

*Master Thesis*

# Communicating beyond the word - designing a wearable computing device for Generation Z

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*Division of Ergonomics and Aerosol Technology*

*Department of Design Sciences*

*Faculty of Engineering LTH • Lund University • 2014*



**LUND UNIVERSITY**

**SONY**



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## Acknowledgements

We would like to thank our supervisors, David de León at Sony Mobile Communication AB and Mattias Wallergård at Lunds University, for their help and guidance during the process. We have appreciated all knowledge and thoughts they have shared with us. We would also like to thank Staffan Hjort, Günter Alce and Klas Hermodsson at Sony Mobile Communications AB for their valuable inputs and cheerfulness.

During the process, we have appreciated all support and help from Björn Svensson and his school class, it has been a pleasure to work with all of you.

Last but not least, a warm thank to Gustav Nord and Marcus Malmberg for all of their support during the process and for finding some of our misspellings.

Lund, June 2014

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## **Abstract**

Humans have always communicated with each other. When the smartphone technology was launched on the market, it revolutionized the way people communicate. This smartphone technology is constantly evolving and during 2014 wearable computing seems to be in the focal point at most smartphone technology conferences.

This master thesis aims to discover how a wearable computing device can further develop the communication between people with focus on communication beyond using words. Generation Z was chosen as a focus group. Their communication patterns, behavior and needs were the central parts for this thesis.

A concept with a Low-Fidelity prototype was developed to visualize how a wearable computing device can be designed to take the communication beyond using only words. This concept and its design were developed using features of participatory design with help from possible end-users. Additionally, a usability evaluation on the final prototype was carried out.

Three essential characteristics of the concept have been identified during the work process; beyond using words, predetermined message and spontaneous and easy. All three characteristics together make the concept well suitable for a wearable computing device since it takes the user's interaction and communication behavior to a new level.

### **Keywords:**

Wearable Computing, implicit Human-Computer Interaction, Participatory Design, Communication behaviors, Generation Z.





## Sammanfattning

Människor har genom alla tider kommunicerat med varandra. När smartphone teknologin lanserades revolutionerade det sättet som människor kommunicerar på. Tekniken utvecklas ständigt och år 2014 fokuseras det på wearable computing under teknikmässor runt om i världen.

Detta examensarbete behandlar hur kommunikationen mellan människor kan utvecklas med hjälp av wearable computing för att få kommunikationen att bli bortom användandet av ord. Generation Z användes som fokusgrupp för arbetet, där deras kommunikationsvanor samt beteende- och behovsmönster utgjorde centrala delar i arbetet.

En pappersprototyp utvecklades för att visualisera ett koncept gällande hur en wearable computing-enhet kan designas för att målgruppen ska kommunicera bortom ordet. Konceptet och dess prototyp togs fram med inslag av deltagande design med hjälp av de tänkta slutanvändarna. Prototypen har även användbarhetstestats på samma målgrupp.

Uppsatsen resulterade i att tre egenskaper för konceptet identifierades; bortom användandet av ordet, förutbestämt meddelande samt spontant och enkelt. Dessa tre egenskaper medför att konceptet är väl anpassat för en wearable computing-enhet och tar användarens interaktion samt kommunikationsbeteende till en ny nivå.



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# 1 Introduction

*Present cell phone technology devices are developing fast and it can be difficult for any person to keep up with the pace. There is also a big difference in how easy it is to understand a new device depending on which generation a person belongs to. Persons born after 1990, primarily those belonging to Generation Z, are used to have a cell phone with them all times and it is seen as a natural device to communicate with. Because of this, communication patterns and habits have changed between earlier generations and people born after 1990.*

*About five years ago, the smartphone was introduced on the market. The smartphone revolutionized people's ways to communicate, one reason was having Internet carried around in the pocket. On today's market, a new technology is becoming popular among the large cell phone developers and other companies within the cell phone industry. This new technology is named wearable computing, for short wearables, as the user wears it on the body. This chapter will give an introduction to the purpose and goal, scope and definitions.*

## 1.1 Background

This master thesis aimed to investigate how teenagers communicate, especially when using cell phone technology. It will also investigate Generation Z's patterns of behavior and needs regarding their present communication through a cell phone and how this can be desirable in a wearable computing device. Because of the large development in communication devices in the past five years, this thesis looked at how it can be developed further for use during the upcoming years.

Due to this huge development it is hard to say what the future will bring, but it has become more common for cell phones and other technologies to keep track of the user and her context. Therefore implicit Human-Computer Interaction (iHCI) was taken in consideration when developing the concept.

## 1.2 Purpose

The thesis' purpose was to examine Generation Z's needs and behavior patterns when communicating and to take this beyond using only words. Therefore, the thesis focused on not having text as a central part of a message.

### 1.2.1 Goal

The goal was to apply the purpose by developing a concept that can be used in a wearable computing device. A prototype was developed to display the concept and how a potential user interface can look like. By developing a Low-Fidelity prototype (Lo-Fi prototype), the reader can easily understand the different ideas and the concept that was created. The usability and interaction design of the prototype were tested by an eighth grade school class in Lund.

Different subjects were deeper investigated to reach the goal and purpose, which are given below.

- Generation Z and their pattern of behavior and needs within communication.
- How children can take on the role as design partner and test persons.
- How wearable computing can be used to enhance communication.
- iHCI and how it can be applied within the concept.
- How communication can be taken beyond using words.
- How the communication has changed during the last five years.
- Usability and interaction design.

### 1.3 Scope

A Low-Fidelity prototype (Lo-Fi prototype) was created to visualize the ideas and the concept for a wearable computing device. Time was a limiting factor and therefore the prototype was only created as a Lo-Fi prototype. Since there are no tools on the market focusing on wearable prototyping, this together with the limited time, the decision on using a Lo-Fi prototype felt natural. Developing this prototype, all functionalities were not completely developed and the focus was on the user interface and the concept as a whole. Potential end-users were a part of the design process by designing, testing and evaluating the prototype. The optimal location of the device on the body was investigated during the design process. The main objective for the thesis was how the communication could be performed beyond using words.

Meeting with the pupils during the design and evaluation sessions, a limiting factor was the amount of pupils the school could release for the sessions, which may have had an effect on the testing validity.

### 1.4 Definitions, Acronyms and Abbreviations

<i>Generation Z</i>	People born between the mid 1990's and the early 2000's.
<i>iHCI</i>	implicit Human Computer Interaction, a system with great knowledge of its user and her behavior in a context.
<i>Lo-Fi prototype</i>	Low-Fidelity prototype, a prototype implemented often with the help of paper and pen.
<i>PD</i>	Participatory design, an approach where the intended end-users and designers work together in the design process.
<i>Wearable computing</i>	A computing device worn on the body.



## 2 Theoretical Background

*The purpose of this chapter is to give the reader a better understanding of the area discussed in this master thesis. Theory will be presented.*

### 2.1 Wearable Computing

#### 2.1.1 Definition of Wearable Computing

According to Mann, wearable computing can be defined as "*the study or practice of inventing, designing, building, or using miniature body-borne computational and sensory devices*" [1]. This implies that the main difference between a wearable computer and a desktop computer or a pocket computer is that it can be worn. The device will always be on and running [2]. According to Bass, a wearable computing device can be defined as [3]:

- It may be used while the wearer is in motion.
- It may be used while one or both hands are free, or occupied with other tasks.
- It exists within the corporeal envelope of the user, i.e., it should be not merely attached to the body but becomes an integral part of the person's clothing.
- It must allow the user to maintain control.
- It must exhibit constancy, in the sense that it should be constantly available.

With computers that can be worn on a person's body, wearable computing reaches a new dimension of ubiquitous computing. Weiser defines ubiquitous computing as a concept that allows a person to interact with many computers at the same time. These are communicating to each other wirelessly and are invisible and embedded in the environment. Therefore, it can be inferred that the significant difference between wearable computing and ubiquitous computing is that the latter implies computational and sensory devices which are not on the person. With ubiquitous computing, the devices are contained within the environment [4]. A wearable computing device is always with its user, which has the possibility to enter and execute commands whenever she wants. Mann describes wearable computing deeper with three operational modes and six attributes that are seen as fundamental [2], which will be described in section 2.1.3.

### 2.1.2 History of Wearable Computing

The first known wearable computing device was presented by Thorp and Shannon in 1966. The device was a tool with the purpose to manually change the speed of a roulette wheel, i.e. it was not possible for the user to program it during use. It was invented already in 1961 but Thorp first mentioned it in one of his publications in 1966 [5].

The modern concept of wearable computing devices was developed by computer inventors belonging to the Wearable Computing Project by the MIT Media Lab. Mann, often referred to the father of wearable computing, started to design wearable computer systems in the end of the 1970s. In 1981 he built and designed a wearable computer system with a head-mounted display that was visible to one eye. The system could handle one-handed input and the user was provided with text, audio and video. In 1994 he built a "Wearable Wireless Webcam" that he connected to his wearable computing device. Thereafter he streamed live video from his device which was available on his website [6].

In recent years, wearable computers have emerged as the new trend. At the Consumer Electronics Show, the biggest convention for gadgets and home electronics in the world, which occurred in the beginning of 2014, a wide spectrum of wearable computers were presented. Most of the devices presented on the convention had its focus on fitness and health. But upcoming products also contain a more overall life-logging functionality for the user [7].

### 2.1.3 Three Operational Modes and Six Attributes

Mann defines wearable computing with three operational modes and six attributes. The operational modes are constancy, augmentation and mediation [2].

Constancy implies that the computer is always ready for interaction with the user, it does not have to be turned on or opened to use. A constant user interface will be provided since the computer runs continuously [2].

The second mode is augmentation. Within wearable computing, compared to traditional computing paradigms, the computing is not the primary task. The user is assumed to not only use the wearable computer device, she will probably also perform other activities at the same time she uses the device. Therefore the computer will be used to enhance the intellect or the senses of the user [2].

The last mode, mediation, implies that a wearable computer does not enclose the user completely, instead it encapsulate her on a higher degree than traditional portable computers. The user can leave the enclosed space with meditation, by blocking or modifying information [2].

Furthermore, Mann defines six attributes of wearable computing from the human's point of view [2]:

1. *Unmonopolizing* of the user's attention  
In comparison with virtual reality game or the like, a wearable computer do not forces the user to only perform one task at a time. The user is able to shift her attention between several things at once, which imply that computing is not the primary task for the user.
2. *Unrestrictive* to the user  
With a wearable computer, the user becomes very mobile and can for example type texts while jogging. The interaction for the user is more instant.
3. *Observable* by the user  
The wearer of the computer can constantly perceive the output medium. Since the interaction is more instant for the user, the wearable computer is almost continuously observable.
4. *Controllable* by the user  
A wearable computer is responsive, which makes it possible for the user to control it at any time.
5. *Attentive* to the environment  
Since the wearable computer is environmentally aware, it enhances the situational awareness of the user.
6. *Communicative* to others  
The interaction with the wearable computer is instant, therefore it is to be used for communication whenever the user wants to.

#### 2.1.4 Social Acceptance

Wearable computing devices and mobile devices have changed the way how users interact with them and what services can be used. According to Profita et al. the social influences currently has a large impact on the acceptance of new technologies. Social acceptance of the wearable technology is important for users in order to adopt to technology. The social acceptability is seen as culture- and time-dependent, affecting the attitude for new technology. At the beginning the attitude can appear as harsh, but with continuous technology exposure the overall acceptance will increase over time [8].

According to Buenaflor and Kim, there are six human factors needed for acceptance of wearable computers [9]:

1. *Fundamental needs*  
Buenaflor and Kim see that the users of wearable computers are strongly attracted to functions concerning health. These functions satisfy the basic

needs of the human, i.e. the physiological and safety needs in Abraham Maslow's hierarchy of needs.

### 2. *Cognitive attitude*

As Profita et al. mentioned, the users' perception of new technology affects their acceptance and adoption towards it [8]. Buenaflor and Kim describe in their article a Technology Acceptance Model developed by Vankatesh and Davis, which explains how a user will adopt and eventually accept new technology. Within this model, there are two perceptions that affect the purpose to use new technology, perceived ease of use and perceived usefulness. The first perception concerns how a user perceives a system that would demand a small amount of physical and mental effort. This perception also includes the degree of complication and difficulty the user feel when using the system. If the user perceives the system as difficult to use, she will become worried about using it more and her confidence will become lower. The second, perceived usefulness, involves the degree a user believe their performance of a task will be enhanced by a certain system. It is also about the degree the user believes the device will be a practical and efficient tool to use for solving existing problems.

### 3. *Social aspects*

There are factors that are related to the interaction and relationship between humans, which might affect the acceptance behavior. Personal privacy is today very important for people. Many are careful about what information they share about themselves due to the potential harm it might cause in a social sense. Therefore it is an important aspect to have in consideration regarding the acceptability of a wearable computer. Culture is also an important social factor affecting the behavior and decisions of people.

### 4. *Physical aspects*

The acceptance of the wearer will be influenced of the wearable computer's physical effect. It is important to have physical comfort and safety in consideration when designing and building a wearable computer. This will determine the wearability and portability of the device. For people to accept a wearable device, it is essential that its weight and size are minimal. The acceptance level will be low if the device is not comfortable. The aesthetic and appearance is also important when designing a wearable device. Since people are mobile, a wearable computer will enhance the acceptance among the users since it is almost always with its wearer.

### 5. *Demographic characteristics*

There are two demographic characteristics which Buenaflor and Kim focus on in their article, age and gender. Age effects if the wearer see a wearable computer and its functions as useful and usable. Gender is also essential to have in consideration. Men and women accept technology differently, mainly

since they care about different functions and attributes of the wearable device. This will affect how they will adopt to the new technology.

6. *Technical experience*

A user's technical experience will have a significant effect on how they will accept a wearable computer. People with more technical experience tend to feel more confident and are more willing to try and use new technology.

Buenaflor and Kim state in their article the importance of identifying the target users and the nature of their context. The influence the above factors have, will affect the target users' attitude and behavior towards accepting new technology such as wearable computers. The authors also see a relationship between technical experience and age, since young people easier adopt and accept new technology than older adults. The younger generations are today more exposed to different kind of applications of technology, which affects their learning, adoption and usage of wearable computers [9].

## 2.2 Human-Computer Interaction

According to Hewett et al. [10], Human-Computer Interaction is defined as

*“Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them.”*

Human-Computer Interaction is seen as an example of cognitive engineering and can be divided into two perspectives, explicit and implicit [11]. The first refers to actions performed by the user which will make a computer act as she expects [12]. The latter will be further described below.

### 2.2.1 Implicit Human-Computer Interaction

Implicit Human-Computer Interaction (iHCI) is defined as *“...an action, performed by the user that is not primarily aimed to interact with a computerized system but which such a system understands as input.”* [12]. This implies that the computer has a greater understanding of its user and her behavior in a context. According to Schmidt, iHCI can be seen as a complement to explicit Human-Computer Interaction since it additional input is added to a computer while it is already performing tasks [12]. The explicit interaction by a user and her control is reduced by iHCI [11].

Schmidt describes three “building blocks” which are identified as the base for using iHCI [12]:

1. The ability to have a perception of the usage, the environment, and the circumstances.
2. Mechanisms to understand what the sensors see, hear and feel.
3. Applications that can make use of this information.

The first two building blocks represents the situational context on a conceptual level and the third building block represents when context is enabled for applications [12].

There are challenges with iHCI, such as accuracy and reliability when a computer determines the context and behavior of a user. For some users it may feel strange to give up their control, it can be perceived as obtrusive. The system might also need time to learn its user's behavior in different contexts [11].

### 2.3 Generation Z

People belonging to Generation Z are born sometime between the mid 1990's and the early 2000's [13]. The group is special because they are generally grown up with a highly sophisticated media and computer environment. Generation Z is also often referred to as: Generation M for multitasking, Generation C for Connected generation, the Net Generation or the iGeneration [14].

Comparing Generation Z to previous generations, Generation Z is much more connected to each other and they like to congregate and to communicate. Generation Z is used to communicate through Facebook, Skype and Twitter etc. but to use email to get in touch feels old fashioned [15]. They are constantly seeking new technologies that help them stay connected [14].

Other characteristics for this generation are that they are very self-focused, they are multitaskers, independent and instant minded. This generation text messages to each other more than they talk on the phone and when texting, abbreviations are common. Examples of abbreviations are [14]:

- LOL: Laughing out Loud
- OMG: Oh My God
- AWHFY: Are We Having Fun Yet?
- BRB: Be right back
- C: Call me

In comparison to previous generations, Generation Z uses their cell phone more often than other generations [16]. With present smartphones, this leads to that they are constantly online and just a click away from interacting with others.

Generation Z are grown with constant use of technology, therefore it can be one explanation of their increased use of cell phone technology. Therefore it is normal for them to use technology and they are innately reliant on it. One consequence for Generation Z in the future is that they might not adapt to new technology as easy as previous generations because they will not be as technologically savvy. The technology need to be easy to use, help them easily solve their problems and provide them with relevant connection to other people or information [17].

A study made by Wikia and Ipsos MediaCT, surveyed 1,200 Wikia users between the ages of 13-18. Some data from the study showed [18]:

- 76% feel that their online experiences will help them reach their goals.
- 66% say that technology makes them feel that anything is possible.
- 64% say they contribute to websites because they like learning about new things.

- 60% of Generation Z says they like to share their knowledge with others online.

Conclusions from the study are that Generation Z is a very connected generation, which makes well for collaboration, curiosity, critical thinking and problem solving. Generation Z likes to spend time on what is important and relevant at the moment. This generation is more likely to engage to learning and activities, enabled by technology, that are relevant for the individual at that time. The constantly present technology and the large use of cell phone imply that Generation Z might also be called the mobile generation [17]. In the future, Generation Z will be highly mobile in the aspect of even higher use of technology, but also in the aspect that they are not locked to one location to use technology [17], as the quote below mention.

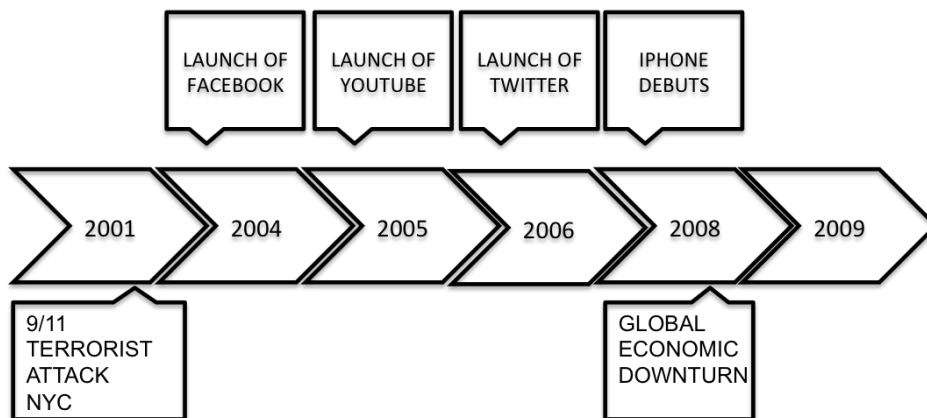
*“It is not out of the question to see the standard 9 to 5 desk job fade into an era defined by mobile work and supported by mobile corporate learning and development” [17].*

### 2.3.1 The Generation as Consumers

To characterize Generation Z as consumers, four different aspects can be used [19].

#### 1. *A focus on innovation*

When growing up, the Internet has always been readily available for Generation Z and therefore they have an innate comfort with the virtual world. It is also normal for them with fast digital development, great strides has been made during their growing independence from children to teenagers, as shown in figure 2.1. Generation Z as a consumer are likely to feel that constant innovations are given and has a high expectation for the pace of “more, smaller and better” versions of previous technological products [19].



**Figure 2.1** Key events when Generation Z grew up [20].

## 2 Theoretical Background

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### 2. *An insistence on convenience*

Most of Generation Z is children of Generation X, a generation that is known for their lack of brand loyalty, independence and cynicism. Generation X was exposed to some difficult trends, for examples the growth in the divorce rate, the economic distress of the 1970's and the rise of working single parents. Many children of Generation X took great care of themselves and, in some case, their siblings as they grew up. This generation is not necessarily expert on multitasking and has a heavy reliance on convenience goods. This use of convenience goods in the home environment is highly likely to rub off on Generation Z. The use may not only be in the home environment, it may also be reflected as an increased reliance on convenience in product attributes as a time saving device [19].

### 3. *An underlying desire for security*

Generation Z has grown up during economically difficult times [19], like Generation X, and these times will have an effect on them. The result may be that Generation Z, as Generation X, will not be very brand loyal but very brand sensitive [19].

### 4. *A tendency toward escapism*

A strong market for Generation Z is likely a market for goods that cater to escapism. The desire after an opportunity toward escapism is likely to be facilitated by technological advances that [19]:

- Make entertainment products like video games more real and compelling.
- Offer greater 24/7 access to social networks.
- Offer greater mobility in devices that offer escapism (e.g. cell phones with media and Internet availability).

### 2.3.2 *Communication Behavior*

Communication within Generation Z is dominated by texting messages, which is also the dominating method when they are communicating with people outside their generation [21]. According to the Pew Internet Project's 2011 teenage survey conducted in the United States of America: 43% of Generation Z feels more comfortable talking to people online than in real life [22]. Among all within Generation Z who answered the survey, the main conclusions were [21]:

- 63% say that they use text to communicate with others every day
- 39% make and receive voice calls on their mobile phones every day
- 35% socialize with others in person outside of school on a daily basis
- 29% exchange messages daily through social network sites
- 22% use instant messaging daily to talk to others
- 19% talk on landlines with people daily. Talking on a landline is also proving less popular, with 20% of teens saying they never or cannot talk on a landline
- 6% exchange email daily.



According to the survey, 77% of teenagers own a cell phone, an increased number from 2004 where 45% of teenagers were cell phone owners. The number of sent and received text messages has increased between 2009 and 2011. The median number of sent text a typical day by an American teenager has increased from 50 to 60. 25% from Generation Z say that they do not talk on a cell phone and nearly 39% talk to people they know over the cell phone. Calling friends on a cell phone has declined from 2009, 38% talked daily to friends over their cell phone in 2009 and in 2011 it has gone down to only 26% [22].

## 2.4 Usability

When using a product for the first time it should not take hours for the user to understand how the product works. The way to use the product should be intuitive by just looking at it. When designing a user-interface it is highly important to have the aspect of usability in mind, otherwise it is not certain that the future users understand exactly how the product works.

The term usability aims to show how easy a product or system is to use, and to put the users' requirements and needs in focus [23]. There are a lot of different ways to define usability. Eason said in 1984 that "*if a tool or system are used it is useful*" [24]. Time has passed by, technology has developed and so has the definition of usability. ISO9241 defined usability in 2008 as; "*The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use*" [25].

When designing a product with focus on usability, designers need to look at a few different aspects. One aspect is how and where the product is going to be used, what the context of use is. The users' goals with the use of the product also need to be taken in consideration, what does the user want to do with the product and does the product support this [23].

Usability of a product can also be analyzed using an approach called REAL [26]:

- *Relevance* - Does the product do what it is supposed to do?
- *Efficiency* - How fast and flawless can the product do what it supposed to do?
- *Attitude* - The user's subjective experience of the product.
- *Learnability* - How easy is the product to use the first time and how easy it is for the user to remember with repeated use?

### 2.4.1 Design Principles

Important aspects of design principles can be explained by Norman and are necessary to have in mind when developing a user interface. He has developed seven design principles which are further described below.

#### 1. *Affordance*

Affordance refers to the design of an object and how that design tells the user how the object could possibly be used, it provides the user a visual clue to the use of the object and functions. When the user knows what to do with an object just by looking at it, it has a good affordance. When simple objects

need pictures or labels to give the user a clue of its functions, the design has failed. To achieve good affordance actual and perceived properties need to be combined [27].

### 2. *Feedback*

It is important that the system notifies the user when an action is made, for example when a user press call on a specific number the system should display that it is calling the number. When doing so, the user sees that a result has been accomplished and it allows the person to continue with the activity [28]. Feedback does not always need to be visual, there are various kinds of feedback. Feedback can be verbal, tactile, audio or a combination of these [29].

### 3. *Visibility*

When designing a user interface the user should get a fast view of what the product offers her to do. Therefore it is important to let only the information that needs to be seen to be visual [28].

### 4. *Mapping*

Mapping refers to the relationship between two items and in user interface design it can be described as the relationship between a control and its function. When taking advantage of physical analogies and cultural standards it can lead to immediate understanding for the user [28].

### 5. *Metaphors*

Metaphors can mean different things depending on the concept they are in. In literature a metaphor can have a symbolic meaning similar to a meaning in a text. When talking of metaphors in the context of interaction design it has more a meaning of conceptual metaphors [28].

### 6. *Consistency*

It is important that the user always recognizes herself in the user interface. Therefore it is important that all information is at the same place all the time, the design looks similar throughout the whole user interface. Instead of removing information that does not need to be used it is better to color it grey than to remove it [28].

### 7. *Constraints*

To prevent error from occurring in the user interface, the best way is not to let them happen in the first place. To constrain the user interaction with the object, the designer can restrict the sort of interaction that may take place [28].

### 2.4.2 Schneiderman's Eight Golden Rules

Schneiderman conducts research on human-technology interaction. He is mostly famous and cited for his eighth golden rules of user interface design [30]:

1. *Strive for consistency*  
Similar situations should require consistent sequences of actions. For example identical terminology should be used everywhere in the interface. The use of color, layout and font in the user interface needs to be consistent so the users always recognize themselves.
2. *Cater to universal usability*  
Understand the needs of varying users, all from novice user to more experienced. The design also needs to support when a novice user gets more experienced, for example the user interface need to allow shortcuts and faster pacing.
3. *Offer informative feedback*  
For every action the user does, there should be feedback from the system. How much feedback the user needs to receive depends on if the action is carried out frequent, if it is a minor or if it is a major action. The response should be more substantial if the action is made infrequent.
4. *Design dialogs to yield closure*  
Organize sequences of actions into groups with a beginning, middle and end. When completing a group of actions, informative feedback should be given which gives satisfaction of accomplishment and a sign to prepare for the next group of actions.
5. *Prevent errors*  
The product should be designed in a way that the user would not make serious mistakes. For example if a user is trying to delete an item it can be a confirmation dialog to ask if the user want to remove the item. If the user makes a mistake the user interface should offer simple, constructive and specific instructions for recovery.
6. *Permit easy reversal of actions*  
Actions need to be reversible when possible. When the user knows that most of the performed actions can be undone it relieves anxiety and it can encourage the user to explore unfamiliar options.
7. *Support internal locus of control*  
An experienced user does not want surprises or changes in behavior when familiar to the system. The user desires the sense that she is in charge of the user interface and that the interface responds to her actions.

8. *Reduce short-term memory load*

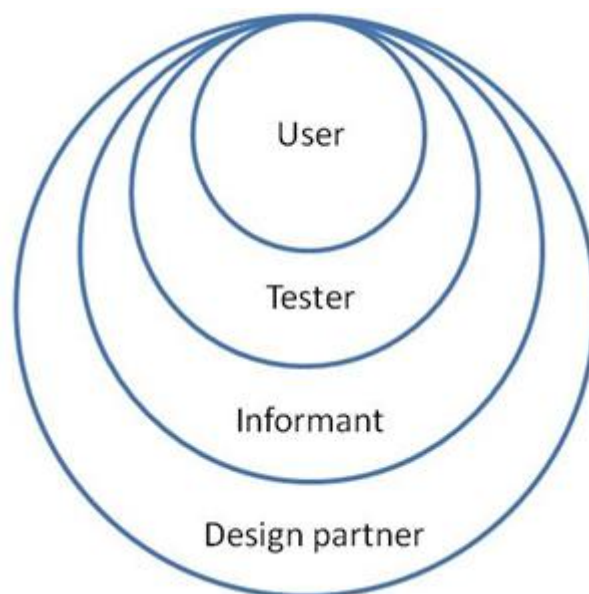
The interface of a system requires avoiding places where the user needs to remember information for a different screen into another. Humans have a limited capacity for processing information in short-term memory.

## 2.5 The Design Process

When a product is developed, it is important to have the intended end-users in consideration.

### 2.5.1 Design Process Involving Children

Druin describes in her article "*The Role of Children in the Design of New Technology*" about four main roles which children can play in a design process of new technology. The roles are user, tester, informant and design partner [31], which are displayed in figure 2.2.



**Figure 2.2** The roles children can play during a design process [31].

Since this thesis contains two activities with children, a design session (i.e Design Partner) and a usability evaluation (i.e Tester), a deeper description of these two roles selected follows.

#### 2.5.1.1 Children as Testers

By having children taking on the role as a tester in a design process, they test prototypes of upcoming technologies. The purpose of having children in this role is to get help from them in the shaping of new technologies before release on the market [31].

When children are in the role as a tester, the researchers are looking to understand their patterns during an activity, if the tester likes/dislikes attributes and changes in learning. The main focus when a child is a tester is to see if the technology meets the design goals [31].

If a child offers feedback and suggest new features, their impact on changes of the technology can be seen as minimal. This may be due to the length of the development cycle and that it is the adults who make the final decisions. Still it is important to listen to what the children have to say since they are very honest and sometimes harsh about the technology they are testing. Children will not hesitate to say what they like and dislike, which can be challenging for the developers to hear [31].

### 2.5.1.2 Children as Design Partners

When a child has the role as design partner, it takes part in the whole research and design process. The child becomes equally important as all other stakeholders in the design of the new technology. This means that the child may have significant impact on the technology design process [31].

In order for the children to understand their role as design partner, they, as an introduction, partake in a brainstorming session together with adults. This will help them to learn and accept their role, but also to understand evaluation and redesigning of technologies. Therefore it becomes important that the children collaborate together with critics, designers and developers when they are in the role as design partner. Different methods can be used during the design process in order to capture the children's thoughts and actions. A common method which is used when children are in the role as design partner is cooperative inquiry. One technique and method within cooperative inquiry is participatory design [31], which will be described in section 2.5.2.

Children who have the role as design partner can make a huge impact on the design process. The children's opinions will always be taken into consideration throughout the development and design process. One big challenge with children in this role is that they need to collaborate with other design partners during the process. This means that they need to negotiate when decisions must be made within the team. It is also a challenge to find researchers and industry professionals who are able and want to work with children as partners [31].

### 2.5.2 Participatory Design

Participatory design (PD) is an approach where the users and designers work together in the design process. The technique is seen as an embodiment of User-Centered Design, which is the oldest and most conventional approach to use when the design process includes the users [32][33]. PD sees the users as the most qualified persons to take control of how their work and perceptions of technology. PD is an iterative approach and follows general guidelines, which helps the users to change roles. They transform from having the role as an observer, to being design partner, expertise contributor etc [33].

## 2 Theoretical Background

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In the implementation of PD principles, there are two leading themes, mutual reciprocal learning and designing by doing. The first theme involves users and designers learning and teaching each other about the technical possibilities and how the work can be practiced. It is the joint experiences which they teach and learn from. The second theme is about learning by doing, i.e. hands-on designing. It can be seen as a creative process involving very low-tech tools, for example Post-It notes [33].

There are two main techniques which are used during PD, modeling and metaphor-based design. The first technique involves what-if scenarios and fantasies which the user implements. The metaphor-based design can be seen as a sort of conceptual prototyping process, which especially can be useful in the design process of an upcoming technology that will be prototyped [33].

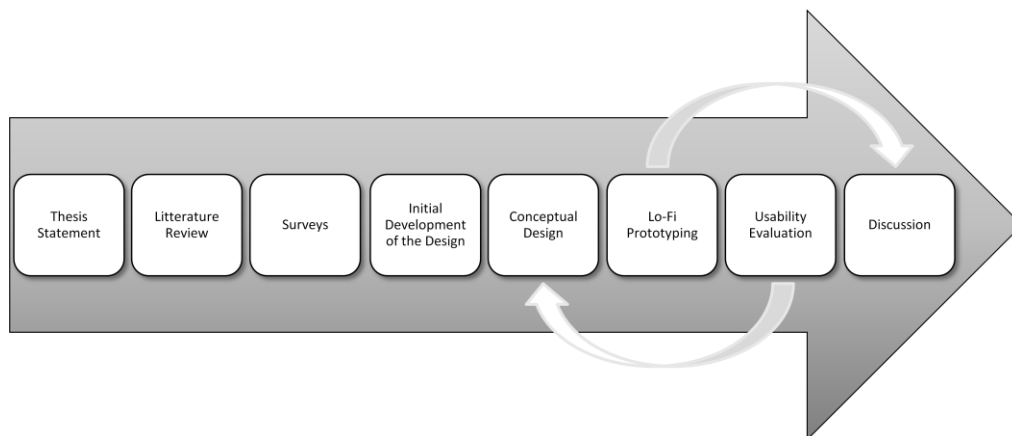
PD and its principles can be seen as the most suitable approach in a design process which involves children. This approach helps the children to feel inspired and that they also can contribute to the design of a technology by collaborating with adults. Using this approach, Druin et al. see the importance of balancing the amount of children and adults working together during process. More adults than children may cause the children feeling outnumbered which will have a negative impact on the collaborative design process [34].

## 3 Methods

*In this chapter the process of work for the thesis is presented. The purpose and how each phase was shaped will be presented.*

### 3.1 Process of Work

The work process of the thesis contained seven different phases. Working on later phases in the process, some of them were reconnected to the earlier phases. Some of the phases were carried out simultaneously, resulting in a constant motion of the process and new inputs were added continuously. The work process of this thesis is visualized below in figure 3.1.



**Figure 3.1** The work process.

### 3.2 Thesis Statement

The first phase in the thesis work was to formulate the statement of the thesis. More general knowledge needed to be learnt in the area of the thesis and also about the latest within wearables. When feeling more familiar in the area, ideas were written down on a whiteboard which later was used to create four different concepts. The final thesis statement was decided during a meeting with supervisors.

### **3.3 Literature Review**

To gain required knowledge about wearable computing, iHCI, Generation Z, communication and usability, a literature review was performed. In the first part of the thesis, most time was spent on searching and reading relevant information. The literature that was chosen came from books, articles and different types of reports. Following sources were used:

- Libhub - The Lund University library database
- Google Scholar
- IEEE Xplore Digital Library

Libhub was also used to find adequate books. Lecture notes from past courses, which were relevant to the thesis subject, were also read.

### **3.4 Surveys**

In addition to a literature review, two different types of surveys were carried out. The first survey's purpose was to gain more knowledge about how the mobile communication has changed during the past five years. The second survey's purpose was to gain more knowledge about how Generation Z is communicating through their cell phones today.

#### ***3.4.1 First Survey – Facebook***

A first survey was made with the purpose to gain more knowledge about how the communication patterns have developed during the last five years. Therefore it was designed based on two starting points: One was to see how mobile communication was in year 2009 and the other was to see how it is today. The survey (see Appendix A.1) consisted of eight questions and its target group was the multitude. Google's survey tool was used and it was published online. 183 people born between year 1946 and 1996 participated.

#### ***3.4.2 Second Survey – School***

A second survey was performed to gain more knowledge about communication behaviors within Generation Z and how they are currently communicating. The goal was to gain understanding in how, what and why Generation Z communicate. This was performed in order to find useful information that later was used when forming the design session with the pupils.

This survey was carried out at an eighth grade school class in Lund, consisting of 26 pupils at the age of 13-14 years. The survey was based on general facts about the communication habits of Generation Z. It consisted of both open and checkbox questions, as shown in Appendix A.2. The answers were summarized in an excel document to get an easier overview. When analyzing the answers, some patterns could be seen from the more open questions.



### 3.5 Initial Development of the Design

Since the future users of the product are supposed to be teenagers, a decision was made to let the end-users be a part of the design process. The first step, in this process, was to find other projects where children were used in the role as design partner. A handful number of articles was found and read.

An interview with Torgny Heimler, Usability Specialist at Sony Mobile's Consumer Experience Lab [35], was conducted. The main reason with the interview was to get his input and knowledge of usability testing and also to get ideas and tips from a specialist within the field.

#### 3.5.1 Pretotyping

Pretotyping can be explained as the art and science of faking it before making it [36]. Pretotyping can formally be described as *"initial appeal and actual usage of a potential new product by simulating its core experience with the smallest possible investment of time and money"* [37]. It can be performed in many different ways, where the main focus is that no expensive materials need to be used and imagination can sometimes be the only thing needed. Pretotyping as a design method is a good idea when discovering new products. This method helps the designers to pretend how the end-product will be used before it is produced and "feel" if the product can be the right one [38]. For example, when pretotyping a cell phone, a block of wood could be used by imagining it is a real device and working perfectly.

Pretotyping was carried out by the authors with the purpose to gain ideas of how the end-product could work and function. The purpose was also to get a feeling of how it is to wear a computer device on the body and to get knowledge if this is the right one to build. A Sony SmartWatch and a regular watch were used during one week, to find the strengths and weaknesses a potential wearable device could have or be avoided.

#### 3.5.2 Pilot Test

Before the design session with the pupils, a pilot test was performed with four other students from Lund University, the Faculty of Engineering. The purpose with the pilot test was to see if the planned program and its structure needed any improvements or changes.

#### 3.5.3 Design Session with School Class

The purpose of the design session was to gain more knowledge about how the end-users would like to use technology, which is attached to the body, and how it could be designed. The focus was on the pupils' patterns of behavior and needs. The session was held at the same school where the survey was performed.

During a time period of two hours, four pupils in the eighth grade participated in a design session, consisting of two boys and two girls in each group.

This session had influences of PD as the pupils played the role as design partner and their thoughts were taken in consideration as much as any other stakeholder that participated. The session was divided in three different parts:

### 3 Methodology

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#### 1. *Introduction*

In this part the children got a short description of the structure and the purpose of the session, as shown in Appendix B.1. A short example scenario was carried out.

#### 2. *Brainstorming*

Scenarios, as displayed in Appendix B.2, were given to the pupils. The purpose with them was that they should brainstorm and come up with ideas to solve them.

#### 3. *Discussion*

A semi structured interview in which short questions were asked to the pupils, was held as seen in Appendix B.3.

During the brainstorming part the pupils were presented three different scenarios. These were created based on two constraints:

- The only available technology for communication was a wearable computing device.
- The user could not talk or hear.

Another base of the scenarios was that they were designed to fit the everyday life of teenagers. They were not only created in words, they also had pictures describing their content. Different building bricks, representing usable material, presented in table 3.1, were created in order to help the pupils start creating and solve the scenarios. Some of the building bricks were figures drawn on post-it notes, as presented in table 3.2. An important aspect was that the pupils had never performed similar test before, therefore the session was not a formal event.

**Table 3.1** Building bricks used during the session.

Book stickers	Magazines	Aluminum foil	Pencils	Color pencils
Glue	Tape	Adhesive	Post-it notes	Paper
Scissors	Toilet rolls	Plaster	Bracelet	

**Table 3.2** Figures used during the session.

Location service	Group chat	Text message	Camera	Happy smiley
Sad smiley	Angry smiley	Flirt smiley	Sticking-out tongue smiley	Excellent characters
Thumb-up	Thumbs-down	Share picture	Heart	Hug smiley
Pencil	Send			

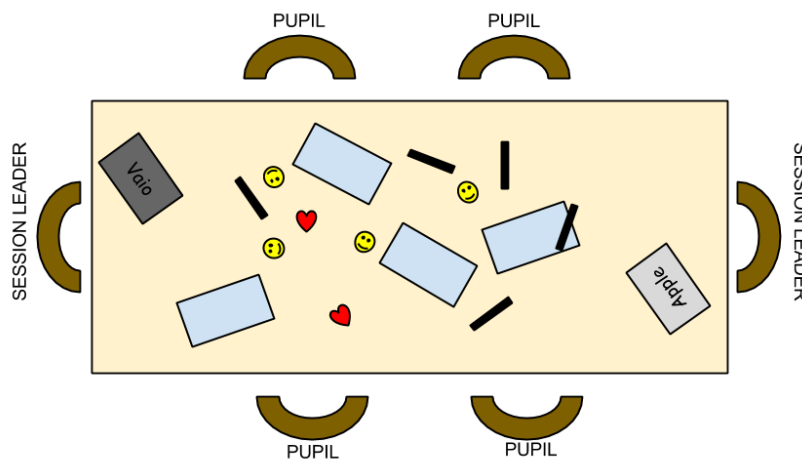
Based on the interview with Heimler [35], the importance of a good introduction to the session was taken in consideration. The purpose with a good introduction can be to let the pupils know it is okay to make a fool out of themselves.

The following data were planned to be collected during the session:

- Keywords/ buzzwords.
- How they were thinking when solving the scenario.
- Type of used gestures.
- Functions they like to use the most.
- On which part of the body they designed a wearable for.
- Their behavior when they were designing.
- What felt natural to them.

The data was collected through audio recording, notes and a camera. A video camera was not used due to the ages of the pupils.

As an introduction to the session, the pupils were asked to draw a picture of an animal starting on the same letter as their given name. While showing their drawing they were asked to share their personal interests and how often they use their cell phone. The pupils were seated between the leaders of the session, as shown in figure 3.2. One of the session leaders lead the session and the second acted more as an observer. The building bricks were placed in the middle of the table in order to be reachable.



**Figure 3.2** The placement of the pupils, session leaders and building bricks.

### 3.6 Conceptual Design

The conceptual design of the concept and its Lo-Fi prototype was created during brainstorming sessions based on the gained knowledge from chapter 2 and design session.

### **3.7 Lo-Fi Prototyping**

A Lo-Fi prototype was created in order to visualize the concept. In the startup phase several design ideas were drawn and the work was somewhat performed separately. The reason for this decision was to not influence each other and to come up with as many ideas as possible. The next step was to integrate the ideas, by taking the best part of each idea to create a final prototype.

Toilet rolls, scissors, glue and color pencils were used to make the Lo-Fi prototype. Toilet rolls were used to see how large the screen could be by attaching them to the arm and to cut it to the desired sizes.

All gained knowledge from the previous phases was taken in consideration when the Lo-Fi prototype was developed.

### **3.8 Usability Evaluation**

The Lo-Fi prototype was tested on pupils with the age the concept was designed for. Data was collected during each usability test to get the intended end-users' perceptions and thoughts of the concept. The collected data during the usability test was:

- The user's feeling of the concept and its prototype.
- What feels natural to the user when interacting with the prototype.
- What the user enjoys and perceives as difficult.
- If the potential end-users see an area of use for the concept.
- If the concept and the icons achieve high usability.
- The user's perception of the concept having iHCI implemented, i.e. awareness of the user's behavior and context.
- How the user interacts with the prototype.

#### *3.8.1 Pilot Test*

Before the usability evaluation with the pupils, three pilot tests were conducted with technically savvy people. The purpose with the pilot tests was to gain knowledge of how the user perceived the concept and its prototype, the scenarios and the test session as a whole.

#### *3.8.2 Test Participants*

The test participants were pupils from the school where the design session was held. Six pupils, three boys and three girls performed the usability evaluation, which lasted for 30 minutes and consisted of three parts: Introduction, testing of the concept and its Lo-Fi prototype and discussion, as shown in Appendix C. One day were allocated for the test session.

The middle part, testing of the concept, contained solving scenarios. The participants read three scenarios, one at a time, with the purpose of sending a message. They were given the pseudonyms A, B, C, D, E and F in the result of the usability evaluation. All the participants were active cell phone users.

### ***3.8.3 Test Environment and Equipment***

The test was performed at a school in Lund. A room with a table and chairs was provided. The test equipment was two cell phones with audio recording, the Lo-Fi prototype and paper for notes. The test persons were able to have the prototype on their body since a toilet roll was used as a wristband. Interactive pictures on the user interface were used to create a real experience as possible.

Data was collected by taking notes using pen and paper, but also by using a cell phone for sound recording. Two kinds of data were collected: qualitative and quantitative. The pupils were asked to think aloud when performing the scenarios.

### **3.9 Discussion**

The last phase of the thesis consisted of a discussion where the whole work process was summarized. The concept and its prototype were evaluated if it had reached the purpose and goal. The concept was also evaluated to see if it had fulfilled the requirements of Generation Z. As a part of this phase, future work and relevance for the industry was also discussed.

### 3 Methodology

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## 4 Results – Surveys

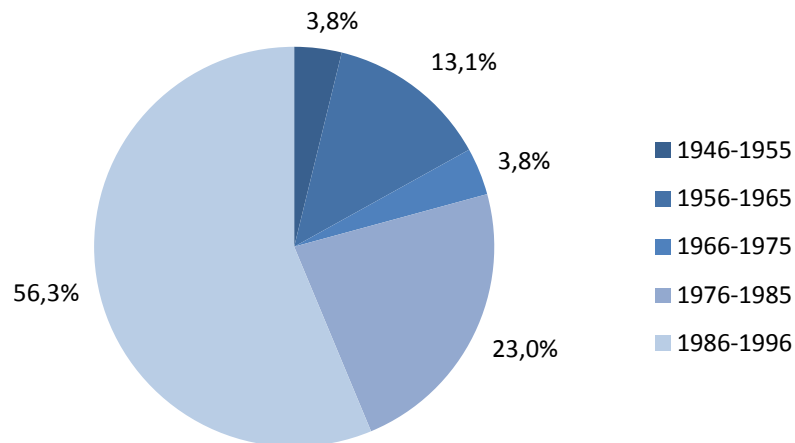
*The purpose with this chapter is getting a deeper knowledge and insight of how the communication has changed during the last five years. The chapter also aims to describe how Generation Z is communicating today.*

### 4.1 Surveys

#### 4.1.1 The Development of Communication Patterns Year 2009-2014

The majority of the responses on the survey, see Appendix A.1, were received during the first day after it was published on Facebook. 184 people participated in the survey and their ages were divided into five intervals, shown in table 4.1.

**Table 4.1** The age intervals of the participants.

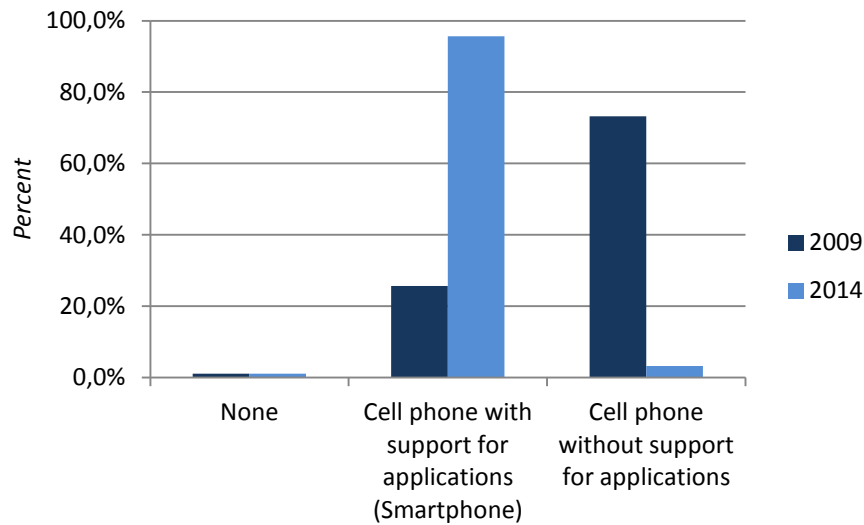


The compilation in table 4.1 shows that more than half of the participants are born between 1986 and 1996, were the majority represents Generation Y.

**Comparison between type of cell phone between year 2009 and 2014**

The participants’ answers on survey questions 2 and 3 are shown in table 4.2. The information in the table displays that the majority of the participants owned cell phones without support for applications year 2009. After five years, it is visible in table 4.2 that almost all participants own a smartphone, a cell phone with support for applications.

**Table 4.2** The type of cell phone year 2009 and 2014.

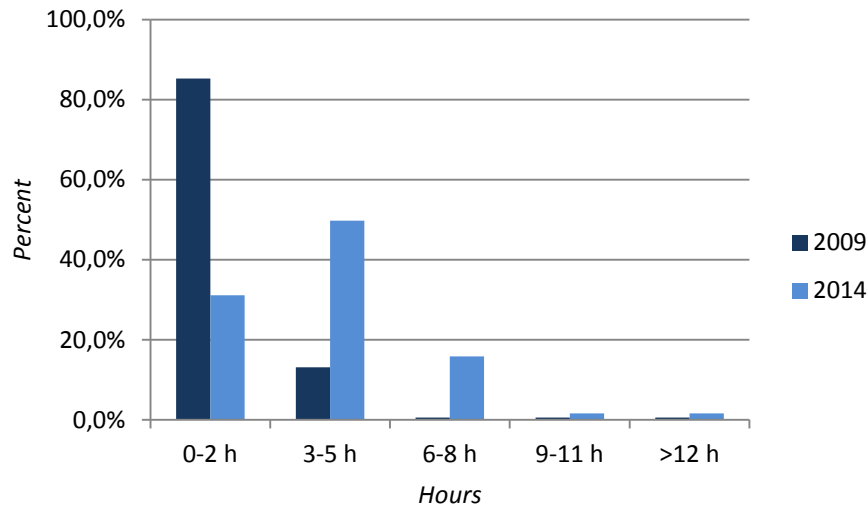


**Comparison between the active use of cell phone**

The participants’ active use of their cell phone in hours is displayed in table 4.3. The table shows that a cell phone was not used as much in a person’s everyday life in year 2009 as it is today, year 2014. The majority, 85.2 %, of the participants only used their cell phones a few hours per day in 2009, i.e. their cell phones were not as omnipresent as they are today.



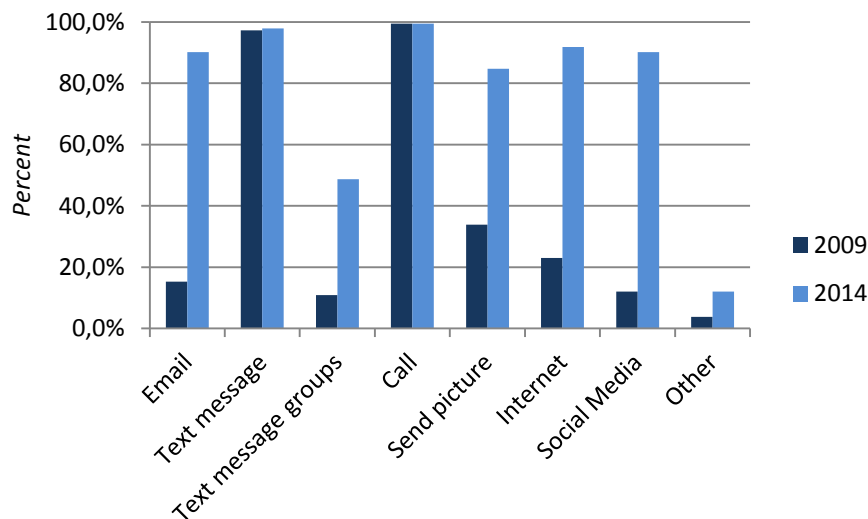
**Table 4.3** The active use of cell phone 2009 and 2014.



**Comparison between ways to communicate between year 2009 and 2014**

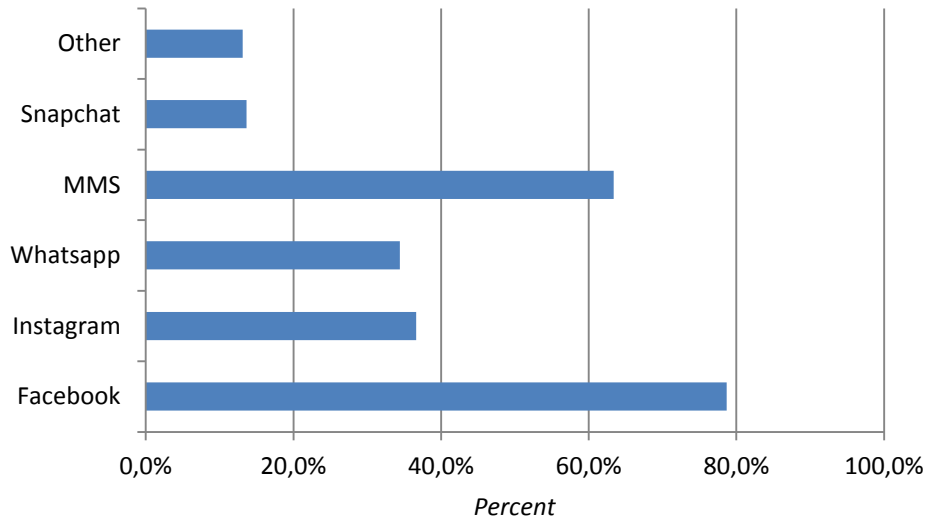
The result from the survey shows an increased use of different ways to communicate from 2009 to 2014, which are displayed in table 4.4. 99.5% of the participants answered that they use phone calls as a way to communicate, both in year 2009 and 2014. The table also display that the number of ways to communicate has increased considerably during five years.

**Table 4.4** Ways to communicate in 2009 compared to 2014.



One of the communication methods that have increased during the five year time period is sharing of pictures. Table 4.5 displays preferred ways to send picture.

**Table 4.5** Preferred ways to share picture in year 2014.



#### 4.1.2 The Communication Behaviors of Generation Z

The participants' answers from the school survey shows that they mainly communicate through text messages, chat and shared pictures. Calling is no longer the primary way to communicate within this generation. The communication is often made spontaneous and within groups, for example via social medias such as Twitter and Facebook.

The participants perceive themselves as omnipresent with their cell phones. Therefore they feel that communication with friends is made smooth and easy via the device.

Most of the participants perceive smileys and abbreviations as easy ways to communicate in text messages. With abbreviations and smileys, the messages become short and fast to write but still contains everything the sender want to convey.

The majority of the participants are users of social medias, mostly to keep in touch with friends and to track what they are doing. The participants perceive it has become more common to not post messages nor sharing their current location on different medias. It is more interesting to just keep track of what friends and relatives are doing. However, the participants still want their friends to share their location and they often "like" their friends' messages.

As mentioned above, the participants enjoy sharing pictures with their friends since they perceive it to be fun to share their everyday life and take note of their friends

living via pictures. The shared pictures does not have to be serious, they can be fun and spontaneous.

#### *4.1.3 Analysis of Surveys*

##### *4.1.3.1 Facebook*

The majority, 56.3 %, of the survey's participants are born between 1986 and 1996, which represents generation Y. This was not unexpected since the survey was published on the authors' Facebook accounts, where the majority of their friends are within that generation. These people are grown up along with the development of innovative technological solutions.

A surprising observation was that the majority of the responses were acquired during the first day after the survey was published online. This shows that many people are online every day on different social medias, for example on Facebook. The responses in the survey also shows that the use of internet, social media, email and sharing pictures in a cell phone has increased significantly since year 2009. This indicates that the user is more online and available for communication in different ways today than she was five years ago. Therefore it can be assumed that it has become more important for the user to be reachable and to share her everyday life with other people, which will probably increase further during the coming years. The increased use of sharing pictures as a way of communication indicates that many of the present users have extended their communication to also be beyond using words.

##### *4.1.3.2 School*

It has become clear that the main ways to communicate today, between teenagers, are through shorter text messages and sharing of pictures. Calling is not the main means of communicating used by Generation Z get in touch with each other. This can be explained by the generation's view on text message and sharing a picture, they are seen as more instant and at the same time more spontaneous. These instant and easy ways of communication have also affected how they write their text messages, they contain more abbreviations and smileys than before. But still, the receiver can understand the context of the message in its entirety.

Through the large use of social media, a teenager has the possibility to get insight of their friend's life whenever they like. At the same time a teenager is somewhat restrictive in sharing information about him or her.

For a teenager, the cell phone is omnipresent, which can indicate that it is very important as a communicating device. Ten years ago, it was more common to get in touch with a friend by knocking on her door or calling her home phone. With an omnipresent cell phone, teenagers find two important aspects of communication as being evident, the need for fun and spontaneity.



## 5 Results – Initial Development of the Design

*The purpose with this chapter is getting a deeper knowledge about how the design of the concept and its Lo-Fi prototype were developed.*

### 5.1 Pretotyping

The Sony SmartWatch and the regular watch were worn 24/7 for one week by the authors. During this period of time valuable functions were found, as displayed in table 5.1.

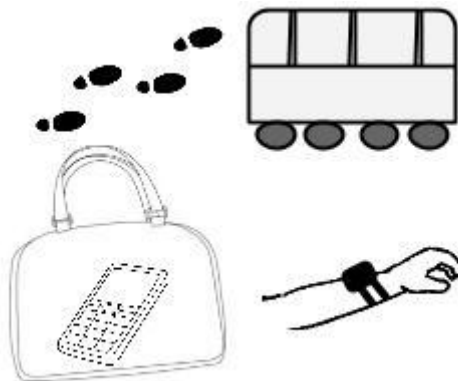
**Table 5.1** Advantages, disadvantages and missing functions found when pretotyping.

<i>Advantages</i>	<i>Disadvantages</i>	<i>Missing</i>
<ul style="list-style-type: none"><li>• Quick way to see notifications</li></ul>	<ul style="list-style-type: none"><li>• Big</li></ul>	<ul style="list-style-type: none"><li>• Quick way to let the sender know you have read the message</li></ul>
<ul style="list-style-type: none"><li>• Discrete when navigating</li></ul>	<ul style="list-style-type: none"><li>• Difficult to ignore</li></ul>	<ul style="list-style-type: none"><li>• A quick way to let a contact see where you are</li></ul>
<ul style="list-style-type: none"><li>• Easy to multitask</li></ul>	<ul style="list-style-type: none"><li>• Needs a cell phone</li></ul>	<ul style="list-style-type: none"><li>• Control Spotify or other external music player</li></ul>
<ul style="list-style-type: none"><li>• Hard to loose</li></ul>		<ul style="list-style-type: none"><li>• Camera</li></ul>
<ul style="list-style-type: none"><li>• Easy for the user to be tracked</li></ul>		<ul style="list-style-type: none"><li>• An easy way to share information of your location</li></ul>
<ul style="list-style-type: none"><li>• Feels natural to wear</li></ul>		

Two different aspects were analyzed after prototyping:

1. The strengths of having the technology device omnipresent.
2. Wearables as a complement to a cell phone, from a perspective of communication.

By having the technology omnipresent and attached to the body, a user would never miss receiving text messages, emails or phone calls. Another strong insight was, when reading a text on a watch, the user did not look busy or occupied. A valuable function that was missed in the Sony SmartWatch was an easy way to let the sender of a text message know if the receiver has read and perhaps liked it. Another missing function was how a user's location could easily be shared to friends. For example, when a pupil is entering a bus after finishing school a notification is sent to her friend telling him her location and that she is on her way, as shown in figure 5.1. Since the wearable device is on the body, it is easy to interact with the device and share a person's location and her direction of travel.



**Figure 5.1** The concept of sharing place when a person is on the move.

A positive perceived experience with wearing a computer device is the quick way to interact with it. This opens up for more instant communication since no time is spent on finding the cell phone, which also might lead to more spontaneous communication.

Since watches were used for prototyping, gesture and movement of the arm felt natural. This indicated that gesture could be used as an input when interaction with a wearable attached, for example on an arm. Pressure as a way of communicating was seen as exhilarating. When receiving a text message and, at the same time vibrating on the wrist, it made the receiver of the message feel somewhat closer to the sender.

### 5.2 Result of the Pilot Test

The pilot test and its participants gave useful feedback regarding how to act and what to say during the session. They felt that there was a wide selection of

material to use when designing for the different scenarios, which were perceived as helpful and easy to understand.

### 5.3 Result of the Design Session

The pupils had a slow start with their creative work, but after a while they started and appeared to have no limits in their thoughts. Regarding the location of the device on the body, both groups came to the conclusion that it felt most natural to have it attached to the arm, like a bracelet. One group talked about having it like a necklace, but when discussing it further they felt it could be unnatural for boys to wear it. Almost all of the pupils were into the idea to have more than one wearable device on their body, where one would be the master. Both groups said and gave the impression that wearing a wearable device on their bodies would feel natural.

Wider gestures are not something they could see themselves doing in public, but using small gestures as when interacting with a smartphone felt natural to them. For one of the pupils it felt more normal to scroll vertically when navigating through the user interface instead of scrolling horizontally, as in present smartphones.

The first group of pupils talked about having functions such as Virtual Reality and 3D included in a wearable computing device. With these functions they were supposed to interact with friends in a Virtual Environment, similar to a community.

Another aspect the pupils mentioned was the need of a wearable computing device to be simple to use. When performing an action only a few presses within the user interface should be needed. The idea of communicating by using colors and vibration was perceived as funny and useable. One of the groups wanted to use colors as a code language in order to keep conversations private. Since these pupils are grown up with the use of a smartphone, their thoughts were often based on applications and how these are presented in a smartphone.

The central functions the pupils see a need of having in a wearable computing device are:

- Cameras for photographing, one facing the user and one on the opposite side.
- Shorter text messages.
- Smileys, both in photographs and text messages.
- Internet access.
- Shock- and waterproof.
- Calling.

The advantages the pupils mentioned were that the device should be smooth, simple and instant to use. The drawback of using a wearable device could be its omnipresence which makes its user antisocial and even more dependent on technology.

During the session it became clear that the pupils felt it is important to personalize the device, both its presence and functionality. By personalizing the device, the user would have great control of it and its functions. Though omnipresence of the device was mentioned as a disadvantage, it was still seen as significant for the user.

## 5 Results – Initial Development of the Design

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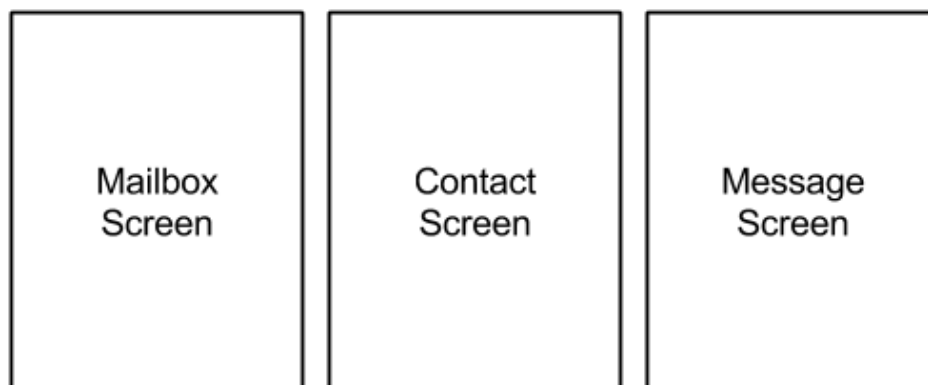


## 6 Results – Conceptual design

*In this chapter the conceptual design of the concept and its prototype will be described.*

### 6.1 The Concept's Overall Structure and its Conceptual Model

When interacting with the prototype, the first screen the user sees is the contact screen which contains favorite contacts and a short cut to the address book. The user can also choose to navigate horizontal, to the left, to see the screen containing the mailbox with received and sent messages. If the user navigate horizontal, to the right, she will see the message screen where she can write messages. The main structure of the concept is displayed in figure 6.1.



**Figure 6.1** The overall structure of the concept.

When a user wants to send a new message, she starts by choosing whom she wants send the message to. The user can choose to send the message to one or many recipients. Next step is to decide what the message should contain. A predetermined message can be seen on the screen since the concept has implemented context awareness. Therefore the predetermined parts a message contains are based on the context of the user and the chosen recipient. The user can then decide which parts she wants to remove from the message, change it to something else than the predetermined or just send the message as it is.

In the design of the prototype of the concept, there are two cameras attached. One is facing the user and one is on the opposite side. These constitute key functions of the concept since its main focus is to make the user communicate beyond using words.

## **6.2 Grouping of the Concept into Natural Groups**

The overall structure of the concept is divided into three parts as seen in figure 6.1: Mailbox, Contact and Message. This will make it easy for the user to know what to do in each part. In the contact screen the favorite contacts are grouped (see figure 7.2) and first seen by the user. Thereafter she can view the other contacts she has. In the message screen the functions are grouped in a grid pattern (see figure 7.3) where the two cameras are more in focus than the other functions.

## **6.3 Metaphors**

Different metaphors, which are further described in section 7.2, have been used to ease the understanding of the concept and its conceptual model. Therefore the metaphors can be seen as a natural part of the concept. An Android cell phone and a computer have been used as inspiration because of the user's recognitions of the icons used within these devices.

## 7 Results – Low-Fidelity Prototyping

*In this chapter the concept and its Lo-Fi prototype are presented and explained. The purpose is to describe each step in the prototype and each design decision.*

### 7.1 Overview, Orientation and Navigation

As described in the previous chapter, the concept contains of three parts: Mailbox, Contact and Message. They are all described more below as well as the receiving part of a message.

#### *Mailbox screen*

By default the user sees received messages when entering the mailbox screen, as displayed in figure 7.1. On the top of this screen the user can choose if she wants to see received or sent messages. These choices are displayed as a folder system with the labels: received or sent. The user chooses one of them by pressing on the label.

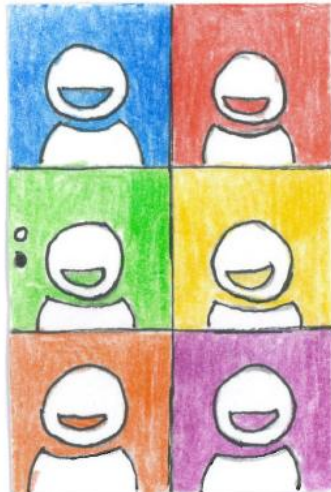


**Figure 7.1** The design of the mailbox screen.

In both cases, the sent or received message is displayed as a list with the name of the contact that the message was sent to, or received from. Pressing on a name in the list, the conversation between the two is displayed and the user can go through previous messages by scrolling vertically on the screen.

#### *Contact screen*

The contact screen consists of two parts, the first part is favorite contacts and the second is an address book. There are six favorites and they are presented based on the user's context, i.e. friends she mostly communicates with. These are displayed in a grid pattern, as seen figure 7.2. The user can choose to send a message to one or more contacts. If the user wants to send to more than one contact, she presses her finger on the contact for a short while and then she can choose more contacts. If a user only wants to send a message to only one person she taps that contact and the message screen will be displayed.

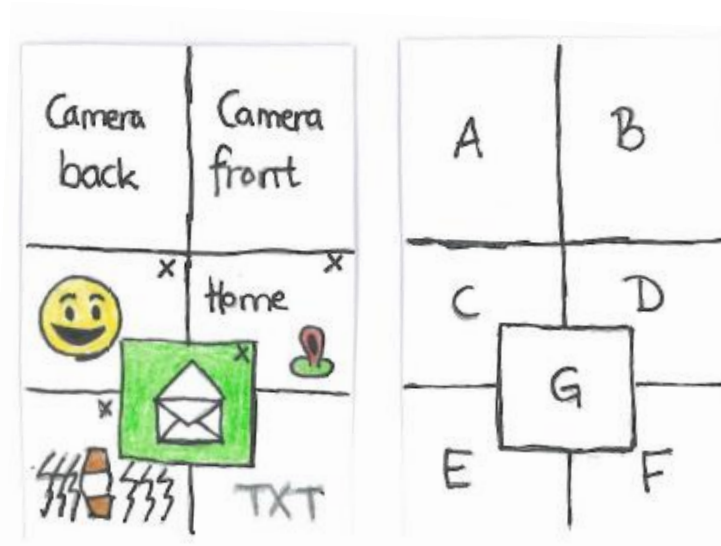


**Figure 7.2** Shows the contact screen with the user's favorite contacts.

If the user wants to see the address book she puts her finger at the lower part of the screen and drags the finger to the top. Here the address book is displayed in the same grid pattern as the favorites but based from the contacts' last names. The contacts and favorites are exchanged through the user's cell phone.

#### *Message screen*

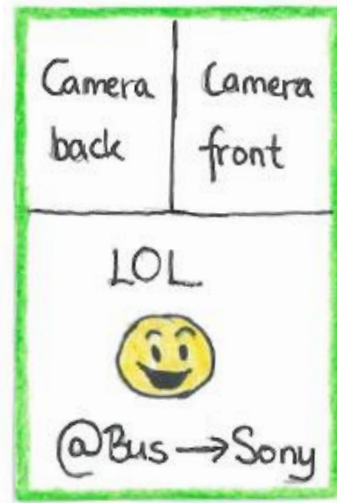
When the user has chosen a contact that she will send a message to, the message screen will be displayed. A predetermined message will be shown, which is created based on whom the message will be sent to, and on the communication patterns between the user and the chosen recipient. It will also be predefined based on the user's present feelings and location, as displayed in figure 7.3. The user's feelings are the experience she perceives in a specific context.



**Figure 7.3** An example of how the message screen can look and a grid panel of the different parts.

The user can send the predetermined message, change it or just send some parts of it. The message screen is displayed in a pattern similar to a grid with seven squares. On the top of the screen, two larger squares can be seen, displayed in figure 7.3 as A and B. Square A displays the view from the camera on the back, facing the user, and square B displays the view of the camera directed away from the user. A picture is taken by pressing the square representing the camera, the user can take pictures from both cameras.

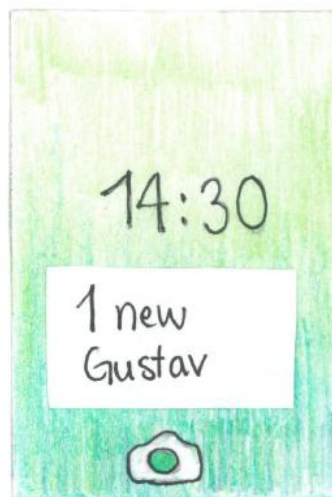
Underneath the camera squares, five more squares can be seen containing icons. In square C, a smiley icon can be found. The displayed smiley is selected based on the feeling of the user and also on which smileys the user normally sends to the chosen contacts. In square D, a location arrow is shown, telling where the user is. A vibration icon is displayed in square E, telling the intensity of the vibration. In square F, a text icon is seen, where the user can write a short text to send. In the middle of the lower part of the screen, in square G, an envelope can be seen, surrounded by a color. This color represents the color that will be displayed around the message as a frame, as displayed in figure 7.4. The envelope represents the message that will be sent and the user needs to press it in order to send the message. When it is sent, an envelope with wings will be displayed.



**Figure 7.4** An example of a received message with a color frame.

#### *Receiving a message*

When the user receives a message, a pop-up window is displayed on the screen with the text: “1 new” and the sender’s name, as shown in figure 7.5. The user reads the message by turning her arm towards the face. If she does not like to read the message at that moment, she can simply turn the arm back and the message will be saved in the mailbox. There an icon will be on the startup screen indicating new messages are waiting to be read.



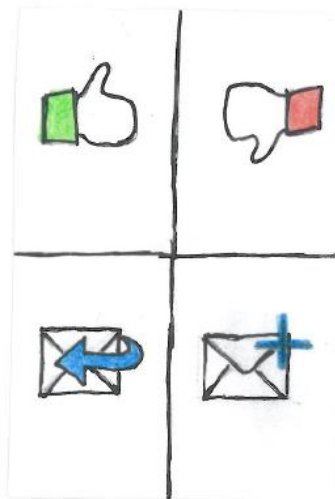
**Figure 7.5** An example of receiving a new message.

The user can, when reading a message, enlarge respective photograph from the cameras by double tapping on them. The photographs will then be shown on full screen and the user only needs to double tap on the screen again to go back.

When the received message has been read, the user has four choices:

- Like the message by pressing thumb up.
- Dislike the message by pressing thumb down.
- Change something in the received message or write a short word on it and bounce the message back.
- Reply with a new message.

If the user wants to perform one of the four alternatives she taps on the window. A menu will be shown with the alternatives displayed in a grid pattern, as seen in figure 7.6. If the user chooses the alternative to bounce the message back she presses the envelope with the reply arrow. The received message will then be shown on the screen. The user can start to draw or change anything in the message and send it by pressing an envelope in the upper right corner.



**Figure 7.6** Four alternatives the user has to answer a message.

## 7.2 Application of the Design Principles

Below, the application of Norman's design principles [27][28][29] are deeper described.

### *Affordance*

All symbols in the system are designed based on the user's real life or icons well known from a cell phone. The areas that can be pressed are visualized as they are a

little thicker. The squares where pictures can be taken display what is viewed from the cameras, letting the user know which camera belongs to which square.

#### *Feedback*

The user will constantly receive feedback when interacting with the system. When a choice has been made by the user, the system will show what is happening on the screen. For example when a message is sent, an envelope with wings can be seen on the screen or when the user has chosen a contact to send a message to, the contact will get a frame.

The user will receive a vibration when a new message is incoming as a feedback that something new is happening and the user will also receive feedback by text on the screen.

When a user does not want to send one of the parts of a message, she presses the cross and that part will be grey-colored to let her know that the system perceived the choice. If the user only wants to send a few parts of the message, the parts that are dragged to the envelope will “fly into” the envelope to let the user know it has been included in the message.

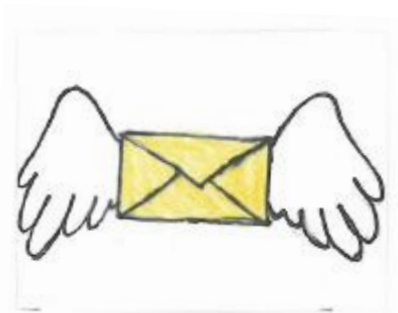
#### *Visibility*

All the choices that can be made will be in colors otherwise it will be in a grey-scale. If there are more screens available vertically, it will be symbolized as dots to let the user know more information can be seen below.

#### *Mapping and Metaphors*

Metaphors used in the system are:

- An envelope symbolizes the message which will be sent. This has been chosen because it can be seen as a real letter sent by physical mail.
- An envelope with wings to indicate that a message is being sent. The wings symbolize that the envelope is flying away, as shown in figure 7.7.



**Figure 7.7** A symbol showing the user that the message is being sent.



- The cross in the corner of the different parts in the message screen symbolize that they can be removed and will not be sent.
- Grey-colored symbolize in the message screen that it have been deleted and will not be sent, as displayed in figure 7.8.



**Figure 7.8** When an icon is being grey-colored.

- The smileys symbolize feelings and gestures that the user can do in real life.
- The vibration is a metaphor by a wristband surrounded with waves, as seen in figure 7.16. This can symbolize that the wristband is moving. More waves indicate the insensitivity of the vibration.
- The thumb up is a metaphor to symbolize that a message is liked.
- The thumb down is a metaphor to symbolize that a message is disliked.
- The message with a plus symbolize that the user can create a new message.
- The message with an arrow symbolize that the user can reply on a received message.

### *Consistency*

All of the parts within the concept will always be at the same place, independent of the user. The same terminology is used everywhere within the concept and the meaning of a symbol is always the same regardless of where the user is navigating within the concept.

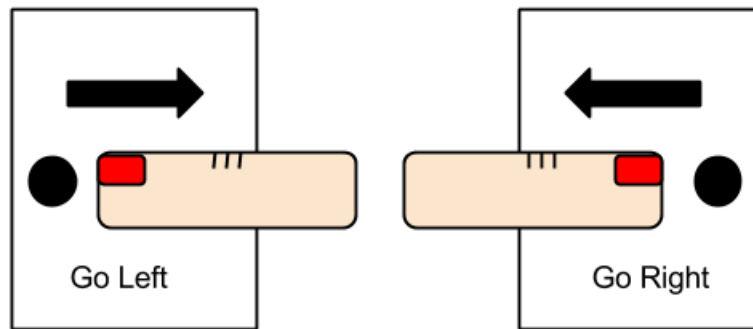
### *Constraints*

A constraint within the concept is that the user needs to choose the contact that the message will be sent to before composing the message, otherwise no message can be created and sent.

When answering to a message, the user needs to do an active choice in which way she wants to reply. In this way the user cannot answer to a message without being aware of her action.

### 7.3 Interaction Techniques and Gestures

Gestures are used as the main interaction technique within the communication system. To scroll between the main screens in the system, the user drags the screen by putting the finger on the side of the screen where she likes to go and the drag the finger over the screen, as shown in figure 7.9. Choosing a contact from the address book, the user uses a gesture to drag the screen from the bottom to the top.



**Figure 7.9** How the user drags one of her fingers between the main screens.

The user turns her arm towards her face to read an incoming message. If the user does not have the time to see the message, she just puts the arm in a natural position, i.e. turns the arm in the position it was before looking at the screen.

If the user only wants to send some parts in a message, she drags the icon to the envelope. In case the user only wants to delete some parts of the message she press the small cross in the corner and the icon will be grey-colored.

A user scrolls vertically through the mailbox list of either received or sent messages if she wants to navigate through each list.

A regular interaction technique within the concept is pressing an icon to make a choice. The user will need to perform this action in all of the three parts in the concept as well as when the user receives a message.

The user writes directly on the screen and her finger can be seen as a pencil when writing text to send in the message. The handwritten text will then re-code and transformed into computer-written text.

When a user wants to answer a message by bouncing it back, she can form the message directly on the screen by using her fingers, for example to form the smileys to a more suitable one or maybe draw an own figure over the message.

## 7.4 Layout and Grid

The layout of the concept was developed to be as simple as possible and with icons keeping their positions through the different stages due to consistency reasons. The concept is divided into three parts in order for the user to easily keep track of where she is. All options are displayed in a simple way and the user sees all options that can be done on that screen, otherwise it is simply a swipe away.

## 7.5 Sizes

The screen is four centimeters wide and six centimeters high, which gives the screen an area of 24 square centimeters. This size has carefully been chosen by using different sizes of toilet rolls, since it is important for the screen not to be too large or too small. It cannot be too large since it is placed on a user's arm, who does not want to look like she is wearing a large computer on the arm. She may perceive it as not being socially accepted. The screen cannot be too small because of all the information the user wants to see and interact with.

## 7.6 Colors

The concept contains of different colors. Cheerful colors have been chosen for a more positive action and negative colors for a more negative action, as displayed in figure 7.10. Colors have been chosen to be used in the concept to enhance the user's understanding of choices and her experience.



**Figure 7.10** How colors are used to strengthen what the different choice means.

Color is also a part of what a user can send in a message. The purpose with sending a color is to share and strengthen the emotions. Using a color as a communication method, can let the user more easily communicate beyond using only words to express herself. A color is predetermined based on the context of the user and also on which colors she normally sends to the chosen receiver. The color that is being sent can be seen surrounding the envelope, as seen in figure 7.11. The user can press on the colored area and choose another color if wanted.



**Figure 7.11** The color to strengthen the feeling of a message.

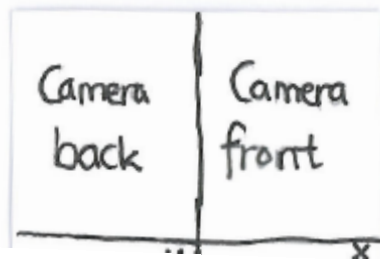
### 7.7 Icons within the Message Screen

The user's favorite contacts has their individual pictures as an icon, the user can then easily and fast see who she wants to send a message to.

The icons on the message screen may be different every time a message is being sent, but the overall structure is always the same. This will help the user to recognize herself every time. There are seven different icons on the message screen:

#### *Camera*

Two camera squares can be seen on the top of the screen. They display what can be viewed from the two cameras in that moment, as seen in figure 7.12. The user takes a photograph by pressing on the screen where she wants to take a picture from. Both screens can be used in the same message. When a photograph has been taken, a small cross will appear on the square's upper right side. If the user wants to retake the photograph, she presses the cross and the view of the camera will be shown again. The user can ignore the camera areas if she does not want to take any picture to send. The user only presses on one of the camera areas if she only wants to send one picture.



**Figure 7.12** Camera icons.

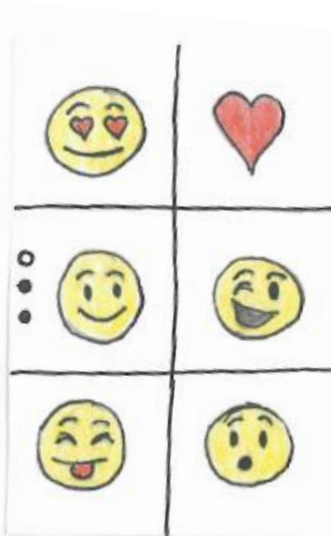
*Smileys*

A smiley icon is used where the user can decide which smiley is going to be sent, as shown in figure 7.13.



**Figure 7.13** Smiley icon.

When pressing the smiley icon, a grid pattern with more smileys will appear, as displayed in figure 7.14. When the user has chosen a new smiley to send, she presses the chosen smiley and the new smiley will be shown as this icon. A user can only send one smiley at the time. This decision was a result from the design session, where the test participants did not see a need of sending more than one smiley if they had the possibility to include pictures within the message.



**Figure 7.14** The layout of the smiley window.

*Location arrow*

A location arrow is used as an icon to show the user's location, as seen in figure 7.15. The icon is similar to the one in Google Maps and therefore the user feels familiar

with the icon. Next to the arrow a text of the user's location can be seen. When the user presses this icon, a new window shows where the user has a list with nearby locations and transportations.



**Figure 7.15** Location Icon.

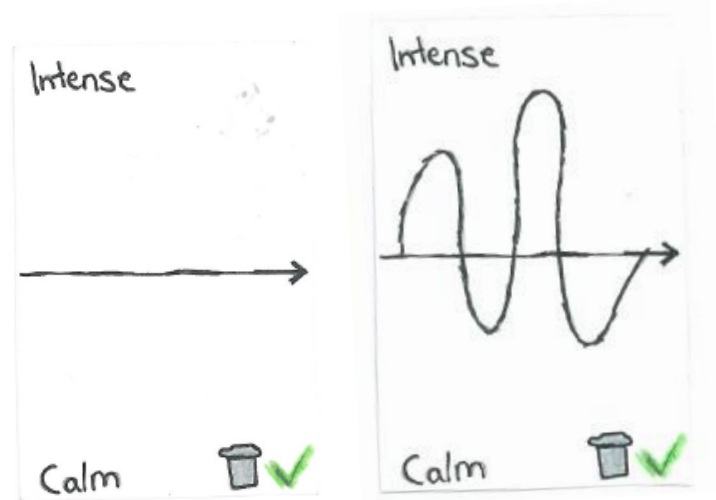
*Vibration icon*

A vibration icon can be found in the lower left corner, as displayed in figure 7.16. This icon shows the user how intense the message's vibration will be.



**Figure 7.16** Vibration icon.

If a user wants to send another vibration than the predetermined, she presses the icon and a new window is shown. The user decides how intense the vibration will be by drawing a curve, as displayed in figure 7.17. While the user draws the vibration curve, the device will vibrate simultaneously to give the user direct feedback.



**Figure 7.17** How the user can design a vibration to send.

#### *Text icon*

In the lower right corner a text icon is located and has the text “TXT” on it, as shown in figure 7.18. The text has been chosen as the icon name because it is a common abbreviation of the word. When a user presses the icon a new window is shown and the user can write text to send in the message. Only short text can be sent and the user writes text using her finger as a pencil and the system converts it to computer written text. The text icon is always grey-colored when the user enters the message screen which will minimize the focus on including text in the message.



**Figure 7.18** Text icon.

### **7.8 Sound**

Sound will not be included in this version of the concept since vibration will enhance its presence and the user's attention more due to the placement on the body. The placement may have an effect on the user's perception of the device. She might perceive it as public and therefore the user do not want it include sound.





## 8 Results – Usability Evaluation

*The purpose with this chapter is to present the result from the usability evaluation. The participants will all be referred to as she in the text below due to anonymity.*

### 8.1 Results

#### *Participant A*

The participant found it difficult to understand the overall picture of the concept, she said a couple of times that she focused on the details. Despite this, she understood what to do in each of the steps when testing the prototype. The participant liked that the use of pictures were the central part of the communication, instead of using words. Answering a message, she did not like the icons "like" or "dislike" a message, she said it felt "done" and not new and fresh. During the session the participant asked a lot after a setting function to change the predetermined message. When interacting with the prototype she thought it felt natural to swipe and press on the screen. The participant thought it was tricky in the beginning to understand it was two cameras and how they were connected to the user interface. The participant did not like the concept's knowledge of her position and feelings, she said it felt uncomfortable for her and that it was intruding on her privacy. When sending a message, the participant did not need a preview of the message before sending it and she wanted a mailbox for sent and received messages. The participant thought there is an area of use of the concept and she enjoyed it since it was accessible and easy to use. The participant said she would buy a device containing the concept if other people had a similar device.

Overall, the participant thought it was easy to perform the scenarios and she almost instantly understood what needed to be done to solve the tasks. The participant wanted to have physical buttons when taking pictures, but after a while she understood she needed to press on the screen to take a picture. Other simple tasks for the participant were reading a message and finding the edit screen. Answering to a message, it was a bit tricky for the participant to understand that she could draw on the screen, she wanted a menu to choose a new smiley from.

#### *Participant B*

Overall, the participant enjoyed the concept and she felt there is an area of use for it. The two cameras on the prototype were liked by the participant, but in the beginning it was difficult for her to understand there were two of them. The possibility to take and send two pictures in one message and that the action could be done fast and easy,

were two things the participant really liked. Using vibration instead of sound as a notification was a function the participant mentioned as particularly good. The participant said she wanted to unlock the screen before reading the received message, otherwise the message could appear due to unintended actions. In the beginning, the participant felt it was weird to choose the contact before writing the message. The participant also found it difficult to understand the icon of sending a new message when answering a received message, otherwise she found it easy to understand the icons in the prototype. When answering a message, the participant liked that the message could easily be answered by pressing "like" or "dislike". She found a value and an area of use for these functions. The participant enjoyed the predetermined messages within the concept and its knowledge about the user's behavior and context. To decide which parts to send within a message, was something the participant wanted to be in control of and she found it natural to erase the parts which she did not want to send. A preview of the message was not desirable by the participant since she thought the user would gain knowledge of it after a short time of use. It was important for the participant that the future device had a mailbox for received and sent messages. The participant said she felt it was easy to use the prototype and she enjoyed that it was a fast way to send a message.

When performing the scenarios it was easy for the participant and she had a good understanding of the concept and its functions. The trickiest part was to change the smiley when answering a message, she wanted to choose from a menu. With a bit of a help, the participant understood that she could draw on the screen. The participant had a wish to send an own picture in exchange for the one in the received message.

### *Participant C*

The participants thought the concept was "cool" and liked it a lot. The participant particularly enjoyed to communicate through feelings and colors since she felt it was easier ways to express herself. The participant really liked answering a message by pressing the alternatives "like" or "dislike" since she felt they were easy and fast ways to communicate. Interacting with the prototype felt natural to the participant but in the beginning she found it hard to understand that there were two squares for each camera on the screen.

The participant wanted the future device to have a mailbox for received and sent messages. A predetermined message and the concept's knowledge of the user's context and behavior, was seen as interesting and fun by the participant. The participant liked how detailed the message was and she enjoyed that feelings and pictures was the central part of the communication instead of using words. The prototype felt user-friendly and the participant perceived an area of use for the concept.

The participant found it simple to perform the given scenarios and to understand the functions of the concept. When taking a picture for the first time, the participant believed she needed to take both pictures at the same time. Reading a received message was easy and when answering a message the participant wanted to start drawing on the screen directly but quickly understood she needed to go via an edit screen. When choosing the right icon to answer a message, it was tricky to understand

what the different envelopes represented in the edit screen. The participant wanted a menu when changing the smiley but it felt natural to draw the cross over the pictures.

#### *Participant D*

The participant really liked the concept and its prototype. The participant also said that she could not see these functions in present cell phones. The future device needs to fit the user perfectly and also be personalized by a user in order for the participant to buy it. The functions within the concept were suitable and it was funny that many different things could be sent in a message. The participant liked that only some part of a message could be sent quickly. The concept's knowledge of the user's behavior and context was perceived as smart but somewhat scary. The participant did not know if she could trust the concept of having accurate knowledge of the user's feelings. She wanted to be in control of which parts within a message should be sent and also be able to change them if needed. Removing a part of a message felt natural and the participant liked that the removed part got grey. To get an understanding of the concept was a bit difficult at the first view but the participant felt it was simple to learn. The participant did not need a preview of a message, she understood how it would look without the preview. A mailbox was desirable for received and sent messages.

The scenarios were performed fast and easy. Often the participant wanted a setting screen to change parts in a message. The participant interacted naturally with the prototype and had a great understanding of it. When answering a message she wanted both to press "dislike" and to reply to the message. The participant also wanted to have a menu to choose a new smiley from but with a bit of a help she understood that she could edit directly on the screen.

#### *Participant E*

The participant said it felt easy to send a message with just a few finger presses. She understood how the different parts of a message were linked together and the meaning of the different icons. It felt natural to interact with the prototype and the participant especially liked the cross in an icon for removal from the message. The concept felt user-friendly and the participant enjoyed its knowledge of the user's feelings, behavior and context. The participant wanted to be in control of which parts should be sent and felt it was easy to remove or change parts of the message if needed. The participant felt that the present cell phones lacks these types of functions the concept offers. This and its usability and quickness contributed to the participant perception that there is an area of use for the concept. Seeing a preview of the message before it is being sent was desirable but not important. However, the participant wanted a mailbox for received and sent messages.

Most of the scenarios were performed smoothly. The participant looked for a physical button when she wanted to take a picture, but after while she understood she needed to press on the screen to take the picture. The participant understood meaning of the different icons. When the participant wanted to send a message, she tried to put two fingers on the screen and then push the message away by drawing the two fingers upwards on the screen. Answering a message and changing the smiley, she tried to

swipe the existing smiley away and believed there were smileys in a prioritized sequence next to it. Drawing a cross on the screen was easy to understand.

### *Participant F*

The participant thought the concept was really “cool” and liked the two. The concept felt user-friendly and was easy to understand from the beginning. The participant perceived that there is an area of use for the concept and said she wanted to use it more than her cell phone. The concept's knowledge of the user's feelings, behavior and context was perceived as both fun and scary. The participant did not want any unauthorized person to see what the concept knew about her, except when sending a message. The user also wanted to be in control of which parts to send and removing parts of the message felt simple. Answering a message, the participant enjoyed the "like" or "dislike" because of the simple and fast way to answer. A preview of the message was desirable and the participant wanted a mailbox for received and sent messages.

The scenarios were performed simply and fast. The participant first tried to shake the prototype to take a picture. Later on, she understood it was not the right way and she pressed on the screen. The participant understood the mapping of the icons when interacting with the prototype. Answering a message, she found it difficult to choose between the envelopes on the edit screen but she chose the right one. The participants tried to press on the smiley to change it, but when nothing happened, she tried to draw on the screen.

## 9 Discussion

*The purpose with this chapter is to discuss and analyze the concept and the developed prototype and relate it to the purpose and goal.*

### 9.1 General Discussion of the Result

#### 9.1.1 Analysis of having Teenager as Design Partners

From the work carried out during this master thesis, it was perceived that having a design session with the intended end-users was rewarding. They gave useful information regarding how they communicate with each other and friends, but also their requirements on a product with focus on communication. The participants gave valuable ideas concerning the design of the device and they showed high commitment to the session.

After the session it was learnt that having four teenagers in one group was a good number. The test participants supported each other and at the same time it was easy for everyone to feel they could express themselves. It was tricky for the teenagers to think “outside the box” and to know what was expected of them, therefore it was learnt it is important to have an informal feeling. During the session, it was also found that it was a good idea to have scenarios as a base. These were to help the teenagers to know where to start and to have anything common to talk about. It can be a bit hard to start being creative therefore it is important to allocate enough time.

#### 9.1.2 Analysis of the Usability Evaluation

One idea that emerged during the design session was to use colors as a communication method. The two groups were divided regarding this type of method, one of the groups wanted to use color as a code-language with respect to the user’s privacy. The other group did not care as much about the privacy aspect. Therefore color was chosen as a function within a message but with the privacy in consideration. The user has the possibility to change color and the concept also detects which colors that are used between with different people when they are communicating. Therefore color can be seen as a code-language.

During the usability evaluation, the test participants enjoyed communicating beyond words, i.e. they perceived it simpler to express themselves by picture and symbols than using text. Developing a product with high usability is an important aspect to have in consideration when Generation Z represents the intended end-users. This

aspect was also enlightened by the participants during the usability evaluation since they felt the concept consisted of it.

The purpose with having two cameras is to make it easier for the user to express herself. The user will have the possibility to take a picture of both what is in front of her and on her expression. During the usability evaluation the participant took these pictures in two ways. A participant tried to take both pictures at the same time and some of them took the pictures one at a time. Both ways can be performed and it is the user who determines how to perform the actions.

A product which consists of iHCI can be seen as the upcoming technology and is well suited for wearable computing devices since it is worn on the body and is omnipresent. However, some of the participants felt the awareness of context and behavior as somewhat scary, which is also seen as one of the challenges with iHCI. During the discussion of the usability evaluation, the majority of the participants said they would accept it and saw it as “cool” and therefore would use the functions of iHCI. The main requirement they had were the possibility to control which functions to share.

Another aspect the participants mentioned during the usability evaluation was if they could trust the concept’s knowledge of the user’s behavior and context. This is also one challenge with iHCI, the accuracy and reliability when a computer determines the user’s context, behavior and needs.

The trickiest part during the usability evaluation, when interacting with the prototype, was to change the smile of the smiley. In the beginning it felt unnatural for the participants to draw on the screen in order to change the smile. However, in the end all of the participants understood how they should perform the gesture of drawing on the screen. This reaction was not seen as weird since the participants are used to interact with menus and settings through the use of cell phones. It was exciting to see how easily their behavior and way of interaction could be changed.

The growing trend with wearables and the participants’ thoughts and perceptions during the design session and the usability evaluation, show that there is a big area of use for the concept developed along with this thesis. The participants found the concept simplifying communication compared to their cell phones. However, they still saw it as a complement to their cell phones and not a replacer, which was a desired result.

During the usability evaluation, one of the participants thought she would only use the future device if her friends would use it. This thought can be related to social acceptance of the device and in the long run it may imply exclusion for those who do not own one. This can both be seen as a strength and a weakness with the concept.

Two functions, calling and email, were chosen to not be a part of this concept. The analysis of the surveys showed that the use of these functions have decreased during the past five years and will not likely be the main ways to communicate in the next five years. However, the participants of the design session said they wanted to be able to call and email from the future device. Since the thesis has its focus on

communication with pictures, symbols and color, the two functions were not seen as needed for the concept and its purpose.

There were no negative comments expressed during the usability evaluation about the size of the prototype, it was perceived as good and moderate. The visible information on the screen felt relevant for the participant, they did not miss any information.

Sharing the location through the concept was perceived as somewhat strenuous by the participants during the usability evaluation. They wanted to share their location depending on the situation and their context, which was already taken in consideration when developing the Lo-Fi prototype. The user of the future device can remove her location in a message and when deleted it will not be shared. However, when sending a message, for example in a hurry, the user may forget to delete the location if she wants to. This may put the user in an awkward situation depending on who the receiver of the message is.

### 9.1.3 Essential Characteristics of the Concept

During the work process of the thesis, three essential characteristics of the concept have been identified;

1. *Beyond using words*

Sending a message, the focus is on sharing feelings and experiences. The user has the possibility to share pictures, a smiley, a color and, if preferred, her location. This characteristic makes it possible for the user to express herself in new ways, by either sharing all parts of a message or just one of them. When two persons communicate with each other and have the same context, expressing themselves or showing something can be done easier by using only pictures. The known phrase “*a picture can say more than 1000 words*” can be seen as implemented in the concept.

2. *Spontaneous and easy*

When a user wants to communicate it can be done spontaneous and easy because of the placement of the future device. Having the future device omnipresent, the user only needs to take her arm in front of her and perform little interaction on future device. Therefore, the user can quickly send a message when feeling or seeing something she wants to share in that moment.

3. *Predetermined message*

The communication is based on the user’s context and behavior, this implies that the different parts of the message are predetermined along with user and the chosen receiver. This characteristic is considered to enhance the second characteristic since the awareness enables the user to send a message quickly. Having predetermined parts in the message, enables the user to only send one of them if desired, which also enhances the first characteristic.

Two of the characteristics, number 1 and 3, are applicable for a concept in a cell phone. All three characteristics together make the concept well suitable for a wearable computing device since it takes the user’s interaction and communication behavior to

a new level. The concept drives the user to not use words when communicating, instead the focus is on the user's feelings and experience in different situations. Involving iHCI in the concept and within a wearable computing device, it makes the user communicate even more spontaneously and instant than before. With the spontaneous communication and the focus on feelings and experience, the context of the user becomes more interesting. The context of a user will, with the concept, be one reason for having the communication behaviors of Generation Z altered. Each part within in the message can communicate more than words between two persons, depending on their contextual understanding. This change will be easier for Generation Z than previous generations, because of their already large use of smileys and abbreviations in messages.

### **9.2 Methodological Considerations**

The participants' results from the usability evaluation can have been affected by the level of the developed prototype. If a High-Fidelity prototype of the device was developed, the interaction with the prototype would have felt more real and somewhat similar to the end-product than interacting with a Lo-Fi prototype. Testing a Lo-Fi prototype requires more imagination of the participant and in some situations more understanding of the concept. During the usability evaluation, a majority of the participants found it hard to understand that the prototype consisted of two cameras and that they were displayed in the two camera squares, as shown in figure 7.3, on the screen when creating a message. This sometimes resulted in longer time of understanding by participants of the overall concept and how to take pictures.

Due to time limitations, the concept was only developed into a Lo-Fi prototype. This was considered as a good decision since the Lo-Fi prototype could be more detailed developed, but also that it could be attached to the body. The participants of the usability evaluation gave the impression to quickly understand its functions and how it should work in the reality, despite the level of prototype.

Having Generation Z representing the intended end-users of the concept, it is important to have their great experience of using applications in consideration when having them as design partners. During the design session, their experience affected their design of the device since they wanted it more "appified". They wanted the possibility to have application such as Spotify, Instagram and Facebook in the future device. Using intended end-users in the design process of the concept was a very good decision, they gave useful thoughts and ideas that were taken in consideration when developing the Lo-Fi prototype.

### **9.3 Relevance for the Industry**

One relevant aspect for the industry would be having the intended end-user involved throughout the design process of products. It can be valuable for the industry since it will help companies gain knowledge about the end-users and their needs. One problem of having the end-users involved may be the confidentiality, which is very important for companies.



Another aspect is how the concept takes wearable computing to the next level. Present wearable computing devices on the market are focused on health and wellness and simpler notifications. Therefore, it can be interesting to develop a device containing more functionality, which the participants in the usability evaluation also asked for. By adding more functionality to the device, it will be more attractive to a larger target group.

The thesis and the produced concept can help the industry to reach and to understand a new target group. Interesting for this group of end-users is that they have no problem sharing more information about themselves, which can open up for new possibilities when developing future devices.

#### **9.4 Future Work**

If the concept is developed into a High-Fidelity prototype, then the technical feasibility and the real feeling of the concept can be tested and evaluated. The work that has been carried out in the thesis shows a great potential for the concept. The end-users that have participated throughout the work thought the concept was “cool” and all of them would purchase it if it were launched on the market.

Other future work is to understand the technical requirements of the future wearable computing device. Within the work of this thesis, the technical possibilities were not taken in consideration. For example, the future device is assumed to have a bent and slim screen with high resolution and long battery time. It is also seen as robust with two cameras that can be fitted in to the wristband. The device is also developed as a standalone device that is still connected to a cell phone. It is also desirable to look at how iHCI can become technically feasible and implemented within the device.

The prototype of the concept displays a device that is shaped in rectangular form. The participants of the usability evaluation found the shape suitable and not too big. However, it is possible to have other shapes in consideration when developing the concept and its device further and also to look in to the technical feasibility. Due to the placement of the device, its screen is public for others. This is an aspect than can be taken advantage of. With this aspect, the future device can transmit information to its surroundings of the user, for example a smiley can be displayed on the screen in order to show the public the mood of the user.

During the thesis, the area of social acceptance for using wearables has been briefly studied. It was found that the participants during the design session and the usability evaluation could consider using a wearable on their arms. The participants felt it was important that the concept fulfilled a certain purpose to them in order for them to use it. Therefore, possible future work can be looking even more into the aspect of social acceptance, especially if a higher level of prototype is developed.

The concept can be developed further regarding its context awareness. One thought is that the concept will not only have knowledge about its user, it will also have knowledge about the contacts, for example of how they are feeling. Having information about the intended receiver in advance can open up for a user to start communicating even if she did not think about sending a message in the first place.



## 10 Conclusions

*The purpose with this chapter is to summarize the conclusions of the performed work.*

From the research and development of the concept and its Lo-fi prototype, it can be concluded that wearable computing devices are very suitable for Generation Z to use when communicating. Due to the developed concept's omnipresence, it supports the fast and spontaneous communication this generation uses. Having a concept where pictures, colors and smileys are in the center points for use, takes communication beyond only using words. The developed concept and its prototype have a new focus, which will take wearables to the next level. Sending two pictures in one message can make it easier for the user to express herself and this function will probably be implemented in future devices. It was also found that it is very important for Generation Z to be able to personalize the future device, for example by altering the theme within the device and by letting the user change her way of interacting with the device. This makes the aspect even more important to consider when designing a wearable. The lack of the possibility for the user to personalize the device will probably have a negative effect on the demand of the product.

Using iHCI as a part of the concept was found exciting and “cool”. It is well suited for wearable computing since the omnipresence of the future device will enrich people’s everyday life. The device developed as defined by the concept will have great knowledge of its user because of where it is worn, on the body. How Generation Z has grown up have affected how they embraced new technology compared to older generations. Having iHCI within the concept will simplify an already intensive communication performed by this generation and they will easily understand this progress of new technology.

## 10 Conclusions

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## Appendix A: Surveys

### A.1 Survey Distributed Online on Facebook

1. Födelseår: \_\_\_\_\_
  
2. Vilken typ av mobiltelefon hade du privat för 5 år sedan?  
 Mobiltelefon utan stöd för applikationer  
 Mobiltelefon med stöd för applikationer (Smartphone)  
 Annat alternativ: \_\_\_\_\_
  
3. Vilken typ av mobiltelefon har du privat idag?  
 Mobiltelefon utan stöd för applikationer  
 Mobiltelefon med stöd för applikationer (Smartphone)  
 Annat alternativ: \_\_\_\_\_
  
4. Ungefär hur många timmar om dagen använde du din mobiltelefon aktivt för 5år sedan?  
 0-2 h  
 3-5 h  
 6-8 h  
 9-11 h  
 >12 h
  
5. Ungefär hur många timmar om dagen använder du din mobiltelefon aktivt idag?  
 0-2 h  
 3-5 h  
 6-8 h

Appendix A: Surveys

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9-11 h

>12 h

6. På vilka sätt kommunicerade du med din mobiltelefon för 5 år sedan?

Mail

SMS

SMS-grupper

Ringa

Skicka bilder (T.ex. via MMS, Facebook, Instagram etc.)

Internet

Sociala Medier (ex. Facebook, Instagram, Twitter och YouTube)

Annat alternativ: \_\_\_\_\_

7. På vilka sätt kommunicerar du med din mobiltelefon idag?

Mail

SMS

SMS-grupper

Ringa

Skicka bilder (T.ex. via MMS, Facebook, Instagram etc.)

Internet

Sociala Medier (ex. Facebook, Instagram, Twitter och YouTube)

Annat alternativ: \_\_\_\_\_

8. När du delar med dig av bilder, på vilka medier delar du med dig av dessa då?

Facebook

Instagram

Snapchat

Whatsapp

MMS

Annat: \_\_\_\_\_

## A.2 Survey Distributed in School Class

1. På vilka sätt kommunicerar du med dina vänner via din mobiltelefon?

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2. Varför kommunicerar du med dina vänner via mobiltelefonen?

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3. När du skriver ett sms, består sms:et av mycket smileys?

- Ja  
 Ibland  
 Nej

4. Tycker du det är lättare att uttrycka dig med hjälp av smileys?

- Ja  
 Ibland  
 Nej

5. När du skriver sms, skriver du oftast förkortningar av ord?

- Ja  
 Ibland  
 Nej

Appendix A: Surveys

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6. Ungefär vad stod det i det senaste sms:et som din kompis skickade till dig?

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7. Varför använder du dig av sociala medier (Ex. Facebook, Twitter, Instagram osv.)?

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8. Like:ar du ofta vänners inlägg/kommentarer/meddelanden?

- Ja
- Ibland
- Nej

9. Brukar du tala om på sociala medier var du befinner dig, till exempel att du är hemma hos din vän eller när du är ute på stan?

- Ja
- Ibland
- Nej

10. Skulle du vilja veta var dina vänner befinner sig när du exempelvis kommer till skolan på morgonen?

- Ja
- Ibland
- Nej

11. Varför delar du med dig av bilder till dina vänner och de till dig?

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12. Vilka typer av bilder delar du och dina vänner med varandra? Exempelvis:  
Selfies, på vad du gör, spontana och/eller på saker du tycker är snygga m.m.

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## Appendix B: Document for the Design Session

### B.1 Manuscript for the Introduction

1. Hälsa alla välkomna!
2. Börja med en kort presentation om oss själva
3. Berätta vad vi läser och varför vi gör detta (Vi gör examensarbete på Sony)
4. För att presentera alla: Skriv ditt namn och rita ett djur som börjar på samma bokstav som ditt namn.
5. Fråga om deras fritidsintressen,
6. Hur mycket de använder sin mobil
7. Hade de kunnat vara utan sin mobil i en dag/vecka?
8. Berätta syftet med sessionen - LoFi och att vi kommer tillbaka
9. Berätta att det är bland annat så här man kan jobba som ingenjör och på det här sättet vi tar fram idéer och tankar på universitetet.
10. Poängtera att det är de som är våra experter.
11. Beskriv hur sessionen kommer se ut
12. Berätta om Ljud och bild!
13. Vi kan visa ett exempel på hur man kan göra under första scenariot
14. Frågor, oklarheter?! Förtydliga att det är ok att när som under tiden att ställa frågor. Det finns inga dumma frågor, är det något som är oklart är det vi som beskrivit något fel. Säg även att vi aldrig gjort detta innan och att de får vara med oss att utforska hur detta kan bli.

#### *Syfte med sessionen*

Ni ska i och med detta tillfälle hjälpa oss att ta fram ett koncept och lite av en design till hur man kan kommunicera med hjälp av teknik som man bär på kroppen för år 2020 och framåt. Detta innebär att ni inte behöver tänka på tekniska begränsningar. Ni ska hjälpa oss att ta fram en pryl som ni skulle vilja använda er av att kunna kommunicera enkelt och snabbt med varandra.

#### *Hur sessionen kommer se ut*

Ni kommer att jobba två och två utifrån 4 olika scenario som vi berättar för er, vi kommer under tiden att sitta med er som stöd och om ni har några frågor och funderingar. Framför er ser ni lite olika saker, med hjälp av dem ska ni, på det sättet som ni känner för och vill, bygga ihop och skapa funktioner (förklara vad en funktion är) som kan hjälpa till att få scenariot att fungera. Det finns inga rätt eller fel utan vi är intresserade av att se vad och hur ni vill prata med varandra.

Det kan handla om att ni vill använda er av en kamera att skicka bilder, kanske skicka färger som symboliserar något. Var inte rädda för att använda er av gester (ex. hur ni gör för att låsa upp telefonen), tryck, vibrationer osv. Ni kan göra nästintill vad som helst med det ni ser framför er: klippa, klistra, rita med mera och såklart använda sig av färger. Bara låt kreativiteten flöda. Ni ska utforma detta som ni önskar att en teknisk pryl kan vara i verkligheten! Kom ihåg att det är ni som är experterna!

### *Exempelscenario*

Caroline vill berätta för Sofia att hon är på väg för att möta upp Sofia. Caroline kör bil och kan därför inte använda sig av mobilen och spelar hög musik och kan därför inte prata eller höra.

### *Tidsschema*

<b>Tid (min)</b>	<b>Aktivitet</b>	<b>Detalj</b>
0-5	Intro	Presentation kort av oss plus rita bilder på djur med namn
5-10	Intro	Presentation av dagen, (Berätta syfte)
10-15	Intro	Visa byggstenar + gå igenom exempelscenario
15-	Brainstorming	Frågor från dem om något är oklart.
-100	Brainstorming	Scenario 1, och sen hinn med så många som möjligt, dock minst 2 st.
100-103	Diskussion	Fråga hur de upplevt det och tyck det gått
104 - 110	Diskussion	Frågor om de allmänna
110-115	Diskussion	Frågor om drömscenario
115-120	Diskussion	Avslut/allmänt prat om det vi gjort. Men "avslutat"

## **B.2 Scenarios**

### *B.2.1 Scenario 1*

Du fyller år idag och i morse fick du fina presenter, speciellt den där tröjan som du länge har spanat in på internet. Eftersom din kompis Sara vet att du länge velat ha denna tröja, vill du berätta för henne och visa att du fått just den. Du är på strålande humör och vill genast höra av dig, problemet är att du inte vill att dina föräldrar ska höra vad du säger till Sara och kan därför inte prata. Din telefon har du inte heller i närheten utan väljer att använda dig av den andra fina födelsedagspresenten, teknisk-bärbar-pryl.

Hur gör du för att visa din nya tröja för din kompis, och vilka typer av funktioner vill du använda för att visa den?



### *B.2.2 Scenario 2*

En dag när du går hem från skolan händer det mest konstiga du varit med om. Stålmannen trillar ner från himlen och landar precis framför dina fötter. Du blir såklart i chock men inser rätt snabbt att du måste berätta för din kompis att er idol står framför dig. Du har inte tid att ta fram telefonen som ligger längst ner i väskan, utan bestämmer dig för att använda din nya tekniska-bärbara-pryl.

Hur gör du för att dela med dig av denna händelse och känslan av att er idol står framför dig till din kompis via den nya prylen? Vilka typer av funktioner vill du använda dig av?

### *B.2.3 Scenario 3*

Du har precis blivit tillsammans med din pojkvän/flickvän och är bara sådär superduper kär. Du tänker på honom/henne i stort sett hela tiden, och att prata med honom/henne är något du vill göra konstant. Du vill nu höra av dig till honom/henne och bara visa att du tänker på honom/henne och att du är kär. Problemet är att du sitter på lektion och inte kan prata högt eller ta upp din mobiltelefon. Du får inte heller tappa uppmärksamheten för länge från läraren, då blir läraren nämligen inte glad på dig. Som tur var har du på dig din tekniska-bärbara-pryl som du kan använda dig av.

Hur gör du för att berätta dina känslor för din pojkvän/flickvän och att du tänker på honom/henne i just detta ögonblick med hjälp av prylen? Vilka funktioner vill du använda dig av?

### *B.2.4 Scenario 4*

Du är på väg till skolan en torsdag morgon och vill gärna möta upp din bästis utanför skolan. Ni ska nämligen gå till ett nytt klassrum som du inte hittar till och vill ha sällskap. Problemet är att du sitter på bussen och det är mycket ljud runt omkring dig, detta innebär att du inte kan prata eller höra. Telefonen ligger för långt ner i väskan och den orkar du inte ta upp, utan väljer att använda dig av din nya tekniska-bärbara-pryl.

Hur gör du för att fråga din kompis om ni kan mötas upp på busshållsplatsen och vilka typer av funktioner vill du använda för att dela med dig av mötesplats och tid?

### *B.2.5 Scenario 5*

Du ligger hemma i din säng och är jättesjuk, du har åkt på både halsfluss och feber. Din telefon ligger i andra sidan rummet och din pappa är på nedervåningen. Du skulle verkligen behöva ett glas vatten men är för sjuk för att röra dig samt att du har för ont i halsen för att prata. Som tur var har du en teknisk-bärbar-pryl på kroppen som du kan använda dig av för att få kontakt med din pappa och fråga om han kan komma upp med ett glas vatten.

Hur gör du för att fråga din pappa om ett glas vatten med hjälp av prylen och vilka funktioner vill du använda dig av?

### **B.3 Questions for the Discussion**

#### *Knyt ihop brainstormingen*

1. Hur tycker ni detta har varit?

#### *Block 1, Allmännt om produkten*

2. Vad tyckte ni var roligast?
3. Om det hade funnits en liknande riktig produkt likt de ni gjort under dagen, hade ni velat använda er av den då? - Vad är det som krävs för att få er att använda den på riktigt?
4. Vi hade en liknande testgång med några kompisar. De tyckte att det fanns några konstiga saker med att ha tekniken på sig som de inte riktigt gillade. Kan ni gissa vad?

#### *Block 2, Drömscenarion*

5. Om ni hade fått önska helt fritt över vad en produkt kan göra, utan tekniska begränsingar. Vad hade ni velat att den ska göra då?
6. Vad är det ni tycker är det absolut roligaste med er mobiltelefon idag, och hur hade ni velat utforma om det om ni hade fått möjligheten?

#### *Avslutning*

7. Avsluta sessionen inofficiellt
8. Prata fritt om vad de tycker och deras tankar osv.
9. Inget antecknande här, och stäng av ljudinspelning, men kom ihåg vad som de säger.

## Appendix C: Document for the Usability Evaluation

### C.1 Manuscript for the Introduction

1. Hälsa välkommen!
2. Berätta syftet med sessionen
3. Poängtera att det är eleven som är vår expert
4. Beskriv hur sessionen kommer se ut och att allt inte är “implementerat”
5. Frågor, oklarheter?! Förtydliga att det är ok att när som under tiden att ställa frågor. Det finns inga dumma frågor, är det något som är oklart är det vi som beskrivit något fel.

#### *Syfte med sessionen*

Du ska i och med denna gång hjälpa oss att testa och utvärdera den produkt som vi har skapat ut efter vi var här senast samt annan input vi har fått.

#### *Hur sessionen kommer se ut*

Du kommer få uppläst några scenarion (ett i taget) som du sedan kommer att få utföra. Det är viktigt att du vet att det inte finns några fel utan vi är intresserade av hur du upplever produkten som de ska testa. Vi hade uppskattat om du under tiden du utför respektive scenario kan tänka högt och berätta för oss hur du tänker.

Produkten som du kommer testa känner av var du befinner dig, hur du mår och vem du skickar meddelande till, vilket sedan kommer resultera i att meddelandet innehåller förutbestämd information och alltså ändras från gång till gång.

#### *Tidsschema*

Tid (min)	Aktivitet	Detalj
0-5	Intro	Presentation av sessionen
6-11	Scenario 1	Test av scenario 1
12-17	Scenario 2	Test av scenario 2
18-23	Scenario 3	Test av scenario 3
24-30	Diskussion	Allmän diskussion om prototypen

## C.2 Scenarios

### C.2.1 Scenario 1

Det är återigen måndag och du är på väg till skolan efter en otroligt rolig helg. Du går din vanliga väg och tittar ner i backen, helt plötsligt ser du att det ligger en sedel på marken någon meter framför dig. Självklart går du fram och tar upp den, det visar sig att det är en hundralapp. Det finns inga människor runt omkring dig så du bestämmer dig för att behålla den, detta gör dig såklart väldigt glad! Du vill fotografera den nyfunna vinsten och visa hur glad du plötsligt blev för din kompis, för att göra henne lite avis. Eftersom du har lite bråttom till skolan väljer du att använda dig av ditt nya smarta armband. Dock är det så att din kompis har sovmorgon och du inte vill störa henne, därför väljer du att inte skicka med någon vibration.

Hur gör du för att skicka detta meddelande för att du hittat en hundralapp, din glada min och samtidigt ta bort vibrationen i meddelandet? Låt resten utav delarna i meddelandet vara kvar.

Steg:

1. Välj kontakt bland favoriter
2. Ta kort med hjälp av kameran riktad från dig
3. Ta kort med hjälp av kameran riktad mot dig
4. Ta bort vibrationen
5. Skicka

### C.2.2 Scenario 2

Det är fredag eftermiddag och du sitter fast på lektionen i engelska. Det enda du kan tänka på är att om en timme är det helg. Helt plötsligt vibrerar ditt smarta armband till och du får ett meddelande av din vän. Det är så att hans sista lektion redan är slut och han är ute och cyklar. Hans meddelande innehåller även en smiley som är glad. Du vill svara honom genom att ändra munnen på smileyn till en sur min samt att dra ett kryss över bilden på att han är ute och cykla för att visa att du är kvar i skolan.

Hur gör du för att svara på detta meddelande genom att ändra minen till sur på smileyn samt att dra ett kryss över bilderna?

Steg:

1. Läs meddelandet
2. Gå till svarsalternativsskärmen
3. Välj att svara på det skickade meddelandet
4. Ändra minen på smileyn till att göra den sur
5. Dra ett kryss över bilderna
6. Skicka

### C.2.3 Scenario 3

Det är lördagsmorgon och dags att gå ner till frukosten, men innan du gör det bara måste du höra av dig till din bästis. Du vill berätta för henne att du är så glad eftersom

killen du är kär i skickade ett meddelande till dig igår som bara var så gulligt. Du har bråttom ner till frukostbordet eftersom mamma står och ropar på dig, samt att om din bästis svarar vill du se hennes svar direkt utan att behöva ta med dig mobilen ner. Du väljer därför att använda dig av ditt smarta armband som du har på dig. Det förvalda meddelandet tycker du inte stämmer helt på hur glad du känner dig och vill därför ändra smileyn. Resten av meddelandet vill du gärna ha som det är förbestämt.

Hur gör du för att skicka detta meddelande till din bästis och ändra smileyn till en som har hjärtan som ögon?

Steg:

1. Välj kontakt bland favoriter
2. Ändra smiley till en som har hjärtan som ögon
3. Skicka

### **C.3 Questions for the Discussion**

1. Hur upplevde du de olika scenariorna?
2. Vad tyckte du var roligt och intressant?
3. Vad upplevde du som jobbigt att genomföra?
4. Hur upplevde du att meddelandet var förinställt?
5. När något ska raderas, kändes det naturligt?
6. Skulle du vilja se meddelandet i sin helhet när de är skickat?
7. Tycker du det känns positivt att en produkt vet var du befinner dig, vem du skickar meddelanden till mest och vad dessa ofta innehåller?
8. Tycker du om att produkten vet hur du mår, till exempel när du ska höra av dig till en nära kompis?
9. Känner du att detta är något som du saknar att din mobil kan göra? Skulle du kunna tänka dig att använda en sådan här produkt i framtiden?



