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When I'm Sixty-Four

Exploring digital design solutions to enable elderly people to connect with the next generations

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Larissa Kalbhenn, BSc
Matrikelnummer 0512634

an der Fakultät für Informatik

der Technischen Universität Wien

Betreuung: Ao.Univ.Prof. Dipl.-Ing. Dr.techn. Peter Purgathofer
Mitwirkung: Dr.phil. Christopher Frauenberger

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Larissa Kalbhenn	Peter Purgathofer

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Larissa Kalbhenn, BSc
Registration Number 0512634

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Advisor: Ao.Univ.Prof. Dipl.-Ing. Dr.techn. Peter Purgathofer
Assistance: Dr.phil. Christopher Frauenberger

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Larissa Kalbhenn | Peter Purgathofer

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Larissa Kalbhenn, BSc
Burggasse 76/39, 1070 Wien

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Larissa Kalbhenn

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Kurzfassung

Die zwischenmenschliche Kommunikation hat sich in den letzten Jahren durch den vermehrten Einsatz von moderner Informations- und Kommunikationstechnologie (IKT) stark verändert. Neue Technologien ermöglichen es Momente im Leben augenblicklich mit unseren Freunden und im speziellen mit unseren Familien zu teilen. Besonders geographisch voneinander getrennt lebende Personen profitieren enorm von der neuen Art und Weise sich auszutauschen und können folglich stärker am Leben der anderen teilnehmen. Dem Großteil der älteren Generation fehlt allerdings nach wie vor der Anschluss an die digitale Welt und der gemeinsame Nenner zwischen der älteren und jüngeren Generation bleibt meist nur das Telefon. Die vorliegende Arbeit beschäftigt sich daher mit dem bisherigen Kommunikationsverhalten und den Hürden älterer Personen in Zusammenhang mit neuen Kommunikationstechnologien und verfolgt das Ziel die älteren Familienmitglieder stärker in das digitale Leben ihrer Nachkommen zu involvieren. Der hier vorgestellte Prototyp verfolgt den Ansatz eines *lightweight* Sofortnachrichtendienstes um einen neuen Kommunikationskanal für geographisch getrennte Familien zu etablieren. Um den Bedürfnissen und Erwartungen älterer Nutzern gerecht zu werden, wurde für das Design des Prototypen eine möglichst breite Auswahl an themenspezifischer Literatur herangezogen. Des Weiteren ist der Einsatz von qualitativen Forschungsmethoden ein wichtiger Bestandteil um den zukünftigen Nutzer besser kennenzulernen und herauszufinden ob und wie eine neue Technologie in dessen Leben passt. Der finale *high-fidelity* Prototyp für die älteren Benutzer, in Kombination mit der eigens entwickelten 'Companion' Applikation für die jüngeren Teilnehmer repräsentiert das Ergebnis der vorangegangenen Literaturrecherche und Designprozesses. Bei der abschließenden Evaluation mittels zweier Feldstudien stellte sich heraus, dass sich die neu geschaffene Kommunikationsbrücke zwischen den Generationen positiv auf das familiäre Zusammengehörigkeitsgefühl auswirkt und darüberhinaus die generationenübergreifende Kommunikation fördert.

Abstract

Contemporary information and communication technologies (ICT) greatly shaped the way we communicate nowadays. Communication technology empowers people to be more involved into each others lives and sharing moments has never been easier, especially for geographically distributed families. Unfortunately though, when it comes to technology adoption, elderly people continue to lag behind and intergenerational communication with remote family members is mostly limited to the telephone. This thesis therefore explores issues of technology adoption and attitudes towards communication with the aim to develop an accessible device that integrate older people into the digital lives of their descendants. The prototype promotes the concept of a lightweight instant messaging service and establishes a new communication channel for distance-separated multigenerational families. In order to create a design that meet elderly users' needs and expectations a broad spectrum of related literature is reviewed and qualitative research is conducted to collect individual and personal information in order to create an impression of the targeted user group and identify how technology can fit into their lives. Based on resulting design and user requirements, rapid prototyping techniques are used to illustrate and iterate design ideas and discover first design flaws. The final high-fidelity prototype for the elderly users, together with a custom developed counterpart app for the younger participants, represent the results of the conducted research and design process. Finally, the evaluation of the BK64 system by means of two different field studies suggests that the newly introduced communication modality has a positive impact on the feeling of togetherness and intergenerational communication habits within a distributed family with three or more generations.

Contents

CHAPTER 1

Introduction

1.1 Motivation & Problem Statement

The global population is transforming into an ageing society. Higher life expectancy due to progress in medical treatments and health care and a decline in fertility are leading reasons for the ongoing demographic change [SB11]. The vertical extension of family structures is one apparent effect resulting from this change. The number of living generations within a family has increased [SB11] [SB], however, these generations tend to live apart from each other and geographical distance adversely affect internal family communication. Elderly people have a strong desire to communicate and stay connected to people who are significantly important to them [LHS09] [AMAM14]. However, intergenerational communication with remote family members is mostly limited to the telephone which is cited as one of the most convenient approaches for communication [LHS09] [PD10] [JNK10]. Nonetheless, modern ICT devices e.g. smartphones or tablet computers and the accompanying software applications have greatly influenced the way we communicate. Lightweight communication, is characterised as a brief, spontaneous and informal exchange of information and is strongly shaped by the use of multimedia content. It has become an established communication modality amongst younger generations. Snapchat[1], Instagram[2] and WhatsApp[3] are just a few of the most successful and widespread platforms used for digital communication. A recent study by Vaterlaus et al. (2016) [VBRY16] reported that young adults' greatest motivation for using Snapchat is to keep in touch and connected to family and friends. However, smartphones or other modern ICT devices, coupled with software applications (i.e. apps) are not necessarily built with elderly people in mind and therefore tend to have lower usage rate among older people. Previous attempts [LHS09] [RMB+07] of narrowing the

[1]Snapchat: `https://www.snapchat.com/`
[2]Instagram: `https://www.instagram.com/`
[3]WhatsApp: `https://www.whatsapp.com/`

age-based digital divide demonstrated that senior people are in fact motivated to use unfamiliar and novel technology as long as a significant benefit is offered, whether in a physical, medical or emotional respect [AMAM14] [KC15] [HSN07].

This thesis explores characteristics of an elder person's life including age-related constraints and attitude towards communication with the aim of presenting design ideas which contribute to the research of intergenerational family ties and how they can be supported by novel technology. The central research question this master thesis wants to explore is: *Is it possible to create a digital bridge between the light-weighted communication habits of the younger generations and the traditional kind of communication of elderly people?*. Beside the general interest in the topic of connecting family members and enhance intergenerational family communication with the support of novel technology, the exploration of the topic is driven by the personal motivation to create an alternative to the present WhatsApp family group chat and involve the inexperienced and non-technical senior family members.

Nixplay

The rough idea for a master thesis project first came up early 2015. The challenge to involve an elderly person into some kind of modern digital communication without handing over a, to them, overly complicated smartphone, aroused interest to find a solution for this supposed 'problem'. We started a personal and informal study with a device called *nixplay*[4] which, after some research, we found in the internet. *nixplay* is a web-connected digital photo frame with the ability to receive images via a configured email account but does not provide a way to record or send back any data. We installed the device at the grandmother (86 years) of a friend and handed out the email address to some relatives. Ever since relatives send her images of different day-to-day situations and we noticed her increased well-being and happiness when looking at those pictures. However, we found that sending images via email is a quite ineffective way to share data within a personal context. At about the same time I noticed the increasing interest of my own grandparents in the shared data within our WhatsApp family chat group. This data has served as an additional inspiration for the master thesis at hand.

1.2 Aim of the Work

The aim of this work is to design and build a digital solution for elderly people to (re)connect with remote family members and provide a novel communication tool that addresses the needs and requirements of senior people. In order to support links across various generations e.g. grandparents and grandchildren and establish a usable and useful device that enables users' to exchange content in a simple and effortless way, similar to the present WhatsApp chat group, we need to get deeper insights into communication habits and gain a better understanding of general needs, expectations and limitations.

[4] *nixplay*: We used an early version of the device with the basic feature of receiving images via email. There are now newer versions available at: `https://www.nixplay.com`.

Not only it is crucial to address a wide range of age related impairments including decline of cognitive and physical abilities e.g. loss of vision and memory but furthermore it is important to consider motivational issues [AMAM14] [HSN07]. Anxiety, negative experiences and lack of support have made elderly people reluctant to use modern and unknown technology. The key for a successful and suitable design is to involve the end-user throughout the design process to ensure the design will not bypass their needs. Furthermore, the involvement and participation of family members who are members of the present WhatsApp group chat is an essential element of the research at hand and will significantly contribute to the design exploration and evaluation of the proposed prototype called: BK64[5].

However, the hypothesis is that the adoption of ICT technology can contribute to a senior's well-being and enhance lives of the older generations in a social respect. With a greater understanding of how to design for older adults and with the support of family members it is possible to minimize the age-based digital divide and involve older people into the digital lives of their children and grandchildren.

The exploration of the topic and the design process will take place in a personal family context, since one of the main motivations and inspirations behind this project was to engage an older family member into the current family communication habit. According to [GF13] being part of the context and including family members as participants can be beneficial since they are less reserved when it comes to telling the truth and reveal unmasked opinions. Nevertheless, in order to get a broader view on the research topic elderly people outside this personal context will be interviewed as well.

The focus of this master thesis is the exploration and discussion of possible solutions and the design process, rather than the technical implementation of the proposed result.

1.3 Structure of the Thesis

The chapters of the thesis are organised as follows: At the beginning chapter 2 identifies and discusses a broad range of related literature. This covers relevant research about the elderlys' general approach of ICT, means of communication and communication behaviour and design guidelines and issues that need to be addressed when designing for senior people. The literature review serves both as a good entry point to the exploration of the topic and as theoretical foundation which later guides design decisions. Chapter 3 illustrates the methodological approach of the thesis, outlining the basic strategy and motivations that led to specific applied method in the scope of this thesis. The following chapter 5 documents the practical phase of the thesis including the design process and development of the prototype. Different motivations, concepts and design decisions will be discussed and the system as a whole will be presented including the accompanying

[5]BK64 is an acronym derived from the name of our family group chat/last name of my grandparents: *Bastkowski* and my own last name *Kalbhenn*. 64 is part of the thesis' title and refers to the song *When I'm Sixty Four* published by *The Beatles* in 1967.

application: the Family Counterpart App (FCA). In chapter 6 the focus lies on the evaluation of the final prototype within two different settings and notable findings relating to the functionality and appearance of the prototype. The general results in reference to the initial research question will be discussed in chapter 7. Finally, chapter 8 concludes the thesis and outlines opportunities for future work.

CHAPTER 2

Related Work

The research and study of the relationship between elderly people and novel technology is rather small. However, due to an ongoing demographic shift of the world wide population the interest in senior people and their approach of technology has increased over the last years. The nature of the thesis topic suggests to consult a broad range of related literature. Therefore the literature review conducted in the subsequent chapter adopts a multidisciplinary approach to identify aspects which significantly contribute to the development of an applicable ICT device. Gerontology aspects provide information about the ageing process and the associated challenges which have to be considered when designing for senior users. Furthermore the general use of ICT devices, means of communication and communicational behaviour will be reviewed to identify attitudes of keeping in touch. Moreover, the review of previous attempts to connect distributed families provide valuable information about the design and deployment of new communication technologies. Finally, guidelines and implications for the design of products derived from the field of Human-Computer Interacion (HCI) and human factors and ergonomics will provide important aspects to create design that meet the users' needs.

2.1 Technology and the Ageing Society

2.1.1 Defining Old

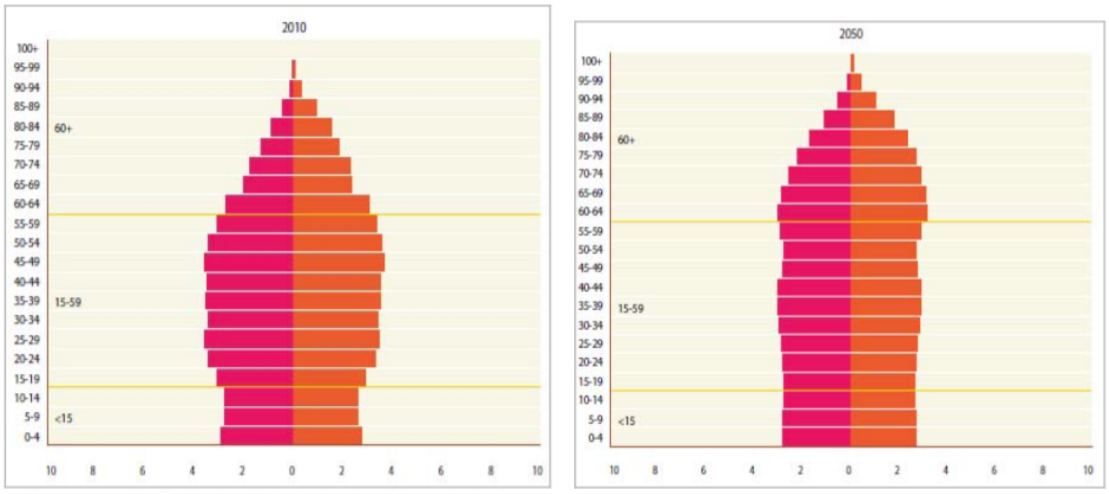
Although age classification varies and there is no typical old person, in developed countries the term *elderly* or *old person* is referred to a person with a chronological age of 65 and above. In gerontology older people are classified into subcategories. Older people aged between 65-74 are referred to as *young-old*, the term *middle-old* describes people between the age of 75-84 and the third subcategory *old-old* contains people aged 85 and above [Rei10]. However, the ageing process is not only defined by age, it is associated with new stages in ones life such as retirement or relocation to more appropriate housing.

According to the World Health Organisation (WHO) [Org] in the developed world the beginning of an old age is closely linked to the retirement age of 60 or 65. The definition and perception of being old is as much cultural as it is chronological. Research distinguishes between the biological, cognitive and social age [Spr11]. In an economical respect, the market of the elderly, called *Silver Market* is characterised as low income, resistant to changes and late innovation technology tool adaptors [Mos16].

Despite an official chronological age many senior people feel much younger than they are and do not like it to be called old or aged. Although they may notice the ageing process that includes changes in cognition, motor or sensory function, they want to be included and relevant to the modern society and remain active, productive and independent as much as possible.

2.1.2 Demographic change

Due to higher life expectancy and decreasing birthrate the global population is transforming into an ageing society. In 2015, one of eight people worldwide reached the age of 60 or above. By 2050, the amount of people aged 60 and above will outgrow the number of people aged under 15 [BMD05](see figure 2.1a and 2.1b). This demographic shift is cited as one of the most significant social transformations of the twenty-first century [Uni15]. Due to achievements and progress in medical treatments and health care people are living a longer and healthier life. However, the impacts and effects of this change are already visible and noticeable in the current society. The majority of the Generation X (born between 1963 and 1978) and a large proportion of the late bloomers (born between 1956 and 1964) have living parents.



(a) Year 2010 (b) Year 2050

Figure 2.1: Age Distribution Population in Developed Countries by the Year 2010 (a) and 2015 (b) [AMAM14]. Image soure: [AMAM14]

Although the number of living generations within a family has increased, these generations tend to live apart from each other [SB]. The concept of a multigenerational house became a real rarity nowadays. Older people are more likely to live at a considerable distance from their adult children and grandchildren.

People living a longer and healthier life. This longevity brings great benefits and many opportunities with it such as the pursuit of new hobbies or old passions. Nevertheless, due to an increasing average life expectancy and limited housing opportunities, *Ageing in place* is an emerging issue. Elderly people will live in their own homes for longer, particularly because of well-developed technical infrastructure and support. Technology enables people to live an independent life for a longer period and according to Kivimäki [Kiv15] the majority of all people prefer an independent life in a familiar and comfortable place for as along as possible before moving into an assisted-living facility.

2.1.3 Aged-based Digital divide

In the last years mobile technology became one of the most popular communication technology in the world. An increasing number of people own mobile devices such as smartphones or tablet computers. However, when it comes to technology adoption, elderly people continue to lag behind. The adoption of mobile technology among older people is not nearly as high as among people under the age of 65 [CGH+10]. According to Pieri et al. [PD10] only a small amount of elderly people are able to take advantage of the digital era and its countless possibilities. Only a happy few managed to join the trend and became a part of the information and communication technology ICT society. But the majority of the elderly have not been integrated within the information society sufficiently yet.

According to the Pew Research Center [Smi] there are mainly two types of senior technology adopters. The group of the *young old* are more of what you can call an early adopter. They are relatively well-equipped concerning ICT and basically have a positive attitude towards new technology. On the other hand, there are the disconnected elderlies. Due to a higher age and the resultant challenges with health and disabilities, this group is less likely to be connected to the world of digital tools and services compared to the *young olds*.

An increasing proportion of elderly people are eager to learn how to use new technology devices and become a *Silver Surfer*[1], respectively. But despite the growing adoption of ICT, the majority of elderly people remain isolated from the digital life and the digital information society. The level of experience of communication technologies between the older and the younger generations differs vastly. Updating a Twitter[2] feed or commenting pictures only by using hashtags e.g. *#beautifulday*, *#ootd*, may be as alien and absurd to older people as making phone calls with an old rotary phone is to younger people [LHS09]. However, researches have revealed that older people are not

[1] Silver surfer is a term to describe people over 50 who use the internet frequently.
[2] Twitter: https://twitter.com/

resistant to new technology [LHS09]. According to Mostaghel [Mos16] older people are in fact motivated and willing to use unknown technology that is affordable, accessible and usable. Furthermore, in order to adopt new technology a clear benefit must be offered. Increasing the elders interest in technology and the support from family and relatives is the next step toward adoption [Mos16] [CB09]. Azuddin et al. [AMAM14] stated that keeping in touch with their family is very important to older people. Therefore one of the main reasons to adopt new technology or use mobile devices is to communicate with family members and be updated about their lives.

The internet is a window to the world [Mos16]. It has become one of the most important medium for communication and information retrieval. But not only the internet itself provides powerful tools and ways to exchange data. Furthermore, smart devices such as smartphones and tablet computers using network connectivity to communicate have become an essential part of our everyday lives. Unfortunately this window remains closed for the major part of the people aged 65 and above. In a research of Blythe et al. [BM05] lack of suitable equipment and software for those with arthritis related problems, lack of training and technical support, the price of access, cultural and linguistic barriers and lack of assistance have been identified as the main barriers to internet access for older people.

Technology is playing an increasingly important role within our information society. But at the same time the older population is growing and it is important to include that part of the population into the digital progress and its benefits. Otherwise exclusion and non-access to mobile technology can be a significant handicap, socially and economically [MA13]. The digital divide or knowledge gap between the elderly and the younger generations is unlikely to be closed in the near future. Nevertheless, this gap will become smaller over time. The young generations still form the majority of technology users. Nonetheless, the older, especially the young-old generation will catch up.

2.1.4 Seniors view of ICT

[PS05] stated that each generation grows up and is influenced by specific types of technologies. The *generation of the household revolution* (born between 1939 and 1948) and the *generation of advanced household technology* (born between 1949 and 1964) for example, grew up with technology that changed and facilitated the daily housework such as refrigerators, washing machines and stoves and sustainably influenced their use and approach of technology in general [KS05]. In a study conducted by Pieri et al. [PD10] elderly people stated that 'old' technologies such as the mashing machine, dishwasher, radio and the VCR are valuable and necessary devices. Furthermore the TV is a fixed component and an integral part of day-to-day life of the elderly. They watch their favourite TV shows on a regular basis and have their fixed TV appointments. Surprisingly, 'invisible computers' including digital TVs and set-top boxes are acceptable and well received modern devices. Coleman et al. [CGH+10] argued that one reason why elderly people have less difficulties using them is, that they do not see them as being computers or advanced digital devices, but more like familiar technologies e.g.

old-fashioned TVs. The most important device, however, is the telephone and mobile phone, respectively.

A great proportion of the older generation has their own idea of young people today. According to some seniors, teenager and young adults spend all day in front of a computer, missing what's important in life and neglecting social relationships. However, elders do acknowledge the positive impact ICT can have on personal communication. They argue that ICT might be supportive for distant contacts but it does not help your relationship with your neighbour [PD10]. On the other hand they fear that the use of ICT may lower the level of direct face-to-face interactions.

Furthermore, ICT or technology that is designed to look after and protect them is not always in demand or desired by elderly people. *Safety first* is important, nevertheless, monitoring devices may undermine a persons dignity and sense of self-esteem [LHS09]. According to [LHS08], however, they do find delight in 'keep an eye on' the younger relatives. [LHS08] indicate that family ties are based on a more asymmetric approach where older people prefer to look into the lives of their offsprings, than vice versa. Although, this does not apply to every family, Lindley et al. [LHS08] advise to acknowledge possible existence of asymmetry within a family when designing products to support intergenerational relationships. Furthermore, designers may aim for a design that "*invite elders to initiate contact*" [LHS08] and trigger more heavyweight communication such as telephone calls.

Many senior people struggle with the use of mobile devices. Poor design, physical limitations and mental barriers have made them reluctant to explore and use modern technology, although modern ICT offers the possibility to keep them active in their work and community [PD10]. Support and help provided by family and friends is essential to enhance the adoption of modern technology among older generations. Furthermore new devices *"need to fit the social context of the home"* [LHS08]. Moreover, Coleman et al. [CGH+10] suggest that similarity to already familiar devices helps to raise the acceptance and overcome fear of the latest technology.

2.2 Traditional and Lightweight Communication

Aside from traditional and conventional communication technology ubiquitous computing becomes increasingly important. Mobile devices became an integral part of everyday life. Internet access, financial transitions and communication have never been easier and more convenient [AMAM14]. But the experience with modern technology by elderly people differs vastly to that from younger generations [LHS09]. The world seems to become smaller but on the other hand increasingly complex for senior people.

Younger generations live a digital online life, spending an increasingly amount of their time online and consuming digital media. The adoption of digital technology is much higher among younger people and their ICT skills are more profound compared to older adults [eSE17] [CGH+10]. Furthermore communication habits of teenagers and young

adults could not be any different in contrast to seniors. As mentioned before elderly people are motivated and willing to invest time and engage in relationships. They think that keeping in touch and stay connected involves dedication which requires a level of intensity [LHS09]. However, this contrasts sharply with the situation of the younger generation which increasingly adopts lightweight tools and lightweight communication patterns. From the viewpoint of teenager and young adults communication is *"constant, peripheral and transient, pervading but always short-lived"* [LHS09].

The telephone is cited as one of the most popular communication device among seniors due to its ease of use [LHS09] [PD10]. Alongside the traditional telephone, the ownership of cell phones increased. According to a Pew Research Center study [Smi] 77% of older American adults own a cell phone whereas the adoption level of smartphones is about 18%. While elderly people use mobile phones primary for phone calls and otherwise leave it turned off, younger generations make a more intensive use of it including: exchanging text messages, listening to music, stream movies and take pictures [PD10]. Smartphone applications such as Snapchat or Instagram are heavily used to take and edit photos in order to share it with a wide range of people described as *followers*. Younger generations seem to have unlimited ways to communicate their thoughts. Tweeting[3], blogging and uploading videos to YouTube[4] are additional examples of how teenager and young adults share content and communicate with their friends and followers. While older people restrict their online communication activity to email and basic web searches [CGH+10].

Lightweight communication can be described as brief, spontaneous and informal and is common among younger generations. It is significantly characterised by the use of multimedia objects such as pictures, videos or GIFs[5] [RMB+07] [LHS09]. Furthermore, abstract symbolic icons like emojis (see Figure 2.2) are a popular way to communicate feelings or activities. However, in a study investigating connectedness of family members conducted by Romero et al. [RMB+07], elderly people stated that abstract information e.g. symbolic icons or text labels, do not create a feeling of connectedness sufficiently. Whereas concrete content or information like thoughtful selected pictures and messages are highly valued.

Based on their research Romero et al. [RMB+07], developed a lightweight awareness system called ASTRA (see figure 2.3) that should enhance and support the feeling of connectedness between family members of different generations in a very light, simple and non intrusive way by exchanging pictures along with handwritten notes. The results of the study suggest that lightweight, asynchronous communication systems like ASTRA perfectly fit into busy and distributed families. Furthermore, users of ASTRA stated that they were able to share experiences which they would have never shared before. Moreover, exchanged data such as text messages and images which where sometimes considered as way too trivial, still managed to create feelings of connectedness.

[3]Twitter: https://twitter.com/
[4]YouTube: https://www.youtube.com/
[5]GIF: Graphics Interchange Format

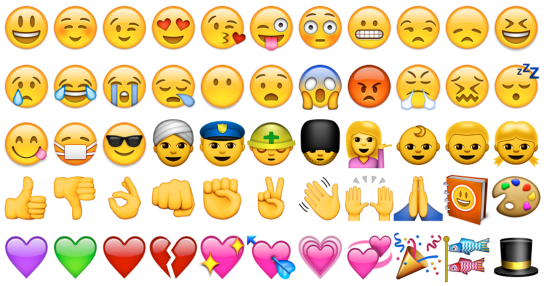


Figure 2.2: Collection of common emojis which are used to express feelings. Image soure: `http://getemoji.com/assets/og/mobile.png`

Figure 2.3: Sharing experiences with the ASTRA system: taking a picture while on the move, adding a handwritten note or sketch, receiving in a homebound device, viewing in a relaxed place [RMB+07]. Image soure: [RMB+07]

The results of several studies indicate that even lightweight forms of communication and contact offer benefits and are likely to be accepted by elderly people [LHS09] [RMB+07]. Even though they cannot replace face-to-face contacts or telephone calls, it is a good way to enhance existing and traditional ways of communication.

2.3 Attitudes to keeping in touch

Elderly people have a strong desire to communicate and keeping in touch with people they love and who are important to them. Unfortunately the process of ageing very often is accompanied by a decline of mobility, hence senior people are less able to leave their homes and socialize with friends and family or meet new people. Face-to-face social contacts become very rare, not least because of retirement or loss of the partner. Furthermore older people commonly do not live in near distance with their relatives which makes personal contact not easy. However, social interactions are vital for the well-being of the elderly and close relationships or *"access to significant relations"* [LHS08] are a principal contributing factor for a happier and healthier life. Shortcomings and absence of communication and connections may cause social isolation and loneliness. Loneliness is stated as one of the main factors of a reduced quality of life [Kiv15] [LHS09].

Lindley [LHS09] suggested that relationships that are emotionally meaningful to elderly people are the greatest source of motivation to invest time and engage in relationships, whether with friends or family. Older people want to partake in the lives of their children and grandchildren and be updated about but not limited to important life events and happenings e.g. childbirths. Furthermore seniors want to report about their own special life events the minute they happened and as soon as possible, respectively. However, they do not want to be annoying or become invasive. Participation and communication needs to be carefully managed without any major intrusion [LHS08] [LHS09]. Regarding their own lives, elderly people stated that they still have busy lives and like to manage and control their availability to others, based on the motto *There is a time and a place for communication*. However, they want to avoid that communication becomes obligatory. Some kind of a surprise factor included in communication habits is delightful and refreshing rather than routine conversations.

Personalisation of communication is very important to elderly people. Seniors appreciate and value the invested effort that is put into a personalised messages [RMB+07] [LHS09]. Personalisation can be obtained through the recognition of a familiar handwriting or a familiar voice. For example a handwritten Christmas card especially picked for the receiver is more precious and valuable than a digital e-mail. The importance of personalised communication could be reflected through voice as well. Seniors stated that if they have the intention to really communicate they call someone in order to hear their voice. In addition to personalisation, reciprocity is an essential issue. Being able to reciprocate and give something back in return is crucial to most elderly people [LHS09]. With respect to digital communication, they want to react on messages and not be limited to be the receiving part only in the communication process. Lindley et al. [LHS09] created an ICT concept *PersonCards* which displays lightweight data (e.g. images) on a situated device at an elder's home. They combine personalisation and reciprocity by giving the recipient the possibility to scribble personal written text messages on the screen and send it back. The concept of handwritten messages on screen was successfully adopted by another research study, called the *Family Window* [JNK10], with the aim to connect distance-separated families. Although participants used this feature mostly for just

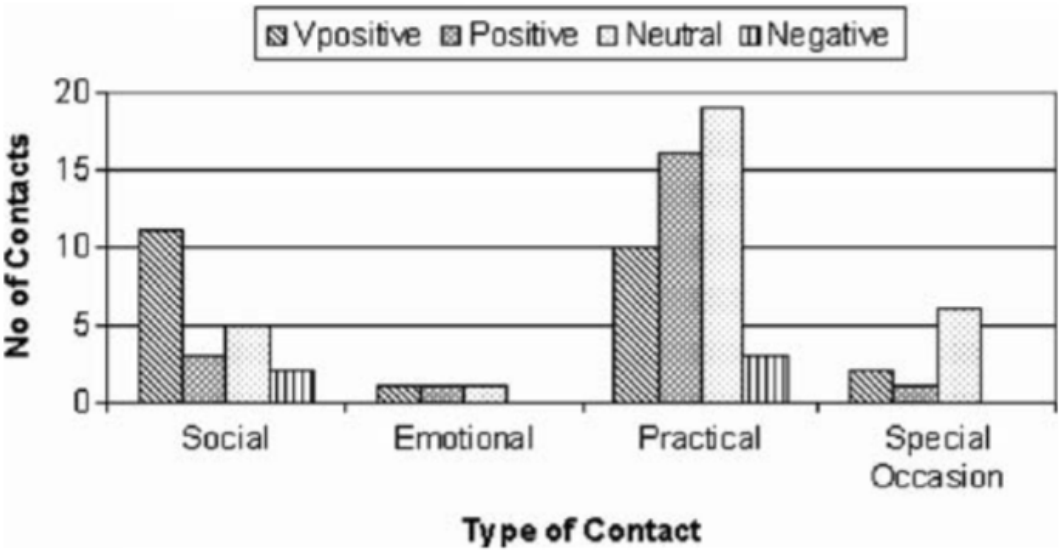


Figure 2.4: Different feelings associated with different kind of contacts. Positive feelings were more related to social contact than practical contact. Image soure: [RMB+07]

writing short messages throughout the day such as a quick 'Hi' or 'Good morning', this asynchronous form of communication was highly appreciated. In general, being able to give immediate response is important but at the same time elders need and want time to reflect before responding [LHS09].

Social and emotional communications where the initiator has a story to tell are far more appreciated than just seeking advice or occasional contact. Figure 2.4 illustrates the different feelings associated with different kind of contacts [RMB+07]. Social communications cause positive reaction, in contrast to practical contact which are perceived more negatively.

Romero et al. [RMB+07] described the phenomenon of after-effects of contacts. Positive emotions and feelings tend to stick around and linger in the background after a nice phone call or receiving a personal post card. They are not directly associated with the contact itself but leave a feeling of connectedness, being involved or feeling in touch.

Although seniors claim to have busier lives than ever they are willing to devote time to communication because staying in touch with beloved people is an important and necessary part of the daily activities of elderly people.

2.4 Age related changes and barriers

Access to software, the internet or mobile technology enables elderly people to maintain their autonomy. Unfortunately though, physical, cognitive and emotional barriers prevent the majority of older people from using new information and communication technology ()ICT). Due to the small number of elderly users their needs and requirements have just not been addressed sufficiently [KC15]. It is important that designers and developers understand their needs and limitations. They need to address a wide range of age related impairments including decline of cognitive and physical abilities e.g. loss of vision and memory [AMAM14] [HSN07]. Furthermore, the key to successful adoption and acceptance of new technology is the ease of use and learning [Spr11].

Although there is no typical old person and there is no standardised ageing process, ageing is a biological reality which everyone has to face in its very own dynamic. Generally, typical characteristics of the ageing process are decline of sensory performance, motor performance and cognitive performance [ZB05]. Gradual changes in e.g. vision, coordination and memory make it significantly more difficult or impossible for the elderly to use modern devices and software, respectively.

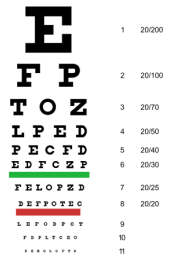
2.4.1 Physical changes

Visual impairment

One of the first sign of the ageing process in later life is the impairment of near-focus, called presbyopia. Due to the loss of elasticity of the lens the eye is no longer able to accommodate to focus on near objects sufficiently. The near point focus of a twenty year old person is 10 cm, compared to 100 cm of an elderly person in their seventies. Fortunately, presbyopia can be corrected with reading glasses or contact lenses. Commonly, people in their mid-forties start to notice changes in their visual ability [FMAH12] [Haw00].

At an older age the maximum opening width of the pupil decreases and less light is able to enter the eye. Due to the reduced opening width of the pupil older people need more light in order to see effectively and sharply. A 60-year old with normal vision needs almost twice as much illumination than a 20-year old person [FMAH12]. Sudden changes in lightning can be quite dangerous because the adaption to changes in illumination slows down with increasing age. Furthermore, elderly people need more time to adjust from indoor to outdoor light and vice versa.

By the age of 50 there is a significant decline in contrast sensitivity compared to a 20 year old person. Contrast sensitivity of the eye describes the ability of the visual system to detect differences in illumination levels and it is an important aspect of visual acuity. Despite normal visual acuity, diminished contrast sensitivity may cause decreased visual function. On the other hand, to compensate low vision, increasing the contrast between an object and its background will make the object more visible. A visual acuity chart e.g. Snellen chart figure 2.5a is used to determine a person's visual acuity, however, these charts are used under ideal contrast conditions e.g. black letters on white



(a) Snellen chart. Image soure: [Sne17]

(b) Pelli-Robinson chart. Image soure: [PW88]

Figure 2.5: Charts used to determine a person's visual acuit (Snellen chart) or deterioration in contrast sensitivity (Pelli-Robinson chart).

background [Ros]. Possible deterioration in contrast sensitivity can be demonstrated using e.g. the Pelli-Robinson chart figure 2.5b.

Furthermore, elderly people can face a reduced sensitivity to color. Especially in the blue-green potion of the light spectrum color perception diminishes and colours seem to look faded and dull [FMAH12] [Haw00]. Bright, warm colors such as orange and red are more easily distinguished by older adults.

Another problem that is very likely to emerge by the age of 60 is a reduction in the width of the visual field. The field narrows and the peripheral vision declines. Therefore peripheral stimuli must be stronger and/or closer the center of vision in order to be recognised.

Changes in hearing

The overall hearing ability declines with age. According to [FMAH12] 60% of the elderly people aged 55 and above face some sort of hearing impairment and 20% of the people older than 80 years require a hearing aid. Elderly people face greater difficulty in the perception of high-pitched sounds and interference from background noise [CB09]. Hence, following a female voice is likely to be more difficult than following a male voice because of the overall higher pitch [Haw00].

Older adults' ability to localise sound is reduced and discriminating speech from background noise is problematic. Conversations within a larger group can be frustrating, exhausting and quite a challenge to older people. Farage [FMAH12] stated that a common complain amongst elderly is that they can hear people talking but are unable to comprehend the words. As a result, many people avoid group situations, reduce their activities and prefer staying at home. Nevertheless, some use workarounds such as lip reading and context cues to understand what's being said.

Changes in touch sensitivity and motor performance

The sense of touch enables us to distinguish between objects and textures, localise touch events and perception of heat and cold [S+00]. While changes in hearing and decreased visual function are things to expect in later life, people are less aware of changes regarding touch sensitivity. The perception of touch, pressure and the ability to detect pain decreases with advancing age. Especially hands and feet have a reduced sensitivity to touch [FMAH12]. The majority of our daily activities rely on our sense of touch and a reduced ability to detect vibration, pressure and touch increases the risk of injuries. Lower pressure and touch sensitivity affect the placement and contact of the body with any surface. In regard of technology the sense of depression of keyboard keys or to operate and control small elevator buttons or touchscreens can be a great challenge.

Ageing is accompanied by motor dexterity and coordination limitations. Older people have difficulties to control, modulate and adjust the forces they apply resulting in a declined quality of handwriting [Haw00] [RH08]. Furthermore, the range of body motion is limited, muscle strength and function declines as well as their overall sense of balance. It is documented that motor responses and performance is slowing down with age resulting, among other things, in reduced smoothness of movement. Elderly people are very likely to suffer from stiffness and joint pain due to arthritis or other conditions. Because of that they have difficulties to grip and hold various surfaces. Additionally, as a consequence of slower reflexes a higher variability in reaction and movement time is needed [FMAH12] [RH08].

2.4.2 Changes in cognition and memory performance

Cognition and memory performance

Age-related changes in cognition vary across individuals and are not consistent across all cognitive domains. According to Riddle [Rid07] attention and memory are the most affected cognitive functions in the process of ageing. Attention is the ability to maintain focus on particular stimuli while disregarding irrelevant and competing information for the current task. Elderly people with decreased attention capacity have difficulties to inhibit competing information unrelated to their initial task resulting in a reduced speed of processing relevant information.

Given the amount and complexity of technology products, cognitive abilities are essential when a person is confronted with a new device or technology. To interact with and use a device or technical equipment properly, procedural knowledge stored in the long term memory is required. Procedural knowledge refers to knowledge exercised to accomplish a task and be aware of how and when to perform something e.g. in the man-machine interaction [ZB05]. Age-related deficits in procedural knowledge is very common amongst older people. However, long term memory tasks involving semantic memory which is responsible for general world knowledge such as historical facts, words and concepts, show very little decline. Although the access to information especially words and names can be slowed down, the organisation of the knowledge shows no significant change with

age [Rid07] [Haw00]. The average capacity of the short term of a young adults memory is about seven digits or items and only show little decline with age. However, tasks that require working memory can be significantly harder for seniors. Active manipulation and reorganisation of information held in the short term memory e.g. spelling backwards may be a challenge [FMAH12] [Rid07].

To perform daily tasks and activities we often use a combination of recognition and recall to support information retrieval from our memory. Recognition is the ability to recognise information or events due to familiarity of previously experienced events or encountered objects while recall is the ability to re-access information from the past stored in the long term memory [Bud]. Studies have shown that there is a significant decline in recall performance in the course of normal ageing whereas age-related declines in recognition are very little [Haw00]. According to Budiu [Bud] recall and recognition differ on the amount of cues that support memory retrieval. Since recognition uses more cues than recall it is a lot easier to recognise things rather than recall a piece of information.

The combination of genes, physical health and continued mental effort are key elements to maintain cognitive function. Being married, living with spouses or children not only prevent elderly from being socially isolated and improving quality of life but furthermore the support of family leads to better cognitive function levels. Bong [KC15] stated that being socially connected to family has, to some degree, a positive impact on cognitive ageing. Nevertheless, we cannot prevent the decline of cognitive performance entirely. Lowering the complexity of applications and devices and enhancing user interaction can contribute to a better design and successful adoption.

Psychological barriers

In the previous sections several physical barriers for the elderly using technology have been explained and discussed. Additional to physical barriers there are mental barriers that can prevent the ageing population from using and exploring modern technology. Mental barriers are those related to an individual's thoughts and attitudes and may be privacy and security concerns, fear of making mistakes, asking of assistance or lack of trust and knowledge, respectively [FDC+14] [Mos16]. Fischer [FDC+14] stated that privacy is one of the primary barriers that impede the adoption of ICT. Research showed that in the domain of health care e.g. health monitoring, some of the older adults will choose human support over technology [CB09] [FDC+14]. One reason for this is the fact that some monitoring devices collect and send personal and sensitive health data to caregivers or other health facilities which causes discomfort. Regarding communication tools and software Bong [KC15] mentioned that elderly people consider WhatsApp[6] as disclosing too much information e.g. 'last seen' information (Figure 2.6) and double tick indicators.

Norman [Nor13] stated that the majority of all people tend to falsely blame themselves when facing problems or difficulties while using technology. In the case of elderly

[6]WhatsApp: https://www.whatsapp.com

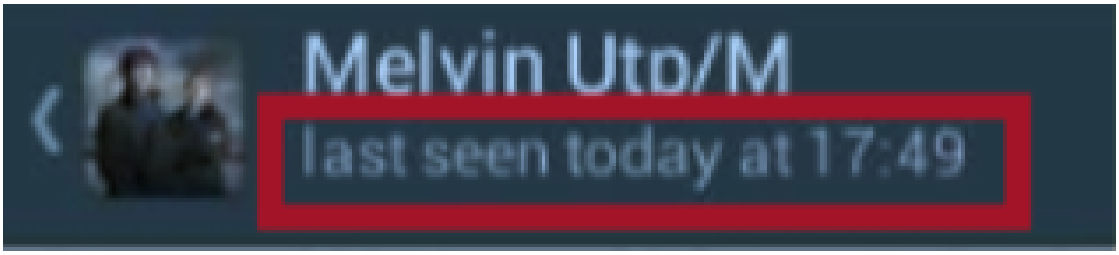


Figure 2.6: *last seen* information. Image soure: [KC15]

persons this problem is more common and severe. In a study conducted by Nielsen concerning senior web users, 90% of the older users blamed themselves when facing a problem compared to 58% of the younger users [Nie]. But instead of blaming the machine or technology people try to hide their failure or blame themselves for stupidity or incompetence. Additionally, the psychological barrier of asking for assistance prevent them from seeking advice or help and they may end up being frustrated and discouraged [Haw00] [FDC+14] [Nor13].

However, greater autonomy, improved quality of life and health outweigh psychological barriers such as privacy concerns that might prevent use. Furthermore, discussions, education and training can help to overcome mental barriers and facilitate the adoption of technology products.

2.5 Guidelines and implications for the design of ICT

Thoughtful design enables the user to understand instructions, to use a technical product as intended and to avoid possible hazards. But designing for an older population is a great challenge, both for the designer and user. Older people are unaware of technological possibilities and therefore cannot contribute to the design process as actively as the younger generation is able to do so. Furthermore, especially young designers have difficulties to empathize with elderly people and envisioning the obstacles and problems which could arise from physical or cognitive impairments [HSN07]. There are significant design factors that need to be considered when designing ICT applications and devices for the ageing population. In the following chapter design principles, guidelines and design implications are being presented and discussed.

2.5.1 Design principles

Designing for the older population or for people with special needs is often referred to as *universal design* [Nor13]. But, moreover, *universal design* means that everybody benefits or at least the design is accessible and usable by a large group of the population. To get started with any design project and create the best possible design solution and develop usable products that fits users needs, expectations and limitations Don Norman [Nor13]

proposed seven principles of design[7] listed in the following:

1. **Discoverability**: The user needs to be able to figure out what to do or how to use a product by interacting with it.
2. **Feedback**: Every action needs a reaction. Indicators like sounds or a spinning rainbow wheel notify the user that his action triggered something.
3. **Conceptual model**: A conceptual model is how user understands a system to work and how something should be done.
4. **Affordances**: Affordance of an object indicates the possible use and promote the desired action.
5. **Signifiers**: Signifiers serve as signs to indicate affordance.
6. **Mappings**: Mapping is used to indicate the relationship between e.g. controls and the corresponding actions.
7. **Constraints**: Constraints reduce the chance of errors, guide the users actions and provide information of what is possible.

As mentioned before Normans design principles are a good way to start any new design project and help to get things done the right way. However, to create a successful and ideal design solution tailored for elderly people Bong [KC15] suggested in his research to additionally consider further HCI principles based on the review and analysis in a research study of Hinze-Hoare [HH07].

1. **Recoverability**: Norman [Nor13] stated that everybody makes mistakes and errors are inevitable. Because of that designers should find and create design solutions on the assumption that people will make errors while using a product. Especially elderly people who are novice users are very likely to make mistakes. Therefore it is crucial to be able to recover from errors. The prevention of errors and the easy reversal of erroneous actions are two possibilities to achieve *Recoverability*.
2. **Familiarity**: Prior real-world knowledge and experience can be applied to new products to meet users expectations.
3. **Consistency**: Be consistent in the design of visual content and interaction to avoid cognitive overload and ensure that users do not have to learn new representations for each content or interaction especially regarding similar tasks.

[7] In his book *The Design of Everyday Things Revised and Expanded Edition* Don Norman updated and modified his design principles with this revised edition.

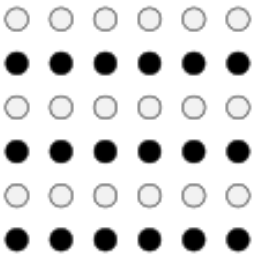


Figure 2.7: *Law of Similarity* states that similar objects perceived as one group of objects. Image soure: [Ges17]

4. **Substitutivity**: The user should be able to achieve or perform his desired action in different ways. For example elderly people should be able to choose between speech modality and touch modality for performing an input task.
5. **Task Migratablility**: The ability to move the performance or execution of a task between the user and the system. *Task migratablility* made spell-checking a lot easier for people.
6. **Synthesizability**: Synthesizability emphasizes the ability of the interface to allow users to construct a predictive mental model of how it operates [HH07]. The user is able to assess the effect of past actions.
7. **Predictability**: The user is able to determine the effect of future actions based on former interaction history. For example the user knows what will happen when he touches a specific button.
8. **Perceptual Ergonomics**: To design and ensure an efficient interface it is important to consider the way people perceive things. For example, avoid using the color blue if the user has a reduced sensitivity to the blue-green potion of the light spectrum.

In addition to the principles discussed above, similarity (Figure 2.7) and proximity (Figure 2.8) are important principles from *Gestalt psychology* which can help to create intuitive design solutions and ensure an effortless learning [KC15] [Nor13]. However, there are nearly endless tips, guidelines and principles in the field of HCI and it is not easy to obey them all. But in order to support and enhance the adoption of ICT by elderly people it is crucial to consider and apply as many as possible.

2.5.2 Design that meets the needs of older users

ICT and technology in general offers the potential to simplify the daily life. Not only technology can make people's lives easier and more pleasant, but furthermore new

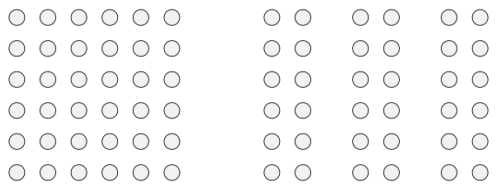


Figure 2.8: *Law of Proximity* states that a collection of objects which are close to each other perceived as one group of objects. Image soure: [Ges17]

technology products provide increased benefits for everybody, especially for the ageing population. Elderly people have a strong desire to communicate and keeping in touch with people they love [LHS09] and, fortunately, communication with friends and family has never been easier thanks to digital and modern technology. However, increased complexity of technology products and design that bypass the needs of elderly people increases their frustration level. In this chapter a few design implications and recommendations are being presented in order to help senior users overcome physical and cognitive barriers, to prevent frustration and to make products accessible and usable for the older generations in our society.

Good design should not only be visual appealing but more important it should be able to accommodate various physical and cognitive limitations. Due to visual impairments it is important to keep designs simple and avoid over-designed interfaces. Irrelevant decorative graphics or animations distract older people from the main task. However, indicators for feedback or changes should be obvious and easy to detect. Several research studies suggest that text should use sans-serif fonts with a minimum font size of 12 point to guarantee readability [Nie] [Haw00] [FMAH12]. Elderly people require a higher contrast to differentiate between fore- and background e.g. black text on white background is a good way to address this issue. If coloured text or graphics are used to highlight information short-wavelength colors like blue-green tones should be avoided. Instead warm colors like red or orange are more suitable to convey information. Furthermore, icons should be tested beforehand to avoid misinterpretation and ensure information is conveyed as intended by the designer. To illustrate the purpose of an icon or button and improve the affordance designers should make use of additional textual description. However, textual descriptions or any other text should be translated into the users native language. Designers cannot assume that everyone is able to understand English. Furthermore technical jargon should be avoided [PD10].

Due to the reduced opening width of the pupil it is important to provide strong illumination. Unfortunately higher illumination can increase glare and decrease a seniors ability to see. To control glare and at the same time provide perfect light conditions it is advisable to use diffuse light sources that distribute light evenly instead of direct light sources. Furthermore, a matte surface or anti-glare filters can help to avoid and minimise glare, respectively [FMAH12] [S$^+$00] [Haw00].

Interfaces or devices that use sound to convey information or get the users attention should use sound signals of at least 60 dB with a minimum duration of 0.5 seconds. Background noise should be eliminated or kept to a minimum while presenting an audio signal or message [FMAH12] [S+00]. As mentioned before, elderly people sometimes rely on lip reading to follow and understand a conversation. Hence, voice messages or devices that use computer generated speech can be problematic, therefore simple instructions and brief messages are preferred. Last but not least volume should be adjustable.

Age-related changes in motor and sensory skills can affect elders ability to explore and use technology. Simple and discrete movements should be supported rather than fast and repetitive sequence of actions. Required speed of double clicks and mouse movements should be adjustable and adapted to the user [FMAH12] [Haw00]. Due to reduced touch sensitivity and motor coordination devices should have a large and textured surface in order to have a good grip and feel vibration. To compensate declined touch and pressure sensitivity an additional audio signal can indicate and reinforce a successful button or computer key action.

Simple and intuitive interfaces are recommended when targeting an older audience. According to a research study conducted by Farage [FMAH12] simplicity, intuitive logic, moderate pace and a minimum of non-relevant information are key factors for presenting information to older people. To avoid cognitive overload and reduce complexity of a task it should consist of just a few simple steps rather than a big sequence of activities.

Menu navigation can be a great challenge for everybody especially for older people with cognitive difficulties. Menus are collections of categories and features that, in best case, should help the user to find features provided by the system. Therefore it is recommended to use one level navigation and create menus with less options and less menu items, which means less to scan, less to understand and less to get wrong [FJ] [NA]. *Mega menus* can be a way to improve the navigation of a website or application and help users explore and find relevant information and tasks. But on the other hand they may cause major difficulties especially for people with low-vision. Therefore Nielsen et al. [NA] advise designers to *keep it simple*[8] and avoid navigation changes. Fletcher et al. [FJ] stated that it can be helpful and supportive to show elderly people a spatial map of the menu to become familiarized with the navigation and relieve the users working memory by making use of recognition rather than recall [Haw00].

Another issue that should be considered by designers is the right choice of the most appropriate input device. According to a research study conducted by Wood et al. [WWR+05] both direct and indirect input devices have their advantages and disadvantages, challenges and opportunities. Based on previous research direct input devices such as touch screens are considered to be less cognitive demanding, have reduced coordination requirements and therefore easier to use for seniors. Whereas a mouse as an indirect input device requires fine and fast motor skills for double clicking and the ability to coordinate spatial information, hand-eye coordination and finger dexterity. The removed indirect input

[8] K.I.S.S principle: `https://en.wikipedia.org/wiki/KISS_principle`

device from the task can be cognitive challenging but on the other hand the use of a touchscreen may cause physical fatigue.

However, it is important to support seniors during their initial use of ICT and provide optimal introduction and learning instructions. Because, no matter how simple the design of new technology might be, it is never simple for technological inexperienced people [LHS09]. Wood et al. [WWR+05] stated that the first experience and first positive impression with any technology product can be essential for further use and technology engagement.

CHAPTER 3

Methodology

In the methods section of the thesis all methods which have been applied in context of the master thesis will be introduced and the underlying motivations for the choice of specific research methods and their design will be outlined. In the original proposal of the master thesis I envisaged the adoption of a participatory design approach for the research process with the motivation to enhance the usability and utility of the product through co-design sessions in collaboration with the future user. During the initial ethnographic research, however, it emerged that Participatory Design (PD) where the user takes active roles in design activities such as joint paper-prototyping sessions would not constitute meaningful information in this context. The agile nature of the exploratory research process regarding its flexibility and adaptability allowed me to change the subsequent procedure and instead of a PD, the study aimed for a more user-centered approach.

The exploratory research took place in a personal family context. Working within a family setting is both, challenging but in many ways offers possibilities which cannot be fully utilized and exploited within a more formal context. According to [GF13] being part of the context and having family members as participants can be beneficial and advantageous since they are less reserved when it comes to telling the truth or unmasked opinions. Nevertheless, in order to get a broader view on the research topic elderly people outside this personal context participated in certain research activities i.e. interview, evaluation.

Figure 3.1 illustrates the methodological approach, applied qualitative methods and tasks of the thesis in chronological order. The methods such as Cultural Probes in combination with observation, qualitative interviews and evaluation will be discussed in more detail subsequently.

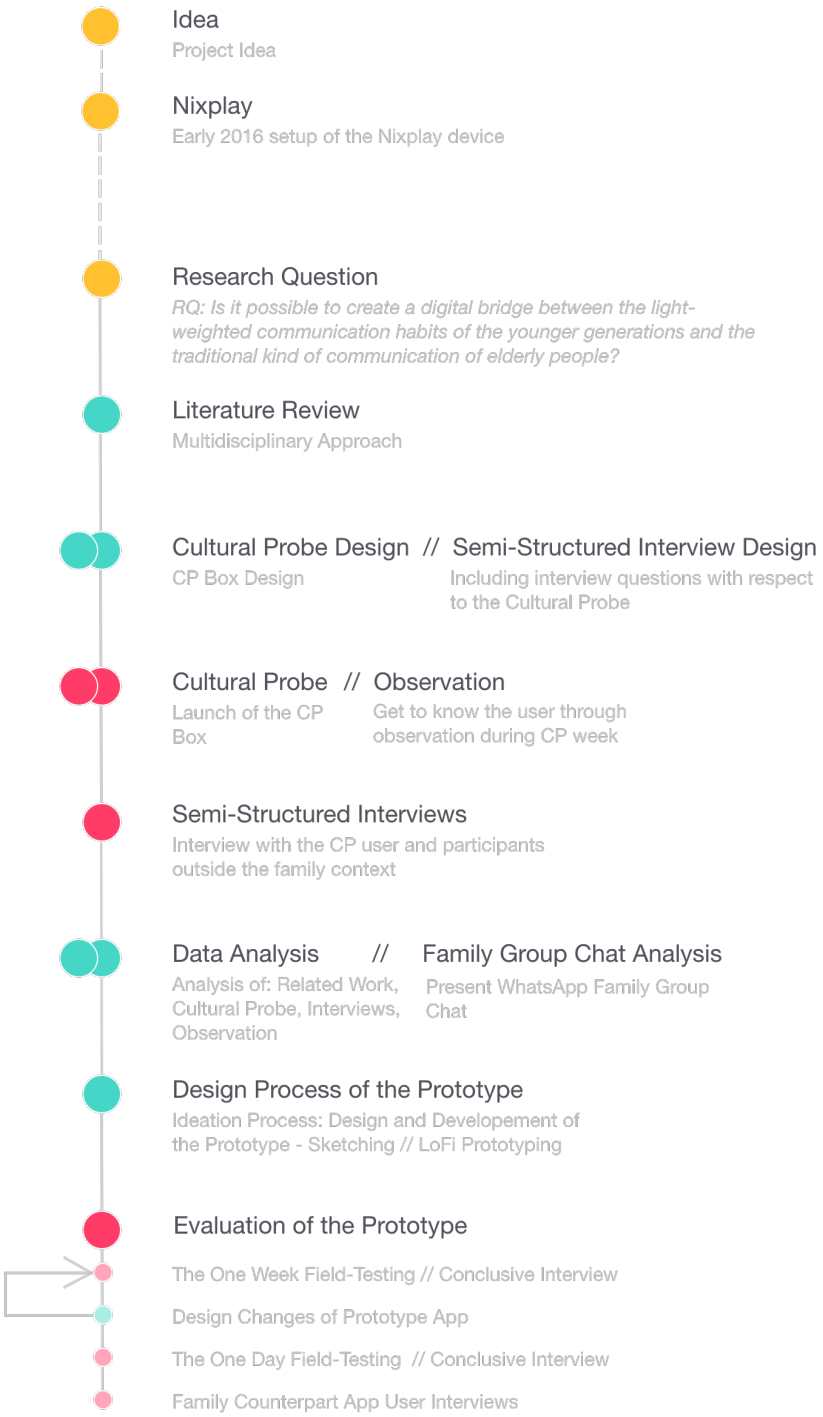


Figure 3.1: Methodological approach.

3.1 Cultural Probes

Cultural Probes Cultural Probes (CP) are designed objects, packages or boxes containing open-ended, unrestricted and provocative tasks and items to support user engagement in an early-stage design phase [BVSD07] [GDP99]. They often apply digital or disposal cameras, diaries, postcards and crafting supplies such as color pencils, glue and highlighters. With the help of CP the researcher or designer can gain insight into how technology or any other product can fit (or why it may not fit) into a particular surrounding [WSP+12]. They are designed to provoke enriching, inspirational and latent responses from participating users in an unobtrusive way. [SCB16] argue that one of the greatest strength of CP is to reveal individual and personal data which enables the designer to create an impression of the user. In the context of this master thesis, Cultural Probes were used with the intention to create an impression of the close relative (grandmother) as a user and as a non-relative person to learn more about the user's general values, interests and attitudes. The CPs and a follow-up interview provided the needed inspirational data for the prototype development.

The probes were launched and introduced during an informal meeting within a familiar and friendly atmosphere. A brief introduction and explanation of the general thesis topic provided the user with a small impression, but without revealing too much in order to avoid strong influence. During the session the materials and suggested activities were reviewed and an example diary entry were carried out together. Nevertheless, information and instructions were kept to a minimum to encourage any kind of future interaction with the provided material. When introducing the CP-box I emphasised that the use of the probes was optional and that the participant was free to choose which and how many tasks they wanted to do. The family relationship to the participant allowed me to stay there during the one-week task and simultaneously observe and document the behaviour of the participant working on the CP on the one hand and general daily routine and tasks on the other.

3.1.1 Design

The design of the CP-box started with a sketching and scribble session to illustrate and refine ideas and thoughts behind this task. The box (see figure 3.2) included a set of different materials such as: crafting supplies, a digital and disposable camera, a diary, a photo album and a collection of adjectives. The probes were designed for an initial one week short-term research in combination with informal observation and a second open-ended *light*-box version containing only the cameras and the photo album. A detailed description of all individual materials are listed in the following:

Cameras The box included one disposable camera and one old digital camera which was similar to the one the participant already owned and knew how to handle. Since older people are not familiar with disposable cameras, the digital camera served as a backup device. Communication through multimedia objects is a key

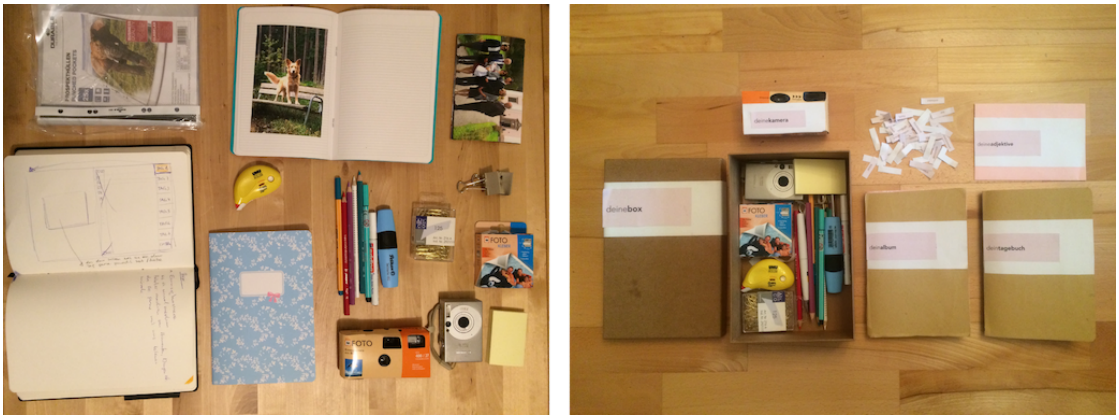


Figure 3.2: Material and crafting supplies used for the Cultural Probe box in the context of this master thesis (left) and box ready to use (right).

aspect of this thesis. The expected camera data should have provided information about things or events that are important for the participant and are worth taking pictures of. It was emphasised that any picture is a good picture.

Crafting Supplies Pens, highlighter, glue, paper clips and Post-its[1] were added to provoke creativity and imagination.

Photo album This photo booklet was a collection of pictures which were previously shared in the family *WhatsApp*[2] group chat and the participant (grandmother) is not member of. To each image in the photo album a question sheet was attached (see figure 3.3 (left)). The motivation behind this booklet was to gain information about the users thoughts and feelings about the shared media data within the family group chat. Again all suggested tasks were not mandatory.

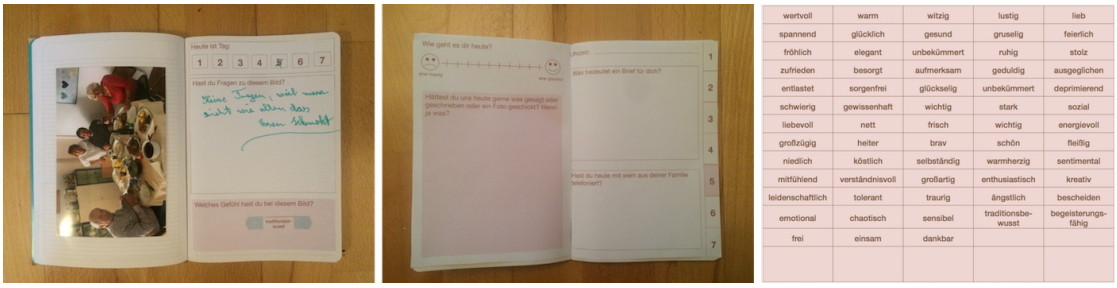
Diary The diary was designed to record daily feelings and communication activities. Additionally each day of the diary included one different question such as: *What does family mean to you?*. See figure 3.3 (middle) for an example of a daily page. The intention was to encourage the user to think about what events or items affects them in both, positive and negative ways.

Adjectives A set of adjectives were added to describe feelings, thoughts or events and associations within the photo album, the diary or else where (see figure 3.3 (right)).

3.1.2 Conclusion

Cultural Probes can help to create a rich picture of the lives and experiences of older people. It is a convenient method to understand and explore the design situation and

[1] Post-it: `http://www.post-it.com/3M/en_US/post-it/`
[2] WhatsApp: `https://www.whatsapp.com/`



wertvoll	warm	witzig	lustig	lieb
spannend	glücklich	gesund	gruselig	feierlich
fröhlich	elegant	unbekümmert	ruhig	stolz
zufrieden	besorgt	aufmerksam	geduldig	ausgeglichen
entlastet	sorgenfrei	glückselig	unbekümmert	deprimierend
schwierig	gewissenhaft	wichtig	stark	sozial
liebevoll	nett	frisch	wichtig	energievoll
großzügig	heiter	brav	schön	fleißig
niedlich	köstlich	selbständig	warmherzig	sentimental
mitfühlend	verständnisvoll	großartig	enthusiastisch	kreativ
leidenschaftlich	tolerant	traurig	ängstlich	bescheiden
emotional	chaotisch	sensibel	traditionsbe-wusst	begeisterungs-fähig
frei	einsam	dankbar		

Figure 3.3: Left: *deinAlbum*: Sample page of the included photo album. Middle: *deinTagebuch* sample page. Right: german adjectives

enrich the design and development of a technology product. However, the application of probes may be constrained by physical, cognitive and attitudinal barriers of the senior participants [WSP+12].

In context of this thesis the use of CP alone seemed not to be an appropriate and very revealing qualitative method in the very first moment. When collaborating with older family members there seem to be a fine line between working on assignments out of interest and out of love or kindness for the relative who concurrently is the designer. However, the probes in combination with a follow-up semi-structured interview and non-intrusive observation have been an invaluable part of the exploration process. The combination of cultural probes and observation provided great insights on the way in which things are getting done, rather than just presenting answers and results of the given tasks. Although the design of the prototype is not entirely dictated by probe results, they did have influence and facilitated later design decisions which will be mentioned in chapter 4.

3.2 Qualitative Interviews

Qualitative interviews have proved to be a useful method for gathering data about the users' believes, thoughts and opinions. By listening to what people say researchers are able to discover their explicit knowledge i.e. "*what they are able to express in words*" [BNS02] about the topic of interest. With regard to the thesis at hand, three semi-structured interviews were conducted to collect information about general usage of ICT, communication habits and preferences and expectations or wishes for a new device. Furthermore, some questions were designed to address personalized/person-specific issues such as the attitude of one interviewee towards the WhatsApp family group chat or the opinion of another interviewee about the *nixplay* device. The questions were drafted in plain language without using technical terms and the scheduled duration of one interview was about 30 minutes. The findings from the interviews which influenced and shaped the later design of the prototype are mentioned at the respective position within the design process (see chapter 4). Additional conclusive interviews with participants of the two field studies (BK64 user, FCA user) in order to conclude the evaluation phase revealed

opinions, problems and inspirational data about the entire BK64 system. See chapter 5 for detailed information about the users' experiences with the new communication system.

3.3 Rapid Prototyping and Hi-Fi Prototypes

If we are about to design a completely new product, it is essential to consider different and alternative solutions. The first idea is not likely to be the best one [Har17], therefore it is important to be creative and generate as many design solutions as possible, individually or as a team [RHR16] [Har17]. Afterwards, in order to create a useful and usable product, various goals and benefits of an idea will be combined, improved or rejected. The ideation process can be highly diverse and can take a variety of forms. Rapid prototyping can be an effective way during ideation to organise thoughts and externalize the possible ideas in the mind of any stakeholder in a quick and cheap way [RHR16]. The designer is able to generate more ideas, quickly get rid of the bad ones and discover or refine the best solutions.

Walker et al. [WTL02] describe prototypes as working models built to develop and test design ideas. The choice of prototype vary greatly depending on the intention of the designer. Low-fidelity prototypes are often used within an early-stage design process. They need less time to prepare and are suitable for quick iterations and modifications. Chapter chapter 4 demonstrates the ideation or brainstorming phase using rapid prototyping techniques such as sketches and lo-fi prototypes. After the analysis of the existing data, sketches and lo-fi prototypes were created[3] to illustrate and discuss various design ideas. Furthermore, sketching has been applied at the stage of developing the Cultural Probes and to illustrate and validate some thoughts during the prototype implementation and coding sessions. Sketching can be used at any stage of a design process because Bill Buxton [Bux07] stated that the importance of sketching is in the activity itself and not so much the resulting artefact (the sketch) or a pretty picture.

High-fidelity (Hi-Fi) prototypes are better for testing realistic interactions, workflow design and User Interface (UI) components [WTL02] [Per16]. Hi-fi prototypes already display strong similarities to the final product, whereas lo-fi prototypes are used to represent a conceptual model without full functionality [WTL02] [Chr16]. Walker et al. [WTL02], however, argue that low- and high-fidelity prototypes are equally good at discovering usability issues and design flaws. The final prototype built within this thesis is a fully functional hi-fi prototype build with technologies such as Swift[4] and *Arduino*[5] (C/C++).

[3] Lo-fi prototypes were created using the wireframe tool *balsamiq*: `Mockuptoolbalsamiq:https://balsamiq.com/`.

[4] Swift: `https://developer.apple.com/swift/`

[5] Arduino: `https://www.arduino.cc/`

3.4 Evaluation of the Prototype

The final prototype represented and concretised results of the initial exploration phase and design process. The focus of the evaluation was to identify if the developed ICT hardware device and corresponding software application can create a useable and useful digital bridge between different generations with different communication habits and may represent an alternative to the current family group chat. The prototype was first tested within a one-week real-world setting including 9 persons (see table 3.1). The family environment of this study allowed me to additionally carry out non-intrusive observation through out the entire field test. To enhance the real-world aspect a second iOS application was developed and handed out to all participating family members (7 people). Follow-up semi-structured interviews and informal discussions with both, the main user and the participating family members provided details and attitudes towards the digital solution developed in the context of this master thesis. The logging data recorded by custom log events using *Firebase Analytics* unfortunately was not really usable because an unnoticed implementation error caused incomplete log events of the users' interaction with the BK64 device and activities within the app. After a small design iteration of the BK64 software application, the device was tested in a one-day field study with another potential, non-related future user of the system. The second field study focused on the evaluation of usability issues and differences to the *nixplay* device. See chapter chapter 5 *Evaluation of the Prototype* for detailed information about the evaluation process.

Table 3.1: Participating family members.

Participant	**Age**	**Family member**	**WhatsApp group chat member**
Participant A	85	Grandfather	No
Participant B	80	Grandmother	No
Participant C	60	Daughter	Yes
Participant D	58	Daughter	Yes
Participant E	48	Son	Yes
Participant F	35	Grandson	Yes
Participant G	33	Grandson	Yes
Participant H	29	Granddaughter	Yes
Participant I	29	Granddaughter	Yes

CHAPTER 4

Design & Development of the Prototype

4.1 Data Analysis

Well-designed products are more than just pretty looking devices. The overall aim is to create a useful and usable ICT device that offers functionality and an appealing look. The data analysis of the literature review (chapter 2 *Related Work*) and the applied research methods (chapter 3 *Methodology*) was a key factor to elaborate first requirements for a successful design. The gathered knowledge about how to design for elderly people from the literature review was used to identify wishes and interpret statements from the interviewees and CP user. The major outcome of the research, however, was the (unexpressed) need for greater involvement and participation in the relatives' modern communication and lives. The *nixplay* user, for example, talked about the graduation of a friend of her grandson at which she was invited but could not partake in person and received live-images via *nixplay* instead (*"I enjoyed the celebration ... I am simply happy when I am able to participate"*). Another interviewee talked about how the WhatsApp group chat negatively influenced the flow of communication: *"If I want to tell my daughter the latest news she often cuts me off and tells me she already knows everything from the chat group. ... I am pretty much excluded"*. However, all participants tend to call a family member almost every single day, which indicates a strong desire for family contact.

As mentioned before in chapter chapter 3 *Methodology* the use of Cultural Probes in combination with the observation and a follow-up interview created useful data that shaped design of the BK64 system. One of the most important insights from the CP week was that the user (participant B) felt quite insecure when writing down notes in the CP booklet and kept asking me if the spelling of the word is correct, even though I emphasised that correct spelling is not important in this context and no one will see these notes. Moreover, I noticed that due to reduced manual dexterity, producing textual

notes was a challenging task for the elderly participant. The idea of focusing on media objects rather than text based messages was further supported by the user's notes in the CP booklet. For example, the question: *What does photos mean to you?* was answered with: *"Memories for life"*. However, some interviewees statements indicate the need to add a response channel e.g. *"I would like to so send images"* or *I would like to reply the moment I get new messages* (*nixplay* user).

During the interview the *nixplay* user stated that she is a very curious person: *"I am a curious person, I am happy if I have closer knowledge..."*. Another statement by an interviewee (*"timestamp would not be bad idea."*) supports the idea of supplementing the main media items with additional information. Besides the wish for further context information, interviewees mentioned audio data as a desirable feature. For example one user stated: *"...it [nixplay] is silent and I thought it would be nice to have some sound ... if he [grandson] sends an image, I have to call him in order to talk to him"*. These statements strongly suggest the implementation of video messages.

When discussing advantages and disadvantages of the *nixplay* device, it was mentioned that they only turn it on when they get notified by the sender of a new message (*"We only turn it on when somebody is telling us to check for the new images"*). The interviewee further stated that she almost completely relies on her daughter when interacting with the device: *"When she's visiting me, I tell her to turn it on."* . The fade-out setting of the displayed images was another disliked feature of the *nixplay*. The images constantly keep zooming-in or out while moving through the screen which was found to be difficult to follow. However, they do like the automatic transition of images: *"Occasionally, we look at them from A to Z ... Everyone like to take a look at the pictures..."*.

In order to determine specific design requirements and features, the answers of the interviewees and similar key statements found in the reviewed literature were translated into key issues and categorised into three topics: *What is important?*, *Wishes* and *Communication*. Figure 4.1 illustrates the classification of the data with the help of sticky notes. For a better documentation and legibility reasons the categorised key issues are displayed in tabular format (see table 4.1). The classification helped to gain an overview of the gathered data and supported the conceptualisation of specific design requirements.

In addition to the main data analysis a less formal but nonetheless valuable small-scale study and analysis of the existing family *WhatsApp* group chat provided information about the general digital communication habits of the members within the family chat. The analysis of the chat data covered a period of three months of communication. The review of the chat gave insights into the following issues:

1. **Content**: The general content and motive of messages.
2. **Time**: At which time most of the messages are being send?
3. **Multimedia objects**: The amount and content of exchanged multimedia data such as videos, images and general links to *YouTube* videos or websites.

(a) General thoughts: *What is important?*

(b) Requirements and wishes expressed by users.

(c) Communication issues and requirements.

Figure 4.1: Data analysis: categorised results of applied research methods.

Table 4.1: Key issues emerged from the gathered data categorised into three topics.

What is important?	**Requirements and wishes**	**Communication**
"live" and "right at the moment"	more information on content	dedicate time and effort
narrate	notification mechanism	voice/handwriting is personal
give back: reciprocity	mobility	time to reflect
time management	sound	Telephone is the main device
respond: mutual communication	easy setup	nixplay: show images to visitors
"Images are memories for life"	no fading	don't like to write (grammar)
vanity or self-criticism: delete content	don't miss something	Morning and afternoons are good for communication
		nixplay: same/fixed place
		"Feel left out"

4. **Language**: Which language is used within messages e.g. english or german slang, special vocabulary, emojis, abbreviations or ambiguous wording.

5. **Structure**: What is the general structure of a message and conversation, respectively e.g. Are there a lot of short text messages rather than one long text?

Table 4.2 illustrates the findings from the WhatsApp group chat categorised according to the five groups *Content (C1), Time (T2), Multimedia Objects (MO3), Language (L4), Structure (S5).*

Design Requirements

After an initial data extraction and classification of the relevant data (see figure 4.1/table 4.1) based on the literature review, interviews and cultural probes in combination with observation, four main design requirements were specified in order to meet the users needs and expectations and develop a suitable device to support links across generations. Aside from these primary aspects, design implications to help senior users overcome physical and cognitive barriers, discussed in section 2.5 *Guidelines and implications for the design*

Table 4.2: WhatsApp group chat data.

Group	Data content
C1	- Occasions like birthdays, christmas, visits. - Special media events, accomplishments, - Links of: Recipes, Youtube videos, online articles - Photos of: meals, pets, family members, from work, articles from print media,
T2	Most messages are being send at noon and in the early evening hours but sometimes users send msg. in the middle of the night or early mornings.
MO3	- Photos, Videos, Website links, Voice messages, GIFs - Photos from more inexperienced users are sometimes blurred
L4	- The main language is German but some users use english abbreviations or slang phrases. - Emojis very often are used as a substitute for text. - Wrong autocorrected words which sometime impede,to understand the context and content.
S5	- Most users write a lot of small messages rather than one big message. - It is sometimes difficult to understand the context due to quickly changing topics during a conversation. - Some users do not take their time for writing„hence messages become wired and faulty.

of ICT, were considered in order to accommodate various age-related limitations. In the following, the established requirements which significantly shaped the subsequent design, are presented:

1. **Reciprocity**: Digital communication may be asynchronous or synchronous but most of the time it is a mutual process involving two or more participants exchanging information. The results of the conducted literature review and interviews suggested that an asynchronous modus with the possibility to respond is suited for digital communication in means of connecting family members of different generations. Senior people have a strong desire to reciprocate and be more than just the receiving part. Therefore, a simple digital frame is not sufficient and it is crucial to provide ways of response options and support and enhance mutual communication.

2. **Additional Information**: A personal video or image is a popular medium within lightweight communication. *A picture is worth a thousand words* is a true statement, however, the research suggested that elderly people like to have additional information to the presented media object. Additional meta data may be a short and personal text message including time, place or occasion of the image.

3. **Notifications**: A classical notification mechanism such as a ring tone for new text messages may not be an appropriate way of notifying the user about incoming or newly received messages. Played only once the user might forget about it but played constantly it can turn out pretty annoying. However, notifications are

crucial because if the user has to actively check the device for new messages it will become frustrating in case nothing new has happened. As a consequence the user will become reluctant to use the device at all. I argue that ambient lightning is a viable alternative and an unobtrusive but clearly visible and instantly perceivable reminder of new events.

4. **Portable Design**: Due to age-related visual impairments it is recommended to use a bigger screen for displaying data such as images and videos. However, the device should maintain a mobile character allowing the user to place the device anywhere in the household or to carry around.

4.2 Ideation Process

In order to find solutions or improve and refine ideas, *Ideation* is a perfect first step towards solving design challenges and problems. Generating a set of designs and considering a broader variety of ideas before settling down too early on one idea is an effective way to start any design process with the eventual goal of creating the "right" and suitable solution to a problem, respectively [Har17]. Harley [Har17] stated that an ideation process can take shape in many forms and that there are no limits. Regarding the ideation methodology which was chosen within the context of this thesis in order to broaden the idea-generation, a mix of sketching and low-fidelity prototyping was applied. From the beginning of this master thesis it was clear that the final prototype will include some kind of Graphical User Interface (GUI) to interact with and display data. Rough sketches (see figure 4.2) helped to visualise first conceptual drafts of an interface, explore the design space and provoke further ideas.

To develop a better feeling for which design elements to include or leave out and what the final prototype interface may look like, Lo-fi prototypes were created using the wireframe tool *balsamiq*[1]. This mock-up activity allowed me to identify usability issues and refine experimental models of a proposed solution to the design problem. The prototyping sessions took some of the previously created and most promising sketches and scribbled ideas to a next level in order to test the ideas quickly and improve them, again without using too many or too expensive resources. The two different approaches of interface concepts which were generated and refined during the ideation process are presented in the following section.

Interface Concept 1

In the course of the previous data analysis and sketching activity it emerged that the use of a larger screen and a plain interface design is inevitable. Therefore, the first interface concept provides only as many design elements as necessary on a spacious display, focusing on the main features such as the presentation of a multimedia object, taking pictures and videos for responses and displaying user information (see figure 4.3).

[1] balsamiq:`https://balsamiq.com/`

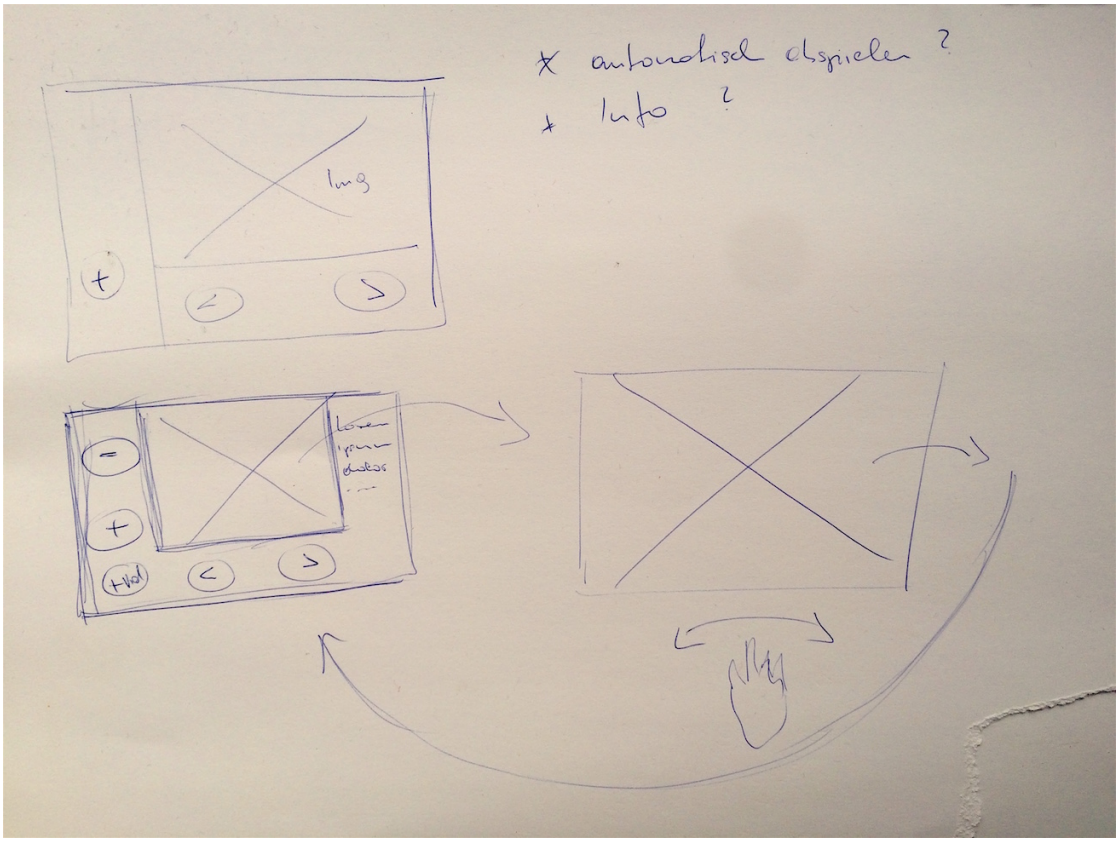


Figure 4.2: Sketch to visualise interface concepts.

The concept aimed for a clearly visible presentation of the main multimedia item e.g. image or video in the centre of the screen. Two prominent buttons indicate opportunities to respond in two different ways, namely video and image responses. The findings from the previous conducted research and data analysis suggest that the use of images and videos as response options are preferable and more suitable for elderly persons, whereas, written text messages can cause problems due to age-related and limited dexterity or general insecurity concerning orthography. Additional information such as text, date and sender of the message are located near to the main graphical content with the intention of only presenting the most relevant data in order to avoid overloaded and cluttered design. Several modifications continuously changed the look of the interface and alternative solutions were explored. Figure 4.4 illustrates the mock-up activity and design evolution of the conceptual interface design.

Interface Concept 2

The strategy of the second concept took a slightly different approach of presenting data and interacting with the interface. This *Snapchat*-oriented interaction aimed for a clean

Figure 4.3: List of major features and proposed color shades for the mock-up process.

and simple look by just presenting the most important part, the multimedia data. Any further design elements were discarded or hidden. Figure 4.5 illustrates the concept behind this idea. The pink area represents the image or video, filling the whole screen. Furthermore, a simple touch gesture on the pink area triggers the appearance of a text area with information about the sender of the message. In addition to the main pink area there are two invisible touch areas on top of it. The green touch area is responsible for swiping to the next or previous multimedia message and the yellow area represents an invisible button to initiate response actions.

The aim of this explorative approach was to encourage the user to actively explore and discover provided features and lower the barrier for technology use. The most important prerequisite for realising this is to provide a permanently accessible tutorial explaining the main features and corresponding gestures. Furthermore, error prevention and easy error recoverability can support and encourage senior people to explore new devices.

However, despite the supposedly plain look and easy gestures this conceptual draft quickly turned out to be too complex and confusing. Through a small feedback session with work colleagues and my own *Snapchat* experience, it became obvious that hiding information and withholding signifiers prevent users from fully exploit and utilise features. The concern of triggering an unknown and maybe unwanted activity behind a touch gesture is more present than I thought it would be, and therefore should not be underestimated. Especially novice users who are not familiar with new design and interaction patterns are likely to become frustrated and overstrained. Therefore, this approach got rejected and was not considered for a high-fidelity prototype.

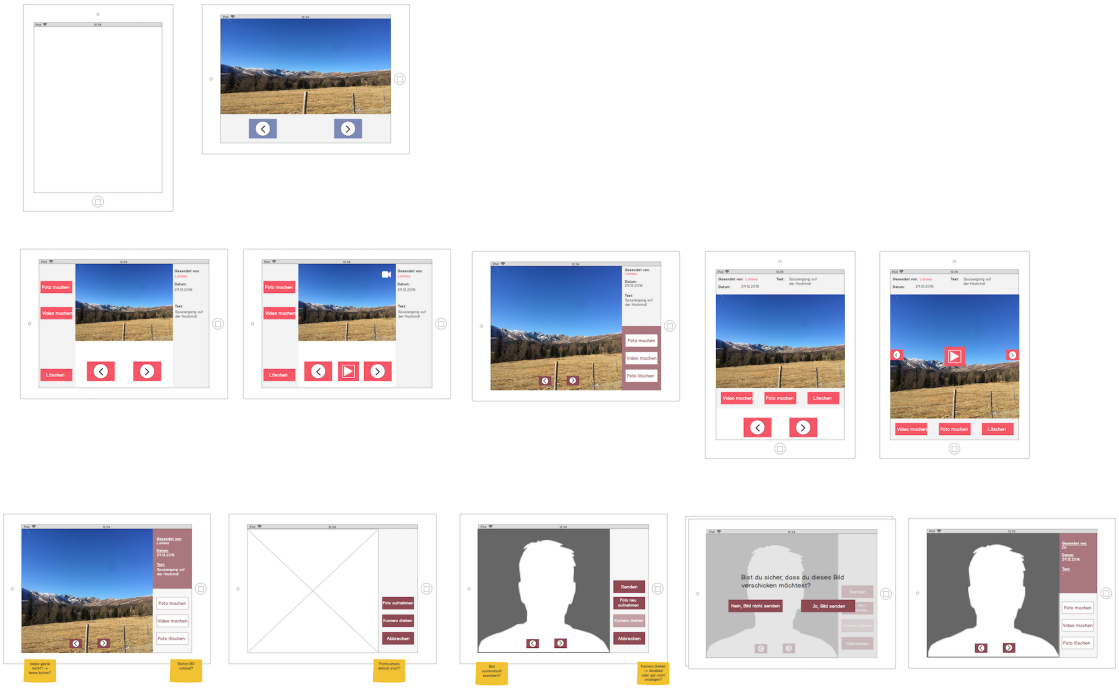


Figure 4.4: Development and refinement of the first interface concept.

4.3 Prototype Concept and Interaction Design

The basic idea was to create a high-fidelity prototype that is relatively simple and fast to develop, but moreover, provide full functionality and allows quick modifications during the one week evaluation and testing phase. The real-world setting and the involvement of the whole family was an integral part of this thesis. Therefore, a second application was developed and handed out to the participating family members in order to generate authentic content, provide 'real' user experience and simulate a real-world chat setting. Furthermore, the second application was extremely helpful to explore and identify wishes and requests for the newly introduced family chat environment.

As a result, the concept of the prototype proposes an information and communication technology that consists of two major components. The first and main device being a portable device with the adopted interface concept from section 4.2 *Interface Concept 1*, that receives and displays multimedia objects and, furthermore, provides the user with the possibility to record and send their own videos and images. Although Romero et al. [RMB+07] successfully implemented a feature within their ASTRA system that allowed users to attach handwritten text to an image, I decided against implementing such a feature and aimed for a more image-based communication instead. The possible response options were limited to the recording of multimedia objects because empirical data and literature review [AMAM14] showed that handwriting and digital texting may constitute an obstacle for some elderly people. Uncertainty of grammar rules or

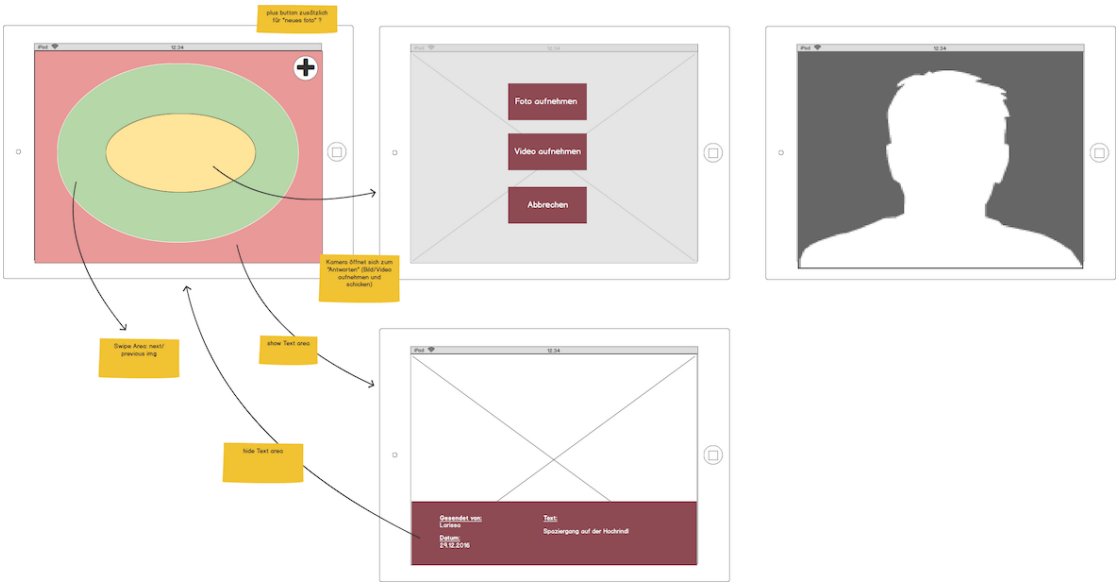


Figure 4.5: Development of the second interface concept.

age-related impairments impede the creating of a text based messages. The second component being a smartphone application that, as mentioned before, allows participants to generate and share content similar to the already existing family *WhatsApp*[2] group chat. See section 4.4 *The Family Counterpart Application* for a more detailed description of the counterpart app. Although one of the aims of this prototype was to create an alternative chat environment, the data from the WhatsApp group chat analysis (see table 4.2) showed that a chat usually consists of a lot of fragmented text-based messages between several persons which might create a major problem for elderly people to follow the context of conversations. Therefore the BK64 prototype does not support a text-only messaging service yet.

4.3.1 iPad Application

An *Apple iPad Pro*[3] with a 12.9 inch display was used as the basic device for the final prototype. According to Nielsen [SRP07] aesthetic and minimal design without irrelevant and rarely used information is a major usability principle. The large screen provided enough space for the main multimedia content and additional design elements such as buttons and text messages and prevent the design from looking cluttered. The implementation of the app started with the design template from section 4.2 *Interface Concept 1*. Figure 4.6 demonstrates small design iterations and the undergone changes and improvements in the course of the implementation process of the GUI.

[2]WhatsApp: `https://www.whatsapp.com/`
[3]Apple iPad: `http://www.apple.com/at/ipad-pro/`

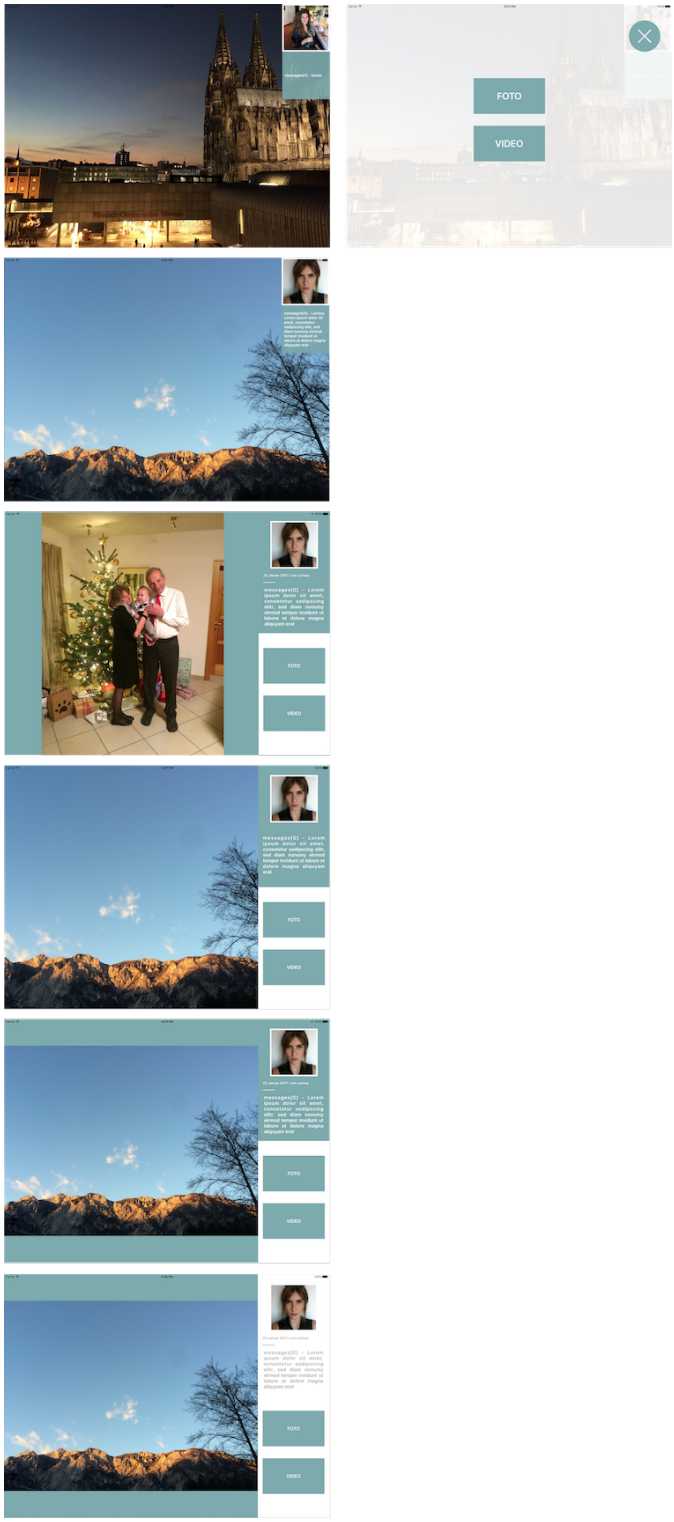


Figure 4.6: Evolution of the iOS Application for the iPad Pro 12.9 during implementation.

The prototype application covered the basic wishes and requirements elaborated during the previous research and which were then translated into main features. The following list gives an overview of the implemented features:

- Receive images
- Receive videos
- Display additional information (text message and user data) next to the corresponding multimedia content
- Send an image
- Send a video
- Delete image or video
- Swipe through messages at any time

4.3.2 Interaction

Products such as ICT devices require the user to interact with them. Sharp et al. [SRP07] stated that for designing usable interactive products it is crucial to consider who will be the user and where the product will be in use. But most importantly, understanding the kind of activities people are doing when interacting with products [SRP07] has a great impact on the future design. Different products require different kinds of interfaces or input and output modalities, depending on the intended activities that need to be supported. The overall aim is to optimize the users' interaction with the hardware or software and support users' activities. The choice of interaction style for the device developed within this master thesis is based on the conducted literature research and the preliminary small-scale study with the *nixplay*[4] device. With Hinze-Hoare [HH07] principle of *Substitutivity* in mind (see subsection 2.5.1 *Design principles*), two different ways to interact with the device were provided to the user.

The first and nowadays convenient way to interact with a device is touch control. The conducted literature review suggested that touch screens are considered to be less cognitive demanding, therefore easier to use for seniors. However, since elderly people are not yet used to touch operated devices and age-related barriers can cause difficulties, as discussed in section 2.4 *Age related changes and barriers*, a second approach for interacting with the device was adopted. Senior people are likely to own a TV and know how to perform basic operations such as switching the channel or adjusting the volume. Thus, a simple and familiar TV remote control provided the user with the same actions as the touch display does. Furthermore, Hinze-Hoares [HH07] principle of *Familiarity* (see subsection 2.5.1) was taken into account. The users' real-world knowledge of a remote's On/Off button was used to turn the BK64 device on and off. The selected remote control was adapted and buttons were limited accordingly to the provided features (see figure 4.7).

[4] nixplay: `https://www.nixplay.com/`

Figure 4.7: TV remote control used of interaction.

A crucial workaround for launching the iOS application significantly enhanced the usability and accessibility of the BK64 device and the corresponding application, respectively. Whereas a launch of typical iOS app first of all requires the user to unlock the device by pressing the *Home Button*[5], followed by the actual launch of the desired app, the implemented workaround made use of the *Guided Access*[6] provided by the Operating System (OS) which keeps the iPad in a single app. Furthermore, the app was constantly running in the foreground to be able to instantly react to remote control actions. In order to imitate a 'turned off' or 'sleep mode' a black canvas was pushed on top of the apps' main screen and the background light was programmatically dimmed. When the user activated the app, the black canvas was dismissed and the background light was turned up again. This way it was possible to present a new self-contained system with the iPad as a base device.

4.3.3 Device Case

The appearance of the iPad Pro is very high-end and exclusive, hence a great concern during the design process was that the senior user will be afraid to destroy something and simply use the device, respectively. Güldenpfennig et al. [GF13] suggest that customized cases can add a friendly tone to any prototype. Furthermore, diminishing the technical appearance and hiding complexity can help to reduce the fears of inexperienced users.

[5]Home button: `https://support.apple.com/en-us/ht203017`
[6]Guided Access: `https://support.apple.com/de-at/HT202612`

Additionally, customized hardware can be attached to the basic device and stashed into the case. A box, big enough for the iPad Pro served as a means of covering the high-end look of the iPad, hiding additional hardware (power supply, Arduino shield) and be able to place it upright anywhere in the apartment. The box (see figure 4.8) itself was covered with black structured adhesive foil to give it both, an aesthetic but not over-designed look and a good grip.

(a) The inside of the case.

(b) Outside look of the case.

Figure 4.8: Customized case for covering the high-end appearance and hiding additional hardware.

4.3.4 Notification

A system should provide appropriate feedback and keep the user informed. Without feedback the user does not know when to check for new messages or will become frustrated overtime when every time he checks, nothing new has happened. Notifications are informal messages and reminders that alert the user of general occurrences within a system which have some significance to the user [Fla15]. Passive notifications are informational reminders that report events which are not necessarily urgent but can be of potential interest to the user. In order to alert the user of new incoming messages we used ambient lightning (see figure 4.9). Similar to a badge icon of a smartphone app, a red coloured pulsating light informs the user in an unobtrusive but clearly visible and instantly perceivable way of new messages. Passive notifications can easily be missed or forgotten, therefore the discreet red light will only turn off when the user turns on the device to take a look at the new messages. Since the aim of the BK64 is to stay in touch and exchange messages which are not urgent and need not to be seen immediately, I argue that ambient lightning is a viable alternative to announce events.

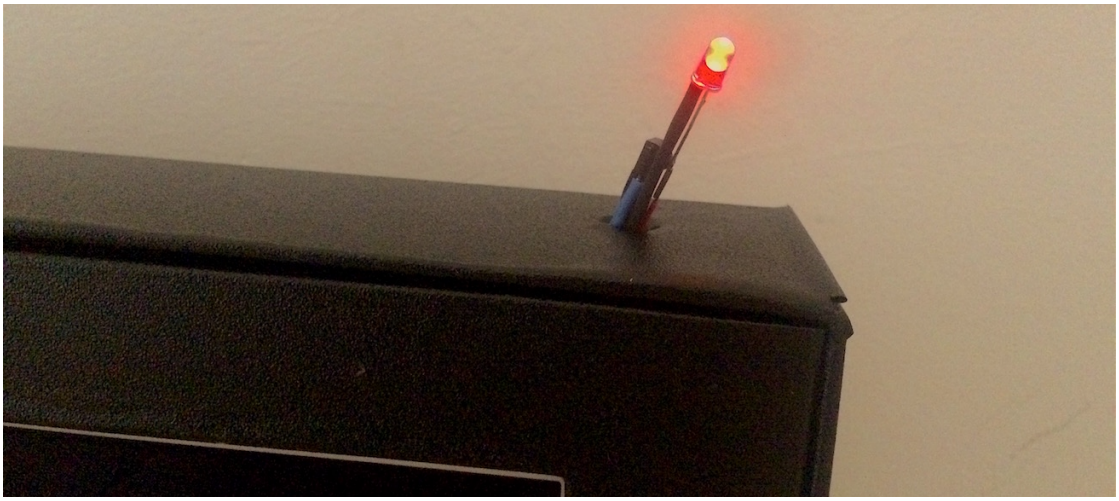


Figure 4.9: Small red LED indicating new incoming messages.

4.3.5 Error Handling

Elderly people are afraid of making mistakes and fear the consequences of incorrect actions [AMAM14]. Whenever possible, the best solution is to prevent the user from making mistakes in the first place [SRP07]. With careful design and trying to eliminate error-prone conditions we try to enhance the users' experience and avoid errors. However, users do not always pay full attention to the task, hence mistakes or errors are inevitable. Whenever the user started an action unintentionally or want to quit an activity, the app provided one simple *cancel* button that stops every activity within the app (e.g. video recording) and brings the user back to the main screen. As mentioned before, the user can trigger this cancel action both, via touch gesture and remote control.

4.4 The Family Counterpart Application

As mentioned before, the concept of the prototype proposed a second counterpart smartphone application distributed to all participating family members. The main purpose of this application was to generate authentic content. Moreover, this real-world setting allowed us to investigate changes and different communication approaches compared to the 'old' family chat. The following list describes all features implemented within this app:

- Share a video.
- Share an image with an optional text message limited to 140 letters.
- Overview of the entire shared data in a grid layout.

- Detailed view of a shared image including the (optional) text message, user information/profile image and timestamp.

The design and development of the FCA was a straight forward process starting with mockups illustrating the basic workflow (see figure 4.10), followed by the actual implementation and a small testing round. The feedback from this test round was used to further improve the app and fix major bugs. Figure 4.11 illustrates five screenshots of the final iOS app: *app icon*, *start* screen, *new message* screen, *message* and *message successfully send* screen. Since all participants own an iPhone[7], the app was developed for *iOS*[8] only.

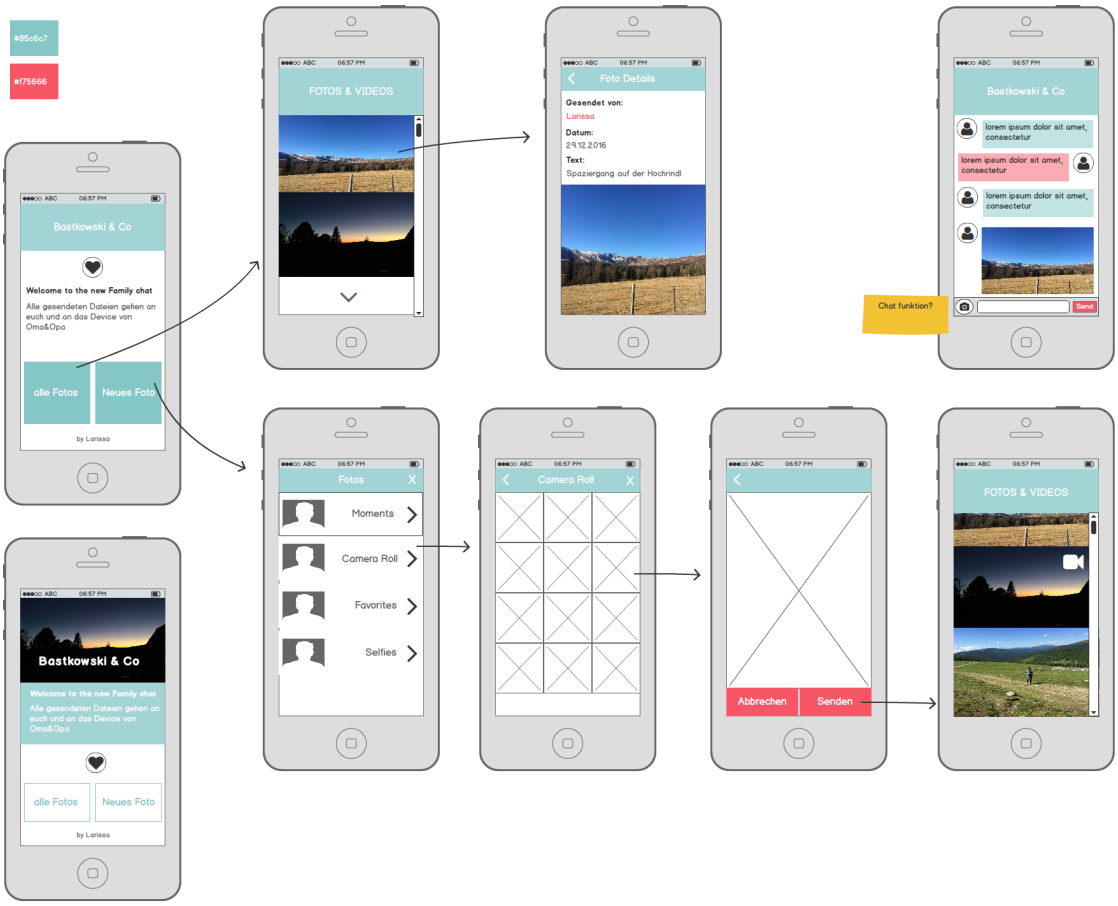


Figure 4.10: The Family Counterpart Application Mockups.

[7]Apple iPhone: `http://www.apple.com/at/iphone/`
[8]Apple iOS: `http://www.apple.com/at/ios/ios-10/`

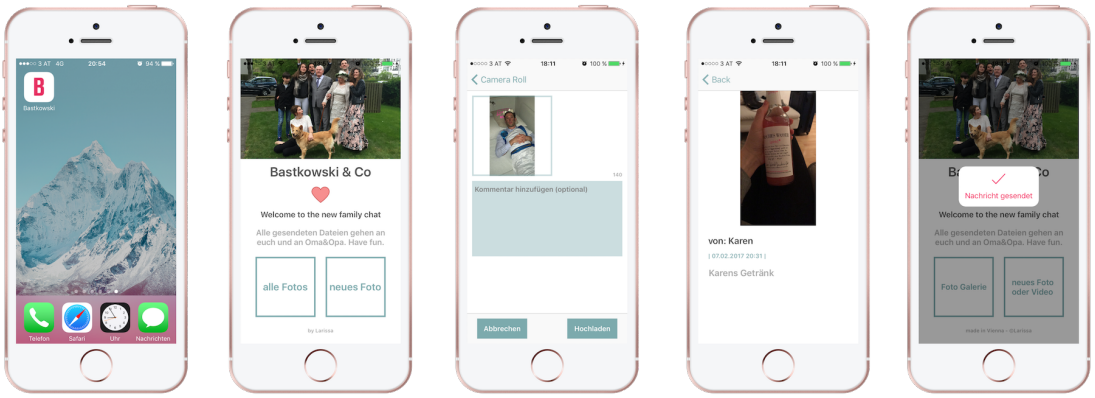


Figure 4.11: The Family Counterpart Application (FCA).

4.5 Development Environment

The native iOS applications for the BK64 device and the *Family Counterpart App* were developed using Apple's IDE Xcode[9]. In order to realize passive notifications using ambient lightning and control the app via a remote control a small Bluetooth-enabled *Arduino*[10] shield was used (see figure 4.12). An IR receiver soldered onto the Arduino shield received the remote control emitted signals and the Arduino shield software application processed the pre-defined HEX values. Each previously defined button on the remote calls a method within the Arduino code which then, transmitted via bluetooth, invokes the corresponding activity within the iOS application. For notification purpose, the iOS app pulls new data within an interval of 15 minutes and, in case of new messages, informs the Arduino to turn on the LED.

4.5.1 Backend

In order to host and manage user generated multimedia data and distribute across devices a backend solution was required. The backend and Database (DB) solution was realized with Google's *Firebase*[11] platform. The platform offers tools and a perfect infrastructure to develop both high-quality apps and quick prototypes at low cost without the need to build your own time-consuming backend infrastructure. The *Firebase Cloud Storage* hosts user-generated content such as images and videos. The cloud-hosted NoSQL realtime database stores data as JSON format and allows synchronisation of the data across all devices accessed via an easy-to-use RESTful API. The provided Firebase SDK for iOS allows the client-side native iOS applications (iPad and iPhone app) to upload and access the stored data. This simple yet powerful and cost-effective set of tools provide useful features and is a perfect approach for a quick progress in terms of developing

[9] Xcode: `https://developer.apple.com/xcode/`
[10] BlendMicro Arduino shield: `https://store.arduino.cc/blend-micro`
[11] Firebase: `https://firebase.google.com/`

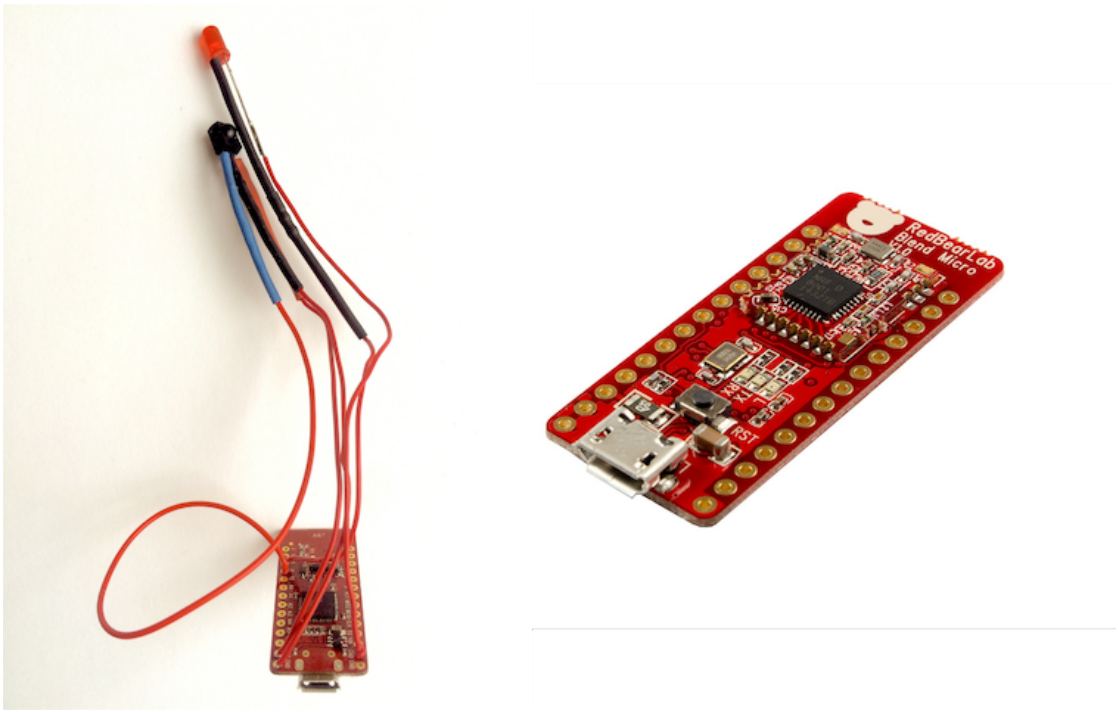


Figure 4.12: BlendMicro Arduino shield with attached IR receiver and LED.

prototypes and enhancing the real-world environment. Furthermore, with the use of *Firebase Analytics* we were able to define custom log events in order to capture and track how users interact with the app.

CHAPTER 5

Evaluation of the Prototype

This chapter focuses on the evaluation of the final prototype and will document findings on the interaction with the BK64 device, usability issues and general opinions of various stakeholders. The chapter starts with a brief description of the basic idea and presentation of the final high fidelity prototype resulting from the preceding research and design process. The first and main user study outlines possible design issues and general attitudes towards the BK64, followed by insights from the second small-scale field study and the FCA users.

5.1 The Prototype

The major challenge was to create a usable device that fits senior peoples' needs and creates a digital bridge between generations. The final high-fidelity prototype together with the counterpart app represented and concretised results of the conducted research and design process. The real-world infrastructure consisting of the main *BK64* device, the family counterpart app and the *firebase* platform was an integral part of the entire thesis project. Due to this set up it was possible to get authentic insights in communication habits and how they are different from the present family chat situation. Furthermore, it was interesting how the prototype influenced the communication between the three participating generations and the general emotional state of participants. Figure 5.1 shows the final high-fidelity prototype before any design changes were applied.

5.2 The One Week Field-Testing

Field-Testing and field research activities are conducted in the user's context and location with the aim to test a system under realistic conditions and learn more about the prospective users and understand how people behave [Far16]. The main evaluation was conducted over the course of one week in cooperation with nine participants, all members of the family and seven of them using the current family group chat as a

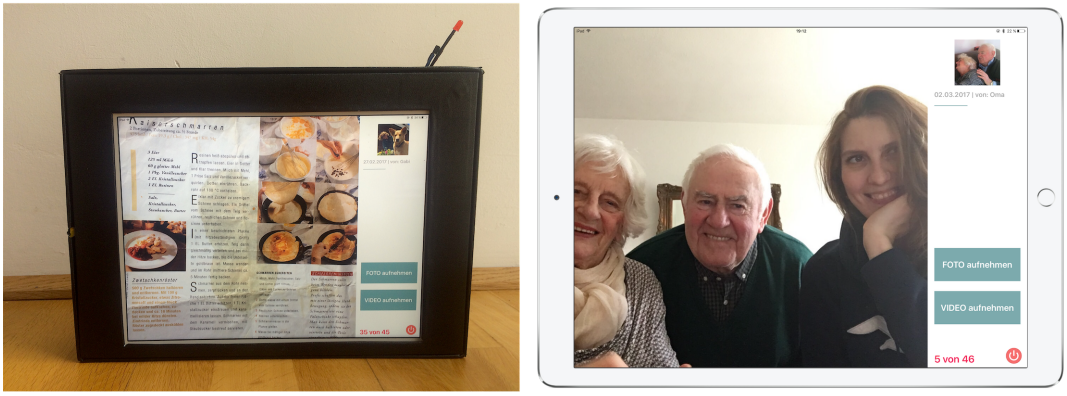


Figure 5.1: The BK64 prototype.

main communication tool to share data among each other. Two participants (80 and 85 years old) represented the main targeted user group of technological inexperienced elderly people aged 65 and above. The aim of the field test was on the one hand an efficiency check of the interaction design of the BK64 device and on the other hand to study the feasibility of the new type of communication within a distributed family. The private family visit throughout the week in combination with the observational but unobtrusive research activity resulted in revealing insights of the users' natural environment, communication habits and how well the new communication system fits into their lives. Figure 5.2 shows the usage of the prototype in two different locations. A mobile wifi hotspot router[1] for SIM-cards served as a workaround for the non-existent internet access in the grandparents' home.

After the first two days of the field trial the by then collected data and feedback was used to modify the design of the iOS application and improve the usability. The solely moderate changes of the GUI during this first design iteration prevented major user confusion and disorientation within the app, yet eliminated basic design flaws such as small font size and unintelligible annotations. At the end of the one week field-testing a qualitative interview with the two senior participants was conducted and the resulting data were used for further design modifications. Furthermore, follow-up discussions with some of the counterpart app users brought up valuable ideas and improvements for a substituting group chat environment.

[1] Huawai: http://consumer.huawei.com/at/mobile-broadband/mobile-wifi/features/e5330-at.htm

Figure 5.2: The BK64 prototype used in different locations.

5.2.1 Evaluation Findings

Communication

The BK64 prototype was first set up in the living room area but quickly got moved into the kitchen. The role of the kitchen as a meeting point or gathering place and the general morning routine, being a joint breakfast, have been the major decisive reasons for relocating the device into the kitchen. After an extended and unhurried breakfast while catching up with the latest news, the newest messages on the BK64 device were viewed and often initiated a positive emotionally charged discussion. Especially videos were highly valued and contributed to happiness and an overall wellbeing. Aside from these 'breakfast sessions' and notification triggered (pulsating LED) usage of the BK64, participants enjoyed taking a look at the pictures and videos while having their afternoon coffee breaks.

One of the most significant observation was the fact that participant B (3.1) mentioned the BK64 content almost every time while speaking to friends and family over the phone. Videos seemed to remain a special memory and particularly worth mentioning when talking to friends and family members, whether they did or did not part take in the field study. Furthermore, newly posted videos gave a significant impulse to call the sender in order to talk about the video and express one's gratitude for sharing the content. Participant F believed that this new lightweight form of communication influenced old communication habits by lowering the psychological barrier to call busy (younger) family members and the transmitted multimedia objects served as an invitation to respond. Furthermore, some of the FCA users stated that making some loved one noticeably happy by simply sharing a video or image motivated them to send further messages.

In total, 48 messages have been exchanged during the one week field study (see 5.1). 36

messages were send by users of the counterpart app illustrating various situations such as sportive activities, celebrations or photos of meals. Another important finding was that the shared content basically were not any different from the one currently shared within the family WhatsApp group chat. Of course, there were some messages especially addressing the new chat members (grandparents) but I argue that this effect is due to the whole new communication situation including the oldest generation. Other than that there was no significant difference between the type of shared content of the new and old chat.

Table 5.1: BK64 findings: Exchanged data

Type	**#**
Photos send	11
Videos send	1
Photos received	27
Videos received	9
Total	**48**

In the conclusive interview participant B said she is too old and has no time for learning new things. She mentioned that the housework, hobbies e.g. knitting and doctor appointments occupy much of their time and new technology is just not their thing anymore: *"... well, I am just too old for this"* or *"oh dear, I don't get along with it"*. When participant A asked me if they need to get internet access, B quickly answered: *"... go away, I have no time for anything already."*.

The interview data of the preliminary exploration phase revealed that participant B feels excluded and very disappointed when telling a story which everyone already knows because it was previously shared within the WhatsApp chat group. The BK64 device successfully addressed this issue by involving the older generation in the new way of storytelling and keeping them up to date. It is interesting to note that the two senior participants got very excited every time they noticed the red notification light indicating new messages. Sometimes, participant A was the first to notice the light and reminded B to go to the kitchen and take a look at the new pictures. Both of them then gathered together in the kitchen and took a look at the new message(s).

Usability

Jakob Nielsen defined the usability of a product as a "*... quality attribute that assesses how easy user interfaces are to use*" [Nie12]. Although the general usability of the prototype seemed to be fine I did identify some short comings in the design. Some procedures and design artefacts were easy to learn and easy to memorize, while others did not really seem to work well and the user was not able to accomplish the given task. The GUI elements concerning the sender information and (optional) text message were easy to understand and served quite well its purpose of enriching the main media content with further, detailed information. The profile image of the sender effectively communicated

who the sender of the message was. The only thing that had to be changed during the first small design iteration was the font size and color of the text message from 22 pt to 28 pt and from grey to a dark grey. Furthermore, the visible distinction between an image and a video was improved by adding a bigger play button as an overlay to videos.

One of the biggest issues from a usability perspective which were discovered during the evaluation phase was that the workflow of recording an image or video and send it to the other participants was not working. Due to technological constraints regarding the implementation of the recording process, the workflow consisted of three and five steps, respectively: *1) start the camera, 2) take the picture or 2a) start video recording 2b) stop video recording 2c) preview video, 3) send the data* (see 5.3 and 5.4). Step 2 and 3 were depicted through one button which simply changed its label according to the current action. Unfortunately, this change was not eye-catching enough and the user did not noticed any change within the button. While younger generations are more likely to be receptive and used to subtle label changes, senior users need more distinct changes to draw their attention and guide them through an activity.

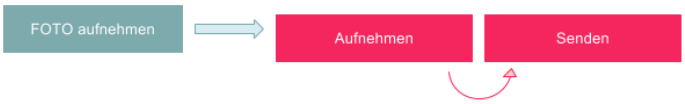


Figure 5.3: Record photo workflow: 1) start camera 2) take picture 3) send picture

Figure 5.4: Record video workflow: 1) start camera 2a) start video recording 2b) stop video recording 2c) preview video 3) send video

Another important insight from the user study was that the users obviously made use of their real-world knowledge regarding the TV remote control and learnt quite fast how to operate the device with the adjusted remote control. The users appreciated the possibility of swiping through messages from a certain distance. On the other hand, participant B stated that operating the device through touch gestures is a little bit faster. During the last day of the field study the iPad was removed from the case and the users were able to explore the device in a different way. Without the bulky case it was easier for the user to hold the device. For one thing, the large screen with a diameter of 12.9 inch did provide enough space for every design element without looking cluttered, then again, the large screen turned out to be a little cumbersome and caused difficulties while concurrently holding and operating the detached iPad using touch gestures.

Regarding the notification mechanism I did not witness any problems. The pulsating red light did not disturb users in any way, for instance during afternoon naps, however, it did visibly transmit the information of a new message. A key prerequisite for the success of such a passive notification system is that no urgent information is being shared otherwise a simple light probably would be an insufficient method to convey information or call attention.

One interesting observation finding was that participant A mistook a posted video for a live video call and started talking back, similar to a *FaceTime*[2] conversation. That is owed to the fact that some family members, when visiting participants A and B, like to make FaceTime calls with distant family members, especially during certain events like christmas, and participant A and B joining this conversation.

5.3 The One Day Field-Testing

The one day field-testing aimed for additional insights of participants outside of the family context. On the one hand I was interested in further opinions of the overall design and concept of the BK64. Apart from this, I asked the participant (female, 87 years old) to point out significant differences to the until then used *nixplay* device. See 1.1 for detailed information about the *nixplay* device. For this small field-test the GUI was adapted one more time based on some results of the *The One Week Field-Testing*. The applied changes included:

- A requested button for deleting images and videos was added to the interface.
- The distinction between an image and a video was improved one more time.

The field study started with an explanation of the BK64 device, its general purpose and a brief instruction of the features. The reactions were mainly positive. The participant stated that, especially when living alone, it is always nice to hear from friends and family. The most valued feature of the BK64 and the biggest explicitly mentioned advantage compared to the *nixplay* was the screening of videos. Another advantage of the new device was the notification of new incoming messages. The participant stated that she usually only turns on the *nixplay* device when somebody calls her and tells her new images were uploaded. Hence, the notification mechanism of the BK64 was a huge simplification of the status notification of new messages. Regarding the operation of the device both, touch gestures and the remote control were gratefully accepted and appreciated (see figure 5.5).

The participant mentioned that one advantage of the *nixplay* device compared to the BK64 was that it offers an automatic playback of all images. She stated that it is nice having pictures automatically running in the background while having a coffee party and

[2]FaceTime: `https://support.apple.com/de-at/HT204380`

Figure 5.5: The One Day Field-Testing: The adapted BK64 prototype in use (with and wihtout the case).

chat with friends and family. Nevertheless, she appreciated the provided possibility to manually switch through all messages. Furthermore, I noticed that adding a loop mode (figure 5.6) when manually swiping through messages would enhance the user experience of the BK64.

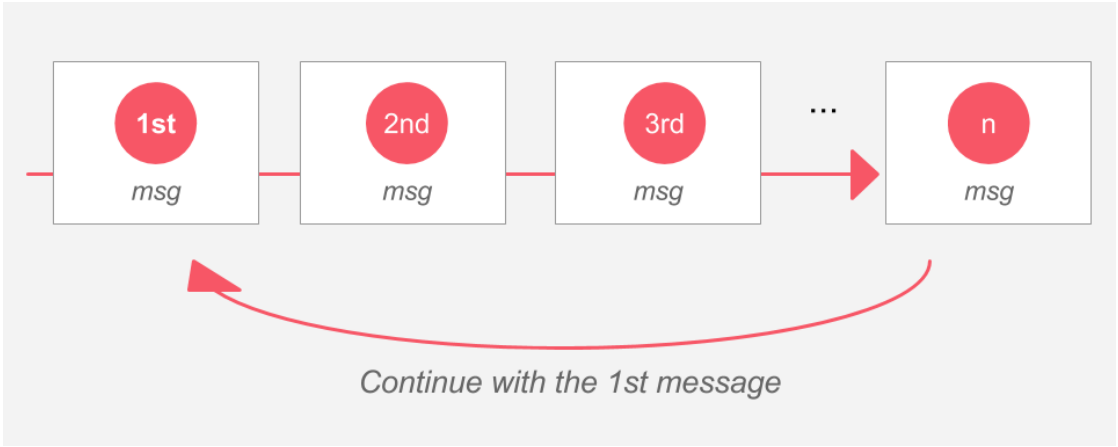


Figure 5.6: Loop mode: At the end of all messages, continue with the first message.

Regarding the recording of an image or video the participant encountered the same troubles accomplishing the task like the first participants did. This observation may support the assumption from the first field study that the workflow design of this feature is not convenient and needs to be re-designed. Nevertheless, with a little assistance the user did enjoy recording videos and images of herself in order to send it to other family members. However, due to a self-critical attitude the button for deleting *selfies*[3] or any other pictures uploaded by someone else, turned out to be a mandatory feature.

[3]Selfie: A photograph that one has taken of oneself.

5.4 Family Counterpart App

When introducing the BK64 concept and distributed the personal family counterpart app all participants were kind of excited and could not wait for the study to begin. The possibility to finally share content with participant A and B without any major effort was an enrichment to all of them, especially for the ones who live in a greater distance. As mentioned before, participant F became even more motivated to send further messages after receiving extremely positiv feedback from participant A and B e.g. participant B called and thanked him for all the nice videos and images of the great-grandson (8 month old). The fact that participant A and B cannot see their grand-grandson very often due to the great living distance made those messages for both parties incredibly valuable. When asked about communication changes, participant F stated that the BK64 study did influence the way he communicates with his grandparents a lot. He used to keep the grandparents up to date about the grand-grandsons growth by sending them real little photo albums now and then or give them a call once a month. But the new effortless way of sending latest images/videos 'on the side' was cited as a tremendous simplification of keeping in touch. His wife mentioned that she would love to deploy this new way of communication within her own family too because some of her older family members are located in Venezuela.

During another small follow-up discussion with one of the FCA users, the interviewee mentioned that participant B called her and mentioned things like: *"I am too old for this."* or *"I don't understand new technology."*. However, she as well mentioned that participant B always commented about the posted videos: *"It is so great to see these funny videos."* or *"I laughed so hard when seeing this video... "*.

The personalized app including the start screen with a family portrait[4] and a customized app name and icon of course have been a highlight to everyone. Although I did communicate to all FCA users that the design of this app was not the focus of this master thesis but more as a means of producing authentic content and meta-information about communication habits or changes. However, I did receive some valuable and promising suggestions for additional features. One of the first reactions of a user was if it is possible to send simple text based messages similar to the WhatsApp chat. Another user stated that a notification mechanism would provide information about newly posted images or videos. I was aware of the fact that notifications are a mandatory feature nowadays but due to technological constraints it was not possible for me to implement this feature within the context of this thesis (see section 4.5). But even without notifications indicating new messages, users stated to occasionally open the app and enjoy the already posted images and videos. Another requested and nowadays common feature was the possibility to save multimedia items to the OS library.

[4]Family portrait of the grandparents with all of their grandchildren.

CHAPTER 6

Discussion

The aim of this exploratory research was not to present a final or conclusive answer to the particular raised question. Rather than that, the study explored the research question originated from a personal experience with the aim of presenting an alternative solution of how to bridge light-weighted communication patterns of younger people and the traditional ways of connecting preferred by older generations, in order to support intergenerational family communication. Eventually, the study resulted in a fully functional prototype of a light-weighted communication system that can be used by various generations within a family in order to exchange media objects. The presented BK64 prototype established a asynchronous communication platform within a family setting and all participants enjoyed the newly gained channel to communicate. Overall, the findings from the user studies suggest that the BK64 concept was a promising attempt to create a digital bridge between remote family members of different generations. Although the concept of a lightweight instant messaging service seemed not to offer anything new to the younger participants and user of the FCA, not at the first glance anyway. The adopted chat approach of exchanging data with grandparents on the side, however, was new and highly appreciated by them. It has clearly enriched the otherwise limited contact to the older family members in a way that was not possible before due to the lack of contemporary ICT technology at the elders' home. The fact that it was now possible to communicate depicted life events to grandparents rather than just narrate stories via telephone has added a level of expression that is able to create greater intimacy between distributed family members. Furthermore, besides strengthening internal communication between members, the use of the BK64 system created lingering feelings of happiness and pleasure amongst individual users which confirms Romero's [RMB+07] phenomenon of after-effects of contacts.

One of the most interesting finding of the study was that the exchanged data carried out different functions. On the one hand videos and images contributed to the well-being of the senior users by eliciting positive emotions during and after the use. On the other hand,

the exchanged data served as conversation topics during phone calls with friends or family. The latter indicates that the telephone might not be replaced by any other technology as a convenient communication tool any time soon. But the additional information and content enhance the traditional ways of communication regardless of the actual shared content. These results are in accord with recent studies [LHS09] [RMB+07] indicating that elderly people benefit from lightweight communication, however they do not replace existing communication forms such as phone calls or face-to-face contact. Elderly people like to give feedback and talk about the exchanged multimedia objects, like younger generations do within a WhatsApp chat when someone posted a new video or image. The mere 'consumption' of multimedia data is not enough in most cases. Reciprocity plays an important role within communication and the general life attitude of seniors, respectively. In terms of ICT, a feature for responding (e.g. scribbled messages on screen or recoding images/videos) can serve as an additional feedback channel for elderly people. However, regarding the design of novel ICT that supports intergenerational family ties, designers should acknowledge possible asymmetries in communication patterns. Some senior people may use the provided response option, whereas others may see more value and are perfectly satisfied in only monitoring the activities of their beloved ones. The results of the user study showed that the for the BK64 main device selected way to create their own content and respond to people has not been the best choice. The workflow design was difficult to understand and the device only allowed recording images/videos from a 'selfie' perspective. Elderly people are somewhat self-critical and vain when it comes to images of themselves. Therefore they prefer to take images of events or items that bear a meaning and are important enough to share with family members e.g. christmas tree or family dinners. The research at hand further supports the idea of a 'communication-trigger' and demonstrated that in the elders' home situated lightweight technology can act as an initiator for more heavy-weighted communication forms such as phone calls. Received images or videos can function as a motivational factor or invitation and trigger further connection actions.

Elderly are in no way lacking willingness to learn more about new technology and devote time to communication with the aim of connecting or maintain relationships with beloved ones. But there are certain conditions that significantly supports the adoption of new (ICT) devices. New technology should offer some kind of benefit to elderly people (e.g. emotional benefit: see latest pictures of the new grand-grandchild) and arouse their interest in technology and engagement in something new, respectively. That's because no matter how much effort the designer puts into the design in order to develop a suitable and simple-to-use device, learning something new is never easy. Technological inexperienced elderly people, in particular, inevitably are going to encounter problems or difficulties while operating any new device, which will subsequently lead to frustration and a reluctant attutide to further use the technology. Another key towards a successful adoption is the support by family members and adequate introduction and learning instructions. My presence throughout the entire one-week field study has proven to be advantageous regarding basic technical assistance at any time. Elderly users feel a little less left alone and more comforted when they can ask someone for technical

advice, particularly during the initial period of use. However, the field study confirms Norman's [Nor13] statement that senior users tend to blame themselves for any mistakes even if it was absolutely not their fault (e.g. empty battery). Hence, I tried to encourage the users by emphasizing it was not their fault anytime a problem occurred.

What is important to note is that elderly people emphasize they have busy lives, therefore we cannot assume that their lives revolve around technology like the ones of younger generations may do. Senior people probably won't carry the device around all of the time like younger people tend to do, therefore the presented concept is not suitable for the communication of urgent content. Furthermore, learning processes may occupy much more time and setbacks may discourage or annoy elderly people from time to time. But I hypothesize that the benefits of the casual digital connection e.g. social involvement and co-participation in shared moments, outweigh possible obstacles. The presented prototype seemed to be a good attempt to connect remote family members of all ages and become more involved into each others lives on a more direct and emotional level. Part of the older users' longing for social interaction with beloved ones could be satisfied and the younger users were happy to finally share something with the oldest generation of the family. Unfortunately though the BK64 main device primarily was used in a more passive way, which clearly was not the aim to create yet another digital photo frame simply with a richer feature set. But I argue that this may be owed to the fact that the realization of response concept was not the most favorable solution. Nevertheless, the senior users clearly liked the idea of sharing their own content with family members. The overall discreet design of the BK64 device and software application, otherwise created great user experience and the attached textual information (i.e. text message, user data) successfully provided further contextual clues to the main media object. Regarding the interaction with the device, by offering different input modalities and let the user decide how he wants to interact with the device (i.e. touch gesture or remote control), the device provided the freedom to place and use it according to the situation. For example, placed a little further away it can act as a presentation screen during coffee parties (remote control) or it is more of a personal digital photo album which can be ‚browsed through' while sitting in an armchair (touch gesture).

Finally, I think it is worth to mention that during the entire study I had several informal discussions about the thesis' topic and my intention to digitally connect remote family members of different ages, resulted in thoroughly positive feedback. Especially young adults (between the age of 25 and 35) mentioned that they would love to establish such a device/communication system at their grandparents' homes.

6.0.1 Limitations

Even though this project was limited to a comparatively small sample size of participants, I think the findings at least made several small but noteworthy contributions to the field of intergenerational family communication and how it can be supported by technology. My personal involvement as the granddaughter through out the one week field trial might influenced the daily routines of my grandparents i.e. main targeted users, a

little, but with regard to communication activities I tried to keep the influence to a minimum. Furthermore it needs to be mentioned that the study is limited by the lack of information about the use of the BK64 system without my presence at the elderlies' home. Nevertheless, my double role as a designer/researcher and family member/user of the WhatsApp group chat gave me access to more private situations and existing knowledge of my family's communication habits, which helped me to find a solution that fits into this context. However, every family got their own custom communication practices and the presented concept may not qualifies for another family.

CHAPTER 7

Conclusion & Future Work

The thesis at hand explores the design and development of an accessible and useful ICT device for elderly people and presents a design idea of how technology can create a link across generations. In terms of methodology, following a user-centred design approach was found to be appropriate for the development of a digital connection between remote family members. Applied qualitative methods helped to get to know and understand the future users and reveal their thoughts and preferences about current communication patterns and elicit their expectations of a new communication device. The comprehensive multidisciplinary literature review not only acts as an entry point for the exploration of the topic but furthermore serves as a theoretical foundation to identify design requirements that meet the elders needs and thus be able to create a valuable device that fits into their every day life.

The main goal of the study was to create a digital bridge between the light-weighted communication patterns of younger generations and the traditional kind of communication of their elderly relatives in order to support intergenerational family communication. The BK64 prototype, eventually, established a new two-way communication channel for remote family members and enabled them to exchange messages consisting of media objects (image or video) supplemented by (optional) textual comments. A key strength of the lightweight BK64 messaging system was the successful involvement of digitally disengaged elderly people (aged 80+) by providing them with their own custom designed device for receiving and sending messages, thus enable reciprocal communication. The presented approach seems to be beneficial for both parties. The younger technically oriented users are happy to finally share moments of their lives with their grandparents, effortlessly on the side and the older generations enjoy the co-participation in those events. The study demonstrates that the continuous sharing of messages and thus telling little personal stories has a positive impact on the feeling of togetherness and general communication habits within a distributed family with three or more generations, whether it is a one-way or two-way communication. The prototype not only created a new type

of communication, moreover it positively influenced old habits by contributing additional content to conversations and acts as an initiator for further heavy-weighted contact (e.g. telephone calls). In general, therefore, it seems that presented approach does not replace existing communication forms, but offers an additional opportunity to connect and participate in each others lives. Furthermore, the system might serves as a good entry point to the digital world of communication and narrows the aged-based digital divide.

However, further studies need to be carried out in order to evaluate a longer term usage of the system and to assess long-term effects on communication habits. It would be interesting to investigate how elderly people respond to conversation breaks which are common in a group chat setting. In order to completely replace the WhatsApp family group chat but maintain the involvement of the oldest generation further modifications of the FCA application have to be made. For instance, one possibility could be to add a merely textual based chat feature, thus create a fully functional messaging app similar to WhatsApp and additionally provide the user with an option to choose if a media object should be forwarded to the elderly's device or just be uploaded within the FCA app. In terms of two-way communication, it would be interesting to see how a revised version of the response workflow/approach would influence the behaviour of senior users or if it would have produced comparable results. Without a doubt, there is room for improvement but the study demonstrates that the presented approach has a good potential to become a suitable social messaging tool for different generations. Moreover, it could be shown that solutions designed around the individual needs of certain marginalized groups are worth the effort. Neither commercially available digital frames, nor state-of-the-art smartphones can provide the same user experience as custom-tailored devices or software can do.

List of Figures

Acronyms

CP Cultural Probes. 27, 29, 33

DB Database. 48

FCA Family Counterpart App. 4, 29, 47, 51, 53, 58, 59, 64

GUI Graphical User Interface. 37, 41, 52, 54, 56

HCI Human-Computer Interacion. 5, 19, 20

ICT Information and Communication Technology. xv, 1, 3, 5, 7, 9, 12, 14, 17–21, 23, 29, 33, 36, 63

IR Infrared. 48

LED Light-emitting diode. 48

OS Operating System. 44, 58

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Bibliography

[AMAM14] M. Azuddin, S. A. Malik, L. M. Abdullah, and M. Mahmud. Older people and their use of mobile devices: Issues, purpose and context. In *The 5th International Conference on Information and Communication Technology for The Muslim World (ICT4M)*, pages 1–6, Nov 2014.

[BM05] Mark Blythe and Andrew Monk. Net neighbours: adapting {HCI} methods to cross the digital divide. *Interacting with Computers*, 17(1):35 – 56, 2005. Design for Civil Society.

[BMD05] Mark A. Blythe, Andrew F. Monk, and Kevin Doughty. Socially dependable design: The challenge of ageing populations for hci. *Interact. Comput.*, 17(6):672–689, December 2005.

[BNS02] Elizabeth B.-N. Sanders. From user-centered to participatory design approaches. In *Design and the social sciences: Making connections*, pages 1–8. CRC Press, 2002.

[Bud] Raluca Budiu. Memory recognition and recall in user interfaces. `https://www.nngroup.com/articles/recognition-and-recall/`. Accessed: 2017-03-21.

[Bux07] Bill Buxton. *Sketching User Experiences: Getting the Design Right and the Right Design*. Morgan Kaufmann Publishers Inc., San Francisco, CA, USA, 2007.

[BVSD07] Kirsten Boehner, Janet Vertesi, Phoebe Sengers, and Paul Dourish. How hci interprets the probes. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '07, pages 1077–1086, New York, NY, USA, 2007. ACM.

[CB09] Neil Charness and Walter R Boot. Aging and information technology use: Potential and barriers. *Current Directions in Psychological Science*, 18(5):253–258, 2009.

[CGH+10] Graeme W. Coleman, Lorna Gibson, Vicki L. Hanson, Ania Bobrowicz, and Alison McKay. Engaging the disengaged: How do we design technology for

digitally excluded older adults? In *Proceedings of the 8th ACM Conference on Designing Interactive Systems*, DIS '10, pages 175–178, New York, NY, USA, 2010. ACM.

[Chr16] Prinz Christoph. snap.science - social science communication to experience research and open innovation. Master's thesis, Technische Universität Wien | Fakultät für Informatik | Institut für Gestaltungs- und Wirkungsforschung | E187, 2016.

[eSE17] eurostats Statistics Explained. Being young in europe today - digital world. http://ec.europa.eu/eurostat/statistics-explained/index.php/Being_young_in_Europe_today_-_digital_world#Data_sources_and_availability, 2017. Accessed: 2017-03-27.

[Far16] Susan Farrell. Field studies. https://www.nngroup.com/articles/field-studies/, 2016. Accessed: 2017-05-05.

[FDC+14] Shira H Fischer, Daniel David, Bradley H Crotty, Meghan Dierks, and Charles Safran. Acceptance and use of health information technology by community-dwelling elders. *International journal of medical informatics*, 83(9):624–635, 2014.

[FJ] J Fletcher and R Jensen. Overcoming barriers to mobile health technology use in the aging population. http://www.himss.org/overcoming-barriers-mobile-health-technology-use-aging-population Accessed: 2017-03-22.

[Fla15] Kim Flaherty. Indicators, validations, and notifications: Pick the correct communication option. https://www.nngroup.com/articles/indicators-validations-notifications/, 2015. Accessed: 2017-05-03.

[FMAH12] Miranda A Farage, Kenneth W Miller, Funmi Ajayi, and Deborah Hutchins. Design principles to accommodate older adults. *Global journal of health science*, 4(2):2, 2012.

[GDP99] Bill Gaver, Tony Dunne, and Elena Pacenti. Design: Cultural probes. *interactions*, 6(1):21–29, January 1999.

[Ges17] Gestalt psychology. Gestalt psychology — Wikipedia, the free encyclopedia. https://en.wikipedia.org/wiki/Gestalt_psychology, 2017. Accessed: 2017-03-08.

[GF13] Florian Güldenpfennig and Geraldine Fitzpatrick. Towards rapid technology probes for senior people. In *Human Factors in Computing and Informatics*, pages 664–671. Springer, 2013.

[Har17] Aurora Harley. Ideation for everyday design challenges. https://www.nngroup.com/articles/ux-ideation/, 2017. Accessed: 2017-04-03.

[Haw00] Dan Hawthorn. Possible implications of aging for interface designers. *Interacting with computers*, 12(5):507–528, 2000.

[HH07] Vita Hinze-Hoare. The review and analysis of human computer interaction (hci) principles. *arXiv preprint arXiv:0707.3638*, 2007.

[HSN07] Andreas Holzinger, Gig Searle, and Alexander Nischelwitzer. On some aspects of improving mobile applications for the elderly. In *Proceedings of the 4th International Conference on Universal Access in Human Computer Interaction: Coping with Diversity*, UAHCI'07, pages 923–932, Berlin, Heidelberg, 2007. Springer-Verlag.

[JNK10] Tejinder K Judge, Carman Neustaedter, and Andrew F Kurtz. The family window: the design and evaluation of a domestic media space. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pages 2361–2370. ACM, 2010.

[KC15] Bong Way Kiat and Weiqin Chen. Mobile instant messaging for the elderly. *Procedia Computer Science*, 67:28–37, 2015.

[Kiv15] Tero Kivimäki. Technologies for ambient assisted living: Ambient communication and indoor positioning. 2015.

[KS05] Sylvia E Korupp and Marc Szydlik. Causes and trends of the digital divide. *European Sociological Review*, 21(4):409–422, 2005.

[LHS08] Siân Lindley, Richard Harper, and Abigail Sellen. Designing for elders: Exploring the complexity of relationships in later life. In *HCI 2008 Culture, Creativity, Interaction*. Association for Computing Machinery, Inc., September 2008.

[LHS09] Siân E. Lindley, Richard Harper, and Abigail Sellen. Desiring to be in touch in a changing communications landscape: Attitudes of older adults. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '09, pages 1693–1702, New York, NY, USA, 2009. ACM.

[MA13] S. A. Malik and M. Azuddin. Mobile technology for older people : Use of personas. In *2013 International Conference on Research and Innovation in Information Systems (ICRIIS)*, pages 97–101, Nov 2013.

[Mos16] Rana Mostaghel. Innovation and technology for the elderly: Systematic literature review. *Journal of Business Research*, 69(11):4896 – 4900, 2016.

[NA] J Nielsen and L Angie. Mega menus work well for site navigation. https://www.nngroup.com/articles/mega-menus-work-well/. Accessed: 2017-03-27.

[Nie] Jakob Nielsen. Seniors as web users. https://www.nngroup.com/articles/usability-for-senior-citizens/. Accessed: 2017-03-22.

[Nie12] Jakob Nielsen. Usability 101: Introduction to usability. https://www.nngroup.com/articles/usability-101-introduction-to-usability/, 2012. Accessed: 2017-05-09.

[Nor13] Don A. Norman. *Design of Everyday Things: Revised and Expanded.* New York : Basic Books, 2013.

[Org] World Health Organisation. Proposed working definition of an older person in africa for the mds project. http://www.who.int/healthinfo/survey/ageingdefnolder/en/. Accessed: 2017-03-09.

[PD10] Michelle Pieri and Davide Diamantinir. Young people, elderly and ict. *Procedia - Social and Behavioral Sciences*, 2(2):2422 – 2426, 2010.

[Per16] Kara Pernice. Ux prototypes: Low fidelity vs. high fidelity. https://www.nngroup.com/articles/ux-prototype-hi-lo-fidelity/, 2016. Accessed: 2017-04-03.

[PS05] Gerd Paul and Christian Stegbauer. Is the digital divide between young and elderly people increasing? *First Monday*, 10(10), 2005.

[PW88] Robson J G Pelli, D G and A J Wilkins. Pelli-robson contrast sensitivity chart. http://www.psych.nyu.edu/pelli/pellirobson/, 1988. Accessed: 2017-03-08.

[Rei10] Jori Reijula. Using well-being technology in monitoring elderly people a new service concept, 2010.

[RH08] Stéphanie Rossit and Monika Harvey. Age-related differences in corrected and inhibited pointing movements. *Experimental Brain Research*, 185(1):1–10, 2008.

[RHR16] J. C. Roberts, C. Headleand, and P. D. Ritsos. Sketching designs using the five design-sheet methodology. *IEEE Transactions on Visualization and Computer Graphics*, 22(1):419–428, Jan 2016.

[Rid07] David R Riddle. *Brain aging: models, methods, and mechanisms.* CRC Press, 2007.

[RMB+07] Natalia Romero, Panos Markopoulos, Joy Baren, Boris Ruyter, Wijnand Ijsselsteijn, and Babak Farshchian. Connecting the family with awareness systems. *Personal Ubiquitous Comput.*, 11(4):299–312, April 2007.

[Ros] Bruce Rosenthal. Visual vs. acuity contrast sensitivity. `http://www.optometricmanagement.com/issues/2006/march-2006/visual-acuity-vs-contrast-sensitivity`. Accessed: 2017-03-20.

[S+00] Vicki L Schmall et al. Sensory changes in later life. Technical report, [Corvallis, Or.]: Oregon State University Extension Service;[Olympia, Wash.]: Washington State University Cooperative Extension;[Moscow, Idaho]: University of Idaho Cooperative Extension System;[Washington, DC]: US Dept. of Agriculture, 2000.

[SB] Richard Suzman and John Beard. Ageing and health. `http://www.who.int/mediacentre/factsheets/fs404/en/`. Accessed: 2017-03-09.

[SB11] Richard Suzman and John Beard. Global Health and Aging. `https://www.nia.nih.gov/research/publication/global-health-and-aging/preface`, 2011. Accessed: 2017-03-08.

[SCB16] Susanne Maaß and Sandra; Koch Daniel; Schumacher Regina Schirmer Carola; Bötcher, Anneke; Buchmüller. Partizipative entwicklung von technologien für und mit ältere/n menschen : Abschlussbericht zum forschungsprojekt "partec - partizipatives vorgehen bei der entwicklung von technologien für den demografischen wandel". 2016. 119 S.

[Smi] Aaron Smith. Older adults and technology use. `http://www.pewinternet.org/2014/04/03/older-adults-and-technology-use/`. Accessed: 2017-03-14.

[Sne17] Snellen chart. Snellen chart — Wikipedia, the free encyclopedia. `https://en.wikipedia.org/wiki/Snellen_chart`, 2017. Accessed: 2017-03-08.

[Spr11] Wolfgang Spreicer. Tangible interfaces as a chance for higher technology acceptance by the elderly. In *Proceedings of the 12th International Conference on Computer Systems and Technologies*, CompSysTech '11, pages 311–316, New York, NY, USA, 2011. ACM.

[SRP07] Helen Sharp, Yvonne Rogers, and Jenny Preece. Interaction design: beyond human-computer interaction. 2007.

[Uni15] United Nations. World Population Ageing 2015. *Department of Economic and Social Affairs, Population Division*, (ST/ESA/SER.A/390), 2015.

[VBRY16] J. Mitchell Vaterlaus, Kathryn Barnett, Cesia Roche, and Jimmy A. Young. "snapchat is more personal": An exploratory study on snapchat behaviors and young adult interpersonal relationships. *Computers in Human Behavior*, 62:594 – 601, 2016.

[WSP+12] Joseph Wherton, Paul Sugarhood, Rob Procter, Mark Rouncefield, Guy Dewsbury, Sue Hinder, and Trisha Greenhalgh. Designing assisted living technologies 'in the wild': preliminary experiences with cultural probe methodology. *BMC Medical Research Methodology*, 12(1):188, 2012.

[WTL02] Miriam Walker, Leila Takayama, and James A Landay. High-fidelity or low-fidelity, paper or computer? choosing attributes when testing web prototypes. In *Proceedings of the Human Factors and Ergonomics Society Annual Meeting*, volume 46, pages 661–665. SAGE Publications Sage CA: Los Angeles, CA, 2002.

[WWR+05] Eileen Wood, Teena Willoughby, Alice Rushing, Lisa Bechtel, and Jessica Gilbert. Use of computer input devices by older adults. *Journal of Applied Gerontology*, 24(5):419–438, 2005.

[ZB05] Martina Ziefle and Susanne Bay. How older adults meet complexity: aging effects on the usability of different mobile phones. *Behaviour & Information Technology*, 24(5):375–389, 2005.