather than on the person.[13]

Computation is done within the environment. This means that all information the environment computes are stored within the specific area. The data which is stored are for the most part personal, since it is gathering and providing you with information which concerns you only. In addition, you are the one that personalized the environment. The environment could be set up to learn and anticipate your needs by remembering your habits. This is where questions concerning privacy of such technology is raised. In example, if you should be so unlucky to end up in court, then the data which is stored could become a prime target for a subpoena.

Furthermore, privacy is affected when entering hostile environments. Example mentioned in the article by Rhodes et al. [13] - if a person from a competitive company enters an other company's ubicomp environment, they would not like to have their personal information uploaded to their database. Some advantages might be gained from that information.

Another problem which is presented is maintainability of personalized settings in the environment. Imagine that an environment frequently has to update and manage multiple users. The environment would continuously have to add and delete users to each and every object in that environment. If such environments were implemented, how can we minimize the risks of privacy leaks? Could wearable computer be a solution to these problems?

2.2 Wearable Computing

Personal computers today are lot more portable than the early computers. As a result, we are rarely without them during the day. Most common portable and hand-held computers used today, are smartphones, laptops and tablets. Unlike these devices, wearable computers have an always "on" concept. This means that the computer is always interacting with the environment around us. Because of this concept, it is quite obtainable to make the wearable computer our intelligent assistant. While interacting with the environment around us, it can provide continuous information. Wearable computers, as to hand-held devices, have the benefit of being hands-free. This enable users to be even more mobile, and interaction with the wearable does not need to obstruct any other activities the user might be engaged with.[22]

2.2.1 First Wearable Computer

If you define wearable computing as something that you wear, which have both hardware and software, then the first wearable computer was invented back in 1955. The device was about the size of a cigarette pack and was placed in a shoe. The purpose of this device was to predict which octane the ball in a roulette wheel would land on. The invention proved to give 44% accuracy. The computer had two switches which were operated with the toes. One switch initialized the computer, and the other timed the roulette wheel and the ball. Musical scale was transmitted to the user when the rotor had been timed. The musical scale consisted of eight tones which marked when the rotor octanes passed the most likely mark.[34]

Some argue that the invention was one of the first wearable computers, although it was kept a secret from the public until 1966. Meanwhile, two other wearable devices had already been introduced. Nevertheless, the development of wearable computers have been steady but slow from that point on. Between the late 90's to the 21th century, the focus on wearable computers have reached the public in a broader sense.

2.2.2 The Smartwatch

Peoples lives tend to change when adopting and employing new technology. When the smartphone was commercially introduced, people were relying on it to aid them with various tasks during everyday life. As a result, fewer people are wearing watches today, because they expect and know that their smartphones can provide the time.[29] Smart phones are with us almost every moment of every day, like the watch has been for centuries up to the introduction of smartphones.

Traditional watches have for centuries, and still today, been used to access time and date. However, as technology continue developing, computers are implemented in more and more everyday objects which have been around for decades. Eventually, the smartwatch

was invented. The development of microprocessors and wireless modules has enabled the smartwatch to become quite versatile.

Smart Environment Living

Fill a room or area with intelligent appliances, devices or other type of services implemented in artifacts, and you got a smart environment. The concept of smart homes embraces the idea where different devices in the home, are able to interact and provide information to the user. Among these could be e.g. lights, temperature, intelligent appliances, different types of sensors, and entertainment devices. These devices can gather information and be controlled, but the devices themselves are not ideal to carried around on your person. Therefore, the environment must communicate with a device, which the user can carry around. This enables the user to access information gathered from the environment more efficiently. A smartphone is both a convenient and mobile device which could handle such a task. However, studies show that people rarely carry their smartphones around when they are at home.[29] This is where the smartwatch provide a higher level of accessibility and mobility than the smartphone. Situated on your wrist, you are less likely to take it off, regardless of where you are and what you are doing.

User Interaction

Among the various smartwatches developed, different styles of interaction have been employed. The older generation of smartwatches provided quite limited user interaction compared to the ones that are and being developed today. One of the first smartwatches was the IBM's Linux Watch. Similar to other watches from this generation, user interaction was limited to tangible buttons and a poor software menu. Mainly their purpose was to enable the user to only access information quickly.[29] This still applies for the smartwatches developed today. However, we are now also able to control and send data back from the watch to the connected devices. In many cases, this is achieved by a having a host application on your smartphone. From this application, other applications can be installed on the watch which enables data transfer, like notifications, to be viewed on the watch. Sony is one of which who uses a host application to communicate with their smartwatch.[3]

Compared to the early smartwatches, additional interaction styles are supported in today's smartwatches. Some supporting both touch and gesture-based interaction.[12] Enabling the watches to recognize user gestures is achieved by implementing sensors. These are sensors like accelerometer, gyroscope and magnetometer. More about sensors are mentioned later in this section.

dWatch is a smartwatch prototype which was developed in the 2012.[12] They further describe that the watch has three main functions:

1. Stand menus and gesture-based interaction for controlling devices.
2. Receive notifications from the environment and other dWatches.
3. Ability to customize displays - dWatches could incorporate different privileges. The watches with the same privileges could share the responsibility of a device.

[12]

Figure 2.2: IBM's Linux Watch: One of the First Smartwatches

These watches implement the interaction styles from the older generation and the new. However, there is one interaction style which is still in the early stage, namely tangible gesture interaction. An example is the stylus pen on the Samsung Galaxy 10. Similarly, some tablet PC's have their own stylus pen. This concept has derived from an intersection of tangible and gestured-based interaction.[29]

Incorporating gestured-based interaction in the smartwatch has shown to be very fruitful. A research which focused on gesture-based interaction, proved in their research to be 95.5% accurate. Furthermore, the study pointed to no obvious differences between environments, or if the user was standing, sitting or walking.[23]

Hardware

For smartwatches to become smart enough, some main components have to be implemented. Among these are a microprocessor, sensors and a wireless module. Deciding on which microprocessor to implement, depends on the tasks the watch is aimed at handling. Sensors are significant components which enables the user to interact with the watch, and environment through gestures.[29]

Most commonly implemented sensors are the accelerometer, gyroscope and magnetometer. The former enables gestures like swipe, shake and tilting. Second enables the watch to provide information about orientation, like forearm rotation etc. The latter enables recognition of pointing and additional tilting gestures. Essentially, without sensors the smartwatches today would not be able to detect user movements. Interaction with a smartwatch without sensors, would only rely on tangible buttons and touch screens.[29]

Furthermore, by implementing a wireless module the smartwatch is able to communicate with other devices. Frequently used wireless module is Bluetooth technology, which enable the smartwatch to connect to e.g. your smartphone. The sWatch implemented RF technology, which is not equally profitable in regards to data transfer.[12][29]

Software Architecture

When discussing hardware choices, it depends on which tasks the smartwatch is intended for. Similarly, when establishing the smartwatchs software architecture, it is important to consider how it should communicate with an environment or single device. Currently there are three main architectures which smartwatches have been known to utilize. These are as follows; All-in-one, client-server and gateway-integration.[29]

An all-in-one architecture addresses all tasks which are supported and provided by the user through the smartwatch. With this architecture, the smartwatch is able to perform all of its own computation, which also makes it quite a powerful device. Examples of these computational tasks can be sensing data collection, gesture recognition, command issuing and general interaction with users. Although, performing its own computational work, the smartwatch must carry a good battery to have the capability to constantly perform at a high level.[29]

Client-server architectures are well known within the area of collaborative and distributed computers. The conceptual point of this technology is that the client handles interaction with user, and the server performs the computation tasks provided by the client and the user. Implementing this concept into the smartwatch reduces the number of tasks and computation power needed within the watch. With this architecture the smartwatch becomes dependent on an external entity to perform the more heavy computational tasks. This external entity could in example be your smartphone. However, if implemented, the interaction between them should be transparent to the user. Additionally, this solution is highly dependent on a continuous and stable wireless connection with the entity.

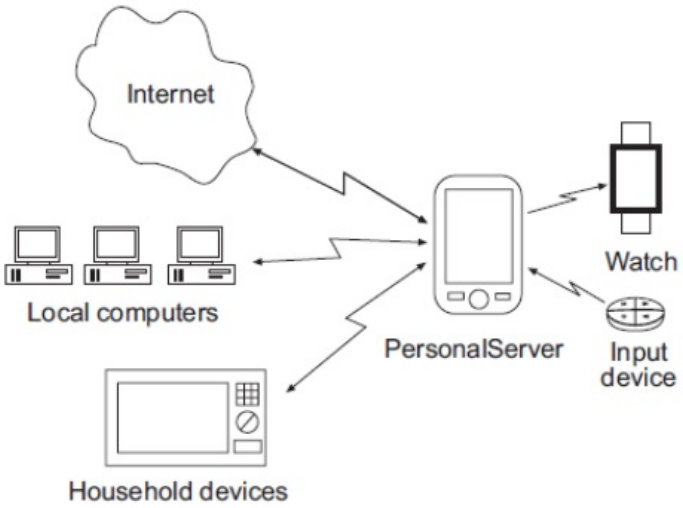

Figure 2.3: Client-Server Architecture

In example, in a smart home the smartwatch could gather and display information to the user, while sending raw data to the external entity to perform the computation. Tasks that would be computed by the server would be tasks like gesture recognition.

Gateway-integration was implemented in the dWatch. This architecture is normally utilized when, in this case, the smartwatch can not directly communicate with the appliances in the environment. Instead, communication passes through a gateway before reaching the intended device. Considering that manufacturers could start developing their own line of intelligent appliances, this architecture enables integration of different solutions.[29]

2.2.3 Concerns within Wearable Computing

Concerns related to ubiquitous computing was with privacy and maintaining personalization. Could wearable computers be a possible solution to those issues? Hand-held and wearable computers have personal information stored. They are devices which the user carry around and are rarely without. Within a smart environment, the personal profile does not need to be stored within each object in the environment, but instead in the wearable. However, wearable computers also have some issues to be considered.

Power Management

Depending on where computation is performed, power management could become an issue, especially if the wearable is handling most of the computation. Having to remove and charge the watch regularly would quickly become a nuisance. Therefore, a long lasting power unit should be present in a wearable. Commercially, the size of the watch would be one of the main aspects considered whether or not to buy it. Implementing watches with big batteries making them big and bulky, would most likely reduce the interest in that watch. In contrast, a small battery pack with a limited up time, would also become an issue. So, what is the perfect balance, or more importantly, how can we charge the wearable without the user having to take it off?

There are several types of battery and ways of absorbing power to the battery. But when deciding which type of battery to implement in any device, there are some aspects to consider. Before designing the electronics, packaging and functionality, you should consider the size, cost and weight of the battery.[32] The smartwatch has very limited space and users would most likely not want a very heavy watch.

Developing a watch which the user never really have to take it off, would be ideal. Where the watch gained power from the environment. Pace makers need and have a very long lasting power supply. It utilizes a plutonium-238 power source. However, if this was to be used in commercial products there would be political problems. Looking at chemical batteries, solar panels, human actions and radio transmission, there are some possibilities but not without related issues.[32] Secondary batteries which are rechargeable would be the most logical choice to utilize. The only question is how to charge these without causing user frustration. Some type of wireless charging would be a solution.

Heat Dissipation

Heat dissipation could become an issue and it is linked to power management. Frequent utilization could render the smartwatch to become quite hot. Regardless of how frequent the user utilizes the watch, the temperature should not exceed 40 degrees Celsius.[32] Considering that the watch is situated on your wrist and the average human temperature is 37 degrees Celsius, a much higher temperature above that would become uncomfortable. A higher temperature would also decrease the users willingness to frequently use the watch.

There are many technologies which are used to decrease heat dissipation. Related to wearable computers there are several ways to deal with high temperatures, some which includes using the user. Using user movement, like arm swing, perspiration, chill batteries while charging and later let the battery absorb the heat, water reservoir stored in a sponge, or phase-change materials.

2.3 Related Methodologies

In this section I present methodologies which are related to SPES, the technique I have chosen to base my paper on. These methodologies contain techniques and aspects which are in some areas similar to different aspects of SPES. This part of the chapter provide a broader insight of some of the different ways to implement techniques and what their related findings were.

Some of the techniques I mention are; role playing, using props in scenario-based and user-centered design, designing for work and domestic settings.

2.3.1 Role Playing

Janis et al. in "The Influence of Role Playing on Opinion Change"[21], wanted to find out when induced by role playing, would openly expressing opinions which might not relate to participates own convictions, facilitate opinion change. Participants were divided into two groups; active control and passive control. Active participants were asked to be an advocate for a predefined outline, which included statements and arguments. As the active controls role played, the passive controls were present listening. A questionnaire was performed four weeks before this session and right after. Based on those finding they were able to conclude that openly expressing opinions, induced by role playing, facilitated opinion change.

This research gave me more insight if enactments could facilitate opinion change in later enactments. What would cause differences in opinion between performing different sessions of SPES.

2.3.2 Using Props and Drama to Inspire Design

Hutchinson et al. [18] presented the use of technology probes as a new method for designing technology for and with families. Two probes were developed to collect data surrounding contextual use, with intended users of the technology probes. A probe called VideoProbe and the MessageProbe was developed and tested in their research. The probes proved to reveal scenarios which were both within the practical and creative sense. These were scenarios which dealt with coordination of children, planning meetings, and a easy way of communicating and sharing with other households. They concluded that the method of developing and using technology probes, were promising for when designing new technology. Further, it allowed the users to work with new technology, which they thought increased their creativeness.

The method of developing and using technology probes and SPES, both involve the intended users. When testing the probes they were within the the homes' of the users. Similarly, SPES is performed in the user's real context, and using a prop for the user to interact with.

Scenario-Based Design

In Howard et al. [17] they present a form of scenario-based design. During scenarios, they allowed participants to freely select props and endow them as they saw fit. With this type of design, they sought to further immerse the user in the scenarios that were presented by the observing designers.

In their research, they hired professional actors to act out posed scenarios, while the design team observed. At times the designers would pose questions to the actor, related to the ability of their selected prop and the scenario itself. Questions were asked to further gain insight to how the actor was using the prop in the scenario.

Their reasons for using and allowing actors to endow props, was because they meant that it dissolved tension on the actors part, by having something to interact with. Furthermore, they felt that using props kept the actors from suggesting omnipotent endowments during scenarios. It also allowed the designers to gain more understanding of how the prop affected the scenario. The main focus during the scenarios, was to observe the context of use regarding the prop, rather than the activity and goals of the participant.

During the scenarios, the design team would to some extent manage how the scenario played out. Mostly to keep the actor from posing unnatural endowments and situations during acting. These interjections was also used as an aid for the actor, to help their innovation process. With their interjections they also wanted to increase the actors excitement towards the props and scenario itself. This was to keep the actor interested and engaged during enactment.

Props and endowments In their research they posed some issues related to the use of props and endowments. They presented two ways of endowing and using the prop which they called; opening-up and closing down. Opening-up was when the selected prop already had specific endowments the actors had to relate to. During the scenarios the design team would remove some of these predefined endowments, to allow the actor more and more freedom. Whereas the closing-down approach went from no endowments to a quite constricted prop later in the scenario. When posing these to ways of endowment, they found that the opening-up method became frustrating for the actor, because it initially limited their creativity. Still, when these constraints were later removed, the actor still felt frustrated and less creative towards the prop. They realized that it was easier for the actor to acquire and adapt to incoming constraints, than removing constraints.

These scenarios where not acted out in realistic settings or locations. However, they state that location is an extended prop, and new challenges can be found when the user is set to act out scenarios in a real location relating to the scenarios.

They concluded their report by posing some rules of thumb relating to participatory design.

- Allow time for personalization of prop, to make performance more real.
- Interlace performance and design. Prevent that the designers become spectators rather than participants in the innovation process.
- Use more than more prop, to increase creativity.
- Help actors to endow their props. This way you can you can increase the actors interest and immersion by posing intriguing endowments.

- Let endowments come from performance rather than the technology itself.
- Use both endowment processes; closing-down and opening-up.
- If possible make use of the power of location, which in itself is a contextual prop.
- If the performance start to become more science fiction than plausible fiction, loop back to set the actor on track.

These steps help the designer's sense of immersion and understanding between the context of use and the technology itself, which can produce innovative product ideas.

User-Centered Design

Similar to Howard et al. [17], Brandt et al. [14] focuses on how the use of drama and props aid the users to envision future artifacts. In their research they stress the need to be creative and exploratory to gather insight within different perspectives of various artifacts.

Based on research done by Keith Johnstone, Brandt et al.[14] mention that status is a factor when people are interacting. Status awareness might give additional insight to design possibilities of an artifact. An artifact can be made to disrupt, maintain or adjust a high-low status relationships between users.

Designing for a work setting Brandt et al.[14] discuss two project where they utilized drama in their user-centered design process. The Smart Tool project aimed at developing design concepts for tools which refrigerator technicians used when servicing machines. During the design process, they focused on bodily expression and the human aspect of the scenarios, to understand how the technicians worked.

Tasks which the refrigerator technician would perform, were divided into essential parts. With the use of drama, the designers expressed with their body, their interpretation of specific parts from the various tasks. They presented a pose to describe the different situations. This made the designers gain a common understanding and interpretation of the specific situations. Furthermore, they realized how specific their poses had to be to avoid ambiguity.

Personas Brandt et al.[14] did not want the design concepts to only evolve around specific work situations and environment, but also consider peoples different personalities. Personas were therefore developed to look at how lifestyle and personality would affect and differ from their initial design concepts, where these aspects where not considered. By taking the role of these personas, the designers were able to gain empathy for them. Various ideas emerged when using personas, mostly because of the differences in their described personalities.

In the second phase of the Smart Tool design process, the designers acted out scenarios in a simplistic staged environment. This way they were able to identify problems and related solutions. As new ideas emerged they were immediately acted out.

Later, they introduced the Forum Theater technique into the scenarios. Forum Theater, developed by Augusto Boal, was one of their inspirations in this research. It is a drama technique were users could be actors or audience. The audience is supposed to suggest and directly influence how a scene or play should be played out. The designers acted out how they thought a refrigerator technicians day would be, while the user, which

were actual technicians, observed as the audience. This way the designers gained expert knowledge, which helped them to fill gaps in their interpretation and knowledge concerning different situations in the scenario.

Designing for a home setting In Brand et al.[14] the second design project, the Dynabook project, focused on developing design concepts outside of work. They realized when designing for the domestic space, that props needed to be less specified and more open, compared to the props used in the Smart Tool project.

Dynabook is a design concept for electronic books. Instead of focusing on specific tasks, the designers now had to understand and analyze users interests, gender, age, lifestyles, preferences, environment and situations.

Staging a brainstorming session Brainstorming sessions with enactment of scenarios, were performed at to explore the domestic area. A room was staged as a home with common interior elements. One of the designers acted as three different people. Who the designer was at various stages, was defined by wearing or holding a specific prop. The actual scenarios were based on common daily situations which occur in the domestic space, spread across morning, afternoon and evening.

As scenarios were acted out, the designers would take pauses were they would discuss and reflect over the situation. Observing designers would ask questions to elaborate on specific situations.

After the designers brainstorming session, they introduced users to the design process. Users would create their own scenarios in their own home. A cardboard was used as a prop which represented the Dynabook.

Difference between design settings Brandt [14] discuss the importance of the brainstorming sessions, and selecting the most fruitful ideas to the next stage in the design process. Furthermore, they stress how fragile the domestic setting is compared to the work setting. Within a work setting, designers only need to observe one specific work setting. Whereas in a domestic setting, there are several situations and people to observe at the same time. On the other hand, designers found it easier to develop design concepts for the domestic space. They concluded that it was because it was more difficult to familiarize themselves with the technicians and their work context. Therefore, developing design concepts for that context, demanded more time to comprehend the setting itself.

Props in user-centered design Brandt [14] found that props profoundly influenced the stages in the design process. Discussions would mostly revolve around the prop, regardless of project. Presenting props within the users home created a meeting on more equal terms, where users could freely express their options in a safe environment.

In the Smart Tool project, three props were used. One which you could use to see whatever you liked. Second, do whatever you liked, lastly one where you could store whatever you liked. These props were used by the refrigerator technicians when the designers were acting out scenarios. Suggestions posed when using the props was immediately acted out in the scenario.

In the Dynabook project, different shapes were cut out of cardboard. When meeting the users for the first time at home, the props were introduced. Then users were asked to come up with ideas and purposes for the different props.

Detailed props More detailed props were later developed and tested. When presented to users, these props actually generated less ideas than the props with almost no details. The simple props seemed to allow and increase the users creativity, while more detailed props helped designer discover missing design features.[14]

Chapter 3

Methodology

The main focus in this chapter is directed towards the different phases in my research. These phases are as follows; exploration, prototyping and testing. My research is based on the utilization of exploratory and observational methods. This chapter provides overall information about the adopted methods. In addition, further explanations are given of why and where in the project these were used.

There are five main sections in this chapter; Participatory design, SPES, Exploratory phase, information about the test family, and the remaining methods are placed beneath the section called Development phase. In this last section methodologies are presented in chronological order. Further information about how methods in this section was performed, in described in more detail in the prototype chapter 4. Here, results related to the different methods are also presented.

3.1 Participatory Design (PD)

Participatory design is in itself is a research, where the research focuses on design of items, systems or used to gain other type of tacit knowledge. This knowledge is gathered from users which can aid improvement or development of systems and future artifacts. Like other types of research, PD has related methodologies and techniques which can be utilized.[31]

Over the years participatory design has been in constant development. Earlier adaptations of PD included more extensive and direct interaction with the users. In later adaptations, interaction with the users has been less direct, and there is more focus on observation and analyzing props and the use of them.[31] SPES adapts a later version of PD, where interaction with the user is less extensive and the focus of the designer, is to observe the user's interactions with the environment and prop.

Researchers pose several limitations and challenges with participatory design, within both the methodological and practical aspect of the research. Some argue that this type of research might gather information which the designers interpret their own way. Therefore, it is fruitful to invite the users after observations to co-interpret and analyze the designers observations.

Furthermore, since the method aims to improve an aspect in a users life, it bases itself on existing habits and work-flow. Therefore, it has been stated that the method is not suitable for finding new inventions or more extensive alterations. Others fear that

participatory design research have a higher risk of overseeing certain stakeholders during observations.[31]

Considering the practical limitations of this methodology, it is a profoundly time consuming type of research. More importantly, it require continuous critical participation from users.[31]

3.2 Situated and Participative Enactment of Scenarios (SPES)

SPES, a technique described in Iacucci et al. [19], is the foundation and inspiration behind my chosen topic in this paper. It is a technique which was developed to help designers envision future services and devices. SPES was developed as a possible solution for when designing for mobility. In Iacucci et al.[19] they describe three problems when designing for new mobile services.

1. Open-end character of the design, which has to co-develop services and devices without a particular focus on user activities.
2. Designing for mobility, where there are new challenges especially in relation to group interaction and the context.
3. When moving out of the workplace and away from the desktop, socio-cultural aspects are increasingly influential.

Inspired by participatory design research, SPES combines ethnographically oriented observation and intervention. Unlike other techniques and methods in this area, SPES has found a way to link concept testing and field research studies. By allowing users to participate and posing possible future situations, was found successful in generating ideas through enactment of surfacing scenarios.

SPES involves users by enacting scenarios in real life environment and context. The method is performed by the user acting out scenarios and interleaving the use of a dummy device in their everyday routines. This way the users everyday life contributes to envision and enacting future applications and devices that could be useful.

When performing the technique, the designer would shadow a user throughout a regular day, over one or two days. A photo camera was used to take pictures of specific situations and enactments that occurred. In addition notes and drawings of situations and actions were documented. As a opposed to traditional scenario-based design, where scenarios are predefined in a lab by designers, SPES allows for co-creation of scenarios in the users real and current context. To trigger enactments with the mock-up, the designer would, in interesting situations, invite the user to utilize the dummy device. In other situations the user would engage the mock-up by their own initiative. The user and designer would have discussions after enactments, about ideas, possible devices and features.

Iacucci et al.[19] describe that the reason for why SPES was successful in envisioning future devices and services, was because the scenarios are extracted from real life situations, which make them more detailed. Furthermore, that when implementing a phenomenological approached where the users and designers are experiencing and co-developing design, is more fruitful than basing design on abstract models.

I choose to combine this method with the smartwatch as the dummy device, to aid my research in exploring what role a smartwatch could have within a smart family home. Although, SPES is successful in finding new devices based on scenarios, I focused on what

services and functionalities the smartwatch could embrace. Furthermore, how a family would interact with a smartwatch within the home, and which purpose it could meet.

Together with the test family I performed two sessions of SPES. The main focus and objective between the different sessions varied. First session focused on observing which services the family displayed. Second session was based on one of the services found during the first session. Here the method was used to discover features and interaction styles within the chosen service.

3.3 Exploratory Phase

Exploratory research does not aim to find a answers to the stated research questions. Instead, the research focuses on exploring the research questions in various levels of depth.[5] The exploratory phase explains how services for the smartwatch was identified and which method was used to find them. Here, the scope of the specific service was defined. Further, an explanation is given to why the specific service was chosen for further development.

The main scope of this phase was to adapt SPES and find services for a smartwatch that would be useful in a family home. Since the future intended users would be a family, involving these users from the beginning would enhance the possibility for a fruitful end product. Smartwatches have been around for some years. However, they have not been marketed for commercial use until recently. Smartwatches are finding their way onto wrists of ordinary consumers, which allows for quick and seamless interaction with numerous thinkable environments and objects.

Considering that smartwatches are becoming more known, my research is still quite unfamiliar for most families. As an unknown area, testing such services on families could offer some issues. These issues are mostly related to user feedback after testing. Users might find it difficult to express and give feedback to a service which is utilized in new situations, and in a non-existent and unfamiliar context. Therefore, the risk of developing non intuitive design solutions are much higher, if future users are not involved early in this kind of project.[19]

The research done by Iacucci et al.[19], made me both aware and interested in the way they involved users from early on in their developed methods. The two methods presented, describe a tight and frequent work and utilization of future intended users during a design process. In my research I used the SPES method as a tool to engage users, as a result their idea processing came more naturally. Movement and gestures observed during these sessions were natural and were what they felt was the most intuitive way of interaction. A lot of peoples actions are based on habits, instinct and are done subconsciously. Therefore, asking users to present ideas and interaction suggestions without the user enacting scenarios, would be risky and perhaps not so fruitful.

3.4 The Test Family

In my research my target users were people within a family which lived together. As my project is inspired by Iacucci et al.[19], I needed to involve real users in my design process, from idea to design development. Originally I aimed at recruiting two families to include in my research. However, since I managed to find a very outgoing family with six children within different ages, a second family would not be necessary.

The family consisted of two parents and six children, where the children were from 13 to 18 years old. From observing the family, I found that they were very outgoing, open minded and creative. Each family member was free to speak their mind and everyone was taken seriously. Furthermore, the family was used to both computers and smart phones, some of them were also above average interested in technology. Getting to know the family was important for when analyzing the results from the various adopted methods. Considering that families have different routines, dynamic and technological interests, the results would be affected by this.

3.4.1 First Meeting

When meeting the family for the first time, the intent was to get to know each other, considering I would spend a lot of time with them in their home over the next months to come. To aid my research, it was useful to get to know their daily routines, family activities, occasional activities and their individual relationship with technology. It was important to inform the family of the scope of the project, and which aspects they would be involved in. During the meeting I described in detail the different phases the project would undergo. In addition, what my role would be in the different phases, which devices they were to handle and how data was going to be gathered and documented.

3.5 Development Phase

Based on the findings from SPES in the exploratory phase, one service was chosen for further development. The development phase describes the methods I used to develop and test the wireframes and later the interactive prototype. More details concerning the circumstances around these methods, and how they were performed, are presented in the prototype chapter 4.

3.5.1 Personae and Scenarios

Personae and scenarios was created to aid me with the interface development. Here the future intended users are described and to how they would use the application.[30] During prototyping it was an useful tool which reminded me of the diversity of the possible end-users. The various personae and scenarios are depicted in the prototype chapter 4.

3.5.2 Wireframing

Wireframes are low-fidelity paper prototypes, where some or each screen of the prototype is depicted on paper.[30] After deciding on which service I wanted to develop, I created and tested wireframes to improve the prototype by replacing non intuitive and unnecessary aspects. The wireframe design was the basis for further design and development of the interactive prototype.

3.5.3 Prototyping

The prototype of the chosen application underwent several stages of development, from paper to interactive prototype. As the different prototypes were tested I tried to keep an

equal level between a vertical and horizontal prototype. An equal level means a balance between functionality and features in the application.[30]

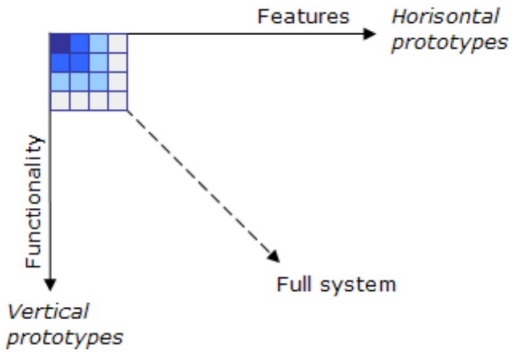

Figure 3.1: Vertical and horizontal prototypes

The prototype chapter 4, has two main phases, which describe the methods and test methods I used during prototype development. These two phases are the exploratory and development phase. The prototype chapter is dedicated to the development of the service from idea to interactive prototype. Describing the development stages in detail and their related results.

3.5.4 Low Budget Testing

Low budget testing, also known as guerrilla testing, was used for formative and summative testing.[35] This means that the prototype was tested when it was in a low-fidelity and later in a high-fidelity stage. During the development phase, the prototype went through several stages from idea to interactive prototype. Along the different stages, low budget testing was performed to remove non intuitive aspects of the prototype. Depending on where the prototype was in the development phase, the tests were performed at the Østfold University College and in the family's home.

3.5.5 Gonzo Testing

Gonzo testing is a form of usability testing where you seek out the intended users where they are.[35] Tests are performed in the application's intended environment. In the family's home I got the test the different stages of the prototype. Scenarios from the SPES session was used and interleaved with the family's daily routines. Observations about user interaction, application design and features, information structure and behavior was collected.

When analyzing the video footage from the two sessions of gonzo testing, I was interested in observing the users behavior and reactions while using the smartwatch. These observations were interesting, because they highlighted the differences in the family 's expectations and actual experience. Further, to see how these observations differed from observations made during the SPES sessions. Lastly, observing how they interacted with the smartwatch and how it affected the family's way of communicating.

Chapter 4

Prototype

The content of this prototype chapter is divided into three sections; exploratory phase, development phase and prototype development environment. The exploratory phase presents details concerning how I explored and gathered results about the family's expectations. In the development phase I describe the different stages of the prototype development, from idea to application. Results gathered relating to the different stages in both phases are also presented. Lastly, the last section describes the details around the development environment surrounding the prototype application.

4.1 Exploratory Phase

This phase focuses on how I gathered information about user expectations, relating to areas of use, specific services and interaction styles. To gather and map this information I adapted a participatory design inspired technique called SPES, short for Situated and Participative Enactment of Scenarios.

4.1.1 Situated and Participative Enactment of Scenarios (SPES)

SPES was developed to address challenges related to designing new mobile services and devices. During enactments, mock-up devices are used to access information about how the user adapts and uses the device in their daily life. Observations made provide information surrounding user's experiences, which are fruitful to use in the design process of services and new technological devices. Additionally, the technique creates a mutual understanding, between the designer and user, of which areas of use and interaction styles would be most fruitful.[19]

Objective

The main objective while performing this method was to observe which type of interaction and area of use the family exhibited, when using the dummy smartwatch. Between the two sessions performed, the aim for the first session was to mainly observe how the participants adapted and which utilization areas were exhibited. These observations could prove to be possible future services for the smartwatch. During the second session, the main focus was to observe possible features and interaction styles towards a specific service, based on a service which was observed during the first session.

Observer Roles

Two observers were involved while performing both SPES sessions. A friend and I was the only two people to interact with the family. During both sessions observational notes were taken. Initially I had decided that we both should have a non guiding role during sessions, so that we would not be a disturbance for the users, during their enactments. However, we both at some point in the sessions interacted with the family, to make sure that users were still engaged in the scenarios.

I decided to divide the home into two observation areas. Where my friend mainly observed the living room, and I the kitchen area. Although, we were not restricted to these areas. The division of observation areas was made based on the fact that if family members traveled to a specific area, then it was clear who was going to keep observing that participant.

Participants

In both sessions the following participants participated; mother, father and six children. Their ages were as follows; 13, 15, 16, 17, 17, 18. The parents were in their late 40s. In relation to technology, most of the participants were within a user category called knowledgeable intermittent users. These are users who do not retain navigational paths, but are familiar with different applications and interfaces.[30] All participants owned their own personal computer and smartphone. Participants were encouraged to think out loud while enacting, but no pressure was held towards it. However, when performing in-depth scenarios, they were asked to verbally explain what they were doing and why. Furthermore, when interesting scenarios were observed, they were also encouraged to elaborate on the area. Again, they were not pressured to answer.

Equipment

In SPES a device is used to aid user enactment. Before the sessions I created devices which were supposed to simulate smartwatches, see figure 4.1. Using tangible devices during enactments have proved to increase both the user's sense of immersion and creativeness.[18][17] The dummy device was created by using a normal watch and a magnet glued onto it. The size and weight simulated a smartwatch quite nicely. Since an actual watch was used, the users had access to tangible buttons, which also made noises when they were pressed.

These dummy smartwatches was also utilized during the wireframe test. Where tac glue was used to place the wireframes on the pretend screen.

Documentation

Observations made during the two SPES sessions were documented with written notes and video. One video camera was used during both sessions, together with a total of two observers taking notes.

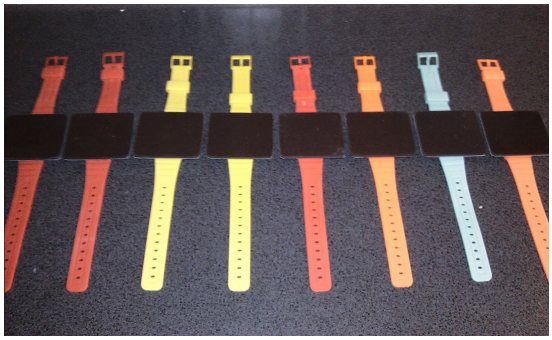

Figure 4.1: Dummy smartwatch

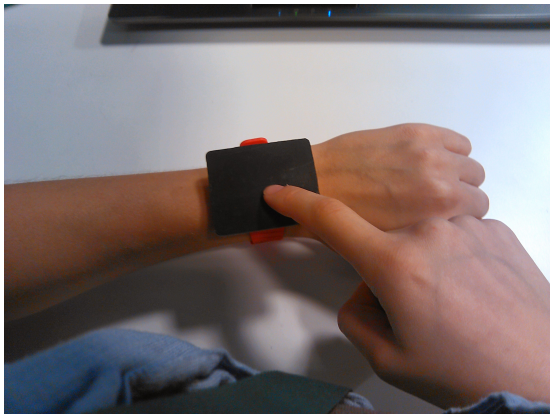

Figure 4.2: Wearing the dummy smartwatch

Participant Debriefing

After the sessions, the family was gathered and debriefed. The debriefing itself was very casual and informal. Here participants got to express any thoughts they had concerning the sessions in general. Any aspects of the sessions that was somehow difficult was brought up and discussed. Some of the questions that was asked during debriefing were:

- What impressions are you left with from this experience?
- What was difficult and what made it difficult?
- Any suggestions or ideas to services/applications?
- What type of functionalities and interaction styles would you like to see within different services and in the smartwatch itself?

Circumstances of Session 1

First session with the family started with a greeting and introduction of the method. The dummy devices was later introduced, in addition to a short display of examples of how the SPES method is performed. During this session, as observers we had a more non-guiding role, where the family members enacted without much interference from us.

Creating gingerbread houses was one of the family's yearly tradition. The family chose to make these houses during the first session, which meant that they spent most of the time in the kitchen. Both observers and camera was faced towards the kitchen. One observer had the responsibility of observing participants that traveled outside the kitchen, while the other kept observing the kitchen area.

Circumstances of Session 2

After the first SPES session, one of the previously observed services, was chosen to be the main focus during the second session. I wanted to choose a service which would streamline an aspect of their daily routines. Additionally, to be something which the family desired. An activity organizer became the center of the second SPES session. The scope of the

second session was thereafter formed around this particular service. I constructed scenarios which was aimed at activities the family already performed during their everyday life. In addition, I created ways to encourage enactment of these scenarios if needed. The basis for many of the created scenarios, was from the family's paper activity calendar, and observations made in the initial session. The paper calendar was where they noted all of their daily tasks and future events.

Similarly to the first session, the participants were encouraged to think out loud. The session was performed mid day on a Sunday. Beforehand, I had asked about the family's usual events on a Sunday. This information was gathered and implemented in the created scenarios, so enactment of scenarios and their usual employs would blend more together, in attempt to observe as normal and natural behavior as possible.

Their usual Sundays consisted of watching television or movies, doing chores, preparing dinner, occasionally having guests over, and the father preparing for work. Before engaging them in the SPES method, I explained the circumstances of the session. Mainly, they would go about their day as usual. I encouraged them to utilize the smartwatch whenever they wanted and in any situation they wanted. Furthermore, I explained that I would initiate certain scenarios at times, which they was supposed to interpret and enact as they saw fit. During the whole enactment, they acted as the dummy smartwatch was running an activity organizer.

SPES Observation Summary

When analyzing the video footage from the sessions, I mainly focused on which areas of use they exhibited, what interaction styles and application features. In the footage from the second session, I focused even more on how they interacted with the dummy smartwatch and which interaction styles they used. This section describes the main observations which were made during the two SPES sessions. Additionally, what was discussed during the debriefings after the sessions.

Session 1 Every year before Christmas, the family had a tradition where they competed to create the best gingerbread house. In teams of two, they all started creating their houses. The family was very eager to use and explain ideas for the smartwatch as they went along. Using the smartwatch to communicate with each other and getting each others attention, was one of the first observations I made. This was conducted by sending audio messages and short text messages, using typing and speech to text as interaction styles. The recipient would receive notifications of the messages on their smartwatch. Amazingly, punishment in the form of small hypothetical shocks, was frequently used when family members was not satisfied with each others behavior.

Speech to text was an interaction style which was frequently observed during the session. Especially when sending and replying to messages, and retrieving information. Further, some participants used their voice to communicate with the smartwatch itself. A scenario was observed where one of the participants told the dummy device to add more gingerbeard dough to the shopping list. The list was communal and available for other users to add items.

Additional scenarios surrounding remote control, entertainment and smart environment was also enacted. Several scenarios were observed where participants interacted with objects in the house through their dummy watch. These were objects like window

blinds, central heating, water kettle, kitchen weight, oven and a static camera hypothetically placed below the kitchen ceiling. One participant acted as he received notification from the central heating system that there was a window open. The smartwatch also suggested that he should close the window and lower the inside temperature. He was able to lower the temperature using his dummy watch.

Furthermore, simple notifications like email was also enacted. Other notifications of chores and events were also observed. The parents sent tasks to the children, which they received as notifications on their own watches. Most of the time the children enacted as if they had the ability to decline received tasks, and send it back to the mother for reallocation. They were also able to send it to someone else in the family.

Several types of interaction styles was observed during the session. Most of which were long press, press, touch, swipes, speech to text and speech control. There was one significant gesture observed however. One participant enacted that she was sharing a picture with an other family member. By physically touching their watches together she was able share it. Lastly, the family was also able to have images and other information be displayed in a hologram. 3D holograms were displayed above of the dummy device's screen, and could be directly manipulated my different gestures like pinch to zoom and multi-touch for different rotations.

Debriefing During the debriefing, the family was able to express their thoughts about the session and their enactment. Here, I was able to gather more insight in their daily routines and what ideas and thoughts they had gathered from SPES. Some participants mentioned that because of the uncertainty of what an actual smartwatch could be used for, they became unsure and held back some of the scenarios they had in mind. Additionally, most of the participants did not have any problems of being observed and filmed. However, a couple of the participants mentioned that they found it somewhat difficult to be completely themselves during the session. Lastly, two participants mentioned that they occasionally felt some pressure to be productive. Despite of this, they summarized the experience as fun.

Organization of family members was one of the main topics discussed during the debriefing. A central part of their daily lives was driving and collecting children from different activities. They expressed a want for a more efficient way of organizing this aspect. As mentioned the family used a calendar to organize the cores, tasks and events for the family members every month. The mother expressed a want to digitize this, with reminders which was sent to the intended family member when a task was due.

An easier way of keeping in touch and monitoring extended family was an other aspect expressed by the family. Considering that the mother's father had a heart starter, they said it would be helpful if also immediate family could receive a notification if it had been activated. Unlike the smartphone, the smartwatch would always be worn. This way they felt more sure that they would able able to see and access the notification immediately. Further, they thought that the smartwatch would provide an easier way to communicate and share their lives with their extended family. They wanted to eliminate the planning and setup of computers with video chat and scheduling phone calls. Instead, they posed that a voice activated command could send a message to the intended receiver, asking if the receiver wanted to start a video chat or phone call.

Session 2 During the second session, I observed a lot of similar services and interaction styles as in the first session. However, there was one natural occurring scenario which was quite interesting. During the session there was an incoming phone call. One participant instinctively answered the call by lifting the the dummy smartwatch up to his ear to answer the call.

Some scenarios was enacted in such a large scale that they were dedicated to their own sections below.

Collectively watching television/movies The family expressed that watching television could be a hassle when several family members were watching simultaneously. To keep them active while watching television, I fronted different scenarios surrounding this setting. The following information was gathered from their enactment and thoughts. When together in the living room, and within a certain range of the television, the oldest person or the smartwatch with the most privileges, would automatically have control over the television. As the sole holder of the "remote control", they could pass the control to another family member or leave the control available for all. When in control, if leaving the room the control would be automatically open for all or pass to the next oldest person in the room. The person within a certain range would receive a notification that they are able to obtain the "remote control". With this notification they could choose to obtain or just acknowledge that the control was available. However, locking the control privilege was also possible. If control was locked to a person, leaving the room would not free up the control. This would then have to be done manually by the person who had locked the control in the first place.

All family members, also without the control, could browse the TV agenda to view currently running and upcoming programs. Users could add program wishes, which could be viewed on all smartwatches within the family. Changing the channel was enacted in two ways; touch and speech command. Similarly, adjusting the volume was controlled through touch and speech, but also with a gesture. The gesture consisted of a hand up/down and shake. In both scenarios, in air gestures was proposed, which they compared with the motions used when interacting with a Kinect. As a last controlling feature, feelings was proposed. Adjusting volume according to how you felt about the current volume level. Being able to control the television was a privilege, and could therefore also be taken away by the parents.

Booking/requesting TV privileges for certain days and time was possible. A organized view of this was available for all, modifiable by the parents. Renting movies online cost money. Whenever a family member rented a movie this must be paid by the renter. An organized view of who, when, which movie and price was easily accessible on the parents smartwatches. Watching individual channels on their smartwatches was also a possibility.

Activity organizer and notifier The family already had a system for dividing and keeping track of different tasks and events in the house. A paper calendar was used for this. The following activities are taken from the calendar which the family used:

Walk dogs	*Vacuum*
Clean room	*Wash clothes*
Dishwasher	*Workout times*

Parent time

Choir practice

Chore free days

Mow lawn / Shovel snow

Meetings

Dentist

Doctor

Health station

Upcoming travel

Bathroom

Kitchen

Social events

School pick up times

The mother expressed her thoughts after the session concerning digitization of their activity calendar:

> An application like this would be a relief for everyone. Also relieving me of having to nag on the family to check the calendar. Further, relieve them of having to go home to see if they have any tasks or events, in situations when they have not planned the day before. If I was able to give them tasks which they were able to accept and get notification of them when they are due, that would be so great.

During the enactments, my main focus was on triggering scenarios which was related to their activity plan, while encouraging them to use the dummy device. The activity plan was basically a list of to-do's and reminders of upcoming events divided on the individual family members.

The mother expressed that the service could also be obtainable and managed on a desktop or laptop computer. Here activities could be created and allocated to the different users. When all parameters were set, notifications and reminder was supposed to occur on the smartwatch at their specified date and time automatically. As users were notified about today's tasks and events, the user would have three options; accept, snooze and set as complete.

Accepting a notified task meant that the task was in progress. Snoozing a task meant that the user would be reminded of the task later that day. A request for how long and how many times it was allowed to snooze a task, became a discussion. At the most, the mother expressed a time duration no longer than 30 minutes. Lastly, the complete option was pressed if the task was done. Upon task completion, the parents would receive a notification. An option to respond to the sender was available.

To ensure that a task is actually completed, the mother wanted to do this physically. Several of the children expressed that a completed task could be documented by sending a picture. However, the mother still wanted to perform the check in person. A reminder list would be created and easily accessible to view which tasks should have been done that day. In relation to completed and incomplete tasks, the parents could distribute points/smiley/stars/thumbs up which acted as a part of a reward system. Every month, the child with the most points would get a reward, e.g. cinema tickets. Also, the child which had most incomplete tasks would get a punishment, e.g. doing the dishes for a week. To avoid punishment, a minimum level of points had to be obtained during a month. Both reward and punishment would be whatever the parents set them to be, and visible for all at all times.

As the enactment continued I issued a notification to the mother. One of the girls was finished cleaning their room. She instantly replied with a smiley face as a part of the reward system. However, she did not physically check the room, but mentioned she would do it later when she was checking the rest of the family members supposedly completed tasks.

Some time later, I notify another family member that they were supposed to walk the dogs. She chose to snooze the task with the maximum amount of time (30 minutes). Short time after I notifier her again of the same task. Because of her injured foot she was actually not able to walk the dogs. Instead she notified her mother by sending the task back to her. The mother quickly received the task and allocated it to another family member. During the debriefing, she mentioned that reallocation of services could also be done automatically.

Service Categories

These categories were formed based on the different types of applications and scenarios observed during the SPES sessions. Some of the most frequent observed scenarios are presented below their respected categories.

Monitoring

- While workout, monitor pulse and workout plan
- View calories burned and differences from previous workouts
- Who, when, what and cost of a rented movie
- Where is a certain family member
- Where was I, when was i there, how long did it take me to get there
- Who is at home right now
- Current health statistics

Organization

- Create tasks, chores and activities
- Set up consequences for high rewards and low rewards
- Set up which bake goods to make for Christmas
- Setting and modifying smartwatch privileges
- Booking TV privileges, request a day and time
- Receiving and delegating an existing task to another user
- Postpone/snooze a task
- Individually notify of irregularities in pickup time from school/practice etc.
- How many is having dinner today

Remote access and control

- Smart Environment Services
  - Turn on washing machine and check remaining time.
  - What is the temperature in the oven
  - What is the core temperature of the object in the oven and what should it be.
  - Check what is in the fridge and freezer and keep an updated list
  - Start central heater
  - Control the TV
  - Control heat
  - View electricity consumption
  - Control lights

  - Unlock/lock door to dog yard
  - What is on TV, choose channel, adjust volume
  - View caller and answer the home phone
- Rent movie
- View television on smartwatch
- Create automatic shopping list
- Add items to shopping list using speech control

Reminders and notifications

- Notify that a user should come to i.e. the kitchen
- Notify when washing machine is done
- Notify when core temperature of object in oven is reached
- Alert of bad connection
- Notifying a completed, snoozed or not able to perform task
- Notify that the central heating has stopped, view cause
- Notify when children are finished at school for pickup
- Notify if family not living under the same roof needs a favor
- TV control is available

Communication and sharing

- Send speech to text messages
- Send audio messages
- Text to speech of notifications
- Sharing files, e.g. pictures, links, videos
- Intercom capabilities
- Send electrical shocks
- Share GPS location
- Take photos with a static camera and share the photo from the smartwatch
- Share updates on social media

4.2 Development Phase

Development phase focuses on the development of a service from idea to prototype. Based on the findings in the exploratory phase, a task distribution application was chosen for further development. During prototyping the service was first realized through wireframes, then later as an interactive prototype. Both prototypes underwent usability tests, where alternations were made due to gathered test results. Lastly, the application prototype was used during re-enactment of previously observed SPES scenarios.

4.2.1 Activi

After the two sessions of SPES, I decided that I wanted to replace the family's task distribution calendar, with an actual application. I named the application Activi. The application would have functionalities like task distribution, reminders, overview, sharing, editing and confirmation.

4.2.2 Personae and Scenarios

Personae are descriptions of fictive people. Their related scenarios describes how a persona could use a device, system or application. Constructing personas and related scenarios helped me visualize how people within different age, interests, technology skills, surroundings and habits would use this type of application in their lives. Further, it helped me when I was constructing the wireframes later on.

Personae

Below I present three personae. Tom a 10 year old boy, Carrie a 13 year old girl, and Miriam a mother of four in her late 40s. The personae describe them as people and what they enjoy doing in their daily lives.

Tom, 10 years old. Tom is in 5th grade of primary school. He enjoys hanging out with his friends and record themselves parkouring. For his birthday he received a GoPro camera from his parents, which he uses to record him and his friends. Tom is well acquainted with using his Android smartphone, GoPro camera and his parents tablet. His parents are very strict, which means that he has a curfew and daily house chores to perform. Two days a week, he also attends Ju Jitsu practice, where he has achieved a blue belt. Two times a year he also take part in Ju Jitsu tournaments.

Carrie, 13 years old. Carrie just started high school, and unfortunately most of her friends ended up on a different high school. She is a very shy and creative girl, and since high school started she has had difficulties making friends. After school she enjoys to go shopping with her old friends. As a hobby she attends piano lessons every week. Her school has a music, drama and dance module, which hosts plays and dance performances every now and then across the school year. At these events Carrie frequently plays the piano in the school orchestra. Carrie enjoys reading fantasy books and has a dream of becoming a writer one day. For her 10th birthday, her parents got her an iPhone. She uses it to keep in touch with her old friends, with texts and calls. When she is at home she also uses her computer for school assignments and keeping her updated on social medias.

Miriam the mother, 49 years old. Miriam is a single mother of four, three girls and one boy, from 13 to 19 years old. Being a mother of four and working full time as a chef at a university, she has little time for much else. When she has time she enjoys to bake. She, her friends and neighbors gather once a month where they bring wine and their baked goods. As a single mother, she has adapted a very strict way of raising her children. They are all expected to help out around the house and do their homework at specific times. Miriam owns a laptop which she uses to pay bills, search for recipes, read news and keep in touch with her friends through social medias.

User Scenarios

Below are user scenarios related to each persona described above. These scenarios describe how they would use the smartwatch and application, Activi, during their daily lives.

Tom just finished school for today and is going parkouring with his friends in a nearby local park. Using his GoPro camera, he records some of the tricks they are doing. While recording his friends, he feels his smartwatch vibrate, a message from his mother is displayed on the screen. "Dinner in half an hour" the message reads. Tom presses the notification and Activi asks if he wants to be reminded of the notification later. He sets a reminder to ten minutes before dinner time and presses "Ok".

Tom finishes his dinner and proceeds to his room to upload today's video to youtube. As he is writing the description for his video, his smartwatch vibrates and one of his regular tasks are displayed, "Pack bag for Ju Jitsu practice tomorrow". Tom snoozes the reminder and continue writing the description for his video.

Ten minutes later he receives the same notification. He sighs, and starts gathering his clothes. After packing his bag, he sits down by his desk and shakes his wrist. The Activi application starts on his smartwatch. He finds the task he just completed and checks it off. Seconds later, he receives an instant message with a star from his mother, and an overview of how many stars he has gotten this month.

Carrie is in the city center shopping with her friends. She suddenly receives a message on her smartwatch. It is from her father, saying that since she did all of her chores on time last month, he is going to treat her and her friends to movie tickets this weekend. She promptly unlocks her watch and opens Activi. She adds a reminders for herself that she is going to the movies this Saturday. She then shares it with her mother and father so they know she has chosen to go that day.

Couple of hours later she is on her way home. She listens to an offline music playlist on her smartphone. A new song comes on, she sighs and taps the screen on her smartwatch and presses a button to play the next song. As she leans back and to enjoy the song, her watch makes a noise. She unlocks the watch and sees an email from her piano teacher. The email reads "No lessons tomorrow due to illness". Disappointed she opens Activi and deletes tomorrow's piano lesson for her list of events.

Stepping through the entrance of her home, she receives three notifications. She browses through them and see that they are all marked chores. Using a swipe gesture she removes all three notifications. When she wakes up the next day, she put on her smartwatch and looks through her notifications. She quickly find the three notifications from yesterday. Dazed and groggy she tries to swipe them away again but they remain. She selects them all and presses a 10 min snooze function.

Miriam is sitting in her living room with her eldest daughter, everyone else is asleep. She is researching what kind of baked good she should bring with her to the next neighborhood gathering. While surfing on her laptop, she remembers that tomorrow starts a new month, and she has yet to set up next months tasks and events. She opens Activi on her laptop and starts adding household tasks, social events and various reminders of her children's sport practices and and other hobbies. She allocates the respective tasks to the related child. She creates the household tasks last, and starts by adding "Dishwasher" and assigns it to her four children. Just before saving the task, she sets the tasks to be repeated every day. She opens her calendar and sees that the task has been added every day for a month.

Her eldest daughter suddenly asks, "Are you creating this months tasks?". Miriam confirms. The daughter quickly unlocks her smartwatch and opens Activi. She checks her list of upcoming tasks, and expresses a sigh of relief. "Good, it is to my turn to do the

dishes tomorrow".

The next morning Miriam is in the kitchen making breakfast, before her children goes off to school. Her children are making themselves ready in their bedrooms. Suddenly, her smartwatch vibrates and she sees that a task has been flagged by one of her children. Her next oldest child enters the living room and says "Mom, I can't go grocery shopping with you this weekend, I'm going to a sleepover at my friends house". "Oh, I forgot" the mom replies. She presses the task and assigns it to her youngest.

4.2.3 Wireframing

Based on the features expressed by the family members in the two sessions of SPES, I researched similar applications to gather labels for the prototype. These were for the most part task manager and task reminder applications. Looking at labels, information and menu structures which was repeated among the researched applications. Some of the applications I researched was Flow, Producteev, Remember the Milk, Wunderlist, Nirvana, Trello and Google Calendar. While structuring the information architecture, I was continuously aiming for a flat structure within the menus. The reason for this was to keep the interaction time with the smartwatch to a minimum. Interacting with a small screen over a longer period of time might become frustrating for the user. Therefore I my aim was to keep any interaction with the smartwatch as limited as possible.

During the research and wireframing, a couple of wireframe variations of the application was created. Finally, one underwent an usability test where eight users participated. Among these participants were both knowledgeable intermittent users and expert frequent users. The family members were all within the first category, knowledgeable intermittent users. What characterizes this group of users, is that they understand the concept and functionality of the system and interface. However, they may have difficulty with retaining system interface structure and the location of the different functionalities.[30]

When developing an application for this group, it was important to follow some guidelines of interface development and structure, which would aid the users when exploring and solving tasks. Since these users have difficulty with retaining structure and whereabouts of the various application features, I needed to lighten the users need to retain information while navigating. A solution was to implement a logical information structure and a clear interface which focuses on recognition rather than recall. Furthermore, it was important to have a consistent use of terminology throughout the application.[30] This would help to keep the user oriented while navigating.

Labels

To aid the development of intuitive labels, similar application was researched to gather possible labels. To further ensure seamless navigation throughout the application, it was important to use unique and descriptive headings and labels.[30] During wireframe development, I strove to upkeep that guideline. In addition to implementing intuitive labels, keeping them consistent throughout the application would also aid users while navigating.

Considering the small screen of the smartwatch and the variety of possible end users, an alternative to emphasize and change font size, symbols or other language should have been implemented. Especially to accommodate people with disabilities, like poor sight. However, due to limited time this was not realized in this prototype.

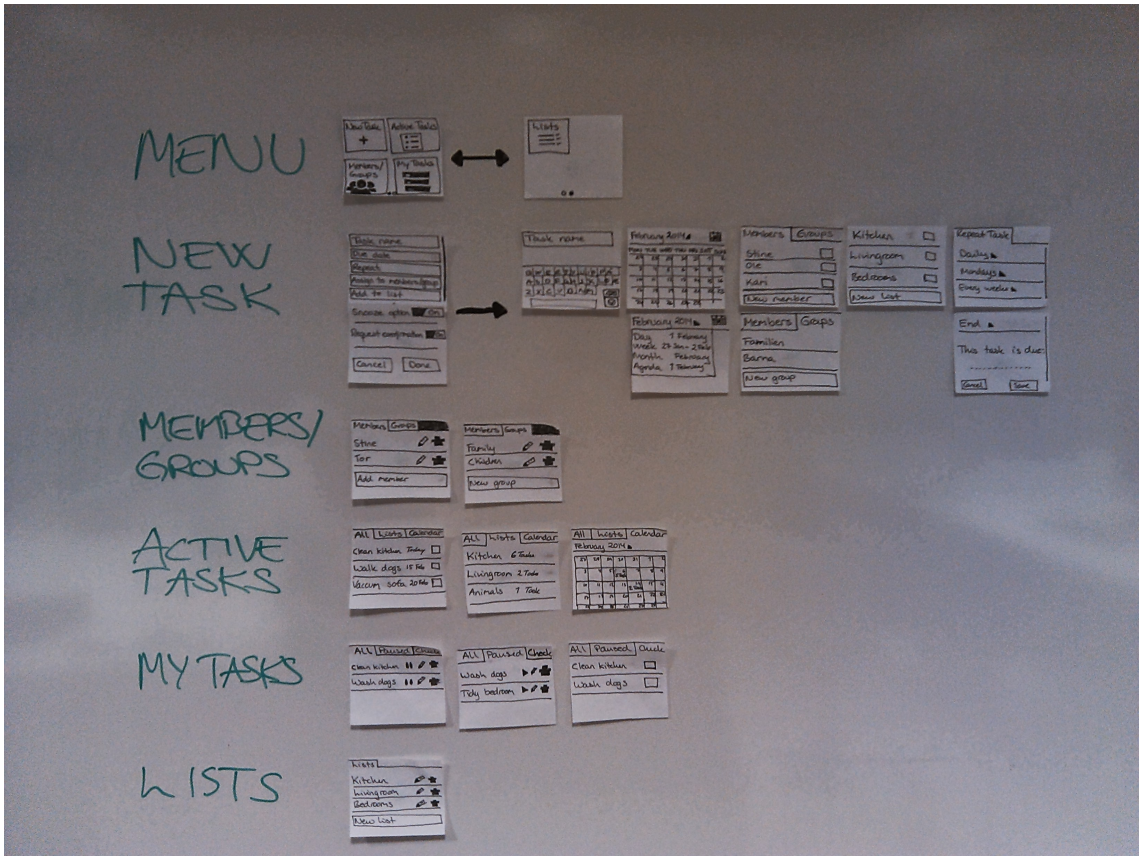

Figure 4.3: Overview of the wireframes that was used during one of the low budget tests. The written text in green is the menu label. Following to their right is their content.

Navigation

When structuring the navigation within an application, it is important to standardize task sequences.[30] This means that when performing tasks with similar conditions, execution of those tasks should have a similar pattern. This way the user only need to familiarize themselves with one way of task execution. To further improve navigation, I ensured that implemented functionality was clearly displayed in the wireframe designs. One example, in the designs I have used multiple choice checkboxes. They inform the user that it is possible to check several items and not just one.

Layout

Arranging the layout on such a small screen was challenging. Finding the balance between, including the necessary information and simultaneously making it orderly, proved to be difficult. To ensure that the user formed the desirable mental model of the different tasks, I implemented similar pattern of execution for similar tasks. In example, I used tabs within the various menus, where the user could navigate between different sub menus. Moreover, the user could find the assorted in-menu functions in the same location as in menus which included similar tasks. Structuring the layout this way, increases the users

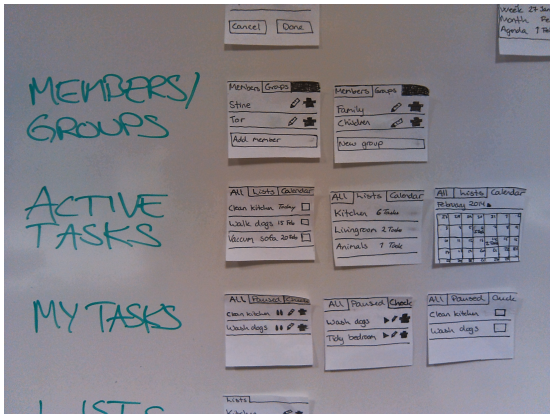

Figure 4.4: Main menus and content

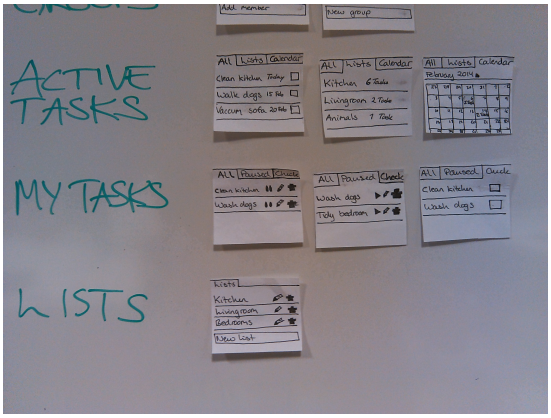

Figure 4.5: Main menus and content

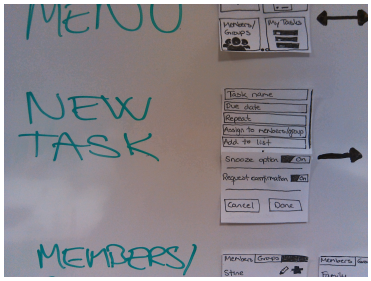

Figure 4.6: New task menu

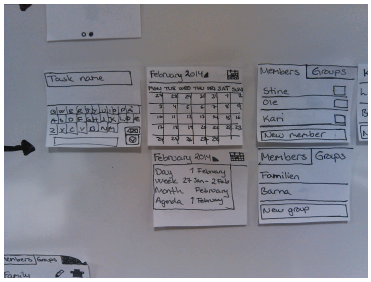

Figure 4.7: New task sub menu

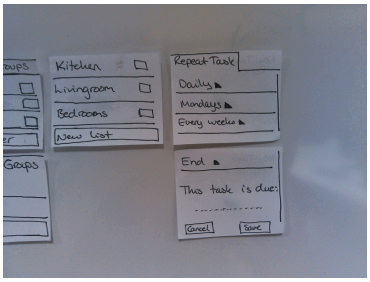

Figure 4.8: New task sub menu

ability to efficiently assimilate information.

Considering the group of end users, it was important to relieve the user from having to remember information from one task to another. When organizing each display, all information needed to complete that task should be available on that exact screen. Therefore, scroll functionality was displayed when all of the information could not be shown on the screen simultaneously.

4.2.4 Low Budget Testing

Low budget testing was performed to make sure that the wireframes of the application was intuitive enough, so that the application could transition into the interactive prototype development phase. The structure of presenting this method is based on the usability testing handbook of Jeffrey Rubin.

Purpose

Low budget testing, also called guerrilla testing because of the spontaneity and lack of formality in the circumstances of the testing, was a method I used during prototyping. It is an ideal method to utilize to quickly and inexpensively discover non intuitive aspects of an application. During the paper prototyping, I performed a low budget test on the on the created wireframes. In addition, the interactive prototype underwent a guerrilla test,

and then later a gonzo test.

Problem Statements

With this method my aim was to discover anything about the application that might be non intuitive and confusing for the user. Therefore, I set out to answer the following questions when testing the wireframes:

- Are the application labels intuitive?
- Is user navigating naturally through the application?
- Is the user displaying inconsistent behavior when using the application?
- Does the user recognize the functionality of the application and its features?

User Profile

The target users for this application are both adults and children within a family, living under the same roof. Since the people within a family are most likely to vary, the user profile is limited to both adults and children old enough to use and comprehend a smartwatch and applications. Two sessions of low budget testing was performed, one with the wireframes and one with the interactive prototype. During the first test session a total of eight participants between the age of 22 to 46 years old. Six of the participants were students, mostly in the expert frequent users category. However, the two older participants were within the knowledgeable intermittent users category. The family were the participants in the last session. Which all fell under the category of knowledgeable intermittent users.

Methodology

This section describes the sequence of events the test was performed with the participants.

Orientation Before the participants set out to solve the test tasks, I introduced them to the application. Explaining its purpose and the overall features. Furthermore, I ensured them that their skills were not being tested but the structure and intuitiveness of the application. To gather as much information as possible, I encouraged the participants to think out loud as they solved the tasks. Lastly, I explained what my role would be during the test. More information about my role as the observer during the tests, is described in more detail below.

Performance Test A total of 13 task was created to test the wireframes, see appendix A.2. When testing the interactive prototype, a total of 11 tasks was created, see appendix A.3. These would navigate the user through the different aspects of the application. With each participant I followed the same performance scenario. The scenario went as follows:

1. Participant greeting and orientation.
2. One by one tasks were read out loud

Wireframes As the user navigated thought the wireframes to solve the task, the wireframes were placed on the dummy smartwatch which was located on their wrist.

3. As the participant solved the tasks, I would take observation notes of their navigation, behavior, verbal expressions and what they had difficulties with.

4. The "Think aloud" technique was used when the user at some point became confused and unsure of how to solve a task.

Each task had a maximum time of completion, however the participant was allowed to complete the task even though time was exceeded. The reason for this is because the participant might still express some valid and interesting points while trying to solve the task. However, the participant would be given a new task when a respected amount of time had passed, to keep the participant motivated and interested in the test.

Participant Debriefing Participants were debriefed after solving the tasks. The debriefing was a way to start a casual conversation with the participant, where any thoughts about the application would be expressed. However, three questions was always posed to the participant after the testing:

- What is your general impression of the application?
- What was confusing or difficult when solving the tasks? What made it difficult?
- Which aspects of the application did you enjoy?
- Do you have any suggestions for improvement?
- What would you use such an application for?

Test Environment, Equipment and Role

The first low budget test was performed at the university college. The location was on school premises in an empty classroom, sitting beside a table. During testing, the dummy smartwatch was used to place the wireframes on as the user navigated through the wireframes. During the second session, the interactive prototype was tested in the family's home. Here the test was performed in their kitchen, one participant at a time. As the only observer, my task was to provide the participants with the tasks, take observation notes, keep track of the time and handle both the orientation and debriefing.

Evaluation Measures

To aid the evaluation of the test results, predefined evaluation points were made. Furthermore, these points were divided into three categories which are classifications used in Jeffrey Rubins usability handbook. Dividing observations into these categories, provided me with a prioritized view of non user friendly aspects in the application. In further development, the observations which were categorized as critical errors, had to be dealt with first. The following evaluation points are:

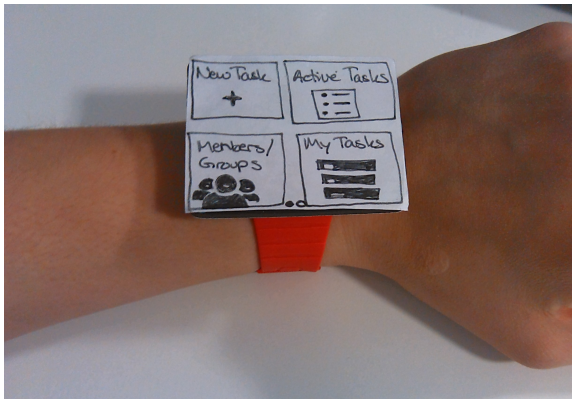

Figure 4.9: Wireframe placed on dummy smartwatch for testing

Observations and Comments When the participants is having difficulties solving a task, gets confused, expresses thoughts or unusual behavior.

Non-critical errors Participants is able to recover from mistakes and solve the task.

Critical errors Participants is not able to solve a task, recover from a mistake, exceeds the allotted time set for the task, or when a participants is not aware that a mistake has been made.

Test Intervals and Prototypes

Low budget testing was performed two times during the development of the prototype. Two session using the wireframes and one session using the interactive prototype. A total of eight participants participated in the first session, five in the second, and five in the last. The last session was performed with the interactive prototype and with the family members as participants.

Test Tasks

In appendix A there are two tables of tasks which were used in the different testing phases. The participants were asked to solve the tasks with either the use of wireframes or the interactive prototype, depending on when the testing was performed during the course of the project. First table contains the tasks which were used to test the application wireframes. As the prototype was developed, some functionalites implemented in the wireframes were removed or implemented differently. Therefore, the second table contains some of the same tasks but also other tasks not used in the initial testing of the wireframes.

Low Budget Test: Wireframe Test Results

After the wireframes were created I performed a low budget test where they were tested. Among the eight participating user, there were six expert frequent users and the remaining two were knowledgeable intermittent users. Both genders was represented, ages were from 22 to 46. Below are the most significant results presented.

Creating tasks All participants managed to create a task without any difficulties. A couple of the expert frequent users became unsure what the "Request confirmation" option would do. He thought perhaps that he would get a notification when the recipient had received and viewed the task sent. Further, some expressed that they wanted a on/off option for the repeat function, which had set a default parameter.

Among the knowledgeable intermittent users, one wondered if they had to use the assign function to themselves, or if it was default. Another user complemented the snooze option and commented that they wanted to be able to add a customized snooze time.

Viewing and managing created tasks There were two ways of viewing tasks, through the "Active Tasks" and "My Tasks" menu. Although, to view other tasks which were not exclusively created by the user, the "Active Task" menu was the only option.

Depending on if the user allocated a task or not, participants who allocated the task to someone else, chose to press the "Active Tasks" menu instead of "My Tasks". Two participants from both user categories, chose the "Active Tasks" menu trying to find their newly created task. These two was also the only two participants who allocated the task to someone else. The six remaining participants chose not to allocate their created task to anyone, which resulted in that they used the "My Tasks" menu to view their task.

One of the expert frequent users became very unsure after creating their task, whether the task would be in either "Active Tasks" or "My Tasks", or within both.

When the participants were asked to pause one of their upcoming tasks, six of them chose "Active Tasks" then performed a long press gesture on one of the tasks in the "All" tab. The two other participants chose "My tasks", however they acted on recall rather than recognition.

In one of the tasks, they were asked to delete one of their upcoming tasks. Here the same six participants chose "Active Tasks" rather than "My Tasks", gesturing a long press to open an additional menu. One of the two remaining users, commented that they would have liked to see a confirmation message before actually deleting the task.

Lastly, the users were given a task to confirm that a task which was allocated to them, was complete. Here their only option was to check off the box beside the task title in "Active Tasks". Again, the users chose either "Active Tasks" or "My Tasks". The users who chose the latter, ended up pressing the edit icon beside the title, expecting a pop-up with a check box, which they could check off. One of the users became confused and ended up navigating between both "Active Tasks" and "My Tasks", looking for a way to confirm completion of one of the tasks.

Viewing all upcoming tasks When the users were asked to find all upcoming tasks, they had only one option, to chose "Active Tasks". Here they could find all upcoming tasks ordered by date, created by themselves and allocated to them by other users. The difference between "My Tasks" and "Active Tasks", was that within the former menu only the users own created tasks, could be viewed and managed. Five participants, however, chose the "My Tasks" menu, expecting to find their tasks which was allocated to them.

One of the expert frequent user made a comment about the menu "Active Tasks", which was a descriptions of the actual functionality of the menu. He stated that "Active Tasks" did not include completed tasks, but instead all uncompleted tasks which was allocated to him, created by himself or other users. This realization was only made by one of the participants, other users became very unsure when solving this task.

Viewing and managing lists All but one of the participants had no problems comprehending the the functionality of the "Lists" menu. When they were asked to view all tasks within the kitchen, they chose the "List" menu. Only one of the participants chose the "Active Tasks" menu and then the "Lists" tab. However, as the user was solving the task he expressed that he remembered that there was a list menu within "Active Tasks". The participant managed to solve the task based on recall rather than the wanted approach of recognition.

Viewing proof None of the participants managed to complete the task concerning viewing proof of completed tasks. One user wanted to long press one of the active tasks to observe the picture. The rest of the participants ended up navigating through the whole application actively looking for that function.

Low Budget Test: Interactive Prototype Test Results

When the interactive prototype was finalized, a pilot test was performed before testing the application with the family. Results from both session are summarized below. Five participants within the family attended the test, and two participants in the pilot test.

Pilot test Pilot tests are performed to insure and check the flow and quality of the tasks created, as well as becoming more comfortable as a test leader.[35] Two participants attended the test, which resulted in an alternation of the sequence of the tasks. Moreover, a couple of pre-tasks were added to give the user more practice and confidence towards the unfamiliar keyboard and basic navigation on the watch. A small concern about one of the labels in the application was raised, although it did not have any affect on the user's ability to complete the task within the allotted time. Therefore, the label was not altered because of it. Furthermore, there was an issue where the keyboard blocked the field of view, so the user ended up typing blindly. However, no changes were made. The reason for this is described in the section below, entitled "Adding people".

Test introduction One by one the users sat down and were given an introduction. They were informed about the content of the test itself and the application features. Because of the size and unfamiliar gestures in the keyboard, additional time was added to tasks which required typing.

Before engaging the user with tasks, they were given the watch to look around and get a feel of the watch itself, such as learning the menu and back gesture. As they were looking around I navigated them to the Fleksy (name of the keyboard) tutorial, where they learned the gestures of the keyboard.

Creating tasks During the test, there were two tasks which based itself on creating a new task. In the application menu, the label for this functionality was "New Job". However, as the task was given to the user, I did not ask them to create a new job. Instead I asked them if they could make a new event/task/happening. By not saying the exact label names, the user had to reflect and deduct which of the four menu button would help them solve the task. This is a technique mentioned in [35]. One of out five participants became uncertain and asked me: "Do you mean a new job?". I replied by stating the task again and using another word, still not using the word "job". Apart from

that participant, there were two other participants who, when given the task, who asked me rhetorically "Ok, so new job then".

The participants navigated easily through the "New Job" menu. When creating a task, a couple of users ended up asking me; "When should it be due", "At what time should I put?", "Should I give it to someone?", "Repeat? No, I don't want it to repeat". This was an indication of that they had early established an understanding and purpose of the "New Job" menu.

One participant used the keyboard to enter the timestamp for the task. Even though the dialog provided a scroll function to set the correct time. This might have happened because the user actually tried to use the scroll function, but accidentally pressed the numbers which enabled the keyboard. The participant did not try to remove the keyboard, instead used it to type in the time.

Deleting tasks When deleting a task the user has several ways to navigate to and use that functionality. Through the "Calendar" menu, the user could use Google Calendar's own calendar application and delete the event from there. Another way was to delete the event in the "All Jobs" menu, where the application had it's own delete function. When deleted, the event is removed from the list and from Google Calendar. Furthermore, the user was able to enter the Google Calendar application through "All Jobs" by clicking on the "Edit" button when selecting an event. Four of the five participants deleted events with the applications own delete function, by navigating through the "All Jobs" menu.

Edit tasks Similar to deleting tasks, the application provided two ways of navigating to the function of editing tasks. Either by selecting an event in "All Jobs", select a task then "Edit" button. Or the user could go through the "Calendar" menu and edit it by using the Google Calendar application.

The users were asked to set themselves as attending on an event, and then share an event with another user. Of the five users, three participants navigated through the "All Jobs" menu. Two of them became unsure and hesitated when they were asked to set themselves as attending and when sharing the task. Apparently the label "Edit" was not immediately linked in their mind, with either sharing the event or setting yourself as attending. Although the navigational path was not immediately apparent the user, they selected the "Edit" button after a short time of uncertainty. The other two participants navigated through the "Calendar" menu. Additionally, they did not have any problems setting themselves as attending or sharing the task.

Adding people When adding people in the application, the user has to enter both name and an email address, using two input fields. An issue occurred when they had to enter the email address. The keyboard ended up covering the input field, which made the user have to type blindly. As there was already a list view in the activity (the page within the "People" menu), the page could not be made scroll-able, which would have solved the issue. Considering that time was limited, finding a solution before performing the actual test with the family, was not an option.

All participants had difficulty adding a new member with a correct email address. Four out of five participants exceeded the time set aside for the task. Two of the users repeatedly alternated on using their index and little finger to type with. Which in addition to their body language, clearly expressed a level of frustration when having to type.

Deleting members There was only one way of deleting members in the application. The user had to navigate to the "People" menu, then select one of the members in the list. By pressing any of the names in the list, a delete function was enabled and the user could either delete the person or abort the function.

All participants managed to complete the task within the allotted time, and navigate directly to the delete function. Only one participant had some difficulties when trying to delete a member. The smartwatch did not register the user's touch the first three tries. As a result the user thought that a swipe gesture had to be used to delete a name from the list. As the swipe gesture did nothing, the user again tried to press on the persons name. Finally, the smartwatch registered the touch and displayed the dialog for deletion.

Additional observations As the users were solving tasks, they were originally wearing the watch on their wrist. During the first few tasks, there were several tasks which required typing. Some users started to complain about pain and discomfort in their wrist and shoulder. To complete the test they were allowed to take the watch off, and solve the task while holding the it in their hands. This observation made it even more clear that interaction with the watch should be limited. Further, when interaction actually is wanted or necessary, typing should be avoided. Instead, implement applications with buttons and simple gestures. Further, enabling the user to complete an operation with as few actions as possible.

4.2.5 Gonzo Testing

Gonzo testing is a testing method within usability testing, where you seek and perform the tests in the user's natural environment.[35] In my case, at the home of the test family. The focus in the two gonzo test sessions was getting the users to re-enact scenarios which was observed during the SPES sessions. During the re-enactment, many scenarios occurred naturally and some was triggered by me.

Purpose

The main purpose of the gonzo tests was to observe the target user utilize the application in the intended environment. Since the application is being used in its target environment by the target user, the gathered results are more accurate than when performing the test in a laboratory.[35] This is due to the fact that users are being tested in their natural and familiar context. Interaction between family members affect how the user interacts with the application.

During the rounds of gonzo testing, I observed the users interact with the application in their natural environment and context. The results gathered from these tests gave a good indication of how future users of the application, would interact and use it at home. Further, it gave an attestation of how user would use and interact with a smartwatch in general.

Problem Statements

By performing the gonzo test, I wanted to get an insight of the overall state of the prototype, and how it was used by the family in the different scenarios. Based on scenarios observed in SPES, a few of these was chosen for re-enactment. The scenarios were then

merged with the families activities for that day. This way the watch and application could be used in the family's actual events of the day.

Problem statements was created to aid the evaluation of the test results. By performing the gonzo test, I wanted to see if there was any differences between the same scenario observed in SPES and observation made during the re-enactment. I created the following problem statements to help evaluation of results:

- Differences in interaction styles and areas of use?
- Differences in reaction to notifications, verbal and behavioral?
- Differences in standby interaction? (Interaction with the watch when there is no particular scenario happening)

User Profile

The main target group for the application was families with children living under the same roof. In my case the gonzo test was performed with my test family. Within this family there were two parents in their late 40s and six children from 13 to 18 years old. All the children had different interests and hobbies. In addition, the family liked spending quality time together by engaging i.a. board games and watching movies. Below are additional descriptions of the user profile for the application.

1. Users which are somewhat familiar with the Android operating system (on e.g. smartphones or tablets)
2. Users that understand and are capable to handle a smartwatch and applications.
3. Users that are used to or want to be able to organize tasks, chores and reminders around or outside the house more efficiently.
4. Users that want more control and overview over their daily routines.

Methodology

This section describes the sequence of events which the gonzo test was performed. Only the family members, except from the pilot test, participated in the gonzo test.

Orientation Before performing the re-enactment, the family members was informed of the circumstances around test. Not going into details, I explained what I was there to observe. Further, that I was not there to test their knowledge towards the application or the smartwatch. I reminded them of the former performed SPES sessions, and that I had created some scenarios which surrounded their today's routines. In addition, I encouraged them to use the smartwatch and application as much as possible and in any situation they wanted. Furthermore, I explained that I might pose scenarios, and it was up to them to act as they saw fit.

Performance Test A total of 34 scenarios had been chosen from the SPES sessions. Five of these were customized for the first session of gonzo testing. If the scenarios were not performed naturally by the family members, ways to trigger the scenarios had been defined before the meeting. Not all of the 34 scenarios where enacted during the test session. Below is the sequence of events of how the test was performed.

1. Participant greeting and orientation.
2. Equipment set up.
3. Engaging in conversation, accepting offered beverages to engage a normal setting.
4. As situations between the family members presented a possible a scenario, a trigger was deployed. In some situations a trigger was not necessary, and the user engaged the smartwatch by their own initiative.
5. As scenarios was performed, I noted observations like user behavior, verbal expression and reactions.
6. The "Think aloud" technique was not used during the session. Although, three of the participants, without encouragement, spoke of their actions now and again.

Participant Debriefing During the debriefings, a casual conversation was had about the use of the smartwatch and application. Further, the following questions were posed to the family members:

- What is your general impression of the application and smartwatch?
- How was it to delegate tasks?
- How was it to receive notifications of tasks?
- What was difficult, and why was it difficult?
- Did you miss any functionalities?
- Suggestion for improvements?

Test Environment, Equipment and Role

What characterizes a gonzo test, is that you test your system where the user is. Which means that what you are testing, is being tested in a realistic setting. Performing tests in the user's natural setting, provide other results than tests performed in a test lab.[35]

Two sessions of gonzo testing was performed. Both tests was performed at the family's home. As the only observer, two cameras was set up to record the family members. Most of the time was spent outside on the family's porch, therefore a camera was set up here. Since the children traveled a lot inside the house, I used a GoPro camera which I carried around to catch their re-enactments in other parts of the house. In addition to the camera, I also carried around small note book to take observational notes. I focused my notes surrounding their reactions, gestures, verbal expressions and behavior.

During the first session I had two smartwatches with the Activi application. These two smartwatches had to circulate among the users between scenarios. This way all users

got to use and re-enact scenarios. During the second session, I had six smartwatches with Activi, which the users used during the re-enactment. In my role as the observer, I triggered scenarios and noted their reactions.

Figure 4.10: One of the smartwatch menus

Figure 4.11: Smartwatch off screen

Figure 4.12: Activi main menu on smartwatch

Evaluation Measures

To aid evaluation of the gathered results, evaluation measures was created. Using Jeffery Rubins categories from his usability handbook, the results were evaluated against the following measures:

Observation and Comments When the user expressed any form of reaction, both verbal and behavioral. Especially, if the user was experiencing minor difficulties with understanding how to use the smartwatch or application.

Non-critical errors When a participant starts a scenario, and has trouble of finding the right application, start over or starts opening several applications, or asks for help.

Critical errors When a participant is unable to complete or recover from a started scenario, both triggered or self initiated.

Scenarios

Below are the most significant scenarios which occurred during the sessions. The fist table presents the scenarios which was also a part of the family's events that day. In the last test session, the users had become more familiar with the smartwatch and prototype. Of the chosen 34 scenarios from SPES, some of these occurred naturally, and some were triggered. During both test sessions the users used the smartwatches which had Activi installed.

Abbreviations and explanations

- Req's: Requirements (Tools needed to complete the re-enactment)

Scenario No.	Scenario Description	Scenario Trigger	Scenario Details

1	Walk the dogs	Has Mary walked the dogs yet?	Req's: Smartwatch and Activi application
2	Leave for meeting at 7pm	When do you have to leave for your meeting?	Req's: Smartwatch and Activi application
3	Pack for weekend sleepover	Has Kate packed her bags yet?	Req's: Smartwatch and Activi application
4	Remember Comet match at 8pm	When are you guys leaving for the match?	Req's: Smartwatch and Activi application
5	Make bed	Has Mary made her bed?	Req's: Smartwatch and Activi application
6	Empty and fill the dishwasher	Who is doing the dishes today?	Req's: Smartwatch and Activi application

The second session, focused more on the general use of the smartwatch. Users were encouraged to use the smartwatch rather than their smartphone, and could download apps if some of their usual apps were missing. Below are the scenarios which were re-enacted.

Scenario No.	Scenario Description	Scenario Details
1	Listen to music	Req's: Smartwatch and Activi application
2	Facebook chatting	Req's: Smartwatch and Activi application
3	Sharing photos	Req's: Smartwatch and Activi application
4	Clean room task	Req's: Smartwatch and Activi application
5	Show an other person a video on Youtube	Req's: Smartwatch and Activi application

Gonzo Test Result Summary: Session 1

Scenario 1 - Walk dogs Both mother and daughter are sitting outside when the mother asked if she has walked the dogs today. Before walking inside the daughter disconfirm. The mother shakes her watch, she creates and allocates a task to her daughter. When they receive the task notification they both decide to snooze it. The daughter continues to snooze the notification an additional two times. Most likely because of novelty, the daughter tries to test her mother by informing her that she has dismissed the task notification. She is eager to see what her mother will do. The mother simply tells her that if she does not do it she cannot get money for her piercing. Surprised, the daughter takes the dogs outside. Perhaps if the reward system had been in place and looking past the novelty aspect, this situation might not have occurred.

Scenario 2 - Leave for meeting at 7 pm Both parents were outside on the porch smoking cigarettes, when the mother reminded the father that he had to leave for his meeting at 7 pm. He created an event for himself and set a reminder for the time he had to leave. After he created the task, he double checked that it could be viewed in

"All Jobs", and that the details were correct. Some time later he received the notification while sitting on the computer. He pulled down the notification window and pressed on the notification. The event opened in Google Calendar where he deleted the event. A couple of minutes later he got ready to leave.

Scenario 3 and 5 - Pack for weekend sleepover, Make bed When the mother remembered to create this task, she left an ongoing conversation. She used a shake gesture to enable Activi and then created and allocated the task to her daughter. After creating the task she seamlessly rejoined the conversation. She did not lock the smartwatch, rather left it displaying Activi's main menu. During the lengths of the conversation she cast several glances at the watch to see if she had received any notifications. Later, she created several tasks and allocated them to her daughter, expressing both verbally and behaviorally that she was enjoyed using the application.

After some time, the mother opened "All Tasks" trying to find out whether her daughter had accepted the tasks or not. She was not able to find any indication of that, so she went back to the main menu and then stopped engaging the watch. Suddenly, she received a notification. This time she used the hardware buttons to unlock the watch. The father was sitting beside her, asking curiously what it was. She pulled down the notification window, and replied that their daughter had received her previously created task. Then she chose to snooze the notification. When trying to show the father what task she had created, the father impatiently suggested a navigational path for her.

When receiving an other notification of the same kind, and she immediately engaged the watch. Further, she stated that she really liked that she got the notifications when her daughters tasks were due. While smoking a cigarette, she received a picture. While viewing the notification, she acknowledged that that something has been sent to her, but was unsure what it was. She was able to open the picture, and became pleasantly surprised to see a picture of packed bags on a made bed. The daughter eventually sought out her mother and asked if she had received the picture. The mother confirmed and praised her. Subsequently, the mother and daughter went to the "Calendar" menu and deleted the tasks that had been completed.

When receiving the task, the daughter was in her room. She felt the smartwatch vibrate followed by a notification sound. She became slightly surprised and unlocked the watch using its tangible buttons. When reading the task notification she decided to dismiss the task. Immediately after she sent an instant message to her mother, stating that she was going to do the task in a short while. While packing her bags, the daughter received additional tasks from her mother. The daughter continued to dismiss the notifications and immediately started on those tasks as well.

Scenario 4 - Remember Comet match at 8 pm For this scenario I created an event and reminder, which would remind them when it was nearly the time to leave for the match. While drinking her coffee, the mother received a notification of the event. Slightly surprised, she pulled down the notification window, read the task name and snoozed it. Then she proceeded to Activi and chose "All Jobs" and "Edit". She wanted to add an additional reminder for later. Trying to figure out how to do it, she rhetorically asked me where she could find the feature. Short time after she found the feature, without any help. She added a new reminder 15 min before the event was due. Later she received her notification. She pulled down the notification window and swiped away the notification.

As she is swiped away the notification, she verbally expressed that she was now finished with that one.

Scenario 6 - Empty and fill the dishwasher When receiving the task notification, she immediately shook her watch to enable the display. She then pulled down the notification window and read the task out loud. As she was navigating to "All Jobs" trying to find the task, she verbally expressed that she performed that task earlier that day. She found the task and deleted it. Before she continued to watch television, she locked the watch using one of the tangible buttons.

Other observations While adding a new notification reminder, the mother stated that she was getting more comfortable with the keyboard. The posture was still sometimes uncomfortable, but if the interaction was quick she did not have any problems. Further, she expressed that she enjoyed the keyboard's delete function, and how easy it was to allocate tasks with Activi. The family members were able to complete all of the scenarios which occurred.

Gonzo Test Result Summary: Session 2

Scenario 1 - Listen to music This was one of the scenarios which I was not able to observe myself. One of the daughters told me that she had logged on to Spotify and used the watch to play music. She said that it worked very well, though the speakers were not the best ones. Further, that if she have had Bluetooth speakers she would have tried using them.

The father also tried to play music from the smartwatch. He found the application and discovered that there were no songs on the internal storage. He went back to the main menu and started creating an Activi task instead.

Scenario 2 - Facebook chatting After receiving the smartwatches, the mother started by logging into Facebook Messenger. She sent an instant message to one of her friends, and received a reply back. She express joy when she realized that she could chat with her friend using the smartwatch. She continued to use the Facebook Messenger throughout the duration of the testing. Every time she got a message, she would immediately checked it. In most of the cases this paused the ongoing conversation she was having with me or other family members.

Scenario 3 - Sharing photos While sitting outside, I sent the father a picture of the mother occupied with the smartwatch. He saw the picture and laughed. He showed the photo to the mother by stretching his arm towards her, so that she was able to see. Later, I sent the same photo to the mother. She found the notification and opened the photo. A similar reaction was observed. She became surprised and laughed.

Both parents were sitting outside smoking and pressing on the watches. Then the mother sent a picture to the father which she took earlier during the session. The father received a notification and opened the watch using the hardware buttons. He opened the notification window, and then pressed on the photo.

Scenario 4 - Clean room task Upon arrival the mother reminded one of her children to clean their room. After a short introduction, I handed out the smartwatches to the family members. One of the children put on the watch and started walking towards her room. While walking towards her room, she yelled out to her mother, explaining that she should just sent her the task when she wanted her to do it. The mother agreed.

Later, the mother remembered that she had not yet created the "Clean room" task for her daughter. She started creating the task while discussing the news with the father. Time passed and the mother received a notification that her daughter should now have received the "Clean room" task. She made a comment about Activi, saying that she was very pleased about how it worked, and that she had become very comfortable and enjoyed using the application. She said it made it so simple and that she did not need to yell or remind her children constantly.

The daughter who received the task eventually came out to the porch. The mother asked if she had received the task from her father earlier. Daughter confirmed and found the task on her watch and showed it to her mother.

Scenario 5 - Viewing and showing a Youtube video Eager to try several apps, the mother started playing a video on Youtube. The father became interested in what she was doing. She shortly explained to him that she was watching a video on Youtube. She then leaned back in the chair, watching the video while smoking a cigarette.

While the mother and I sat outside, we came on to the topic of Oculus Rift. I told her that there were funny videos of people trying it out, which she could watch. She opened Youtube on her smartwatch and asked me what to search for. She found a video and we saw it on her smartwatch. While viewing the video, she was leaning her elbow on her arm chair, tilting her wrist so that she was able to see the screen.

Other observations While sitting alone in the living room watching the news, the father suddenly received a notification on his watch. He immediately unlocked the watch and searched for the notification. He then continued to watch TV with the screen still on.

Both parents were sitting outside engaged in their watches. The father opened Activi and started to create a task. He wanted to add today's events in Activi. While discussing the events of that day with the mother, he started adding a task. While trying to type, the father often changed position, clearly uncomfortable and getting more and more frustrated as he tried to type the task title. Several times he let out a low growl as he paused and resumed typing. In one occasion he swore as he paused and said "I get so hotheaded when big hands and small watches need to work together. I should buy a stylus pen or something".

At the end of the session, only the parents were sitting outside with me, while the children was in their rooms. I asked them if we could all gather, so that I could show them some videos from the SPES sessions. The father opened Activi and started adding a new task. A couple of seconds later the children arrived out on the porch. The father asked if they received his task. One of their daughters laughed and mentioned that there was some spelling mistakes but they understood what he meant. The father had the most difficult time typing on the watch, and repeatedly mentioned that he had too big fingers for the screen. When creating one of the last tasks he used a pen to type.

As I ended the session, I asked if they would like to try using the watches for the next couple of days, preferably with their SIM cards, to really get a feeling for the smartwatch.

They became quite excited and accepted. I asked them if they could give me any feedback regarding the watch over the next days. However, I did not receive any feedback before the project delivery date.

4.2.6 Family's Reflections

After the last gonzo test, I wanted to gather more information about the family's experiences from the different test phases. I showed them some scenarios from the video footage from the SPES sessions. Additionally, I wanted to gather their reflection of what they thought of their own ideas and interactions with the smartwatch. To gather this information, I also showed them video footage from same or similar scenarios watched in the SPES video, from the gonzo test footage.

This was my last meeting with the family, and they got to share their impressions of their own interactions and services they had suggested. It gave me some confirmations of which services were fruitful, what interaction styles were fun and which were not as efficient. In all, it was a nice way to look back at all the time spend with the family, and to gather some last insights from them.

4.3 Prototype Development Environment

This section describes in what environment the prototype was developed. What platform was used, where and how it was tested and how version control was managed.

4.3.1 Version Control

A GitHub account was created to enable version control when developing the application. This way if any changes that were made which was not desirable, an earlier version of the application could be pulled from the GitHub repository.

4.3.2 Platform and Emulator

Eclipse with an ADT-plug-in was used to develop the application. During most of the development, the smartwatches I was supposed to use had not yet arrived. To run and test the application along the way, an emulator was created using the AVD (Android Virtual Device) feature in Eclipse. The following parameters was used to create an AVD to emulate a smartwatch:

Target API Level: Android 4.3 - API level 18

CPU/ABI: ARM

Keyboard: Yes

Skin: Skin with dynamic hardware controls

Back Camera: Webcam

Memory: RAM: 512

VM Heap: 16

Internal Storage: 200 MiB

Emulator Options: Check both snapshot and Host GPU

The AVD settings was found on the Omate Truesmart Wikispace.[7]

4.3.3 Test Devices

Before the smartwatches arrived, an AVD and smartphone was used to test the application. When the Omate Truesmart arrived, it was from then on used as the main test device. It run Android 4.2.2 with a customized UI called UI 1.0. Essentially the watch is a wrist worn smartphone, as you can insert you SIM card in it.

Connectivity wise, it had Wifi 802.11b/g/n and Bluetooth 3.0. Additionally, it had the following sensors; accelerometer, magnetometer, compass and gyroscope.[8]

During the usability tests, the application (Activi) was uploaded onto the smartwatches and used during testing.

Just before performing the second session of gonzo testing, the four remaining smartwatches arrived. These were not Omate Truesmarts, but also smartwatch phones called IKWEAR IK8 and running full Android 4.0.

When setting up all the smartwatches, I created a Gmail account for each of the six smartwatches. Further, I created a personal Activi calendar for each of the accounts and shared them with me. This way I could keep track of what they were using the application for. Then I renamed all of the smartwatches to each family members name and paired all smartwatch together with bluetooth.

4.3.4 Test Areas

The smartwatch was used as a test device at the university college and at the family's home.

Chapter 5

Results

In this chapter, the results gathered are presented in chronological order. There are five main sections which are; SPES, Low budget test, Gonzo test, Family's reflections and results and circumstances surrounding the interactive prototype itself.

This chapter focuses on the most important findings made in my project. It is important to note that the prototype chapter 4 provide all of the results gathered, and are additionally presented in more detail. To read more in-depth information surrounding the results, I would advise to read also the results presented in the prototype chapter.

5.1 Situated and Participatory Enactment of Scenarios (SPES)

SPES was performed two times, one just before Christmas 2013 and one the following January. Every year the family had a competition to make the best ginger bread house. During the first session the family chose to make these houses, and spent most of the session in the kitchen. It was late in the evening and the session stretched over two hours. Seven family members were present.

On a Sunday afternoon I performed the second session, which also lasted for about two hours. While the parents were cooking dinner and watching television in the living room, the children decided to play a board game in the kitchen. As they had an open kitchen/living room floor plan, I was able two observe all participants without moving around too much. Seven family members participated in this session.

During the session, my focus was to observe areas of use and ways of interaction which the family exhibited. Verbal suggestions was also noted. A friend of mine joined as a second observer. In addition, one camera was setup overlooking the kitchen area.

For the second session, I wanted to gather more specific observations concerning one of the applications observed in the first session. A task distribution service was the baseline while performing last session. This time I focused more on observing how the users interacted with this thought application and which functionality it could inhabit. Every family member was handed a dummy smartwatch to interact with during the session. We were two observers and one camera was placed facing the kitchen.

When analyzing the video footage the sessions, my main focus was to note the different application areas the family exhibited. Secondly, how they interacted with the dummy watch and which endowments and features they gave the watch as the sessions progressed. Most of the family members were comfortable with expressing themselves verbally. They

articulated their actions and came up with suggestions for applications. In addition to observed behavior, verbal expressions were also noted.

Five service categories was created based on the services that were observed during the two SPES sessions. Most of the enactments observed was within the categories of; "Organization", "Reminders and notifications", and "Communication and sharing". Several scenarios was enacted here and repeated differently throughout the the sessions. It was clear from an early point that a large utilization area for the family, would be to use the smartwatch to communicate, organize and remind one and other about events in their lives.

5.1.1 Communication and Sharing

Early during session one, the family used the dummy watch to communicate with each other. Considering the number of family members, they found it easier to send voice messages, instead of calling each others names. Also funnily enough, sending physical pokes and shocks from their smartwatch to another.

The family also enjoyed sharing videos, photos and keeping in touch with their extended family. During the sessions they often used their smartwatches to share information with each other. By retrieving and sharing or showing information on their smartwatches, even if they were in the same room. In a couple of the scenarios, they acted as they had a static external camera placed just below the ceiling. With this camera they were able to take photos, controlling it with their watch. It was used to share the family's event with Facebook friends and extended family. The smartwatch became a tool for sharing and retrieving information with each other, extended family and friends.

Further, the family used the smartwatch to gain attention from other family members. Amazingly, it was aslo used to output physical punishment. Small electrical shocks was sent to one another as punishment. To gain attention they would send each other small haptic touches which the receiver could feel as small vibrations from the watch.

Services within this category, was enacted most frequently compared to services within the other categories. The accessibility of the smartwatch enabled the family to quickly handle notification, retrieve and share information with each other. Whatever activity they were occupied with, retrieving information with the smartwatch did not pause their current activity. Instead the activity became enriched because of the quickly accumulated information.

5.1.2 Organization

As a big family, organization was always a time consuming aspect. In addition, most of the children went to different schools. Since the family lived in distance of any good bus connections, they had to be picked up by the parents. Organizing when, where and how many to pick up, was an everlasting game of solitaire. Additionally, the parents sometimes had to pick up and take care of their grandchildren. Managing and organizing took a lot of time and was done through calls, texts, paper notes and notes on their paper calendar.

Frequently, the dummy device was used to create tasks for the children. The mother felt that using the device to distribute tasks, made the children more aware of which tasks they had. They enjoyed interacting with the device, rather than checking a paper calendar. Additionally, how fast a task could be created and distributed among the family members. The mother did not have to sit down and write by hand in the calendar. Instead, tasks

could be created instantly, without needing to look for a pen and then alert the family about new tasks on the calendar.

Organizing privileges were a recurring observation. The parents could easily manage privileges on their devices. This was privileges as control of the television, renting movies and access to the internet. These could be easily taken way by the parents. Additionally, a system of who had the most privileges if e.g. several family members wanted to watch television at the same time. The watch with the most privileges, this could be the parents or the oldest child, would be able to control the television from their watch.

A reward system was enacted as a way to distribute praise to the children. If all tasks in a month had been completed, the child would receive a star/smiley. This was to trigger the children's competitive side, so that tasks would be done. A minimum set of points had to been gained before the end of the month, otherwise a punishment would be given. The punishment would normally be a house-hold task, or take the dogs out every day for the next two weeks.

The family had a lot of extended family living far away. As a result they used a lot of time to organize and find time for both families to have a video chat. They found that the device enables them to quickly share their family moments with other. With the dummy device, the family enacted that they could send haptic feeds through their smartwatches, to their extended family when they were able to have a video chat. If the other family replied a video chat was enabled. While chatting, the family members could proceed with other tasks, and did not have to sit all together. They could all be on the same video chat, but on their own device.

After performing SPES, it became clear that organizing and reminding of the tasks on the calendar, pick up of children, keeping in touch with extended family, was a time consuming aspect in their daily lives. They regularly used the dummy watch to manage the situations mentioned. After the sessions, I discussed some of my observations concerning this aspect. I found that something to replace and increase the efficiency of these habits, was wanted and needed.

5.1.3 Reminders and Notifications

Receiving reminders and notification of tasks was also an observed aspect from SPES. During the sessions the family enacted that they had three options when receiving a task notification; "Snooze", "Completed" and "Confirm". They were able to set their own snooze time with the maximum of 30 minutes. If they chose to press the "Confirm" option, it meant that the task was in progress. Lastly, the "Completed" option was pressed if the task had already been completed.

The children felt that they had more control over which tasks they had to do, and when they were due. Additionally, they were enjoying that their mother did not have to personally come in to their room and nag about doing their chores. Instead, the application would remind them, and they could send instant messages to their mother to ensure her that they were going to do it. During the sessions, the children took more control over their allocated task, and were the one who initiated communication with the parents regarding tasks, normally it was the other way around.

5.1.4 Gestures

The dummy smartwatch provided a smooth surface and tangible buttons for the users to interact with. During the sessions, I observed the following interaction styles; touch, long press, swipe and hand gestures. In a couple of scenarios the users also used the tangible buttons. Interaction was always quick and hassle free. In one of the scenarios the family was watching television, and performed hand gestures to lower the volume. By waving up and down, the user was able to increase and decrease the volume. Another user displayed that the mood they were in, could control the volume automatically.

In many of the scenarios the family used speech to text to send text messages and audio messages to each other. Further, during one of the scenarios the family used their voice to control the watch. They acted out a scenario where they were able to tell the watch to add items to an existing shopping list.

Lastly, direct manipulation was observed when a couple some of the participants interacted with a 3D hologram, which was displayed above the dummy device's surface. They used pinching gestures to zoom in and out of the hologram. Also, they used grab gestures to move the hologram around.

5.1.5 Adapting SPES

Prior to the session, I had only met with the family once before. On the day of the first session, I explained the circumstances surrounding the SPES technique. When the family was presented with the dummy smartwatches, they became quite eager to start.

A big floor stationed camera was placed facing the kitchen, were the family acted out most of the scenarios. During both sessions, a friend of mine joined to act as an observer. The family had never met this person before, and it seemed to affect some of the family member. Based on my observations and debriefings, I found that some of the users had problems with acting natural. This was because of both the camera and the fact that they were being observed. As a result, they became more self-aware, which affected their normal behavior.

During the sessions, they were asked to mostly express themselves behaviorally. However, some participants also had some issues with this. This could have been the reason for why, several times during the session, that enactment and brainstorming got interleaved.

SPES is designed to help users envision future artifacts and services. By introducing the dummy device, aided the users in their enactment, because they had a device to interact with. Furthermore, it constrained the users from acting out too unrealistic scenarios. In some of the scenarios, the users became unsure of the smartwatch's capabilities and constraints. They wondered if their scenario would be possible or not. I allowed them to endow their watches with capabilities. This seemed to increase their interest towards the scenario. Additionally, the whole family became quite creative when discussing their endowments. However, if scenarios became too unrealistic I would pose one of the predefined scenarios, to ground them.

The sessions lasted around two hours. After which, most of the family members were very tired, and started to take of their devices and retreat to their rooms.

5.2 Low Budget Test

Two rounds of low budget testing was performed, one with wireframes and one with an interactive prototype. First round of testing was performed at the university college. A total of eight participants between the ages of 22 and 46, participated. Six of these were student and could be categorized as frequent expert users. Whereas the last two participants were within the category of knowledgeable intermittent users. During testing the wireframes were placed on the dummy smartwatch with tac glue. Each participant was asked to wear the dummy smartwatch on their wrist during the test.

Preforming a low budget test for the second time, the interactive prototype was used. Before performing the test with the family, a pilot test with two users was executed. The pilot test helped me to prepare and adjust the test tasks created. Furthermore, it was useful to discover and fix small bugs in the prototype. Second round was carried out early in the evening in the family's kitchen. One person participated in the test at a time, while the other family members stayed in other parts of the house.

In both rounds of testing, task were posed to the user while notes about interaction, verbal expression, time used and navigation was noted. Additionally, I was the only observer in both sessions. After the family had finished the test, a collective participant debriefing was performed.

5.2.1 Wireframe Test Results

After the last SPES sessions, I did some research and created wireframes of the task distribution application. These were later tested to gather information about the structure of the wireframes, use of labels and navigational flow. Based on the previous results, the wireframes implemented a lot of the functionalites which had been expressed. However, after conducting the first low budget test, it became apparent that some changes to the design was necessary.

The wireframes presented four main menu buttons, New task, Active Tasks, My Tasks, Lists and Members/Groups. The participants did not have any problems with creating task. However, when they were asked to look, pause, edit or delete tasks, most participants had problems of understanding what the difference between My Tasks and Active Tasks were. As a result, many of the participants chose the wrong menu.

Many of the tasks presented was related to finding and modifying tasks. It became clear that as the users were trying to solve the tasks, they tried navigating by recalling locations of functionalities, rather than recognizing the functionalities of the different menus. A possible reason for this, which I realized after the last test, might have been that some of the tasks presented was formulated too ambiguously and unclear. Another reason was that several of the labels were too non intuitive for the users, which ultimately lead to relabeling of most labels before the next test stage. Labels in an application should provide the user with enough to comprehend the functionality of the label's content.[30] Furthermore, I changed the prototype's language from English to Norwegian, in consideration to younger users.

There was one task which none of the participants managed to solve. Users were asked to view a photo proof of a completed task. The proof was indicated beside a task title, in a form of a clip icon. Most users managed to navigate to the correct screen, but did not understand that the icon could be pressed and then the picture would be displayed.

One of the expert frequent users, with Android development experience, alerted me to some aspects in my wireframes which would not necessary be easy or possible to implement. Being aware of this, I started developing an interactive prototype based on the results gathered from the wireframes tests.

5.2.2 Prototype Test Results

The prototype used during the second low budget test and during the gonzo test, was the same prototype version. Due to limited time, I did not make any significant changes to the prototype before the last low budget test and gonzo test. The test results from the last low budget test, is presented in this section.

A pilot test was performed prior to meeting the family. Two expert frequent users participated. The test resulted in some changes to the order and wording of some of the test tasks. Additionally, I observed that when adding people in the People menu, the keyboard blocked the input field. This resulted in that the user had to type a person email address without being able to see what they were typing. However, time was limited so the bug was not addressed.

I met the family after dinner time and performed the low budget test, using the interactive prototype. Five family members participated, and one by one they were sat down in the living room and asked to put the watch on their wrist. Then they were given some time to look around in the smartwatch menus and applications, and to get comfortable with the keyboard.

As tasks were read out to the users, I did not mention any words which were present in the menu of the application. By doing this the user had to deduct their own conclusions of which menu would be the correct one. Only one user became unsure if New Job was the correct menu. All users were able to create and delete tasks without any difficulties.

Some labels in the application still seemed to confuse some of the participants. The users were asked to set themselves as attending on one of the events. To solve the task the users had to first find the task, press Edit, then the task would open in the Google Calendar application. Here they were able to set themselves as attending. Two user navigated directly through the Calendar menu, and the rest through the Edit function in All Tasks.

When the users were asked to add additional people to the Activi application, all but one family member managed to completed the task within the allotted time. This was because of the bug found during pilot testing. The keyboard blocked the field of view, when the user that to type the persons email address.

During testing, it became obvious that any interaction with a smartwatch should be limited and keyboard free. Due to an unfamiliar keyboard and small keys, the typing was the most inefficient and time consuming aspect during the whole test. One of the participants suggested that the watches should have come with a touch pen. An other user complained of wrist and shoulder pain while performing the tasks. Frustration and despair was also expressed when the users had to use the keyboard to complete a task. A solution would be to implement a way to add tasks without having to use the keyboard. During the SPES session, the family used speech to text and voice control. This would be one solution to replace the need for a keyboard.

5.3 Gonzo Test

Two sessions of testing was performed. First session was carried out early in the fall when the weather was nice. Family members were scattered inside and outside of the house. During the first session I only had two smartwatches available, which meant that the users needed to alternate on using the smartwatches. The majority of the session was spent outside on the porch, so I decided to place a camera outside of a window overlooking the porch. When family members traveled around inside the house, I would follow the user who was wearing the smartwatch.

Before the test, I had gathered scenarios observed from SPES which I wanted to trigger during the gonzo testing. Triggers to initiate these scenarios had also been created. Additionally, by looking at their paper calendar, I formed the session around what the family was doing that day. This way their day would seem as normal as possible. Testing took around two hours and was performed early in the evening.

For the second session, I had received the last four smartwatches and used all six of them for the last session. Similar to the first session, other scenarios from SPES was chosen to be triggered during testing. If they did not occur naturally, I would trigger them by asking pre-defined questions. This session was also performed early in the evening and mostly outside. A camera was placed outside overlooking the porch, and another camera placed on the wall, overlooking the living room area.

Figure 5.1: Four IKWEAR IK8 smartwatch phones used during the last re-enactment session.

When reviewing the video footage, my main focus was to observe their behavior towards the smartwatch, reactions and interactions. Both verbal and behavioral expressions was important to gather, to get a complete image of the different situations that occurred. Further, to confirm that the observed behavior and verbal expressions expressed concurred with my own observation and interpretations.

Novelty

During the first session of testing, the focus was mainly on having the users to utilize the Activi application. That day's actual events had been added to the list of scenarios to be performed that day. This way the use of the smartwatches would be based on actual events rather then manufactured ones. This could have been an aid to increase more natural interactions and behavior during the test.

The family had only used the smartwatch and application once before, during the low budget test. As I started the test, they were focusing on using Activi for their events and tasks. Instead of exploring the smartwatch and application, they were actually just using the application like it was an every day thing. This meant that even though they only had used Activi once before, some the novelty aspect had diluted. When the users received notifications, even though they were still unaccustomed to having the watch vibrate on their writs, they proceeded very naturally to view and in some cases, responding to the notifications. When finished, they locked the watch and proceeded with what they were initially doing.

When the users were sending messages or tasks to on another, they would in many cases ask when they saw each other, if they had received the task or message. It is difficult to distinguish if these actions are caused by novelty or is in fact normal behavior. Most likely it was because they did not yet trust or expect the technology to fully operate as they expected.

During the second session, the users were allowed to use the other applications and Activi. I encouraged them to use the smartwatch as often as possible, and in any situations, with any apps. Since they were able to use several applications, the novelty aspect seemed to increase. This lead to several situations where the users were sitting in the same room, only engaging the smartwatch. Sometimes informing the rest of the family what they were doing. Since they have had little time to explore other application on the smartwatch during the low budget test, their curiosity now increased and so did the novelty aspect.

Receiving Notifications

Only two smartwatches was used during the first session. When the mother received a notification, the father became curious to what it said. She easily explained that their daughter had now received the task she had created earlier.

When receiving a notification they often became surprised, which they expressed both verbally and behaviorally. During the first session, one of the daughters was in her room when she received a task from her mother. She was supposed to pack her bags for the weekend. Since the application itself did not implement the possibility to "Confirm" tasks when receiving notifications, she instead sent an instant message back to her mother. She expressed that she wanted to ensure her mother that she was going to perform the task shortly. After sending the message, she actually started packing. When she was finished packing, she send a picture of the packed bags to her mother.

When viewing the recordings, I noticed that their reactions when receiving notifications, was very similar to when they were receiving notifications on their smartphones. No matter what they were doing or talking about, as soon as they received a notification they immediately had to check it. The conversation or activity they were engaged in, paused. While checking their notifications, they would sometimes partly engage in the e.g. conversation. When finished, they resumed the conversation or activity. Due to some novelty aspects, the family became a little more surprised when they received notifications on their smartwatches.

In situations where no one was conversing, most of them would sit in front of the TV occupied with their smartphones. I observed a similar situation during the re-enactment. They were all sitting together not talking, engaging their smartwatches, exchanging some words now and then. However, it is very difficult to distinguish situations caused by novelty aspects and normal behavior in this situation.

Typing

What I first observed during the sessions, was that the users spent a lot of time when using the keyboard. In most cases, the tasks and messages had a lot of spelling mistakes, and when they managed to spell correctly, they had spent a lot of time typing. A lot of frustration was expressed both verbally and behaviorally, especially from the father. He repeatedly mentioned his fingers was too big for the small screen. However, the mother was one of the users who thought that she was getting more used to the keyboard. She mentioned that it was difficult the first few times, but that she had become more and more comfortable typing. Still, it was clear that using a keyboard on such a small screen, was going to be too time consuming and frustrating for users. As mentioned above, speech to text and voice control, interaction styles observed during SPES, would be possible solutions in future development.

Gestures

During the low budget testing I used an application called Shake, which enabled me to open Activi just by shaking the watch. The family found this very useful and used it a lot during the re-enactments. In most situations, when the family wanted to show something on their watch, whether it was a video, picture or task, they would shake their watch to enable the screen. It was especially used when they wanted to use Activi. This was an other good indication that the users would rather not spend a lot of time engaging the smartwatch's small screen, but use gestures to interact with it.

Communication and Sharing

One interesting aspect I observed during the sessions, was how the children responded when receiving tasks. I had observed in many of my visits outside any testing, how the children reacted when their parents told them to do something. The parents were usually met with avoidance, confrontation and hesitation. In one of the first scenarios the mother had sent a task to one of her daughters. The daughter instantly replied, confirming that she was going to do the task. Later she sent her mother a proof that the task was done. Not much later, she approached her mother asking if she had gotten her picture. Notably, there might still have been some novelty aspects surrounding the scenario. However, the children seemed to enjoy sending proof, rather being sought out by their parents asking if they had started or completed their tasks.

In an opposite observation, the father received a task from the mother, telling him to bring the computer outside. Since he was sitting only a few meters away, he verbally replied when he got the notification, that he would bring it soon. Both observations is an indication that the smartwatch could replace the need for verbally informing and reminding people of something, which would save the family a lot of time, considering how many they are. They could be at different locations and still get their notifications of tasks, instead of the parents having to call and remind them.

Several times during the two sessions the family sent each other pictures, instant messages and tasks. It seemed like they enjoyed the simplicity of sharing the smartwatch provided, even if it was a proof of a completed task. I noticed during the session that there was no discussions regarding if a task had been started or completed. I observed, however, that the mother praised the children when seeing them, after receiving a proof of

a completed task. Their habit of asking and reminding each other of started or completed tasks, did not occur in any of the two test sessions.

The mother was the first one to log on to the Facebook Messenger app. When receiving notifications she checked them immediately and replied. Her interactions with the smartwatch, was short and casual, even when she had to use the keyboard. Similar to my observations when the family used their smartphones, when notifications on the smartwatch was received, they shortly left the conversation and rejoined it short after.

5.4 Family's Reflections

As a last measure to gather more results, I wanted to know the family's reflections surrounding the differences of how they used the dummy smartwatch and actual smartwatch and application. I showed the family a couple video clips from the SPES sessions. Then I showed them a similar scenario but from the re-enactment sessions with the actual smartwatch and application. Their thoughts and reactions gave me more information regarding which interaction styles and services was fruitful and natural.

Scenario	SPES observation	Re-enactment observation
Answer a call	Put the smartwatch up to the ear without touching any buttons	1: Put the smartwatch in front of the mouth
Sharing a picture with a family member	Bumping the smartwatches together	Used an application called Shoutr, swiping the file to users
Postponing / Declining a task	Sighed and either: 1: Simulated pressing a snooze button with customized snooze time 2. Simulated a touch button pressing "No"	1. Snoozed task by pressing "Snooze all" 2. Deleting the task in Activi
Receiving a task notification	1. Pressed "Later" 2. Sent it back to the parents for reallocation	Checked the notification immediately then either: 1 Swiped away the notification 2. Pressed on the notification to view it. 3. Sent an instant message to ensure that the task was going to be executed

5.4.1 Answer a Call

In retrospect, the family though that their solution for answering a call was quite amusing. However, they realized it would be quite uncomfortable to actually to have a conversation like that. When viewing the re-enactments with the actual smartwatch, they expressed that there was little difference. In the latter scenario they had realized that the watch had working speakers. The father added that he would now in retrospect have answered the phone with his Bluetooth ear piece, which would have been connected to the smartwatch.

5.4.2 Sharing a Picture with a Family Member

The family thought that their initial solution was fun. However, they realized that it would not be very efficient, considering when they would be in different rooms or locations. They thought that sharing a picture without physically having to bump the smartwatches was much more effective. However, they would not have minded if both options were possible.

5.4.3 Postponing/Declining a Task

They were not surprised that they still snoozed some tasks. Further, they mentioned that it would most likely happen if they kept using the application in the future. The mother mentioned that the smartwatch would still relieve her of having to remind every one of tasks to be done. Additionally, the reward system would hopefully be in place. Which would enable them to not snooze the task for too long, considering that they would know what the month's price and punishment would be. Further, they thought that having the reward system and an overview of who had completed most task, would increase their competitiveness and snooze less tasks.

5.4.4 Receiving a Task Notification

When using an actual smartwatch the family was much more eager to view their notifications. When viewing the video, they thought it was interesting how eager they were to check and handle their notifications, and how similar their interactions were. Further, they noticed that receiving a task on the actual smartwatch had a much more positive effect on some of their children, which was not something observed in SPES. Since Activi did not implement a "Confirm" feature for received tasks, some of the children sent instant messages to their parents instead. They were positively surprised of the difference between the two sessions. However, they wondered if that would still be the situation when using the smartwatches every day.

5.5 Interactive Prototype

From idea to prototype, Activi went through several changes. The application started out as an observed service in SPES, with a lot of functionality. As it proceeded into wireframing stage, non intuitive information structure and navigational flow, became obvious. After testing, it became clear that labels needed to be altered, in addition a restructuring of the information architecture. During the prototype development, the application was stripped of some of its functionalities, due to complex wireframe designs and limited time. It resulted in an application which implemented the most important and significant features of an activity reminder and distributor. Creating, allocating, editing, viewing and reminders of tasks and events was implemented. By integrating the Google Calendar app, file sharing and instant messaging applications, Activi became a realization.

5.5.1 Meeting User Expectations

During the testing of the interactive prototype, apart from a couple of issues, the users managed to use Activi well. They were able to easily understand and comprehend the applications and its features. User expectations in this section refers to the features and interaction styles observed during SPES, and features mentioned during the debriefings.

In terms of meeting the user expectations, the application did occupy the ability to; create, allocate, reallocate, delete, set reminders and receive notification repeat, give an overview of upcoming tasks, snooze and decline task notifications. Although, some of these last mentioned features were not an in-application feature. Still, it proved to meet most of the users expectations during the test. Considering that most of their enacted and expressed features were available in the application, either in-app or other supporting applications.

Confirm Completed Tasks

When a user wanted to inform that a task had been done, they had the option to either delete the task, send an instant message, or a file with proof. However, during the SPES session it was made clear that even though if proof was sent, the task would always be checked physically. Therefore, an in-application proof feature was not prioritized. By implementing the use of Google Calendar, the users were able to delete tasks when they were complete from inside Activi. This would also delete the task from their calendars in Google. The task would still be visible in the task owner's calendar. Task owner was also able to view when an user had deleted the task from their calendar. The creator would also receive an email if someone deleted one of their created tasks, which in this case meant that the user was finished with a task, and it could now be checked physically.

Reward System

During SPES, I observed that when a task had been completed, they acted as if they were sending positive feedback in the form of stars or smileys. This was a part of a reward system, were the users were able to see how many stars or smileys they got during a month. A note of the months price for the most e.g. smileys, was viewable everybody's watch. Also, if a family member did not gain the minimum amount of smileys, a punishment would be given. Unfortunately, this was something that was not implemented in Activi, but something I would like to implement in the future development of the application.

Task Editing

The actual implementation of editing tasks, proved to be a bit confusing for the family in the beginning. When editing a task, they had to go to the overview of all tasks, in-application, and press "Edit", which would send them to the Google Calendar version of the task. Here they were only able to add reminders, edit name, date and time and add or remove users the task was allocated to. I could have avoided that initial confusion, by implementing in-application editing of tasks. In example, when editing a task the task could be opened in the same layout as when creating tasks, but with the parameters of the task already set.

Task Reallocation

In the application prototype, the family was able to decline received tasks. By deleting the task inside Activi, the task had theoretically been declined. When a user "declined" a task the creator would receive an email. However, during SPES I observed that the family was able to reallocate tasks immediately after a task had been declined. During the gonzo testing, the users expressed the want for a more efficient way of reallocating tasks, than

what was already implemented. In future development, reallocation of task would happen automatically if the task was a repetitive task, and allocated to more than one person. Automatic reallocation was a feature expressed by the mother during a debriefing after a SPES session.

Chapter 6

Discussion

In the result chapter 5, I presented my most significant findings. These were findings from two SPES sessions and two low budget tests, using both wireframes and an interactive prototype. Then two sessions of gonzo testing was performed, where the users re-enacted some scenarios observed during SPES. The re-enactments aided the gathering of the family's experiences towards an actual smartwatch. Lastly, I presented some of the family's reflections, by showing them video from the SPES and gonzo testing.

In this chapter I examine and discuss these findings further. I look at how other work was similar or different than mine. Further, how these differences could have affected my findings, and what I could have done differently. The chapter is presented in a chronological order relating to the sequence of the problem statements presented in chapter 1.

6.1 Adapting and Performing SPES with a Family as Participants

Bringing the smartwatch in to the family home was an interesting journey. The family had only heard about smartwatches from friends and commercials, but never physically used one themselves. Performing this kind of research was quite difficult, considering my aim was to observe natural use and behavior with a smartwatch. Due to limited time, it was difficult to dilute the novelty aspect surrounding the smartwatch. This made it complicated to distinguish between natural behavior, and behavior caused by novelty feelings. Still, during the project several services and ways of interaction towards the smartwatch was mapped. Additionally, with a combination of observations and participant debriefings, services and features were gathered and one of which was chosen for further development.

Before performing the SPES technique, the family was introduced to the dummy smartwatches which I had created, see figure 4.1. There was a noticeable increase of excitement towards the project as they were presented. The SPES technique uses dummy devices to make it easier for users to envision future services and artifacts. Similar observations were made in Hutchinson et al. [18], where they designed technology probes to aid inspiration of design for and with families. They found that using these designed probes, users became more creative and playful in their initiatives. Furthermore, Howard et al. [17] stated that using props provided a way of managing the enactments, to gather services which were within "plausible fiction" rather than "science fiction".

> When an actor is unconstrained and technology omnipotent little is learned.[17]

During the enactment, situations occurred were participants became unsure of the possibilities and constraints of the device. In these situations I helped them endow their device to aid the continuation of their performance. The idea was gathered from Howard et al. [17], were they aided the participants in endowing their props. In their research they found that providing intriguing and simple endowments, kept the participant interested. As the family members received endowments, it increased their interest and sense of immersion, which triggered interesting and mostly fruitful scenarios. However, some endowments were not not presented specific enough. This resulted in scenarios which were more within "science fiction" rather than "plausible fiction". Scenarios like having a 3D hologram be displayed above the screen of the smartwatch. However, when scenarios were posed, and aiding the participants with specific endowments, it provided mostly fruitful services within the "plausible fiction" category.

By using dummy devices and allowing endowment, the users were kept engaged while performing the SPES technique. Although they were active and creative, some users had some difficulties expressing themselves behaviorally. In Brandt et al. [14] mentioned that we are taught to express ourselves verbally or textually. When having to combine this with bodily expression, some participants might become more self aware. This might be related to why a couple of the participants mentioned during debriefing that they had problems with acting normal. Considering that we are taught to express ourselves textually and verbally, by demanding behaviorally expression, might have been the reason for the mixture of enactment and brainstorming. To identify services which where a result of the SPES technique, I had to try to distinguish between the scenarios which were acted out and brought forth by brainstorming. Perhaps if I had spent a little more time on explaining and showing the family how to perform SPES, there might have been less brainstorming and more enactment.

It was important to try to distinguish between the scenarios that were enacted, and brought forth through brainstorming. The reason for this is because observing the user's interaction with the device in a real contextual environment, is where the SPES technique is successful. In Howard et al.[17] they reported that real environment are contextual props, which help to gather realistic contextual information. Using the dummy smartwatches and the their home as props, the observations gathered from encatments would therefore be more fruitful. The reason is because it is generally harder for users to envision and converse about future services, without actually using it in their daily lives.[19] Using a device creates a relation between the device and their every day lives. Services based on observations of user's natural and instinctive utilization areas and interaction styles, would therefore provide more reliable future services and devices.

Using the dummy smartwatch as a prop during the sessions, contributed and increased the sense of immersion among the users in their enactments. It also provided some constraints in the family's enactments, which proved to yield more services which were within "plausible fiction" rather than "science fiction". Unfortunately for some participants, enactment and brainstorming got interleaved when they felt pressured to show bodily expression.

6.1.1 Challenges when Performing SPES

SPES and the dummy smartwatch was successful in inducing creative and interesting services. However, inducing creativity within an already imaginative and verbal family, produced aspects which made it difficult performing a strict SPES technique. As stated

in Brandt et al. [14], we are taught to express ourselves verbally or textually. During the initial SPES session, I observed several instances where the enactment itself became the topic of conversation. As a result, the sessions transformed into a mixture of enactment and brainstorming.

During the debriefing, a couple of family members expressed that they sometimes felt a bit pressured and difficult to be creative and act natural. This was one of my concerns before performing the initial SPES session. Only one meeting had been held before the session. Considering the family's statement during the debriefing, it did not help to have two observers and a camera in the house, watching them. Because of this disturbance, a couple of the family members had difficulties with acting normal. As mentioned in Janis et al. [21], the reason for this was because some people can be hesitant to expose themselves to others. The combination of the disturbances and the need for bodily expression in the enactments, could have been the reason for the intertwining of enactment and brainstorming. This made it difficult to distinguish the scenarios which were a result of SPES and a result of brainstorming. In retrospect I should have spent more time with the family, prior the the sessions. Additionally, it would perhaps helped with I had some more predefined scenarios to pose to the family. This might have eased their pressure of having to be creative, because they would react subconsciously to the posed scenario.

Janis et al. [21] found that when an user, during role play, conforms to a role or verbally expresses opinions which might not relate to their own, will facilitate opinion change. Even though the users expressed their own opinions and where themselves, they might have been affected by the pressure to be proactive and productive during the sessions. This could have affected their conversed and brainstormed ideas, affecting each other and building upon each other ideas. Further, the disturbances of the observers and camera made them more self aware of their behavior. Therefore, it was even more important to distinguish between observations made surrounding their behavior and what they expressed verbally.

Another challenging aspect when performing the SPES technique, was taking good observational notes. The family consisted of many people who were enacting. When taking observational notes it was important to distinguish between what the users said and did. A weakness of field studies is that, it is very easy to start noting solutions to problems which occur while observing users,[35] This was something I had difficulties with. When the family was enacting, a lot services and applications were explored, I took my self in writing ideas and solutions to the different scenarios as they occurred. Instead, I should have focused on taking only notes of what I observed. Perhaps if I had performed a pilot session, prior to meeting the family, I would have had some practice on how to take good observational notes. Furthermore, I should have constructed more specific scenarios. In [35], mention that it is important to to lead the users any way. I was afraid that if my predefined scenarios were too specific, I would guide the enactment too much. Trying to find a balance of being a good leader without leading, was challenging.

6.1.2 My Experiences and Reflections

During the two sessions of SPES, I was able to map many services and user interactions towards the smartwatch. However, there are still some aspect I would have wanted to do better. Aspects which might have affected my results.

During the first session of SPES, the family members were quite eager to use the smartwatch while enacting. However, because of disturbances and the pressure to be

productive, the content of the enactment frequently became the topic of conversation. As a result, it lead to a mixture of enactment and brainstorming. Distinguishing between the two became difficult, so all observations were noted. I would have wanted the SPES sessions to be mostly enactment, and encouraging brainstorming during the debriefing sessions.

Initially, I wanted to engage in a non guiding role while observing the first session. However, when brainstorming and SPES got interleaved, I felt it was necessary get more involved in their enactments. I posed some scenarios which enabled them to focus on enactment, instead of conversing about possible smartwatch applications. Similar actions were used in Howard et al. [17], where they would re-iterate a scenario when the enactments became unrealistic and not so useful. Posing scenarios when brainstorming or "science fiction" scenarios occurred, eased the brainstorming for a short while, and provided enactments of services within "plausible fiction".

Since only one meeting was held before the initial session, the family might have felt more comfortable expressing themselves behaviorally, if they had more time prior to the session to get to know me and the other observer. Further, I should have given the family more time to comprehend the circumstances surrounding SPES. By introducing some guidelines before session and been more strict, could perhaps have damped or removed the brainstorming aspect in the sessions. Although, having too many ground rules could have made their enactments less natural and restricted their creativity. When presenting the technique to a family, it needs to be informative and clearly visually displayed, so that they easily can comprehend the parameters of the method.

Cameras and observers proved to be a disturbance for some of the family members. Instead of using a large camera, small cameras should have been placed just below the ceiling in the most used areas in the house. The disturbance which the camera caused might then have decreased, allowing the users to forget that they were being recorded. As an observer it was difficult to not be a disturbance when observing them. Especially when I had to follow them around in other parts of the house.

Considering that the family already consisted of eight people, having an additional observer during the session made the home quite crowded. Further, having an other observer which the family had never met before, was an additional disturbance during their enactments. Instead of an extra observer, I would have discretely placed several cameras in their home, as mentioned in the section above. I found that occasionally when the family initiated it, involving myself in their discussions, simultaneously trying to not affect their enactments, provided an even more natural setting during the enactment. Instead of strictly being an observer, I then became a part of their enactments.

Lastly, I would have wanted to set aside even more time to explain and display the method to the family. Furthermore, performed additional sessions with even more predefined scenarios. It would have helped me to master the technique better and become a much better test leader. Furthermore, I would have wanted to perform a pilot session. Here the family and I could have enacted together, to gather scenarios for the next session. The pilot session would also have prepared me and formed more detailed scenarios.

6.1.3 Suggestions for when Performing SPES

Performing the SPES technique with a large family was quite demanding. There were many people to observe, and the house became quite crowded. Perhaps it would have been less demanding if I had chosen to observe two small families instead. When entering

the home of a family, it was difficult not to be a disturbance to their natural behavior. Further, when bringing cameras and observers in the comfort of their own home, their natural behavior was affected. When performing the SPES technique, the family members should not feel restricted in their own home. They should feel that they are able to move freely and act naturally, without having the feeling of needing to be in certain parts of the house. Based on my experiences of performing SPES, one should strive to remove anything that could be a disturbance for the family. Be the only observer when performing the technique. The more unknown people in the house, the more aware the family became of their behavior. Further, do not place large and clearly visible cameras in their home. Cameras are a disturbance to the participants. Place cameras out of sight, and make sure they are not inhibiting the family members from moving freely through the house. Since you are the only observer, to be able to observe what is going on in other parts of the house, place small cameras below the ceiling in all of the main rooms in the home. This way you are able to observe all participants most of the time when reviewing the footage.

Allow the users to get to know you better before performing the method. This will make them more comfortable around you, and make them less self aware. This could be done by having a couple of casual meetings before the initial session. Additionally, allow the users to familiarize themselves with the dummy device prior to the session. This would help dilute novelty aspects surrounding the device. When the devices were presented just before the initial session, it caused the family to be over-productive while acting out scenarios. These first scenarios were more within the "science fiction" category.

As an observer in the family home, it is difficult not to be treated as a guest. The family will interact with you and occasionally initiate discussions with you. In these situations it is important not to place constraints on their enactments, but rather acknowledge their interaction and pose scenarios to continue their enactment.

In Iacucci et al. [19], they describe that the SPES technique is normally performed over 1-2 days, with 3-4 scenarios per session. However, this could not be done when performing the technique in a family home. After 2-3 hours of enactment the family became very tired. This was because of the disturbances brought into their home, which did not allow them to relax and act completely normal. Since the family became exhausted after 2-3 hours of enacting, observing them continuously when they were at home over two days, would be too strenuous for the family and myself. Instead I suggest to perform several sessions on different days and times during the day. This way you are able to observe the family within different aspects of their daily lives.

6.2 Services Observed During SPES

Based on all the observations noted during the sessions, five service categories were created to provide an overview of the services. The following categories were Monitoring, Organization, Remote access and Control, Reminders and Notifications, and finally Communication and Sharing. A more complete list of services can be viewed in the prototype chapter 4. Both services within "plausible fiction" and "science fiction" is presented there.

At the beginning of the project, I was very interested in seeing which services the family would display towards the area of ubiquitous computing. My interests before the SPES session, was to develop a fruitful service within that area. Several scenarios where observed where the users where interacting with smart objects through the dummy device. Among these, were smart kitchen appliances, oven and kitchen scales. Furthermore, scenarios

occurrd where a the washing machine alerting when it was finished, and house heating central provided information about power usage and possible adjustments to decrease current usage.

Similar to how Weiser [24] envisioned people would interact with a smart environment, the users naturally acted out scenarios where they interacted with smart objects through their dummy devices. They were able to create their own IoT (Internet of Things) world, interacting with several of their appliances and objects in their home. The observations proved that the smartwatch could possibly facilitate user interaction with a smart environment.

As enactments related to smart environment and objects were acted out, the family did express a concern relating to how available their interaction with the objects would be outside of their home. Considering, if the purest form of ubiquitous computing would have been implemented, which is having all computation performed in the smart environment and not on the wearable device.[13] The family became unsure of how private these interactions would be, and further stated that if someone wanted to obtain that information, they were afraid that they would most likely succeed. Still, they found the concept quite interesting, and agreed that it would most likely make some aspects of their daily routines more efficient.

The personal computer is used to pass time rather than contributing in everyday activities.[33] When selecting a service for further development, I wanted to chose a service which would contribute in the family's daily lives. When surveying the gathered results from SPES, a task distribution service was chosen. The family frequently displayed scenarios towards that service, and further expressed their desires during the debriefings. By choosing that service I hoped to help the family streamline organization and allocation of tasks and events. A service which would relieve them of time consuming and possibly unnecessary routines.

6.2.1 Realistic and Unrealistic Services

During the SPES technique I observed users enacting both realistic and unrealistic scenarios. In Howard et al. [17], these were called designs within "plausible fiction" and "science fiction". As a result of unspecified endowment and eager participation, some of these "science fiction" scenarios were i.a. 3D holograms which were displayed from the screen of the watch. Direct manipulation was used to interact with the hologram. However, scenarios which were unrealistic, helped to keep the family interested and creative during enactments. As long as the scenarios did not last for a longer amount of time, I did not step in to pose scenarios to help change their focus to other scenarios.

Some scenarios which the family enacted was not theoretically unrealistic, considering that the technology is actually available. However, the likelihood of it being implemented in any of the upcoming smartwatches, is less certain. The scenario in mind, is the when the family was able to send small electrical shock to other family members as punishment. However, this is somewhat similar to what the new Apple Watch has implemented application. Their taptic engine allows the users to actively send customized haptic feedback to each other.[1] This would have been a practical solution for when the family wanted to get each others attention, or when trying to contact external family.

In the service category of communication and sharing, the users were observed using speech to text and their voice to control their watches. This was quite interesting considering the launch of Google's new API, called Android Wear. Android Wear is an API

which is customized for smartwatches. Interaction-wise, the user operates the system by using voice control. Further, it relies on speech to text instead of the keyboard.[4] This was the most frequent observed interaction style during the enactments. If Activi had been implemented based on this operating system, the users would not have complained about small screens and pain when using the watch.

Scenarios within the smart environment aspect was also observed. These were scenarios where the participants interacted with objects around the home through their dummy device. Some of the scenarios were controlling heating, window blinds, a refrigerator which kept track of its contents, and controlling various kitchen appliances. Controlling, accessing and viewing information about the objects were all performed through the device.

However, evaluating if these interactions would be realistic or "science fiction", would depend on the smartwatch's software architecture. There are three types of software architecture which smartwatches have been known to utilize; All-in-one, Client-Server and gateway-integration. Using a smartwatch and environment which is based on an All-in-one architecture, would enable the participants to interact with the objects without having the watch needing to send the computational task to an other unit.[29] This would also be the solution which the family specifically enacted.

If the environment was based on a client-server architecture, the smartwatch would have to send the larger computational tasks to a more powerful unit, like the smartphone.[29] However, if several smart objects were sending information that needed to be computed by the smartphone, this could became a bottle neck quite quickly. The user might experience that information is not retrieved or viewable on the smartwatch before a longer time has passes, when perhaps the user has lost their patience and interest.

Lastly, a gateway-integration architecture could be used if the watch itself is not able to communicate with certain smart objects. This type of architecture might have to be implemented if smartwatch manufactures and smart object manufactures, develop items that can only communicate with certain objects or smartwatches, e.g. objects from a certain type of brand. The dWatch implemented this type of architecture.[29]

Many of the realistic services observed, were closely related to how and what they used their smartphones for. These were scenarios like checking email, browsing the internet, listening to music, taking and sending pictures, sending text messages, updating and sharing on social media. This give an indication of that the smartwatch could in fact replace the smartphone altogether. If a sophisticated way of interacting with the smartwatch was developed, and the smartwatch itself would not be too large and uncomfortable, it is not unlikely from what I observed during my research that the smartwatch could replace the smartphone.

6.2.2 Observed Interaction Styles

Today's smartwatches are quite more sophisticated than IBM's Linux Watch. Similar to this early developed watch, newer watches also have tangible buttons.[29][8] However, as technology has developed, touch screens, sensors and speech recognition now provides several ways of interacting with a smartwatch.[7][4]

The dummy smartwatch provided a smooth surface which simulated a screen, which was used for several types of interactions. These were interactions like touch, swipe, long press, and pressing of the tangible buttons. Furthermore, I observed the participants enabling the sensors by using gestures. These were mostly shake and wave gestures. Many smartwatches are implementing more sensors in their product. This enables developers

to develop applications, which enables users to operate the smartwatch by performing many types of gestures. These sensors enable the watch to sense when a user is tilting, shaking and rotating their forearm. The family expressed that gestures provided a fun and easy way of interacting with the device. Perhaps if I had developed Activi to be based even more on gestures, they would have had even more fun with the watch. Additionally, complaints about shoulder pain and small keyboards might have not been an issue.

Tangible and gesture-based interaction was also observed in one scenarios during the gonzo testing. This is an interaction style which is an intersection of the tangible and gesture-based interaction. An example is stylus pens which are commonly used on tablets and larger smartphones.[29] The observed scenario, was the father complained that his hands were too big for the screen. He then picked up an ordinary pen and used it to type in the title of a task. He was quite pleased that it worked and complained less about the screen. I do not find using this type of interaction style very fruitful for small screen. Based on my observations, other interaction styles in the lines of speech control, are more user friendly when operating smartwatches. Perhaps for some type of users tangible gesture-based interaction or touch interaction would be the only solution, for example for mute people.

Direct manipulation was observed when the family interacted with their 3D hologram. Here they used specific interaction styles to interact with it. These were pinching to zoom, grabbing to rotate and multi-touch. Even though this is a "science fiction" scenario, the interaction style they used to interact with it has some advantages. Direct manipulation is easy on the users retention, and presents a clear visualization of a concept. This makes it easier for users to learn and intrigues them to explore the functionality further.[30] During the my observations I noticed that the family became quite exited and creative when entering these "science fiction" scenarios.

Speech to text was frequently observed during the SPES sessions. It was used to send text messages and audio messages to each other. Further, voice control was used to tell the device to add item in a shopping list on the watch. These interaction styles are the ones which newer smartwatches are based on. Smartwatches which runs the new operating system Google Wear, has voice control and speech to text is one of the main interaction styles.[4] Based on my observations, this would be the most fruitful way of interacting with a smartwatch. It is quick and the user interacts less with the screen. The screen is mostly used for viewing information. This interaction style would enable the users to be engaged in other activities while operating the watch.

6.2.3 Behavior and Reactions Observed During SPES

In this section I discuss some observations I made concerning how the family was affected by using a smartwatch during their daily lives. More specifically how it affected the participant's behavior and reactions. Before every session with the family, we discussed their routines for that day. In addition, I personally got to observe how the family's routines and habits, especially how they interacted and related to their paper calendar. The paper calendar was where they wrote all of their events, tasks and reminders.

The dummy devices created a lot of excitement during the sessions. Together with the disturbances of the camera and two observers, the family might have felt the pressure to perform and be productive. When users feel pressured to express themselves behaviorally, their actions could become less natural. This is because some users can become more self aware. [14] Since this might have affected how they reacted in some scenarios, it was

difficult to know if their reactions were natural.

The family expressed excitement and justification when allocating tasks to each other. When the children were reminded of tasks which were due on their paper calendar, the parents was often met with avoidance, confrontation and hesitation. During SPES, the children mostly reacted by snoozing or declining the notification. In some cases they would also try to send the task back to the parents for reallocation, or tried to convince them that the task was performed. As a result the parents would confront them, and use the device to sent a small electrical shock as punishment. Further, they would decrease their points as apart of the reward system.

In Brandt et al.[14], a mention of a related research done Keith Johnstone, said that it is important to consider the status of the people who are interacting. By considering status among the participants, could prove to provide additional insight to design possibilities. It could give further insight to how an artifact could affect a high-low status relationship. Either it could disrupt, maintain or adjust the relationship statuses. Prior to the introduction of the actual smartwatches in the gonzo testing, the parents clearly had the high status, while the children had the low status in various degrees. However, after observing the family using the smartwatches, allocating and receiving tasks, the relationship seemed to have been affected. The parents still had the high status, but some of the children gained more status. This was because they took more responsibility when receiving a task, compared to how they previously responded. Their status was affected because the parents were pleasantly surprised by their attitude and how they followed through with their tasks, which helped the child gain more respect from their parents.

The SPES sessions lasted for about 2 hours. Around the second hour a decrease of enactments was observed. The family members were tired and started to retreat to their rooms, and taking off their dummy smartwatches. This was an additional confirmation that the family did not completely express their natural behavior during the session. Considering that they were not able to relax during the session, enacting scenarios and being creative became after a while, too strenuous for them.

6.3 Disparities Between a Family's Expectations and Experience

Through the last decades, technology has found its way in to the the family home and affected our habits and daily routines. But has this accumulation of technology been for the better or worse? Looking back, the family household was found place for washing machines, refrigerators and vacuum cleaners. These technologies aided the housewife in her every day routines. By using these devices, time was saved and tasks became easier to perform.[16]

After introducing the smartwatch in to the family home, how did the family's gained expectations from the SPES sessions, differ from their gained experiences with an actual smartwatch? Additionally, did the use of the application and smartwatch affect their behavior in any way? Considering the fact that people are different with different experiences, it is a discussion based on subjective experiences and observations of human behavior.

6.3.1 Differences Between Using a Dummy Smartwatch and Actual Smartwatch

When introducing the actual smartwatches and application, I wanted to explore if there were any distinctions between the use of a dummy smartwatch and a real smartwatch. More specifically, I wanted to see if there were any differences within the areas of use and interaction styles.

During the gonzo testing, I was the only observer. In addition to two cameras, I tried to collect all interaction the family performed with the watch. To observe as natural interactions and behavior as possible, I would have wanted to dilute the novelty aspect much more, than what I had time for. Leaving the smartwatches with the family for a couple of weeks, before performing the re-enactments. The family would then have had the possibility to get more familiar with the application and smartwatch. As a result, I could have observed more natural interaction and use of the smartwatch.

Interaction Styles

Similar interaction styles were observed when the users were utilizing the actual smartwatch and dummy device. Touch, swipe and tangible buttons gestures was frequently observed during SPES. Interestingly enough, only a few observations were made during SPES, where the users were using touch gestures. When the interaction was observed, not more than two or three touches was used to complete a scenario. This gave an early indication of that the users would not like to engage the screen for too long. Additionally, users only used the tangible buttons once or twice. A possible reason could have been, that users were not able to see to see the buttons under the "screen" of the dummy device. Therefore, they were somewhat forgotten. With the actual smartwatches, touch, swipe and tangible buttons, were how the users mostly interacted with the smartwatch. However, this was because of the limitations of the application. The application itself was based on touch and swipe gestures, and had clearly visible tangible buttons. Furthermore, very few applications have adopted hand gestures in their applications. My reasons for not implementing hand gestures is because it is quite difficult, especially if several hand gestures were to be implemented. Developing an application which can distinguish between different types of gestures, would be quite complicated.

An actively used interaction style observed during SPES, was speech to text and voice control. When engaging the smartwatch using these interactions, the family members would raise their hand towards the face, and speak to the dummy device. It was mostly used when they were replying and sending instant messages to each other and searching the web. The family expressed that this was the quickest way to engage the watch, which also added some fun. It was interesting to observe this interaction, considering that the newly launched Android operating system for smartwatches, Android Wear, uses this type of interaction as the main way of interacting with smartwatches.[4] Based on my observations, I can conclude that speech to text and voice control, is an intuitive way for users to interact with a smartwatch.

Similar to many smartphones, the smartwatches ran full Android, where the main menu was customized for smartwatches. However, this meant that most applications were fitted for a screen of the size of a smartphone. When users were using applications on the watch, there were often a lot of information displayed on the screen, which caused very small touch targets. As a result, when the user tried to navigate, their touches had to be

very precise or they would accidentally press other buttons. During the SPES session, it was implicit that the smartwatch would present the user with view-able information.

During development I had some concerns that the users would find the keyboard a hassle to use. Still, I decided to test it out. During the initial tests it proved to be very time consuming and not very user friendly. Further, in the re-enactment session the family spent a lot of time and expressed frustration when using the keyboard. During the re-enactments, one of the participants by his own initiative, adopted a tangible gesture-based interaction. Tangible gesture-based interaction is an interaction style, which is an intersection between tangible button and gesture-based interaction.[23] The participant took a normal pen, and used it to operate the keyboard on the smartwatch. However, I do not believe that this type of interaction is suited for smartwatches. The scenario occurred as a result of the users being frustrated. Frustrated because he was not able to type correctly when using the keyboard.

One of the actual smartwatchwes, Omate Truesmart, had implemented a standard swipe gesture. Depending on which direction you swiped, either a menu or back button function was enabled. An application called Shaker was used during the gonzo tests, where the user could initiate Activi by performing a shake gesture with their wrist. Gestures was something that the family really enjoyed using. During the debriefings, they thought it provided a quick way of interaction, and would have liked to have seen more gesture based interaction in the application. Based on my observation, the family enjoyed how easily accessible the smartwatch was. Further, when using gestures to interact with it, increased that experience, additionally brought more fun into the whole aspect.

Behavior, Routines and Habits

During the re-enactment sessions, I observed that the users reaction when receiving a notification, was almost identical to when they received notifications on their smartphone. When an incoming notification was received on the smartphone, they would immediately check it, and reply if the notification demanded it. The conversation would pause for a short while, then resume. Similarly, when receiving notification on their smartwatches they would instantly check it and stop what they were doing, or shortly leaving a conversation. Additionally, they became a little surprised when receiving notifications on the smartwatch. This was most likely because of the unfamiliar vibrations from the watch.

During the enactments and re-enactments, the family members would very often share files or tasks. However, then using the actual smartwatches, they would ask if the recipient had received the item. This behavior might have occurred because the smartwatch was still a new technology for them. Perhaps if the family had used the watches and application daily, there would be no novelty feelings towards the watch and application. They would have grown to trust the technology more, which might have helped to dilute, perhaps remove the novelty aspects.

There were many scenarios which could not be re-enacted in the gonzo testing. Basically, because of the lack of supporting applications in the smartwatch, and smart objects in the environment. However, some scenarios were re-enacted, where interesting differences were observed. Receiving tasks was one of the most interesting difference between using the dummy smartwatch and actual smartwatch. During SPES, when the parents allocated a task to their children, they were met with avoidance, confrontation and hesitation. During the re-enactments, when receiving a notification they chose to either snooze the task for a little while, or send an instant message back to the task creator, that the

task was being performed. When the task was done, a picture was sent as proof back to the parents. In most of these scenarios, the parents were met with less confrontation from their children, as opposed to what was observed during SPES.

Based on my observations and debriefings, using the smartwatch for task allocation, seemed to make the children more responsible and willing to accept their tasks as they were reminded of them. The children felt that they had more control over their tasks and when they were due. Additionally, they were enjoying that their mother did not have to personally come in to their room and nag about them having to do their chores. Instead, the application would remind them, and they could send instant messages to their mother, to ensure her that they were going to do it. During the sessions, the children took more control over their allocated tasks, and were the one who initiated communication with the parents regarding tasks, normally it was the other way around.

With the smartwatch, the need for social interaction when distributing tasks, were not needed. Additionally, it provided reminders which could be snoozed, which relieved the parents of the habit to repeatedly having to remind the children of their tasks. Being that the children within the family were teenager, they most likely enjoyed their privacy a lot. By introducing the smartwatch, provided an opportunity for parents to distribute tasks and task reminders, without having to physically confront the children to do something. With the smartwatch the children did not have to be confronted. In my observations, confrontation mostly lead to defiant behavior. When using Activi, they could receive and handle tasks when they were alone, in the space of their own comfort. This might have been the reason for the positive behavior I observed during the re-enactments.

From Wireframes to Interactive Prototype

When I started developing the application, I spent a lot of time going over the observed functionalities from SPES, and the results obtained during the wireframe tests. While structuring the interface and implementing functionalities, it became clear that some of the functionalities created in the wireframes, would become complicated to realize. Being new to Android development and having limited time, some features were left out or implemented in a different way, during the prototype development.

In the initial wireframes, there was a feature which allowed the user to check off completed tasks. This was not added in the actual prototype. Instead, the user was able to delete tasks, which would be the indications of that a task had been completed. When a user had completed a task, and deleted it from the application, the task would also be removed from their Google Calendar. If the original task was created by an other user, the creator was able to view who had deleted the task. This way the creator was able to see who supposedly had completed a task, and could now physically check if it was actually done. As expressed during SPES, a physical check would be performed regardless.

During the initial enactments, the family was observed creating tasks, allocating tasks, getting reminders and snoozing them. Since the family was already using a paper calendar to organize events and tasks, I chose to use Google Calendar as the place to add tasks and events. Normally, they would have to ask someone at home, or go home to check the paper calendar to see if they had any tasks that day. By using Google calendar with my application, the family could easily check their tasks, get reminders and snooze them when they were due. All of which were features which were observed during SPES. Organizing to pick-up children from school, could easily be done, if the children created events in Activi the parents would receive a notification of the event. That is why using Google

Calendar presented as a good solution for event organization.

The application ended up possessing most of the significant features of the service, in-application and by using the Google Calendar application. These features were creating, editing, deleting, allocating, repeating, get reminders and notifications, and sharing tasks and events. By using Google Calendar, allowed the tasks to be synced to all of their other devices where their Google Calendar could be reached. This was also an emphasized point made during the SPES sessions. Further, it enabled the family to re-allocate and edit existing tasks.

One of some features which were not added, was the ability to pause and resume created tasks. Instead, tasks created and repeated in the interactive prototype, needed to be recreated every year by default. Adding members to groups was an other feature which was left out of the prototype. Moreover, the option to request confirmation and view proof of completed tasks, was not implemented in the application itself. Instead, I encouraged the users to share photos or videos through Bluetooth or an other application, called Shoutr. Shoutr proved to be a very intuitive file sharing application. Further, it also presented an easy way to share calendar events.

When developing the interactive prototype, I wanted the users to be able to quickly access and view information. By using larger fonts and good spacing between elements. Further, by implementing a flat structure in the application, and presenting the main information first.

6.3.2 Family's Reflections

In my last meeting with the family, we sat down to view video from the SPES and gonzo test sessions. The videos showed contained scenarios which were observed in both tests. By showing them the footage, I wanted to document their reactions to their own enactments. Additionally, to gather their thought about their own solutions and interactions. They were presented with four scenarios; answering a phone call, sharing a picture, postponing/declining a task and receiving a task notification.

After the videos the family was left with a mixture of impressions. They realized that some of their solutions with the dummy smartwatch was funny, however in practice would be inefficient. On the other hand, they were pleasantly surprised of how similar their reactions were, e.g. answering a phone call. Further, the parents were surprised by the fact how different some of their children reacted when given a task. The children expressed that they felt a small increase of responsibility, because their parents was no longer checking up on them.

When it came to using the smartwatch itself, the family thought that aspects which required longer interaction, were less likely to be used. An example given, was surfing the web. Considering the size of the screen, they concluded that they would probably use other devices for such activities. However, they were quite excited about using the watch for file sharing, instant messaging and phone calls. Especially the mother expressed that she would use the watch a lot for phone calls. This way she did not have to carry a device around. Further, they envisioned that they would use the watch when needing to quickly access information when on the move.

Long interaction with the watch quickly became uncomfortable, mostly because of the necessity to use the keyboard in many scenarios. The family might have had a different experience if they had used the newer smartwatches which uses voice control and speech

to text. With the newer smartwatches the family would also have been presented with a better layout of information, in the applications on the watch.

In relation to Activi, they envisioned that they would use the application for handling their events and tasks. Although, the parents mentioned that they would have wanted to be able to create tasks on their laptop computer aswell, and mostly use the smartwatch for notifications and reminders. However, adding tasks using the smartwatch would still be practical for sudden occurring tasks or events.

Chapter 7

Conclusion and Future Work

7.1 Conclusion

In my research I explored what distinctions there were between a family's expectations and experiences when using a smartwatch. Further, which differences could be observed in relation to areas of use and ways of interaction. Additionally, how these experiences affected their daily lives, in relation to behavior and routines.

The basis for my research was a participatory inspired design technique called Situated and Participative Enactment of Scenarios (SPES), which I adopted to explore and help me answer my research questions. When adopting SPES, I also explored the aspects of the method itself.

The idea and development of smartwatches has long existed, but never been developed, introduced and marketed to consumers in this magnitude before. This made me interested to see whether or not the use of smartwatches in family homes, could affect their behavior and routines. Further, how a family would implement the technology in their home.

SPES was successful in enabling enactment of scenarios among the family members. Using dummy smartwatches, increased the users interest towards the technique and their sense of immersion. By posing scenarios and creating endowments for their watches, enabled the participants to continue their enactments and provided scenarios which were within "plausible fiction", instead of "science fiction".

Unknown observers and floor-placed cameras were disturbances, which made it difficult for some family members to relax and and be themselves during the SPES sessions. Encouraging a combination of bodily expression and verbal expression, made some participant self aware, which resulted in less enactment and more brainstorming.

When performing the SPES technique with a family, I suggest to have several shorter sessions. Each session should not exceed two/ three hours. Further, place many small cameras out of sight, in e.g. below the ceiling, in all of the main rooms. Be the only observer and set a side time, prior to the session, to give the family a change to get to know you as a person. Additionally, make sure that nothing in relation to the used equipment, is inhibiting the family from moving freely inside their home.

The smartwatch poses several areas of use within the family home. SPES revealed that the most attractive areas of use were services within the categories of communication and sharing, reminders and notifications, organization and remote control. I found that the family's experiences did in many ways meet their expectations in relation to the area of services. Considering that the smartwatch is a wearable device, it enabled the family to

quickly access information, receive notifications, reminders, share and communicate with each other.

Many of the utilization ares mentioned above, were coherent with what the family also used their smartphones for. This means that the smartwatch would be successful in replacing the smartphone. However, there are some aspect concerning the smartwatch which needs to be addressed and altered before a replacement could be realized. Since the family used smartwatches with operating systems developed for smartphones, the screen in many situations became an issue. Most applications were not developed for such a small screen, apart from Activi. As a result the keyboard was the most frustrating aspect of using the smartwatch.

Furthermore, the smartwatch proved to be an ideal device for interacting with a smart environment. The family in several situations, interacted with and controlled objects in their home during the SPES sessions. Depending on the future development of smart objects, the smartwatch could facilitate user interaction with a smart environment.

When it came to interaction styles, there were several coherence's between the family's experience and expectations. These were interactions like touch, button press, gestures and swipe. However, there was one interaction style which the family frequently used during SPES, which was not observed during the re-enactments. Namely, speech to text and voice control. For the family, it provided an easy way of interacting with the smartwatch, because they did not need to engage the small screen for longer periods of time. As a result, I found that the smartwatch would not be ideal for services with possibly time consuming features.

A smartwatch operating system and applications, should facilitate quick and seamless interaction with the smartwatch. Furthermore, any interaction should be kept to a minimum. This especially concern interaction where users have to physically engage the screen. Having the users interact with the screen for a long period of time, might cause user discomfort and in some cases some can experience pain, because of the posture. Furthermore, the users will become inpatient, will will decrease their interest in the application.

A good interaction style for a smartwatch would be voice activation and control. This poses a solution which would relieve the users of having to use the keyboard on their smartwatches. Additionally, the users would not have to engage in the screen quite as often.

Looking back through the decades, we can see that bringing technology into our family homes has affected our behavior in our daily lives. Technologies like the vacuum cleaner, refrigerator, washing machines, radio, television and personal computer, have in their own way lessened and streamlined ordinary household tasks, and affected our priorities for better or worse.

My chosen service was within the organization and notification category. Activi was successful in streamlining one aspect of family's daily lives. With Activi the family was able to organize, access and allocate tasks and events more efficiently than their previous solution. Furthermore, it contributed to an alternation of their habits and almost removing a certain behavior. Receiving and looking up tasks was no longer met with confrontation or hesitation. Additionally, relieving the family members of having to remind and check up on each other, removed a time consuming habit.

During the last meeting with the family I was able to gather their reflections, concerning their actions during the enactments and re-enactments. The family was surprised of the similarities in their enactments, how displayed aspects corresponded with available

services and interaction styles on the actual smartwatch. However, they became aware that even though some of their solutions might have been fun, they would have been unpractical to perform in real life.

Based on my observations and their reflections during this last session, I concluded that we cannot always predict how we are going to use technology, before we actually incorporate it into our daily lives. Even then our immediate solutions could prove to be unpractical or inefficient. Solutions might not necessarily fit our daily routines or needs, instead it can become something to pass time. However, they can still reveal technology implementations which users find triggering, intriguing and which appeals to their playfulness. These are aspects worth considering when developing new artifacts and services.

For as long as technology continue to develop, and being brought into the family home, it will affect routines and habit in people's daily lives. For better or worse. Whether is freeing up time or consuming it. It may alter or remove aspects in behavior and habits, even affect priorities.

7.2 Future Work

Starting with the development of the interactive prototype, I was eager to learn about Android application development. I decided to implement Google Calendar in my application, so that when tasks were created they would also be added as an event in the calendar. By using Google Calendar in my application, I gained features like task editing, reallocation of tasks, reminders and enabling the users to manage tasks on multiple devices where Google Calendar was accessible. Initially, I wanted features like task editing and reallocation, to be in-application features. However, due to limited time I ended up using the Google Calendar application for this.

For future development, I would want to implement the features mentioned above in-application, to give the user a sense of a more whole and complete application. Further, I would have added a way to undo the deletion of a task. The delete feature, was intended for tasks that were completed or incorrectly created. If the task was created by an other person, and deleted by an other user, the task had to be reallocated to the user if the task was actually incomplete. A good solution would have been to implement a two-way confirmation for task completion. When one user marked a task as complete, it could then be physically checked, then marked as complete by the task creator, which could then delete the task.

When implementing Google Calendar in my application, it resulted in some unwanted aspects in the application. When repetitive tasks were created in Activi, the users which were allocated to the task, needed to alternate on the different days. In example, if a task was set to be repeated every day for a week, and had two allocated users, one user would have get the task on even dates and the other on odd dates. Additionally, they would not receive or see each others tasks, only their own. The only way to implement this feature with Google Calendar, was to create all the repeating tasks as their own stand-alone event. When the repetitive event was created as a single event, then the users could be allocated. This is an aspect which would have to be changed if the application was going to be used further by the family. Seeing that they would have to manually delete each and every task from the calendar. If the task was set to repeat every day, they would have to delete one task in each day, for a whole year.

Lastly, using the keyboard was both frustrating and a time consuming aspect. Most of the task titles and the content of the instant messages they sent between each other, contained spelling mistakes. They spent so much time trying to type correctly, that the application made them in some scenarios less efficient. For future development, I would not implement the need for users to use a keyboard.

Android has developed an API called Android Wear, which is a customized operating system for smartwatches. If my research had been performed a bit later, I would have used this API, when developing the prototype. It facilitates the smartwatch's small screen and enables quick interactions. Also, it does not rely on the keyboard to input information. Instead it uses speech to text to handle all text inputs. The interaction styles which the Android Wear API presents, facilitates a lot of the interaction styles observed in the SPES scenarios. It eliminates the need for typing in applications, which in the low budget test and gonzo test proved the most frustrating aspect of the whole application. Additionally, the new API displays little information on each screen with large touch targets. This would enable users with big hands, like the family father, to have quick interactions aswell.

All of these imperfections in the application, have most likely affected my results during the prototype's low budget test and gonzo test. Aiming for efficiency, some of these aspects like not having in-application editing, and making the users have to use the keyboard, caused inefficiency, some confusion and frustration among the users. These are all important aspects which I would address in the future development of Activi.

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Appendix A

Low Budget Test Tasks

A.1 Abbreviations and explanations

Below is a list of explanations of the abbreviations used in the test task form.

- Req's: Requirements (Tools needed to complete the test)
- SCC: Success Complete Criteria
- MTC: Maximum Time Criteria

A.2 Wireframe Test Tasks

Task No.	Task Description	Task Detail
1	Create new task	Req's: Wireframes SCC: The participant creates a new task within the allotted time MTC: 50 sec
2	View the task you just created	Req's: Wireframes SCC: The participant view the newly created task within the allotted time MTC: 10 sec
3	Find upcoming tasks	Req's: Wireframes SCC: The participant finds the upcoming tasks within the allotted time MTC: 20 sec
4	How many list are there	Req's: Wireframes SCC: The participant is able to say how many lists there are within the allotted time MTC: 20 sec

5	View all of your active tasks which you have created	Req's: Wireframes SCC: The participants finds the complete list of the participants own created tasks within the allotted time MTC: 15 sec
6	Pause one of your active tasks	Req's: Wireframes SCC: The participant pauses one of the active tasks within the allotted time MTC: 20 sec
7	"Clean kitchen" task is completed, view picture proof	Req's: Wireframes SCC: The participant finds the tasks and is able to view the proof of a completed task within the allotted time. MTC: 30 sec
8	Delete one of your paused tasks	Req's: Wireframes SCC: The participant deletes one of the paused tasks within the allotted time MTC: 20 sec
9	You have cleaned your room today, confirm that your task is complete	Req's: Wireframes SCC: The participant checks off the checkbox within the allotted time MTC: 20 sec
10	Who are you able to share tasks with	Req's: Wireframes SCC: The participant view the amount of members within the allotted time MTC: 20 sec
11	Add a new group	Req's: Wireframes SCC: The participant creates a new group within the allotted time MTC: 25 sec
12	View the upcoming tasks for March	Req's: Wireframes SCC: The participant views the upcoming tasks for March within the allotted time MTC: 20 sec
13	How many tasks are within the kitchen list	Req's: Wireframes

		SCC: The participant says how many tasks are in the kitchen list within the allotted time MTC: 25 sec

A.3 Prototype Tasks

Task No.	Task Description	Task Detail
1	Create new task called "Tidy room", from tomorrow, repeat every month, allocate to me	Req's: Prototype on smartwatch or smartphone SCC: The participant creates the task within the allotted time MTC: 1 min
2	I don't want to tidy room tomorrow, delete that event	Req's: Prototype on smartwatch or smartphone SCC: The participant deletes the "Tidy room" event for tomorrow within the allotted time MTC: 15 sec
3	Add me as a new member	Req's: Prototype on smartwatch or smartphone SCC: The participants adds me as a member within the allotted time MTC: 1 min
4	View the upcoming tasks	Req's: Prototype on smartwatch or smartphone SCC: The participant views the upcoming tasks within the allotted time MTC: 10 sec
5	Assign a task to me called "Clean room"	Req's: Prototype on smartwatch or smartphone SCC: The participants created the task and allocates it to me within the allotted time MTC: 1 min
6	Delete me from the list of members	Req's: Prototype on smartwatch or smartphone SCC: The participant deletes me from the people list within the allotted time MTC: 15 sec

7	You are also going to attend "Clean room", put yourself as "attending"	Req's: Prototype on smartwatch or smartphone SCC: The participant edits the already created task and put themselves as "attending" within the allotted time. MTC: 30 sec
8	Delete the "Clean room" task	Req's: Prototype on smartwatch or smartphone SCC: The participant deletes the right task within the allotted time MTC: 15 sec
9	How many calendars are you able to add tasks to	Req's: Prototype on smartwatch or smartphone SCC: The participant checks and replies with the right number of calendars within the allotted time MTC: 15 sec
10	Create a new task called "Remember milk"	Req's: Prototype on smartwatch or smartphone SCC: The participant creates the task within the allotted time MTC: 1 min
11	Don't have time to buy milk, share the event with someone else	Req's: Prototype on smartwatch or smartphone SCC: The participant share the event within the allotted time MTC: 40 sec

Appendix B

Activi Requirement Specification

B.1 Introduction

Activi requirement specification describes the requirements for the Activi application. Activi is an application which enables an user to create, distribute and manage tasks among other selected users. The application is developed to be run on an Android smart watch. However, the application is fully functional installed on other Android devices, as long as the device minimum runs Android 4.0.

B.1.1 Scope

Activi provides an efficient way of creating, distributing and managing tasks within a family household. The service is run on a smart watch which each family member wears. Keeping track of and reminding family members of house tasks can be time consuming. The service provides automatic reminders and rotation of tasks. The application enables an easy and seamless way of creating tasks, and dividing them on different family members. Activi also provides a task confirmation option, which allows the task owner to request proof upon task completion, in form of video or photo. Furthermore, if a family member is occupied or unable to complete a task at the time, the task can easily be snoozed or request that the task is passed on the the next member of the task.

The main objective with Activi is to reduce the time family members spends on notifying, reminding and checking that task within the home are done. By running the application on smart watches, it is possible to provide non disturbing notifications and a more seamless interaction.

The application needs internet to both display and fetch tasks. Integration with Google Calendars enabled the users to view, create and edit their tasks on other devices apart from the smart watch. This was a feature which was also expressed by the user. Being able to manage task on a bigger screens, would be more comfortable when creating several tasks at a time. Through the application the user are able to view the tasks due date and which additional users are involved.

B.1.2 Definitions, Acronyms and Abbreviations

User: Someone who interacts with the application.

Task Owner: A user who has created and distributed a task among other users.

Task Assignee: A user who has been assigned a task from another user who uses the application.

API level: Android API level points to which version a device is using of the Android operating system.

Activi: The given name of the application.

B.2 Overall Description

This section provides an overall and detailed description of the application and its features. Further explanations are given concerning how and which systems the application is interacting with, and other systems which it is dependent on.

B.2.1 Product Features

Activi implements several features, building on top of the possibilities which the Google Calendar API provide. With Activi you can;

Create a task. Users may create a new task and configure it based on the following parameters; assign to member/group, task intervals, notification option, snooze option and task completion proof option.

View active tasks. As tasks are created and assigned to different family members, they will appear in an organized list ranging with the most present due date and descending. Here the user is able to confirm when a task has been completed.

Manage own tasks. Tasks that the user has created will be displayed in its own list. Here the task can be edited, deleted and proof of task completion can be viewed.

Manage people. Users can add and remove people from their members list. The group option makes it easier and faster to assign one task to several members.

Open Google Calendar. From the application users can open Google Calendar to perform even more modifications to their tasks and events.

B.2.2 Implementation

The application requires the user to be logged on with a Gmail account on their device. Activi is based on Google Calendar in the sense that when tasks are created, they are added as an event on the users Google Calendar. When viewing upcoming task in Activi, the application queries all events from current moment and forward, from the calendars that are synced with the users device. Users are able to delete events within Activi, doing so will also remove the event from the users Google Calendar.

For testing purposes I created Gmail accounts for every family member. This way they were able to add each other to tasks within Activi. Furthermore, I install various applications to aid sharing between the smartwatches mush easier. Shoutr was an application

used to share events and media. Additionally, every smartwatch was connected to each other by Bluetooth. This way the family had several ways of sharing content with each other.

Appendix C

Activi Source Code

Activi's source code is located on disc.