

EMILIA

CONNECTEDNESS

CONNECTEDNESS

- Utilizing ambiguity to reduce loneliness and support remote intimacy and connectedness.

A MASTER OF DESIGN THESIS BY **MARCELO LUFT**

TANGIBLE

TANGIBLE

INTIMACY

EMILIA

Utilizing ambiguity to reduce loneliness and support remote intimacy and connectedness.

by Marcelo Müller Luft

A thesis exhibition presented to OCAD University in partial fulfilment of the requirements for the degree of MASTER of DESIGN (MDes) in DIGITAL FUTURES.

Toronto, Ontario, Canada, April 2017

 Marcelo Müller Luft 2017

This work is licensed under a Creative Commons Attribution-NonCommercial 4.0. To view a copy of this license, visit <http://creativecommons.org/licenses/by-nc/4.0/> or send a letter to Creative Commons, 444 Castro Street, Suite 900, Mountain View, California, 94041, USA.

This work is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License. <http://creativecommons.org/licenses/by-nc/4.0/>

You are free to:

- Share – copy and redistribute the material in any medium or format
- Adapt – remix, transform, and build upon the material

Under the following conditions:

Attribution – You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.

Noncommercial – You may not use the material for commercial purposes..

Share Alike – If you alter, transform, or build upon this work, you may distribute the resulting work only under the same or similar license to this one.

With the understanding that:

Waiver – Any of the above conditions can be waived if you get permission from the copyright holder.

Public Domain – Where the work or any of its elements is in the public domain under applicable law, that status is in no way affected by the license.

Other Rights – In no way are any of the following rights affected by the license:

- Your fair dealing or fair use rights, or other applicable copyright exceptions and limitations;
- The author’s moral rights;
- Rights other persons may have either in the work itself or in how the work is used, such as publicity or privacy rights.

Notice – For any reuse or distribution, you must make clear to others the license terms of this work. The best way to do this is with a link to this web page <http://creativecommons.org/licenses/by-nc/4.0/>

Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I authorize OCAD University to lend this thesis to other institutions or individuals for the purpose of scholarly research. I understand that my thesis may be made electronically available to the public.

I further authorize OCAD University to reproduce this thesis by photocopying or by other means, in total or in part, at the request of other institutions or individuals for the purpose of scholarly research.

Abstract

OCAD University

Digital Futures

Master of Design, 2017

Emilia : Utilizing ambiguity to reduce loneliness and support remote intimacy and connectedness.

by Marcelo Müller Luft

For many elder adults the aging process can be very challenging. A great number of elders experience social isolation, causing them to suffer from depression and loneliness. The Emilia project uses a research through design methodology to investigate and reflect on the application of the concepts of Ambiguity, Tangible User Interfaces and Calm Technology in mitigating loneliness. I designed a prototype called The Happy Box which consists of a pair of internet-connected boxes that aim to support connectedness and Affective Awareness through non-verbal intimate and tangible interaction between elder adults and their family and friends. In this thesis document I describe and reflect on the process of making and testing The Happy Box.

Keywords: loneliness, elder adults, long distance intimacy, connectedness, closeness, affective awareness, ambiguity in design, tangible user interface, calm technology

Acknowledgement

I would like to start off by thanking my thesis supervisors Kate Sellen and Kate Hartman for supporting me with their incredible knowledge and experience adding great value to this thesis. I'm looking forward to having the opportunity to work with you again.

To Marietta O'Mahony, Martha Ladly, Immony Men and David McIntosh for guiding me through the three stages of this thesis project.

To the International Student Office staff, in especial to Susan Kemp and Le Dao for their unconditional help and support provided.

To all OCAD staff and faculty members in special to Darrell Currington and Reza Safaei for supporting this thesis during the prototyping process. I will miss the time spent at the RP centre and the Maker Lab.

And most of all I would like to thank my beloved parents, sisters and my dear partner and friend Andréia for their sustained support. I wouldn't be able to do it without you.

To my beloved grandmother Emilia whose strength and independency inspired this project; My mother Elizabeth and my father Antonio; My sisters Jana, Malu and Malena; And to my dear partner and friend Andréia.

Thank you for your support. Love you all.

Content

1. Introduction	1
2. Context	9
2.1.BACKGROUND AND MOTIVATION	9
2.2. DEFINING ELDERS AND LONELINESS	10
2.2.1.Elder Adults	10
2.2.2.Loneliness and Social Isolation	11
3. Initial Research	20
3.1.REMOTE INTIMACY AND CLOSENESS	20
3.1.1.Defining Intimacy and Closeness	20
3.1.2.Ambiguity for closer and intimate interactions	31
3.1.3.Tangible Interfaces to support Ambiguity and playfulness	41
3.2. AFFECTIVE AWARENESS AND CONNECTEDNESS	46
3.2.1.Defining Affective Awareness and connectedness	47
3.2.2.Supporting Affective Awareness and Connectedness	48
4. Research Methods	52
4.1.RESEARCH THROUGH DESIGN	52
4.2.QUALITATIVE RESEARCH	53

4.3. TESTING AND INTERVIEWS	54
5. The Happy Box	55
5.1. Description.....	55
5.2. Process.....	57
5.3. User Testing and Interviews.....	70
5.4. Results.....	73
5.5. Reflections.....	79
6. Future Research	92
7. Conclusion	93
8. References	96
9. Appendices	105
9.1. APPENDIX A: List of institution and support program for elders	105

List of figures

1. MarkerClock.	18
2. InTouch.	19
3. Feather & Scent.	27
4. Shaker.	29
5. VIO.	30
6. The Pillow.	33
7. Yo.	38
8. LumiTouch.	46
9. Lightbound.	49
10. Cubble.	50
11. Rüg	50
12. The Happy Box	55
13. Lights on The Happy Box.	57

14. First sketch Happy Box.	58
15. First iteration Happy Box.	59
16. Technical Drawing Happy Box.	60
17. Technical Drawing Happy Box.	60
18. Assembling The Happy Box.	61
19. Assembling The Happy Box.	62
20. First iteration of the Tokens.	64
21. Second iteration of the Tokens.	65
22. Second iteration of the Tokens.	65
23. Low fidelity prototype of The Happy Box.	67
24. Wiring Happy Box.	68
25. Happy Box during User Testing.	71
26. Happy Box during User Testing.	74
27. Happy Box during User Testing.	75
28. Happy Box during User Testing.	77

29. Happy Box during User Testing.	78
30. Happy Box during User Testing.	83

1. Introduction

Inspired by living away from my elder parents and having to see them through so many different digital screens I started to investigate ways I could help not only them, but other elders to interact with their loved ones remotely through more meaningful and intimate ways. I wanted to design solutions that bring people together. This thesis project studies solutions to mitigate loneliness by designing connected objects that can bring elder adults a sense of closeness and connectedness through more intimate and tangible interactions between them and their loved ones.

For many elder adults aging can become very challenging. A great number of elders experience social isolation, causing them to suffer from depression and loneliness. Psychological health has been proven to be as important to the wellbeing of elders as physical health. Keeping active social relationships can bring great benefits to their quality of life (Lindley, Harper & Sellen, 2009). Loneliness surpasses obesity as a factor in predicting early death (Hafner, 2016). The causes of loneliness can be a sudden change of environment, like moving from their own place to a care home, or the loss of a partner or a friend; but often it can be related to lack of contact with their families and friends. Sometimes their families are too busy and forget to contact them periodically. Communicating with

younger generations, such as their grandchildren can also be very difficult due to the big cultural gap between them and the lack of common topics to talk about. Worried about invading their families' privacy or becoming a burden, elder adults tend to reduce the frequency by which they visit or call their loved ones (Riche & Mackay, 2010). Often due to physical impairment they also start to avoid activities outside their home, thus diminishing moments of socialization.

Social isolation is related to the condition and state in which people experience a lack of social contact and interaction in their daily lives. On the other hand loneliness is a feeling, an emotion caused by people's desire to feel close and connected when in reality they are isolated and away from their loved ones (Wenger, Davies, Shahtahmasebi & Scott, 1996). Considering that loneliness is related to a lack of closeness and connectedness, I started to reflect on ways that this feeling could be supported through remote interactions.

Similar to loneliness, connectedness can also be defined as an emotional feeling, the feeling of being in touch, a sense of kinship and closeness. Most of the attempts of supporting the feeling of connectedness through technology include works in the field of remote presence and presence awareness systems. For my initial research I specifically considered works aimed at connecting families and friends. Being aware of the status and whereabouts of someone you care about deeply can bring a strong sense of connectedness, but not necessarily every

experience of connectedness will be accompanied by awareness (Rettie, R. 2003). The sense of connectedness can be triggered by a simple text message to say "hi" in the middle of the day or through an act of intimacy between a friend or a loved one. When intimate individuals exchange a text message or talk over the phone, instantly there are multiple feelings that can be experienced - the feeling of being in touch, a sense of belonging and being part of this relationship constituted by the involved parties, and awareness of each other.

The feeling of being connected to a person and being aware of someone even when they are distant is a very intimate experience. Thus for an object to support this feeling it needs to mediate some level of intimacy (Ijsselsteijn, van Baren & van Lanen, 2003). Although intimate acts can be very fleeting and subjective, and therefore hard to be interpreted, for the past years we have seen a growth in the interest to mediate intimacy through interactive media. For this project I look at the work of Vetere et al. (2005, April) on designing technologies to mediate intimacy. I also utilized the concept of Phatic Technologies coined by Gibbs, Vetere, Bunyan & Howard (2005). According to Gibbs et al. (2005) "Phatic Technology, are less concerned with capturing and communicating information and more about the establishment and maintenance of social connection". In the daily exchanges of messages that happen between intimate individuals, often the content has less importance than the act itself, those bits of interaction work more as an indication of awareness, connection and intimacy between the parties. Strong & Gaver (1996)

wrote an enlightening statement in regards to three prototypes they created with the intent of mediating intimacy: “They emphasize the potential for technology to mediate interactions that are indicative rather than explicit, expressive rather than informative, and emotive rather than instrumental”. I believe this quote reflects my intentions with this thesis. The solutions presented here greatly rely on the closeness and expressiveness of an intimate relationship to mediate intimacy and connectedness.

I believe the problem with more traditional communication devices is that they not only require too much effort from elder adults, but they are not intended to mediate intimacy. They are not designed to support the level of closeness and connectedness that I believe to be necessary to mitigate one’s loneliness. Mobile phones and computers also can’t supply what elders expect from an intimate communication exchange. They need to feel that some personal touch and effort was put into the interaction for that act to be valued (Lindley et al., 2009). Thus my intention with this project was to look into solutions such as Phatic Technologies that rely less on screens, that encourage intimacy by not necessarily designing objects to mediate meaning but to mediate emotions, feelings and awareness.

Vetere et al. (2005, April) broke down intimacy into three themes: the antecedents, the constituents and the yields of an intimate relationship. My prototype relies on the antecedents, their secrets and shared knowledge. But it supports the constituents, the expressive, ambiguous and non-verbal acts of

intimacy; as a result this prototype augments the yields of an intimate relationship, including what Vetere et al., (2005, April) defines as presence-in-absence which is quite similar to the concept of Affective Awareness (Liechti & Ishikawa 2000) covered in this thesis.

With the intent of mediating intimacy and its constituents which are non-verbal, expressive and emotion driven rather than content driven, I look at the concept of using Ambiguity as a resource to design, similar to a writer that leaves gaps of a story to be interpreted by the spectator. Ambiguity, according to Gaver, Beaver & Benford (2003), is capable of encouraging closer and engaging interactions with and through systems. I designed this prototype to leave gaps to be interpreted. The information being sent is ambiguous in a way that encourages elders and their families to interpret it utilizing existing context and intimate knowledge that they have of each other. This not only mediates intimacy but brings a feeling of closeness and connectedness. This object was also designed not to convey any clear purpose, using the concept of Ambiguity of context also presented by Gaver et al.(2003). The idea is that users will interpret and use the object as they see fit, resulting in a more personal relationship with the object.

As mentioned before, I believe that many modern communication devices don't offer the means to mediate real, close and intimate interactions, so I looked into the concept of Calm Technology (Weiser & Brown, 1997) and Tangible

User Interfaces (Ullmer & Ishii, 2000) with the intention of bringing users closer to the interface and bringing the people interacting through the object closer to each other by moving the screens out of the way. I use these concepts to convey presence awareness through movement and light. Touch is also one of the many acts of intimacy. Tangible User Interfaces gave me the means to design interactions that use touch as way of mediating intimacy and augmenting closeness.

I designed a prototype called The Happy Box as part of this thesis project. I utilized the methodology of research through design to acquire knowledge through the process of designing and testing this artifact. This process has also shaped the body and focus of this research. I used this prototype to help me confirm some of my assumptions and answer the following research questions:

1. How can ambiguity be used in design to support the feeling of connectedness and encourage the development of more intimate interactions?
2. How can Tangible User Interfaces be used to support the sense of closeness in remote interactions and help improve the communication between elder adults and their families?

I start this document with the Context section, which I broke down into three subsections: The first is where I present my background, motivation, how this project affected me as designer, and also how my personal experiences guided me on how to conduct this research. Secondly, I talk about loneliness and some of the other problems experienced by elder adult that I try to address in this thesis project. The third subsection gives a broad context of intimacy and how it can be mediated through interactive technologies.

The second section is where I present my initial research on the concepts I work with and the fields I worked within. This section is divided in two main subsections. In the first subsection I talk about the concepts of Tangible User Interfaces and Ambiguity as a resource to design and how I used them to mediate intimacy, connectedness. Secondly, I present the concepts of Affective Awareness and connectedness and how Ambient Displays can be used to support this feeling remotely. Following my initial research I present my research methodology, research through design which is the approach of doing research by applying the methods and process of design. It has the main objective of generating knowledge through the process of designing and reflecting.

The fourth main section of this document is where I present the prototype created as part of this thesis project. This section is divided in five subsections. The first is a description of the prototype, the second is where I present the

process - how I went about making it, third is where I present the settings for the user testing and interviews, and in the fourth I present the participants and go over the results. The last subsection consist of my reflection over the process of testing and making The Happy Box.

I end this document with my conclusion, where I present my general findings, and most importantly, explain how the knowledge acquired through this work can contribute to future research.

2. Context

2.1. BACKGROUND AND MOTIVATION

Emilia was my grandmother, one of the strongest people I have ever met. She would take long walks to visit us and to do her groceries. I was young when she passed away at 91 years old, but most memories I have of her are of a strong, independent and happy person. I hope this project named after her can in some way support other people to experience the strength and independence she had. This project is very personal to me from the name it carries to the topic I chose to investigate.

My interest in creating solutions to bring elders and their families closer was greatly influenced by two things that I experienced while living abroad: I had to adapt from seeing my elderly parents daily to only communicating with them remotely. I also had to keep a long distance relationship with my partner in Brazil. These experiences have not only led me to investigate this topic but they were also extremely important to how I as a designer approached the solutions created as part of this thesis project. Empathy is one of the greatest tools in design. I believe that my experience of living away from my family helped me better understand the people and the context that I was designing for, it guided me to create better solutions. During this thesis project I tried to reflect as much as I

could on how my memories of my grandmother and my personal experience of living away from my loved ones could help me better empathize with the people I was designing for.

2.2. DEFINING ELDER AND LONELINESS

In this section I will present the definition of two terms that are really relevant for this thesis and will be used throughout this whole document. First, I will define who this thesis project considers to be elder adults. Secondly, I will present the definition of loneliness and how this has become a big problem for the aging population.

2.2.1. Elder Adults

I started this project with my parents in mind. They are both in their 70s. From the beginning, this is the demographic I was designing for. However, I also know that my mom perceives herself as an elder adult but my father doesn't. He prefers not to define himself at all. The connotation of the word elder can also vary from one country to another due to how each government defines a person as elder for the distribution of social benefits and pensions. Lindley, Harper & Sellen (2008) say that due to the stigma around being old many elders don't perceive themselves as such but prefer to define themselves as being in the way of becoming an elder person instead of being one. I prefer not to define elder here. It is up to a person to define or perceive themselves as elders or not. However as a design consideration

when I was making the prototype, I considered anyone over 70 years old as users, and from now on when I use the words elder or elder adults, please be advised that I will be referring to any person that perceive themselves as an elderly person.

Even though the elderly population is often disregarded as users of modern technology, there is a great number of elders making use of mainstream technologies, such as mobile phones and computers. One of the participants of the user testing conducted as part of this project says that she frequently uses WhatsApp and FaceTime to keep in touch with her children. This should become even more common as we are not far from seeing a whole generation considered knowledgeable in modern technology in retirement. This project doesn't intend to work solely with elders that have reduced or no access to communication technology. This thesis project includes elder adults that live away from their families and who may have some kind of limitation that lessens their capability of engaging in social activities and visiting their families and friends as often as they wish, thus harming their connectedness and bringing a feeling of missing and loneliness.

2.2.2.Loneliness and Social Isolation

Loneliness is a very subjective feeling (Holt-Lunstad, Smith, Baker, Harris & Stephenson, 2015), and as a subjective feeling I believe no one can understand it or define it except the ones who actually feel it. I live away from my parents and keep

a long distance relationship with my partner. I miss dearly the company of them especially when coming home and wanting to talk about my day, but I wouldn't define this as loneliness. I would argue that loneliness is a much deeper feeling than temporary missing someone you care about. So in this chapter I try to define loneliness based on what I have learned by talking to elders during user testing and according to previous research that has been done in this field. I also present some related works that have the intent of mitigating loneliness. Even though the number of cases of loneliness are higher between older adults (Masi, Chen, Hawkley & Cacioppo, 2010), it is extremely important to notice that this is an issue that also affects younger generations. The risks of mortality is actually higher for adults younger than 65-years-olds living alone (Holt-Lunstad et al., 2015). That being said, this project will focus primarily on loneliness and its consequences experienced specifically by elder adults.

For many elder adults the aging process can be very challenging. A great number of them are forced to move from their homes due to issues experienced later in life. In a data analysis done by Perissinotto, Cenzer & Covinsky (2012) using data from a large national survey of older adults in the United States showed that 43% of the 1,604 participants of the study felt lonely. Loneliness surpasses obesity as a factor in predicting early death (Holt-Lunstad et al., 2015). Psychological health has been proven to be as important to the wellbeing of elders as their physical health. Keeping active social relationships can bring great benefits

to their quality of life, and family relationships are very important in this regard (Lindley et al., 2008). The symptoms and causes of loneliness are varied. It can be due to a sudden change of environment, like having to move from their own place to a care facility or the loss of a partner or a friend. The Little Brother, an institution from Canada that provides support to lonely elders, defines five factors that contribute to isolation: loss of loved ones, physical and mobility impairments, mental health conditions and cognitive decline, living alone and poverty.

Frequently elders can end up auto-isolating themselves due to how they perceive family relationships. They tend to reduce the frequency in which they contact their families to avoid invading their children's privacy and disrupting what they usually perceive to be a busy life (Riche & Mackay, 2010). They are also more willing to help than get help from their families because they don't want to be a burden (Lindley et al., 2008). Even though they avoid calling their Family members too often, they value family connection. During a workshop and interview conducted by Achilleos, et al. (2013) the authors identified that keeping in touch with family and friends is greatly valued by elders as way of staying socially active. Even a quick contact through phone or text message can have great impact in how elders feel. A simple sign of care and awareness can make them feel more valued and less lonely. My goal with this project was to support simple but meaningful and constant contact between elders and their families and friends.

Social isolation is a condition and state in which people experience a lack of social contact and interactions in their daily lives. On the other hand, loneliness is a feeling, an emotion related to but not always caused by social isolation. It is associated with people's desire to feel close and connected when in reality they are isolated and away from their loved ones (Wenger et al., 1996). Social isolation is known to be one of the most common causes of loneliness. Having a more active social life can lessen the effect of loneliness. However, at times socializing is not enough to make one feel less lonely - often it is everyday company that matters. Loneliness makes days feel longer. It becomes a loop, day after day of constantly missing being in touch with friends and family, wishing to connect with someone but it never happens. Again, I am not saying that having social activities doesn't help to mitigate loneliness, I would argue that those moments of socialization often are brief and represent just a small percentage of the day. At home, where elders usually spend most of their time, is where they tend to feel most lonely. It is at home where they will miss perhaps a deceased partner, a family member that lives away or a friend they have not seen in awhile. Channel 4 News (2015, November 3) from Belfast, Ireland conducted an interview with two elders. One of them had a daughter who visits sometimes, but she mentioned that it is the everyday company that she misses, that even though some people find it odd she sometimes talks to herself as if she were having a conversation with her deceased husband, just so she can speak. The second interviewee lost his only son and

more recently, his wife. He said that he goes out sometimes, but when he comes back he comes back to an empty house and then loneliness arises again.

One my research interests is to understand how technology could bring benefits to this issue, therefore my initial research in loneliness focuses on works that used some kind of technology as part of their solution. Although I also appreciate the importance of the many institutions and programs that help elders become more socially active, by offering activities or connecting them with volunteers to whom they can talk to.

Most of the work being done into solutions to mitigate loneliness fits into two major categories. First are solutions trying to help elders to engage in social activities, making new connections and meeting new friends. Second are solutions that are trying to help elders feel less lonely by maintaining their current relationships and connecting them to their remote families and friends. These include awareness systems and communication devices. This thesis focuses predominantly on the second category, but I acknowledge the relevance of social isolation as one of the main causes of loneliness. Since loneliness is associated with the missing of someone's presence, someone's company, and also the lack of connection and interaction (Wenger et al., 1996), this thesis project tries to mitigate loneliness by offering elders solutions to feel a sense of connectedness, of being in touch, to feel the closeness and the presence of family members

or friends even when they are away. The prototype made as part of this thesis aims to bring a bit of connection to their daily lives, a bit of light to their empty house so as to lessen the effects of loneliness.

Related Work

One of the common approaches to trying to connect remote families is to use familiar objects to many residences such as clocks like the MarkerClock (Riche & Mackay, 2010) or portraits like LumiTouch (Chang, Resner, Koerner, Wang, Ishii, 2001) and The Digital Family Portrait (Rowan & Mynatt, 2005). Portraits have a significant affective connotation attached to them, so they can bring great benefits to objects trying to mediate affective interactions. The MarkerClock seen in Figure 1 utilizes a clock interface to connect elders and support social awareness between them. The clock detects motion around it and shows the level of activity in its timeline utilizing gradient colours. Elders can use this to be aware of each other's routines and rhythms and also communicate through simple codes by placing some of the available symbols into the clock timeline. The information is ambiguous to encourage elders to interpret it using their shared knowledge and also to maintain an acceptable level of intimacy. During testing the MarkerClock proved to be a great solution to lessen the effect of loneliness. It kept a constant connection between the elders and most of the users stated feeling closer and connected by being aware of each other's routines. The Family Portrait works as a one-way awareness system. It uses the portrait as an interface to show qualitative

data about the elder's activities, but the portrait is located only at the family house, whereas at the elder's residence the sensors capture the data. Even though this was a one-way awareness system, during testing the elderly participant started feeling less lonely by knowing her son was taking care of her. I would argue, however, that this is a very subjective feeling as many elders are not comfortable with being monitored (Lindley, et al., 2008). The MarkerClock has more similarities to what this thesis proposes, but I mention the Family Portrait as an example of how it uses a familiar object to create more affective interactions. LumiTouch will be revisited in Initial Research section.

Social Hue (Davis, Hu, Feijs & Owusu, 2015) is a proof of concept that intends to support awareness and connectedness between elder adults and their caregivers. It uses sensors to capture movement and emotion from both the elders and caregivers and display that information using the Philips Hue Light system, different colours and pattern of lighting will be used to inform different statuses. Davis et al. (2015, March) states that the Social Hue aims to utilize subtle awareness to produce social presence. I like this concept, mostly because in contrast to the Family Portrait in that it works both ways - it is not just a monitoring system but is also a source of awareness and connectedness. It is very interesting how it helps the caregiver take care of elders remotely without them feeling like they are being monitored. Additionally, it helped the elder adult feel accompanied and less lonely when their caregiver was away.

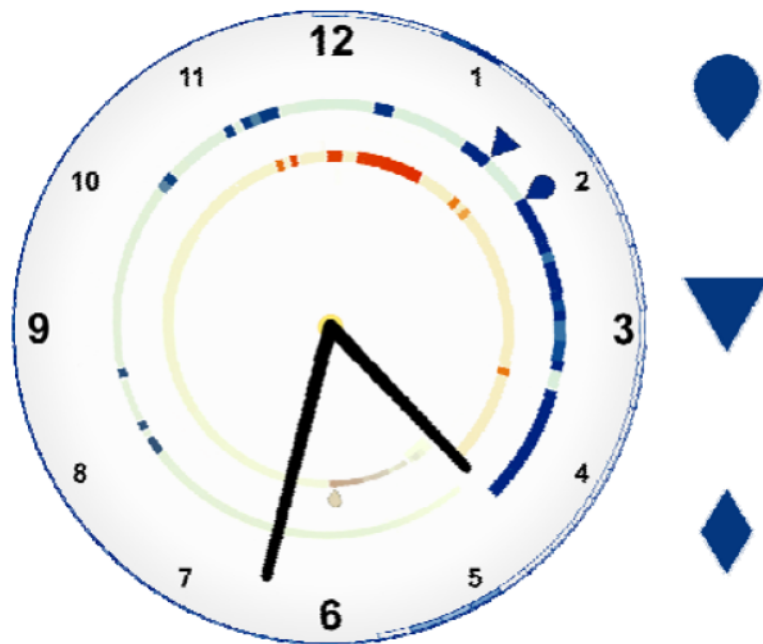


Figure 1. Marker Clock (Riche & Mackay, 2010)

Lindley et al (2008) stated elders often have interest in their families activities and informations, however, most of that information is usually available on platforms and tools that elders do not have access to, such as Facebook. InTouch is an example of works aimed at mitigating loneliness by designing tools to make family data more accessible and support social connection. Created by Baecker, Sellen, Crosskey, Boscart & Barbosa Neves (2014), InTouch is a tablet-based application that allows elders to exchange photos, videos, audio messages and waves (a simple notification sent to their families letting them know that the elders are thinking of them). What I like most about this project is the wave functionality. It is subtle but meaningful, it can mean "I'm thinking of you" or just a "hello", and

this is where it relates to this thesis. Subtle and expressive interactions can be very intimate and powerful in creating a sense of connectedness and awareness.



Figure 2. InTouch (Baecker et al., 2014)

This thesis project approaches very similar problems to those mentioned in this section, however, it differentiates itself in how it proposes to address these issues. Except for the Social Hue which also applies ambient lighting with intent of supporting social presence, these related works use screen-based solutions, whereas this thesis project proposes screen-less solutions using the concepts of Tangible User Interfaces and Calm Technology. Although The MarkerClock also uses a computer as its interface, it was quite influential to this thesis project regarding how it uses ambiguous elements to encourage elders to interpret codes and information using the intimate knowledge they share between them, and also the concept of PeerCare networks presented by Riche & Mackay (2010) as part of this same work. I will further analyze the work of Riche & Mackay in the Initial Research section.

3. Initial Research

3.1.REMOTE INTIMACY AND CLOSENESS

This section is divided into three subsections. First I present the definition of intimacy and closeness for all the different relationships - friends, family and lovers. Secondly, I present the concept of Ambiguity as Resource to design (Gaver et al., 2003) and how it can be used to mediate intimacy and closeness. Lastly I talk about the concept of Tangible User Interfaces (Ullmer & Ishii, 2000) and how tangible interactions can support a sense of closeness through touch.

3.1.1.Defining Intimacy and Closeness

Caring an intimate relationship has great benefits to one's psychological health, so does the feeling of closeness and belonging (Hassenzahl, Heidecker, Eckoldt, Diefenbach & Hillmann, 2012). According to Monsour (1992) the absence or shortage of intimacy in one's life is one of the causes of loneliness. If loneliness may be caused by a lack of intimacy, then it is acceptable to assume that the opposite may also be true - managing to bring a sense of closeness and intimacy to one's life may help mitigate loneliness. This project approaches specifically the cognitive aspects of intimacy - thinking and being aware of each other and sharing goals and general information - and the affective aspects of intimacy - the feeling of oneness and the shared sense of care and empathy (Blieszner, & de Vries,

2001). The affective and cognitive aspects of intimacy, sharing intimate thoughts and information and being aware of each other is what inherently creates the sense of closeness according to Moss and Schwebel (1993).

Openness is one of the main characteristics of an intimate relationship, each participant is expected to share their thoughts, fears, stories or even general information with each other. Intimates often carry deep knowledge of each other which is why many times the acts of intimacy are expressive but subtle and most of the time have no explicit meaning. In regards to that Vetere et al., (2005) stated "Much of what passes between intimates is unsaid and premised on deep knowledge and understanding of one another and occurs in the context of a rich, shared and sometimes idiosyncratic view of the world that may be difficult for others to fathom and comprehend". The most predominant term in literatures about intimacy is self-disclosure, which I noticed to be a common term used by authors to refer to the openness of a relationship. Monsour (1992) defines self-disclosure as the "revealing of information about one-self that the partner was probably not aware of". Even though self-disclosure is part of the cognitive aspects of intimacy, the constant sharing of information and thoughts is also greatly responsible for the sense of awareness between intimates (Vetere et al, 2005). The intention of this project is to take advantage of the already existing intimacy between elder adults and their friends and family and offer solutions that can mediate this feeling and aspects of their relationship remotely and at a distance.

The intent of the prototype made as part of this thesis is to mediate the expressiveness and ambiguity of intimate acts. The acts and themes of intimacy can be different between friends, partners and family. Intimacy can also be approached and interpreted differently according to age, gender, ethnicity, and sexual orientation (Blieszner & de Vries, 2001). The acts of intimacy in a parent-child relationship for example vary throughout a child's life. The themes and acts of intimacy are different in their early life compared to when they get to adulthood (Fingerman, 2001). To better understand intimacy in this different contexts, I looked at literature about intimacy between lover, friends and families involving multiple generations.

Vetere et al. (2005, April) studied intimacy between couples living in a strong-tie relationship. The authors broke down intimacy into three theme groups, the antecedents, the constituents and the yields of an intimate relationship. The antecedents involve among other themes self-disclosure - being open and receptive - and the trust existing between the partners. The constituents are the emotional and expressive - non-verbal, flirting and playful - acts of intimacy. The yields are the results of the intimacy between lovers and include, for example, presence in absence - feeling each other's presence, thinking about each other when apart. Dalsgaard, Skov, Stougaard & Thomassen (2006) studied intimacy specifically in parent-child relationships using as a starting point the themes brought by Vetere et al. (2005), the participants on their study were mostly kids

from 6 to 10 years old and their parents. They identified that self-disclosure is not reciprocal within a parent-child relationship, the parents see self-disclosure as a very relevant aspect on their relationship, on the other hand kids prefer to keep some of the information about their day to themselves. According to Fingerman (2001) when offspring get to adulthood, both the child and their parents do disclose information with each other; but they tend to filter what to disclose and what not to. The child tends to avoid sharing things that may worry or hurt their parents. Friends have a very similar experience to couples in regards to openness. Monsour (1992) asked college students involved in cross or same sex-friendship to define the meaning of intimacy. Self-disclosure was one of the most mentioned answers by both male and female participants.

Closeness can be felt and expressed through the affective and also the cognitive aspects of intimacy - thinking and being aware of each other and sharing thoughts and information (Moss and Schwebel, 1993), but it can also be expressed through physical intimacy, by being physically close perhaps through a hug or through the playful acts between a child and their parent (Dalsgaard et al., 2006) . According to Fingerman (2001) the child's sense and need of closeness is usually reduced when they reach their adulthood, they start to create their own intimate ties with friends, lovers and even with their own offsprings. They usually lose some of their need for closeness with their parents. The parents on the other hand always maintain a need and desire to be close to their child. Intimacy tends

to become more mutual and reciprocal when the child gets to their adult life. In this phase of life, intimacy is expressed through a stronger sense of care and a shared respect for each other's individuality; due to this, closeness tends to be levelled according to each other's need (Fingerman, 2001).

Elders later in life tend to invest more time into their existing intimate relationships, instead of making new ties (Lindley et al., 2008). When communicating, perhaps by phone or even letter, they are looking for the exchange of some level of intimacy (Lindley et al., 2009). The sense of exchanging intimacy or being part of an intimate relationship is extremely important to one's wellbeing (Fingerman, 2001; Hassenzahl et al., 2012; Schiphorst et al., 2007). Living in absence of intimate interactions may bring one a sense of loneliness (Monsour, 1992). Considering elderly's need for closeness and intimacy, this project's intention was to find solutions that give elders the sense of intimacy and closeness they desire, in a way that also allows their friends and families to keep their individuality and perhaps allow elders to define a level of closeness they are comfortable with. Despite the differences described between each of the relationships, I would argue that all of them still share some similarities in how they perceive and approach intimacy. A parent and a child may reduce their closeness later life, but they still care and think about each other. They still share some information with each other, and like all the other relationships they still exchange some level of intimacy and closeness. Therefore this project's solutions to mediate

intimacy rely on these similarities, on the correlations between how each of these relationships perceive the affective and cognitive aspects of intimacy.

Mediating Intimacy

Due to perhaps improvements in travel, the globalization or maybe due to a change in the economy of some countries for the past decade we have seen a significant growth in families moving from one place to another. The consequences are that there a greater number of families members and couples living away from each other (Dalsgaard et al., 2006; Hassenzahl et al., 2012). Elders specifically may suffer even more, as they usually prefer to stay on their places causing them to be away and isolated from their families. Thus there is a significant numbers of projects aimed in using technology with the intent of mediating intimacy at a distance (Hassenzahl et al., 2012). A great part of this solutions are inspired in the expressiveness, simplicity and ambiguity of intimate acts and are intended to support remote presence and awareness.

The first important aspect is that an object or device intended to mediate intimacy should solely be used as such. Moreover it should be limited to a one to one interaction or perhaps a small group, but it most definitely should not be used to talk to general people like using your phone to talk to the bank manager for example (Kaye & Goulding, 2004). The simple fact of having an object that only connects one to this very limited and exclusive group or person can create a sense

of intimacy (Kaye & Goulding, 2004). Additionally even though phones and tools such as Skype and FaceTime are intended to connect people remotely, they are not designed to support subtle, expressive and sometimes ambiguous interactions that are so common in a great number of intimate relationships (Hassenzahl et al., 2012). Their focus is mostly in mediating the exchange of specific and clear messages. Even though they may be used as a way of staying in touch and mediate connectedness, mobile phones weren't designed to support intimate social connections (Dalsgaard et al., 2006). Just as computers they were initially designed to fit the context and needs of the work environment and then lately they were moved to a more domestic context (Dalsgaard et al., 2006). At home these devices were adapted to support more emotional aspects of connections which they weren't designed for (Gaver, 2002). Additionally according to Evjemo (as cited in Hassenzahl et al., 2012) phones may not be the best platform to mediate interactions between grandparents and grandchildren. The author states that perhaps a playing platform may be the best form of mediating remote intergenerational interaction. And according to Lindley et al., (2009) phones may also not be the best medium to support the level of intimacy expected by elders either.

Gibbs et al. (2005) conducted a fieldwork and according to the results they came with some properties that technologies intended to mediate intimacy should have. As expected it should allow self-disclosure while respecting privacy. The

communication should be minimal and allow interpretations. It should support subtle and flirtatious exchanges. Support the use of private and perhaps ambiguous languages that are part of an intimate relationship. It should mediate the sense of presence in absence and presence awareness through peripheral means. And lastly allow the parts to mutually expressed love and emotion through simple and expressive acts, preferably not through words but unspoken acts. As part of the same work Gibbs et al. (2005) also coined a term that defines well what this thesis intended to achieve, "phatic technologies" according to the authors are interactive technologies designed to be less concern in exchanging information and content and being more focus in offering more meaningful and expressive ways of social connection.

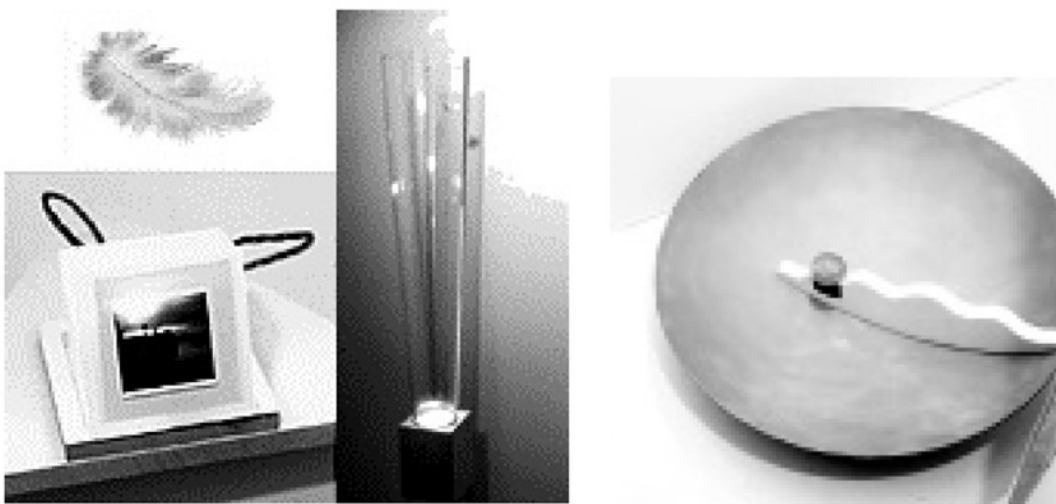


Figure 3. Feather & Scent (Strong & Gaver, 1996)

One of the first attempts to mediate intimacy at distance was done by Strong & Gaver (1996). They created three connected objects that were inspired by the non verbal and sometimes ambiguous interaction between intimate friends and lovers. These objects have the intention of supporting implicit, personal and expressive communication. The first one is the Feather, which consists of a pair of objects, one is a photo frame and the other is a cylinder with a fan inside that rests over a fan. When one of the partners holds the photo frame the fan is turned on and the feather levitates. In regards to this object Strong & Gaver (1996) stated "Seeing the feather drifting in the air intimates the other's attention with a lightness and dynamic that reflects the transience of thought". The second object is the Scent, the scent also has a picture frame as one of the paired objects. When the frame is held an aluminum bowl is heated on the other end vaporizing an essential oil that is inside of it. This system is intended to trigger emotions and memories through olfaction, as suggested by Strong & Gaver (1996) choosing a scent that is specific to the partners can augment these feelings. The last system is the Shaker which according to the authors are for less intimate relationships such as friends. It is a pair of objects, but in this case they are identical devices, one for each partner, inside the object is a solenoid - a kind of motor with a metal rod that when activated goes up or down - that shakes the object. When one of the partners shakes their object this information is sent to the other object that repeats the same pattern using the solenoid. The Shaker allows friends to exchange subtle and tactile interactions remotely. All these three projects are great examples that technology

don't need to be only used as a tool and solely to support task based interactions. They showed that technology can be designed to support more expressive and emotive interaction as well.



Figure 4. Shaker (Strong & Gaver, 1996)

Another good example is the Virtual Intimate Object (Kaye, 2006), the VIO is a computer application that is installed on both partners' computers. It appears as a circle on their task bar, when one of the partners click the circle it turns bright red and then slowly fades away over time. This non verbal and ambiguous output encourages the users to interpret the meaning of changes on the VIO based on the current time and the context that the partners have of each other - a change of colour in the evening may mean coming back from work, a change of colour at night probably means good night. Naturally the intimate knowledge that they have of each other comes into play to support the interpretation creating a strong sense of presence in absence and closeness, Kaye stated:

By itself, without context, a single bit of communication – like any other unit of communication – has no value. However, when received by a individual within a certain context – or, in this case, shared between two people who share a context – that single bit of communication can leverage an enormous amount of social, cultural and emotional capital, giving it a significance far greater than its bandwidth would seem to suggest (Kaye, 2006).

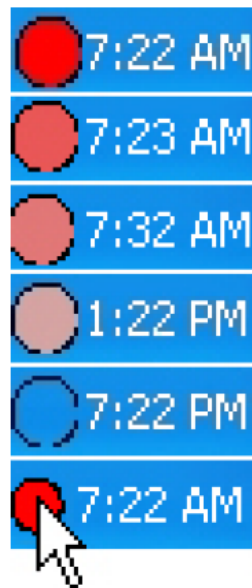


Figure 5. VIO (Kaye, 2006).

Both examples have similar intentions to this thesis. The work of Strong & Gaver (1996) supports the feeling of remote presence and closeness through tangible

and intimate means. Kaye's (2006) VIO allows the intimates to interpret the messages based on the knowledge that they have of each other and also supports remote presence. The solutions created as part of this thesis were inspired by these non verbal and sometimes ambiguous interaction between intimate friends and lovers. Based on the properties suggested by Gibbs et al. (2005) The Happy Box intends to be an exclusive and intimate connection between elders and their friends and family. It aims in mediating intimate and ambiguous interaction allowing the parts to interpret the messages using the intimate context they carry of each other. In the next two sections of this chapter I present how Ambiguity and Tangible User Interfaces can be used to support closer and intimate interactions.

3.1.2. Ambiguity for closer and intimate interactions

The common approach in the field of Human Computer Interaction (HCI) for a long time has been creating easy to use interfaces and designing interactions that have clear and obvious outputs. Thus, ambiguity has been considered to cause harm to the interaction, only being seen as a resource of art and creativity (Gaver et al., 2003). Over the past years though, we started to see some exploration of Ambiguity as a resource for design. HCI has mostly focused on designing task-driven interaction. On the contrary ambiguous design is an interpretation-driven approach. Gaver et al. (2003) stated "By impelling people to interpret situations for themselves, it encourages them to start grappling conceptually with systems and their contexts, and thus to establish deeper and

more personal relations with the meanings offered by those systems". The universe that surrounds us is naturally ambiguous, and I could argue that it is the immensity of it and how much we still don't know about it that makes it so fascinating. As such ambiguous interfaces can also support different results that encourage the development of unique interpretations. In this section I will cover the three types of ambiguity - Ambiguity of information, context and relationship - and how ambiguity can be used to mediate remote intimacy between distant friends and family. Sundström, P., Ståhl, A., & Höök, K. (2005) stated "An open-ended ambiguous design allow for interpretation and for taking expressions into use based on individual and collective interpretations. Ambiguity in a system will also allow for ambiguity and meaning making".

The three types of ambiguity

Gaver et al., (2003) states that ambiguity can either be triggered by the artifact's characteristics or by people's perspective towards it. Gaver breaks Ambiguity into three main types, Ambiguity of information, Ambiguity of context and Ambiguity of relationship. Ambiguity of information is based on how the information is presented or outputted as in the case of interactive media. The information is partially given or delivery with some level of fuzziness to encourage the interpretation of the spectator. Gaver gives the Leonardo da Vinci's Mona Lisa as an example, the whole mystery and fascination around the portrait is mostly focus around the ambiguity of her expression, her smile was purposely blurred by da

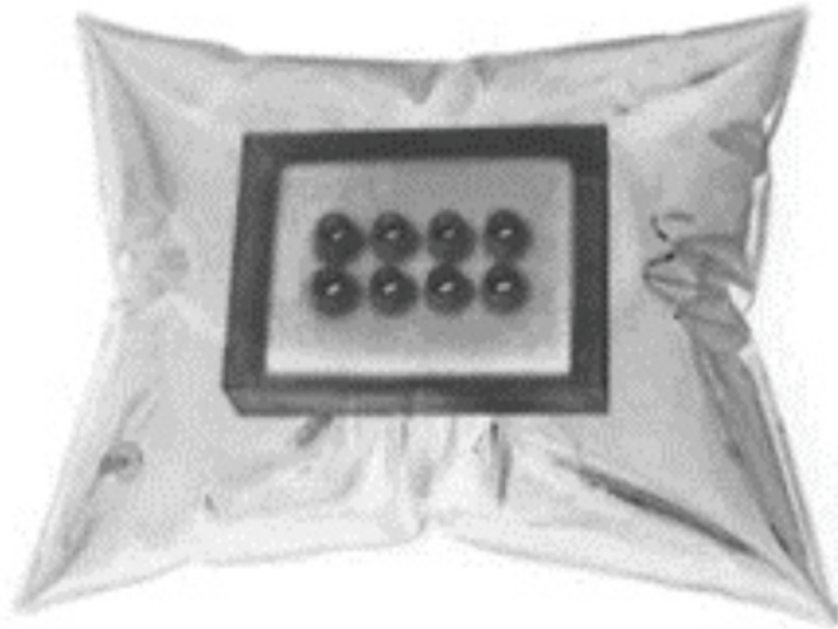


Figure 6. The Pillow (Dunne & Gaver, 1997, March).

Vinci to encourage multiple interpretations. Whereas Ambiguity of context is related to the user's perception towards the artifact, is based on how the user interpret the object's purposes and functionality, and this may be due to the purposely ambiguity of the artifact but sometimes the users go against the intended purposes of the object and reinterpret it in their own way. It could be as simple as using the luminosity of your phone's screen to illuminate the way or as in the example given by Gaver where mothers used their phone's ringtones to calm their crying babies. Lastly, Ambiguity of relationship which is the most subjective of the three types, it relates to the user's relationship with the object. It encourages the users to questioning their own role and the implication of using that artifact. One of the examples provided by Gaver for this type of ambiguity is

the Pillow, which is a conceptual prototype that streams magnetized waves being transmitted from all sorts of electronic devices such as radios, cell phones or even baby monitors and output them on a LCD that is wrapped by a plastic pillow. The data is showed in a abstract form rather than informative. The main purpose is to put the users in this ambiguous situation of having to choose between resisting their curiosity to consume that information or accepting this rather voyeuristic role that was offered to them.

According to the properties brought by Gibbs et al. (2005) in order to a technology to mediate intimacy it needs among other things to allow interpretation and support the frequently private and ambiguous expression of intimacy expressed between friends, lovers and family. Thus, this thesis project look at the concept of Ambiguity in design as a resource to achieve these properties.

According to Sundström et al. (2005) "As affective interaction often times is an invented, on-going process inside ourselves or between partners and close friends, taking on different shades and expressions in each relationship we have with others, ambiguity of the designed expressions will allow for interpretation that is personal to our needs".

Ambiguity to mediate intimacy

The solutions created as part of this thesis project aim to support Ambiguity of information and Ambiguity of context. The prototype interface was designed to

have no predefined content. It is intended to encourage the elders and their families to interpret the Ambiguity of information being sent through the artifacts utilizing the existing context and intimate knowledge that they have of each other. The gaps left by the fuzziness of information will be filled by their intimacy, thus developing their own unique interpretations. For example if a group of friends have inside jokes that only they can understand, what supports their interpretation is the contextual information that they have of each other. This shared knowledge connects them into this intimate and exclusive relationship. One of the constituents of an intimate relationship is the non-verbal and sometimes ambiguous expression exchanged between the parties (Vetere et al., 2005), and the interpretation of this exchanges relies mostly on the knowledge that they have of each other. Ambiguous tools such as the VIO (Kaye, 2006) according to the author are not frustrating and work with intimates because they know each other well, they have been disclosing information with each for quite some time. Ambiguity works with lovers, close friends and family members because they have reached a certain level of intimacy that allows them to interpret each others expressions and ambiguous messages. When one is engaged in a intimate relationship the parts are expected to be open about their feeling and thoughts (self disclosure). The intention of my prototype is to support awareness and connectedness between elders and their families and friends taking advantage of the existing intimate context that the parties have of each other instead of mediating it through the exchange of new information.

Riche & Mackay (2010) did a very interesting project that took advantage of intimacy between friends to create the sense of remote closeness and connectedness. They conducted a research on Peercare which is a network of peers that are also neighbours that take care of each other. Afraid of becoming a burden to their families elders sometimes rely on their own peers that leave nearby creating this network of peercare. They have unique codes to let each other know that everything is fine. They may leave a light on or call one another letting it ring for some time. These codes can be completely ambiguous to outsiders, but for them it means "I'm Ok", "I'm fine, don't worry". A clear case of Ambiguity of context: they reinterpreted the purpose of the light and the telephone into awareness systems. This are simple but important awareness methods for them. This makes them part of this close and intimate group of friends, it makes them feel connected and closer. According to Riche et al. (2010) "The key is their shared, existing knowledge of each other, which enriches their interpretation of even the most limited information and supports their shared awareness of each other". As the result of a user study Riche & Mackay conducted with elderly women they created the MarkerClock which was presented in the "Loneliness and Social Isolation" section of this thesis project. The MarkerClock was inspired by the ambiguous codes these friends were already using to interact with each other remotely. It offers an interface that allows them to continue using their intimacy to interpret the codes to be aware of each other's routines and wellbeing

but it concentrates their communication in one exclusive medium. Reading this paper got me interested in understanding the applications of Ambiguity, specifically in using it to mediate intimacy.

Intimates when exchanging messages during the day often have no concern about the content being transmitted but are focus on the act of being in touch being aware of each other and making oneself present. Intimate exchanges are often non-verbal and expressive. Gibbs et al. (2005) created the concept of Phatic Technologies with the intent of supporting these subtleness, to focus on the act of connecting instead of the content being transmitted. With so many complex messaging apps is interesting to see tools such as the Yo app¹ that as the name suggest allow friends to send a Yo to each other, no message, no content, just a Yo. First the user selects who they want to send a Yo to and then that person receives a notification with a simple Yo, it is simple but it can also mean so many things depending who the user is sending to or what time the Yo was sent for example. As one of the reviews on their iTunes² page says a Yo on a Friday night means something completely different than a Yo Tuesday morning. Apps such as Yo or even Facebook's poke functionality don't focus on the content or the message but on the act of connecting and being in touch. The intention of this project is to apply Ambiguity as way of allowing these subtleness of many

¹ <https://www.justyo.co>

² <https://itunes.apple.com/us/app/yo/id834335592>

intimate social interactions. This thesis looks at ambiguity as a resource to limit the exchange of explicit information as to enhance the interpretations and the emotional aspect of being in touch with someone one cares deeply. As Phatic Technologies, the solutions resulted from this thesis focus in maintaining and establishing social connection rather than exchanging information.

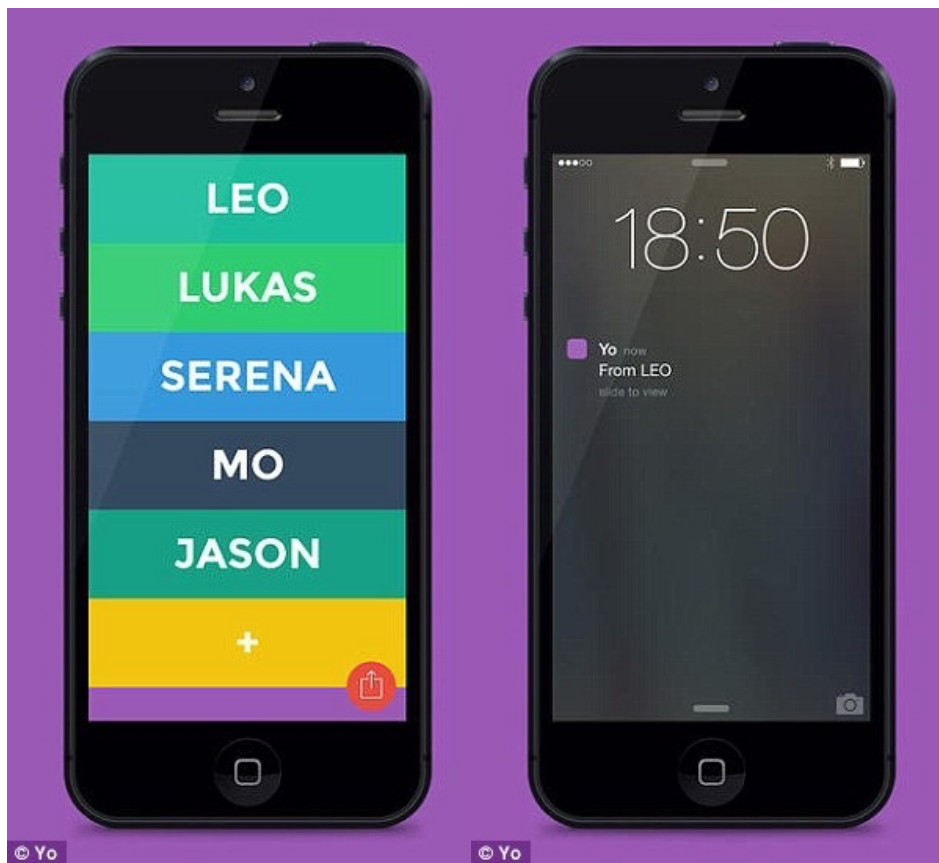


Figure 7. Yo (Retrieved from: <http://www.dailymail.co.uk/sciencetech/article-2661605/sciencetech/article-2661605/>).

Ambiguity can also be used to allow reinterpretations of the object itself, to let the user interpret the object's purposes and functionalities, such as the apartment

light being used to let the neighbours know that one is fine. Sokoler & Svensson (2008) applied Ambiguity of context to create the concept of the PresenceRemote. It has the intent of helping elders to engage in daily conversations without being stigmatized as miserable and lonely. It takes advantages of an activity that is already enjoyed by most of them and adds the social functionality. The PresenceRemote is a remote controller and the elders using it can check which of their peers are watching TV, or what is the current most watched channel on their neighbourhood. The simple fact of supporting them to see their peers “online” can serve as a presence awareness system and allow the elders to feel less lonely. Moreover the authors hypothesized that by being able to see that they are watching the same content as everyone else could make them feel connected with the community. This information can also be used to help them engage in conversations in the next morning about the programming. Elders are usually willing to engage in a conversation or social interaction, however, afraid of being stigmatized as a lonely person or someone in need they generally prefer to hide their intentions and wait for interactions to start by “accident” like bumping into someone while walking on their neighbourhood, using these occasional meetings as what Sokoler & Svensson (2007 / 2008) define as conversation starters. These social interactions frequently relies on the ambiguity of the circumstances and on their participant's intentions (Sokoler & Svensson, 2007). In this example Ambiguity of context was used to adapt a remote controller into a social tool and also to hide its actual purpose of mitigating social isolation.

I find fascinating how ambiguity is part of so many aspects of our lives. Daily social interactions rely mostly on the ambiguity of our reactions or even on the ambiguity of our intentions - it helps in the stability of many of our relationships. Imagine if we couldn't hide our reactions to some of the particular events that happens in our lives - it save us from some embarrassments. Aoki & Woodruff (2005) writes that designers should be aware of those bits of ambiguity that are part of our social relationship when designing communication devices. Aoki & Woodruff (2005) suggests an application of Ambiguity on a different way than what I intended to with this project. Aoki & Woodruff shed light on the importance of designing devices that provide users with the ambiguity necessary to be unavailable or unresponsive without it being considered a sign of rudeness or causing harm to the harmony of their relationship. Due to the mobility and constant connection that communication devices offer they make us think that one should be in a state of constant availability. This could be categorized as Ambiguity of information and Ambiguity of relationship. It gives the user the opportunity of shielding their current status through ambiguity but it also puts them on a situation of having to decide not to take a perhaps important or emergency call.

Applying Ambiguity and simplicity to design can allow the elders to be aware of their loved ones and vice versa without necessarily feeling like they are being

monitored (Hassenzahl et al., 2012). According to Lindley, S. E., et al. (2008) even though sometimes elders may be in need of help they tend to avoid getting assistance because they consider the familial obligation an offence to their dignity. Additionally as Aoki & Woodruff (2005) stated ambiguity is responsible in keeping the harmony of many social relationships. It allows people to be intimate and close while keeping their privacy, which is one of the properties to mediate intimacy presented by Gibbs et al. (2005). Moreover as stated by Fingerman (2001) when offsprings get to the adult life the intimacy between them and their parents rely mostly on the mutual respect of each other's individuality, their closeness is constantly being mediated on a level that both parts feel comfortable with. Designing an ambiguous object and interface can mediate closeness and intimacy allowing both the elders and their friends and family to keep their privacy and individuality. It also has the capability of hiding its main purposes and context, it can shield the elders from the stigma of being lonely while helping them to be in touch and aware of their friends and family.

3.1.3. Tangible Interfaces to support Ambiguity and playfulness

Graphic User Interfaces (GUI) is what interfaces the interaction between humans and computers using graphical and visual elements. In GUI tangible objects such as mouse, keyboards and even touch are used to navigate through and interact with the digital layer of information consisted of menus, buttons and

graphics. Tangible User Interfaces (TUI) on the other hand uses tangible and physical objects as both input and output, the approach is to have computationally mediated objects that are not necessarily identified as "computers" (Ullmer, B., & Ishii, H. 2000). According to Ishii (2008) "TUI makes digital information directly manipulatable with our hands, and perceptible through our peripheral senses by physically embodying it".

During early research and literature review I uncovered insights into what are the elder's perspective on communication and messaging. Elder adults pursue a level of dedication and intimacy that is not supported by modern devices such as computers and smartphones (Lindley, S. E. et al., 2009). They believe receiving a handwritten letter is much more meaningful than getting an email as the person who sent it had to put so much more effort into it. "She has to stop for sometime to write down the message and then post it. It is very intimate and personal" (Lindley, S. E. et al., 2009). Offering tangible and tactile interaction could be a way of supporting the level of dedication and intimacy that adults seek later in life. Additionally physical objects are more flexible and adaptable than GUI, supporting the applications of Ambiguity. Finally the user testings conducted as part of this thesis project shown that remote interactions through TUI have the potential of enhancing the sense of closeness.

Flexibility of physical objects

This thesis project aims to create solutions that allow unique and intimate interpretations by applying ambiguity to its design. TUI among other things serve as resource for these characteristics. Although the output of information using physical object can result in less malleability the input of information in TUI on the other hand gives much more control to its users. Due to its flexibility according to Ullmer & Ishii (2000) TUI can support unique and creative interactions. Different than GUI, like menus and digital button physical objects allow to be moved, arranged and customized by its users. Allowing users to interact through physical objects has the potential of supporting ambiguity by allowing the creation of unique codes (ambiguity of information) and the reinterpretation of the artifact (ambiguity of context).

Playfulness to support intergenerational communication

Remote interactions between grandparents and grandchildren can be quite hard when they live distant from each other. Phones and emails are not successful in mediating intergenerational interactions (Feltham, Vetere & Wensveen, 2007). Moreover, according to Lindley et al. (2009) grandparents often face difficulties in interacting with their young generations due to the lack of shared interests between them. Perhaps the solution can be to offer a medium for playful acts between these generations. Dalsgaard et al's (2006) states that intimacy in a parent-child relationship is often expressed through physical acts such as playful activities and good night hugs. There are some examples that have shown that

mediating playful interaction at a distance can have great benefits to intergenerational interactions (Feltham et al., 2007; Davis, Vetere, Gibbs & Francis, 2012). Tangible User Interfaces as shown in Price, Rogers, Scaife, Stanton & Neale (2003) have the potential to augment engagement and supporting more playful interaction. Moreover allowing manipulation of physical object as an input of information may allow young children that are not yet literate to interact with the artifact.

Multi-sensory Closeness

Oppositely to GUI outputs which are limited to stimulate a very small number of senses, graspable user interfaces have the capability of activating the multiple senses of the human body which gives it the potential of enhancing the sense of closeness by supporting more engaging and emotional interaction (Chang & Ishii, 2006). Adhering to the results collected from the user testing conducted as part of this thesis, which has shown that using physical objects as part of remote interactions has great potential to enhance the sense of closeness. During user testing conducted as part of this thesis participants declared feeling closer and feeling a strong sense of presence by the simple fact of knowing that the other person was touching and handling the input objects at the same time as them. Dahley(1998) in regards to touch stated:

From infancy, we use touch to discover our environment. Through fingers, mouth, and skin, we obtain signals about the physical world. As we mature,

we discover also that touch is a powerful means for communication. The strong handshake, the nudge for attention, and the gentle brush of a shoulder all convey a vitality and immediacy at times more powerful than language. Touch can instantly indicate the nature of a relationship; it is sincere, immediate, and compelling (Dahley, 1998).

Chang & Ishii (2006) and Dahley(1998) statements together with this thesis findings correlate with the great numbers of project using Tangible User Interfaces to mediate remote intimacy and awareness. Feather, Scent and Shaker by Strong & Gaver (1996) mentioned earlier in this thesis use the multiple sensory channels to mediate intimacy between distant partners. Another example is the lumiTouch (Chang et al., 2001) which consist of a pair of picture frames meant to be carry by each of the distant partners or friend. The picture frames have pressure sensors and infrared sensor to detect squeezing and distance which are then transmitted over the internet and translated into light patterns on the second frame. The physical object in this case in the form of a picture frame through the pressure sensors and the light allow the parts to communicate with each other using their own ambiguous and expressive languages. This unique interactions at a distance can enhance the feeling of connectedness and support the sense of remote presence. The concepts of remote presence and

presence awareness will be revisited and explained in more detail in the next



Figure 8. LumiTouch (Chang et al., 2001).

section of this chapter.

3.2. AFFECTIVE AWARENESS AND CONNECTEDNESS

Originally this section wasn't part of this thesis and it was added later as a result of reflections made over the making and testing of The Happy Box. Initially the intentions of this project were to mediate intimacy and closeness between family members using the concept of ambiguity and TUI, however, it was later discovered during user testing that by supporting these feelings of intimacy and closeness in

remote interactions could also result in a sense of connectedness and Affective Awareness (Liechti & Ishikawa 2000). There are many concepts and terms related to awareness systems. For this thesis project I look specifically in the work being done around presence awareness, presence in absence and principally Affective Awareness. This section is divided into two subsection, first I present the definitions for the concepts of Affective Awareness and connectedness, second I talk about some related work and also how these feelings can be mediated remotely.

3.2.1. Defining Affective Awareness and connectedness

Affective Awareness according to (Liechti & Ishikawa 2000) is a “general sense of being in touch with one's family and friends. Which is quite similar to the the definitions of connectedness presented by many authors. IJsselsteijn, van Baren, & van Lanen. (2003) and Romero et al. (2007) define connectedness as the result of staying in touch and maintaining regular contact with others. I also identify that connectedness is related to the sense of mutual awareness - being aware of each other's status and whereabouts. Dey & de Guzman (2006) conducted a field study with college students and the author state that the feeling of connectedness is directly related to one's awareness to their friends and loved ones. Adhering to that Patel (n.d.) states “A sense of connectedness can result simply from just being aware that the other person is ‘there’. Additionally both Affective Awareness and connectedness seem to be related to the feeling of

presence in absence, one of the yields of an intimate relationship and part of the affective aspects of intimacy, which Vetere et al. (2005) defines as feeling each other's presence and thinking about each other when physically distant.

3.2.2.Supporting Affective Awareness and Connectedness

Awareness systems are the common approach to mediate the feelings of connectedness and and Affective Awareness. These are systems designed to support the interpersonal exchange of information about one's status, context and whereabouts. According to Hassenzahl et al. (2012) awareness systems can be defined as "Artifacts that create a feeling of cognitive awareness and continuity by sharing different types of (ambient) information about current activities or moods among partners (without a conversation or doing anything together)". This thesis project has the intention of offering solutions that are not solely focused in functioning as awareness system but also allowing some form of intimate expression. Supporting both awareness and expressive actions can perhaps allow remote interactions to be much more meaningful and enhance the sense of connectedness. Projects such as the Feather and the Scent by Strong & Gaver (1996) first are a one-way awareness system, they don't allow mutual awareness, second they don't give the users the possibility to express themselves. On the other hand the Shaker not only allows remote partners to make themselves present in absence but it also gives them the means to communicate with each other through subtle shaking patterns.

Some examples of awareness systems that also mediate some level of expression are the Lightbound (Tapprest, 2015), Cubble (Kowalski et al. 2013) and the Rүүг (Thompson, Friedland & Cargiuolo, 2005). Lightbound supports awareness between distant family member through intimate, subtle and non-verbal interactions. It offers a pair of connected objects where the output is done through ambient light and the input is done either through one's heart beat using a heart beat sensor or through a pressure sensitive interface.



Figure 9. Lightbound (Tapprest, 2015).

The Cubble works as a private and intimate channel that allows distant partners to express their emotions and exchange awareness. It consists of a mobile phone app and a cube that carries the capabilities of glowing, vibrating and heating. It offers three forms of expression, "Nudge", "Tap" and "Holding Hands". The Nudge allows the partners to glow the cube by sending colour coded messages to each

other. The “Tap” translate tap patterns into vibrations. And if both partners are holding the cube together the “Holding Hands” mode is activated warming up the cube giving a sense of connectedness.

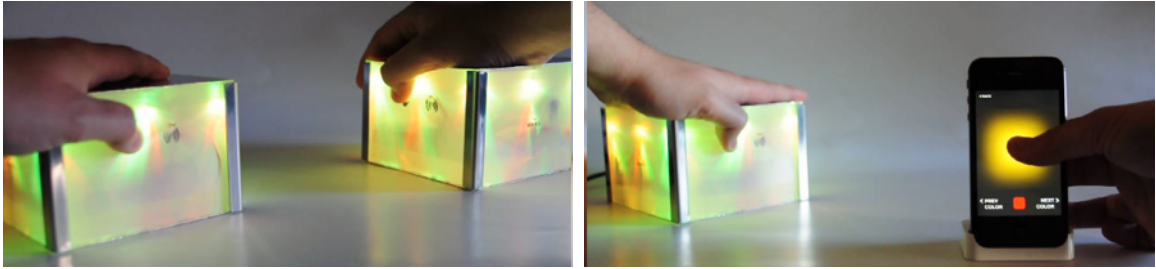


Figure 10. Cubble (Kowalski et al. 2013).

The Rüg consist of pair of connected rugs intended to connect distant friends. The rugs have a pressure sensor and are made out of a heat-sensitive material. If one of the friends sits or walks over their rug the pressure data is sent to the other rug changing its colour by heating its surface according to the pressure shape and pattern sent by the other rug.

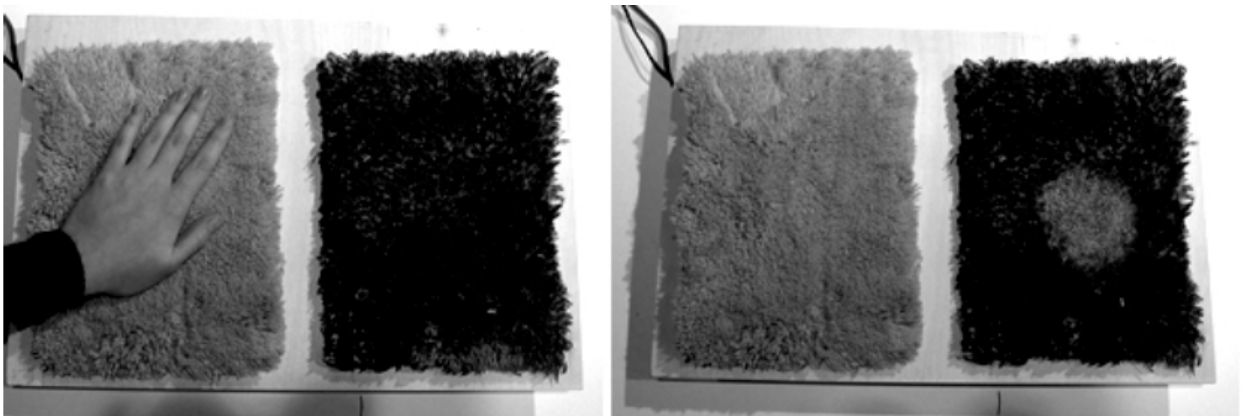


Figure 11. Rüg (Thompson, Friedland & Cargiuolo, 2005).

All of these examples use some kind of peripheral mechanisms and/or ambient displays, which adhere to Hassenzahl et al's. (2012) finding that shows that most of the projects aiming to mediate mutual awareness rely in subtle and implicit forms of expression. Ambient displays are mechanism that uses light, movement, temperature or other ambient elements with the intend to inform and notify the user through their peripheral vision and senses. Humans are capable of being aware of their surroundings - background and foreground - through their peripheral vision (Weiser & Brown, 1997). For example people don't need to stop what they are doing and check the weather on their phones when the rain is hitting the window. People are capable of getting that information at a glance. The information moves smoothly between the centre and periphery attention, allowing the user to continue with their tasks and only being notified when necessary, the opposite of a screen that is constantly projecting harsh light and calling for the user's attention (Ishii, 2008; Patel, n.d.). Ambient displays are a great resources for Affective Awareness as it support the subtleness and expressiveness of intimate act. Moreover it allows elders to get a sense of connectedness and awareness of their love ones at glance, without necessarily having to approach the artifact. The Happy Box intent is to allow elders to interact with their family and friends by supporting intimate expression and as a result support the feeling of mutual and affective awareness and connectedness.

4. Research Methods

4.1. RESEARCH THROUGH DESIGN

One of the challenges for researchers working with problems from outside of the field of Design is that traditional scientific approaches are not capable of matching the many variables and subjectivities of real setting and situations. These ambiguous situations or problems are what Rittel & Webber (as cited in Zimmerman, Stolterman & Forlizzi, 2010) define as “Wicked Problems” and include among other social problems such as loneliness. research through design (RtD) comes into play as a solution to allow researches to approach these rather subjective problems Zimmerman & Forlizzi (2008). RtD is the approach of working with scholarly research that applies the methods and process of design practice with the main objective of generating knowledge (Zimmerman & Forlizzi, 2014). A research through design approach often results in physical (artifacts) representation of borrowed theories and assumptions. Knowledge is acquired as the designers engage in reflecting on the process of getting to the final outcome and also on the results of the final outcome -how the artifacts performed during user testing (Gaver, 2012). As loneliness and social isolation are both societal problem and fit into the definition of “Wicked Problems” this thesis project uses RtD as the method to answer some of its research questions and assumptions through the process of design and testing The Happy Box.

Documentation

The artifact represents and embodies the knowledge acquired through the process of designing and testing it (Zimmerman & Forlizzi, 2008), thus the the documentation of the process of making and testing this artifact was extremely important as to facilitate its replication, Moreover it helps other designers and researches aiming in tackling similar problems in the future.

4.2.QUALITATIVE RESEARCH

This thesis tackle very subjective feelings such as loneliness, closeness, connectedness and Affective Awareness. As subjective matters they can vary from one person to another making it difficult to use comparative and quantitative analysis. According to Yardley & Bishop (2008):

Qualitative methods are particularly suitable for inquiring into subjective meanings and their socio-cultural context, if these meanings are seen as malleable, negotiable interpretations which people offer themselves and others to make sense of their feelings and actions rather than as causes or mechanisms that can be scientifically proven (Yardley & Bishop , 2008).

Thus this thesis choose a qualitative research methods as to collect and analyze the data collected during interviews, testing and design of The Happy Box.

4.3. TESTING AND INTERVIEWS

As a design research project it was extremely important for the artifact to be tested in the actual context that it was designed for. The results needed to be influenced by the subjectivity and irregularity of real life conditions and involve participant affected by this "Wicked Problem". Thus the prototype was dispatched into real settings to be tested as part of the daily routines of families. The prototype was tested with two families for a period of one week with the first family and two weeks with the second family. The main goals of this tests were to first help this project validate some of the assumptions around Ambiguity and TUI being used to support intimacy and closeness between family members, second to understand how this object would fit into their routines and if that would help diminishing some of the effects of loneliness. An interview was conducted with the participants before and after the testing to gather insights into their relationships and to support the qualitative analysis of the results. The result of these testing and reflections are presented in the section "The Happy Box".

5. The Happy Box



Figure 12. The Happy Box

5.1. Description

The Happy Box was designed with the intent of exploring the applications of Ambiguity of information and Ambiguity of context as part of interactive objects. The Happy Box is a pair of internet connected boxes that can be used for long distance interactions. They were designed in the shape of small chocolate boxes that one could give as a gift to a significant other. The top of the box has a grid of six squares, each square has an individual sensor and 4 LEDs. Each box comes

with 6 tokens made out of wood and velvet on the bottom. When a token is placed over a square on the box the infrared sensor detects it and the specific square where the token is placed is lit up on both boxes. If the token is removed the light goes back to its original state. When both boxes have tokens in matching places the matching squares start to pulse.

The grid of 6 squares and the 3 states of the light (off, on and pulsing) give the elders and their families very simple but meaningful means to interact at a distance - to stay in touch and maintain the sense of Affective Awareness. The grid-like interface works almost as a blank canvas - the users can create shapes or codes using all the six tokens at once or separately. The squares of the grid don't have predefined meanings, they are intended to give the users the freedom to create and interpret the information being transmitted. I choose the tokens as the physical object that facilitate elders to interact with the object. They resemble chess pawns - wooden, flat surface on the bottom and a small handle on the top. I also wanted the input to be analog and tangible. It was important for me that the users could physically "touch" the interface without any screen between them. These tokens work as a representation of the tactility and closeness of an intimate relationship.

The name Happy Box was given by one of the young participants of the user testing conducted as part of this thesis, unfortunately she couldn't explain the

reason but I decided to keep it as it represents well my intentions with this prototype and this thesis as a whole. In the next section I will talk about my process of designing and making this artifacts and then I will present and reflect over the results for the two user testings conducted with The Happy Box.

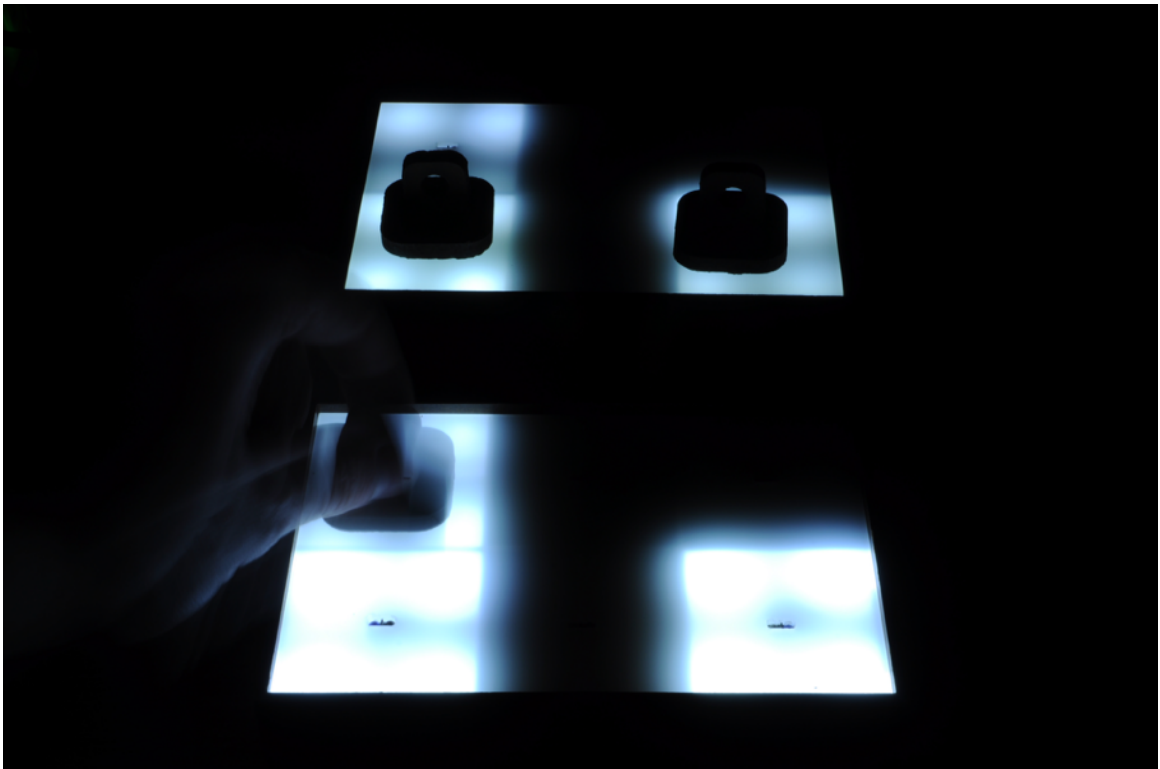


Figure 13. Lights on The Happy Box.

5.2.Process

Design

My first step in designing this prototype was to sketch as many ideas as I could, without caring much about quality. This was a great way of flushing out all the ideas I had. After filtering out through all the sketches I ended up with the one

shown in Figure 14, which was the first sketch for this project. The idea was that this prototype should support not only Affective Awareness but also allow distant friends and family member to interact or communicate at a distance.

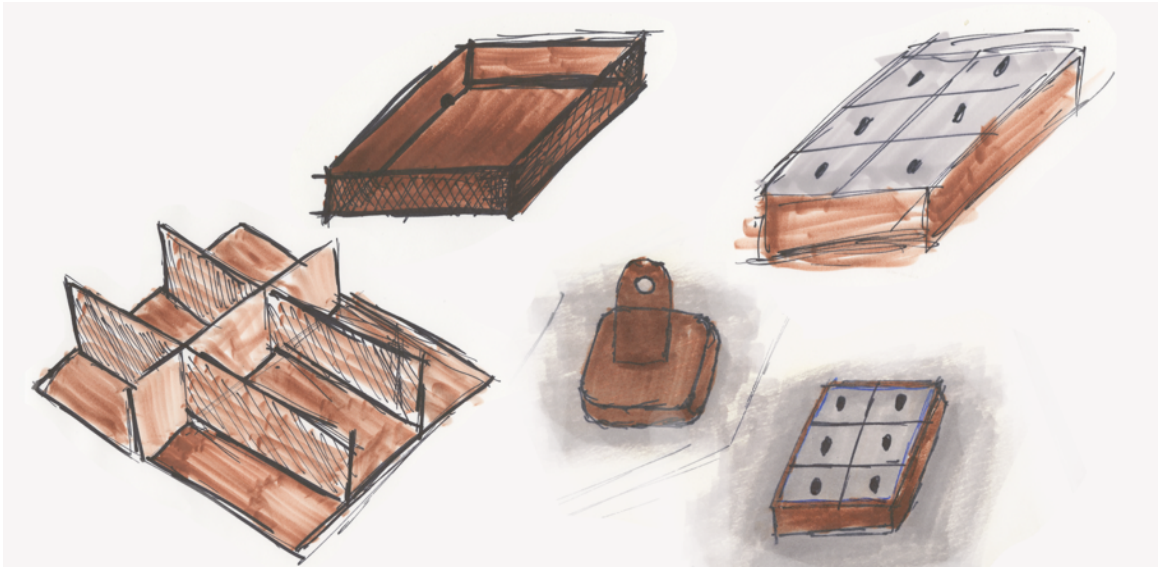


Figure 14. First sketch Happy Box..

When I have an idea, my first step is to make the simplest and quickest version of it. This process helps me visualize size, format and many other factors that are hard to identify in sketches. I went through two main iterations for this prototype. The first iteration was mostly for trying out the material, size and shape for both the boxes and the tokens. It was a 10x10 cm box, made out of masonite wood (see figure 15). Because I didn't want the light to be harsh and too bright, I choose a white opaque acrylic in order to dissipate the light. All pieces were laser cut. This first iteration helped me get a sense of how masonite wood fits with white acrylic. I also used the enclosure to better visualize how the light looks like



Figure 15. First Sketch of The Happy Box.

inside the box and how it dissipate through the acrylic. The main problem with this iteration was the size. Even though I really like how it looked - squared, concise, and nice to handle, once I started trying to put the electronics inside I realize how badly measured it was. The surface was also too small even for young adults with whom I tested at first. There wasn't enough space for the tokens as well, they were falling from the sides. Going through this process help me figure out many of the solutions applied into the second and final iteration.

For my second iteration I wanted to make sure that every millimetre was being measured, I considered every sensor, wires, and LED that would be inside the box,

measured each one of them and created technical drawings for each piece of the iteration II as shown in Figures 16 and 17. These drawings were very helpful later when I was creating the laser cut files. I made the top surface bigger leaving more space between the tokens I also reduced the height to the minimum size, just enough so I could fit the parts inside. To prevent the token from falling off the sides, I designed the box in a way that the acrylic surface sits slightly below where the sides of the box end creating a small edge that keeps the tokens within the grid. Inside the box there is a second structure seen in Figure 18, this structure not only serves as a support for the acrylic surface but it is also holds all the LEDs and

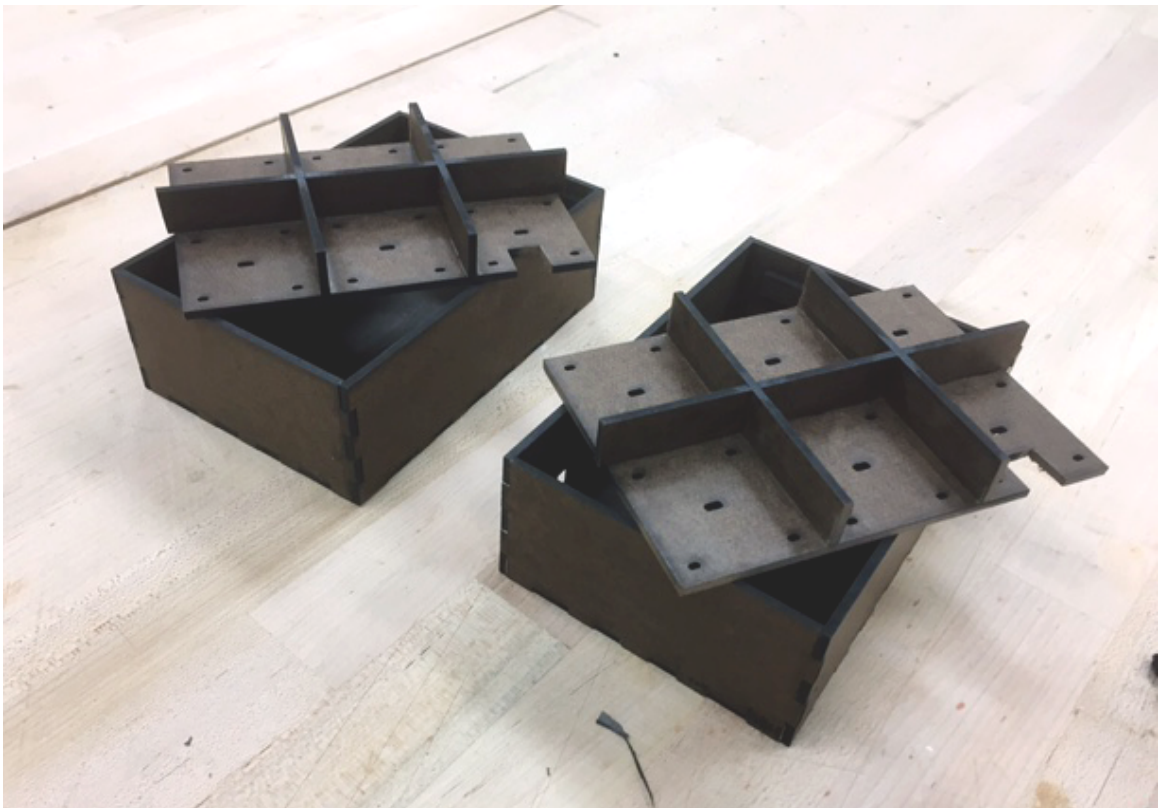


Figure 18. Inside enclosure to hold the acrylic, LEDs and IR sensors.

the IR sensors, this structure is divided in 6 small boxes that are meant to keep the LEDs' light from leaking from one square to the other.

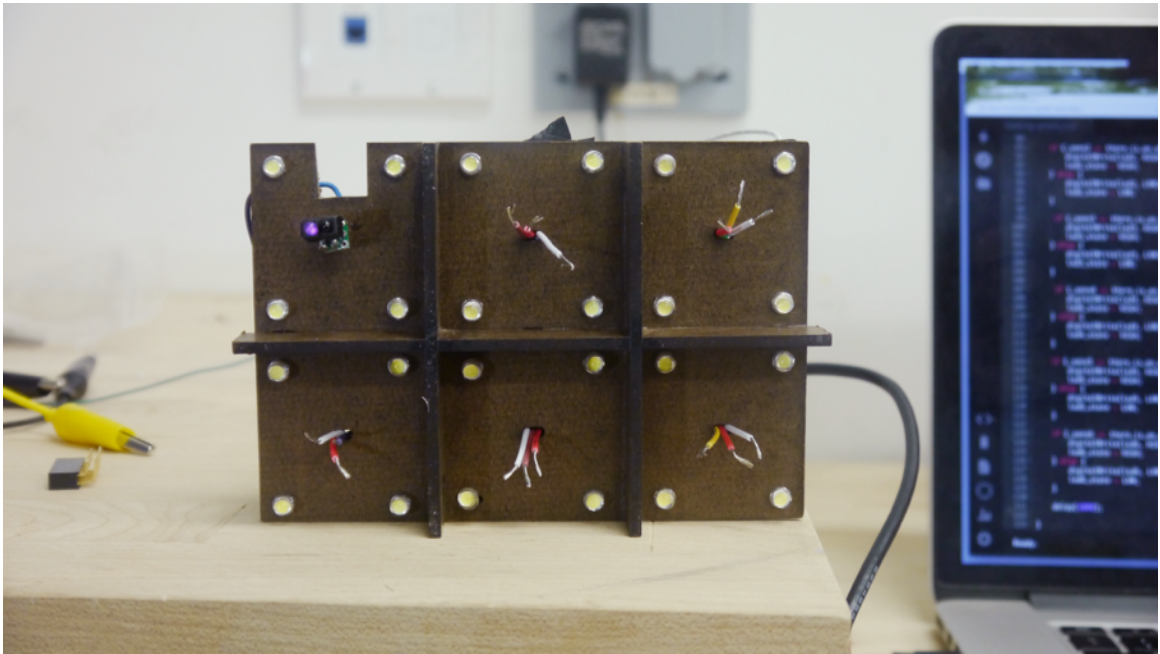


Figure 19. First Sketch of The Happy Box.

Initially the IR sensor would be glued to the top surface but I could not only find a strong enough glue to hold them but it was also really hard to put glue in the acrylic without leaving any marks. The solution was to keep the IR sensors loose, right in the middle of the 4 LEDs only being held by its own wires as shown in figure 19. I decided to use 4 LEDs for each square to even the light, the IR sensor is right in the middle so if I had put only one LED it would have created a projected shadow into the acrylic surface. The choice of dividing the surface into a grid of six was mostly because of a hardware limitation, the Photon has only 6 analog pins - the IR sensors use analog pins - which ended up limiting the grid. My initial idea

was to offer an even grid of 3x3, I didn't think that limiting to 3x2 would be an issue, but during testing some of the participants mentioned that it would be better if they could have at least a third row on the grid.

Wood was the material choice for most of the parts. Unfortunately masonite is not natural neither has the texture of hardwood but it gives the aesthetic aspect of wood helping this objects to fit into the social context of an elder adult home. Wood is a warm and natural material, different of what is found in most technological devices such as metal and plastic. Temperature is also a quite relevant aspect for this object, as I'm trying to mediate warm feelings such as connectedness, closeness and intimacy, I personally believe that if had offered a cold interface such as metal and plastic, first, it wouldn't have the same effectivity, second, it would be poetically contradictory as this project aims to mediate warm feelings and emotions.

The tokens (pieces used to interact with the box) were also laser cut out of masonite. I first called them tiles then a moved to call them tokens when I added the handles. "Token" better represents what they are meant for, tokens of connectedness and intimacy. I want the input of this prototype to be tangible, I want the users to be able to move and adapt the interface as they see fit. I want it to be playful. Handling and touching the tokens as you interact with someone you care is meaningful and poetic, it naturally bring you closer. When I laser cut the first iteration for the boxes I tried different shapes for the tiles and textures as seen in



Figure 20. First iteration of the Tokens.

Figure 20. The first thing I had to change for the next iteration was the thickness, it was really hard to pick them up from the surface specially as I was designing this for elder adults that have higher chances of having physical and visual impairments. The second iteration had a thickness of 1/4 of an inch, twice the thickness of the first iteration. It was much easier to pick them up, but it wasn't quite what I expected. I decided to design handles as shown in figure 21. This allows the tokens to be pinched, facilitating interactions. The handles are attached to the centre of the tiles and have small holes in the middle of it so as to facilitate the pinching. To facilitate sliding I added a dark brown velvet to the bottom of the tokens. It matches the dark brown of the wood and it also helps the tokens to slide perfectly through the surface. To attach it to the token I laser cut small pieces



Figure 21. Second iteration of the Tokens.



Figure 22. Second iteration of the Tokens.

of velvet on the exact size then I glue them to the tokens using heat activated adhesive. It keeps it solid and gives it a nice clean finish as shown in Figure 22.

Technology

Both boxes are powered using Photon boards - micro controllers with built-in wifi connection. They are responsible for controlling all the electronics and transmitting the information between the boxes.

To detect the tokens I used infra-red sensors (IR). They work even in very dark settings. In order to better understand how IR sensors work I created a grid of them on a breadboard and serial print the readings I was getting from it. This is one of the best options to start any DIY project, it gives you an idea of what kind of value it returns and it helps you understand the best ways of using many of the sensors available. One of my intentions was to hide any sign of technology, such as wires and sensors. I tested some of the materials that could be used to cover cover the sensors without compromising the readings, unfortunately except for transparent materials most of them had some level of interference in the readings, so I had to leave the IR sensors unobstructed by making holes in the acrylic where the IR sensors are.

The output of The Happy Box is done through white LEDs. It uses the concept of Calm Technology and ambient displays to give the users very subtle notifications

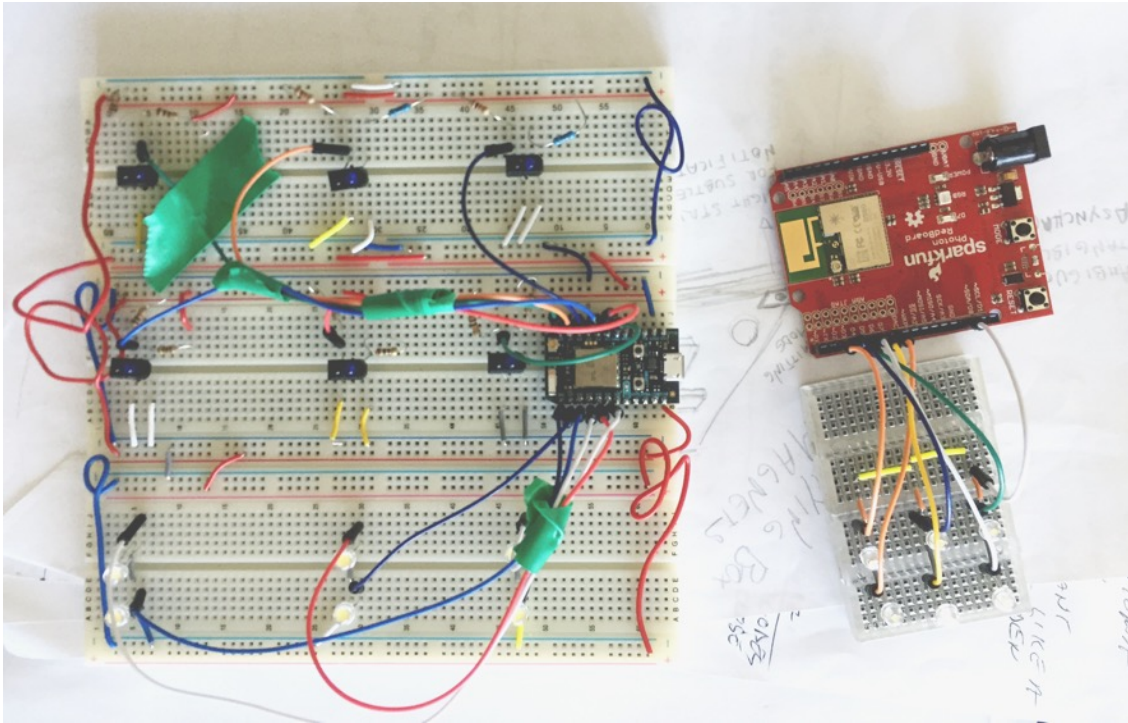


Figure 23. Low fidelity prototype of The Happy Box.

when needed without requiring full and constant attention such as screens. To test the LEDs I wire them with a grid of IR sensors and tried to turn them ON when the IR detected something. This was one of my first low fidelity prototypes as seen in Figure 23. It helped me test the behaviour of IR sensors and write my first lines of code.

Wiring

The plan of assembling and wiring was relatively simple, I would wire all the LEDs' common grounds and have one wire for each group of 4 LEDs, the infrareds I would solder to micro pieces of protoboard, from it I would just pull 3 wires from

each sensor. I would have 7 wires for the LEDs, 1 for each of the 6 squares and 1 ground; and 18 wires for the IR. The plan was to have all of this on the top part of the box so I could always open in case something goes wrong. However, after wiring and soldering everything I couldn't plug the wires into the breadboard located inside the box. There were too many cables. Having this problem forced me to step back and start re-planning all the wiring again. The solution was to first change all the wires from rigid to flexible wiring. Second, to handle all the wires on a larger protoboard that is attached to the bottom of the separation box as shown in the Figure 24. On this protoboard I have a row for ground and a row for power so I can power both sensor and led, this board also has all resistors for the IR sensors reducing even more the wires. I have now only 14 wires in total coming out of the protoboard to the photon, 6 for the LEDs, 6 for the IR sensors and one ground and

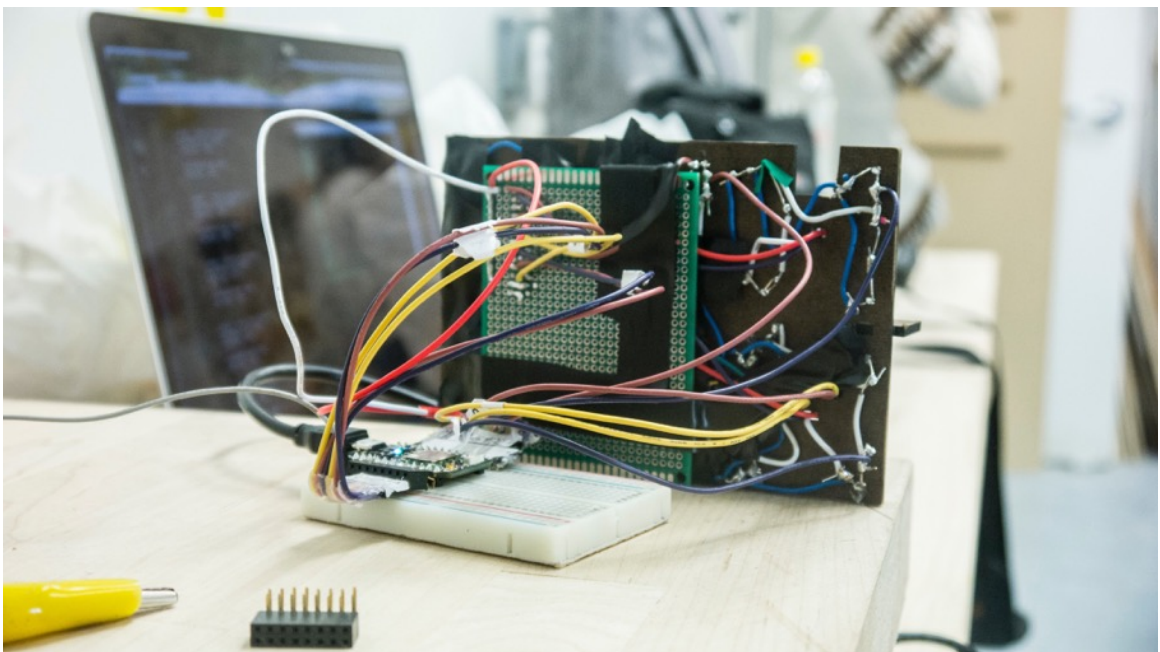


Figure 24. Wiring Happy Box..

one power. Third I add female to male plugs into this wires so all I had to do was to plug them into the breadboard. All of this not only keeps the box concise but most importantly makes it solid for user testing and easy to be maintained. My last change in hardware was to swap the breadboard of one of the boxes for a shield that holds the Particle Photon and is much more reliable in keeping the wires in place.

Coding

My first low-fidelity prototype was made of two breadboards stuck together with 6 IR sensors and 6 LEDs, this setup allowed me to write my first lines of codes. I set a threshold to be considered as “there is something here” and every time the IR readings would go below that number the light would go on. This was a simple behaviour but it wasn't exactly communicating with a second set of IR and LEDs. My second step was to merge all the readings from the 6 sensors into one string to send it to the other box because the `particle.publish()`³ function only accept strings. Once the string is published whoever is listening to that event through the `particle.subscribe()`⁴ function will get the data being sent. The data was stored in a string so I also had to write a code to parse the data before being able to run it through the conditional statements. This conditions are basically if and else statements that check which IR have detected a token and in which box, if at least

³ This function publishes an event to the Particle cloud in the form of a string.

⁴ The `particle.subscribe` function allows you to subscribe to any event being publish to the Particle cloud.

one of the boxes have detected a token in one of the squares the correspondent light will be on in both boxes, if both of them have tokens on the same part of the grid that light will pulse. The pulsing was quite a challenge. Pulsing a light requires PWM output and not all pins on the Photon are compatible with that, so the solution I found was to fake that using a library called SoftPWM⁵, it basically varies the blinking speed of the LED in a way that it looks like it is pulsing but it is actually blinking really fast in different speeds and intervals, this library was also helpful in creating a fading effect when turning the light on or off, instead of a harsh change of state. You can have access to The Happy Box's code at my github profile⁶.

5.3. User Testing and Interviews

With the intent of validating my assumptions I dispatched the prototype for two rounds of user testing each with a different family. As a design research project it was extremely important for the artifact to be tested in the actual context that it was designed for. The results needed to be influenced by the subjectivity and irregularity of real life conditions. I wanted the object to be tested as part of the families' daily routines during a longer period instead of short period task based testing in a controlled environment. One of my interests was to see how the Ambiguity of context would encourage participants to have different

5 https://www.pjrc.com/teensy/td_libs_SoftPWM.html

6 <https://github.com/marceloluft/Emilia-Happy-Box>

interpretations of this object, essentially how each family would use The Happy Box and what they would use it for. Secondly, I wanted to validate my assumptions around Ambiguity of information: how they would interpret the messages and if the intimacy between the participant would influence their interpretation. In order to get better results the participants needed to get use to having the artifact as part of their routines, thus both user testings took place on the participant's house, for a period of 1 week for the first round, and 2 weeks for the second round.



Figure 25. Happy Box during User Testing.

Setup and first interview

On the first day of testing I went to each of the participant's house to setup the artifact - connect it to their wifi or to a mobile router in case the

participant didn't have access to the internet - and to explain the basic functionalities of the artifact. I also used this opportunity to have a brief conversation with the participants to understand their relationship and routines, the data collected during this conversations helped me further analyze the results.

The goal of explaining the basic functionalities was to give the participants a sense of how the artefact worked instead of how it should be used or what it should be used for. My speech to the participants would be something close to "These two boxes are connected through the internet, anything you do in one of them will be reflected on the other one, you can place tiles on the top surface to turn the lights on, if both boxes have a tile on the same area the light will pulse so you know you have matched positions. You are welcome to use it when and how you see fit, you can also move the box around and place it anywhere within your house. At end of this testing I'll come back so we can talk about the experience and get feedback from you". I tried to avoid influencing them as much as I could, I wanted the result to be influenced only by the participants' own context and routines. I also gave them the choice of where they wanted the box to be installed, I thought it would be interested to know where they choose to leave it. I believe that the location of an object within a house can tell how important that object is to the family in relation to the other object that make the environment.

Second interview

At the end of the testing period I had a group discussion with the participant family. This discussion happened within a week after the test ended to make sure that their thoughts on the experience were still fresh in their memories. This discussion had a semi-structured interview format, the content of the discussion was constantly being shaped as we were discussing the experience. I mainly kept myself as a facilitator leaving the space for the participants to discuss and reflect. But I also tried to gather some specific data during this interviews such as the general feelings of the family after having this device as part of their routines, if this artifact helped them feel closer and connected, if having this device there changed in any way their routines, how they used the device and what for, and if they would use this device for a longer period of time.

5.4.Results

In this sections I will go about presenting the results from the user testing conducted with The Happy Box. This section is divided in two subsection, one for each family, I'll present you the participants information and the results for each of them. In order to be clear, from now on when referring to a specific participant I'll be addressing them by using the letter P (for participant) followed by ID number.

Family 1

The first round of testing was done with two participants for a period of 1 week, it involved two participants, P1 and P2. P1 is a 93 years old woman, mother of

P2. She lives with two caregivers that split the time to help with her routine. She spends most of the time at home. She has a well defined routine that seldom changes, except when she receives the visit of friends and family. If she wants to go out she depends on her child to drive her. She had the box installed beside her rocking chair as seen in Figure 26 and whenever she would go to her bedroom one of the caregivers would install it beside her bed. She didn't have internet connection so I had to setup a 3G router at her house so I could connect the box to the internet. Due to low cell coverage in her area there were moments of instability on the connection, this instability may have influenced the results but I will reflect on this further on this section.



Figure 26. Happy Box during User Testing.

P2 is a 60 year old woman, daughter of P1. She works part-time and carries a very active routine. She doesn't have any impairment or limitation. She lives not far from her mother, approximately 5min driving, which allows her to visit her mother frequently. On the first day of testing I had the chance to talk to them about their relationship, such as how frequently do they meet or talk to each other. They both said⁷ that they have very frequent interactions during the day, they either talk through the phone or P2 visits her mother. She usually calls her mother in the morning after she wakes up and at night before they go to bed. They see each



Figure 27. Happy Box during User Testing.

⁷ All the interviews were conducted in Portuguese and translated “by the author”.

other almost everyday when P2 joins her mother for lunch, or at the end of the day when she picks up her grandchild and take them to visit P1. P2 asked her box to be installed in the living room beside her TV where she could see the light coming on as shown in Figure 27.

P1 and P2 carry a very close and intimate relationship. They maintain daily contact through the phone and through regular visits. This element of their relationship played a big role in how and what they used the artifact for during the testing.

The first days of testing they were mostly exploring the functionalities and getting used to having this artifact as part of their routine. From the second day forward they were using it to do “check ins” of their schedule during the day, in the morning after waking up or when coming back from work they would put a token on the box to let each other know, for example. The interesting part is that they didn’t actually plan to use it as such, they were just exploring it and using it when and how was more suited to them, but unintentionally they started to interpret the light coming from the box based on what they knew about each other's schedules. For example if the mother would see the light pattern changing at the end of the day she knew that her daughter had gotten home. After a few days they were using it throughout the day to let each other know what they were doing without actually having to “tell” anything.

Family 2

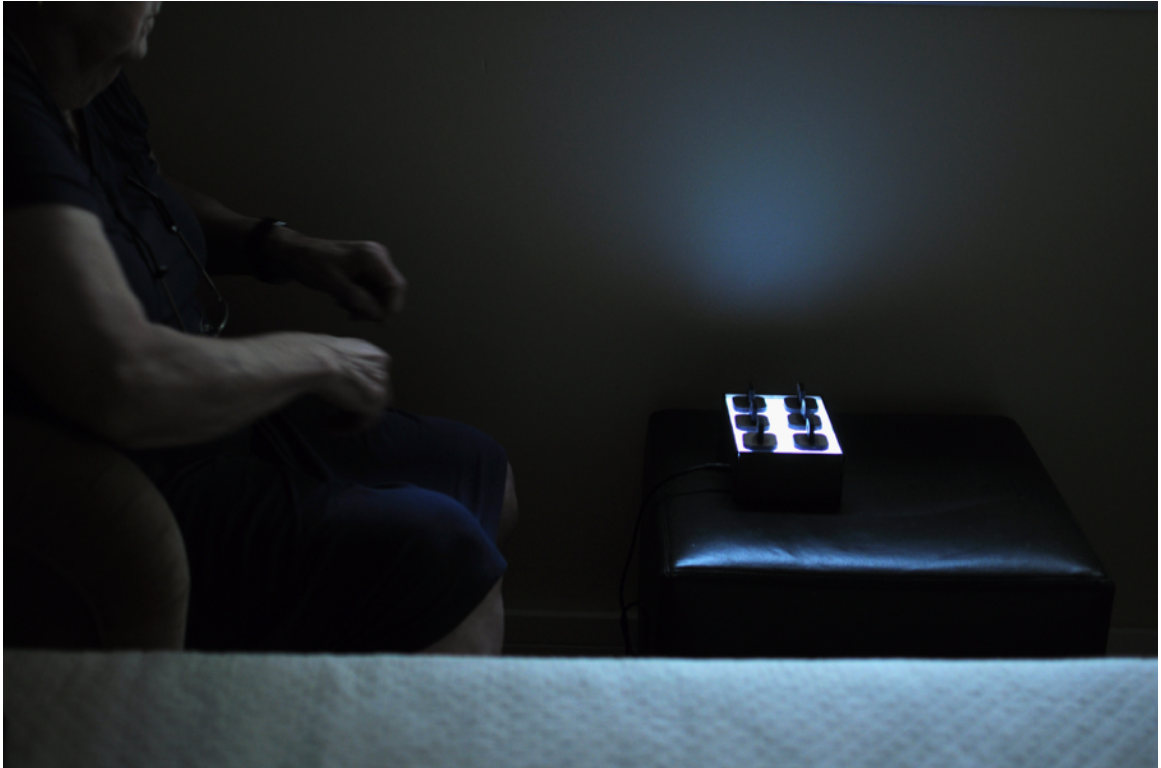


Figure 28. Happy Box during User Testing.

The second round was conducted for a period of 2 weeks and involved three participants, P3, P4 and P5. P3 is a 70 year old woman, mother of P4 and grandmother of P5. She lives with her husband and spends most of the time at home, watching TV in her bedroom. She considers herself a novice in technology but she has a smartphone that she uses to access Facebook and talk to her family through WhatsApp. She has low mobility due to a debilitated knee, therefore she depends on her child or husband to drive her around. As seen on Figure 28 she

asked to have the box installed beside her bed, in front of her armchair where she



Figure 29. Happy Box during User Testing.

spends great part of her day.

P4 is a 43 year old woman, daughter of P3 and mother of P5. P5 is 4 years old. P4 lives with her husband and her child. She is a stay-at-home mom and spends most of her time between her home office and the living room. She lives close to P3's house, she visits her two to three times a week. Both participants identify the frequency that they talk to each other as high. They currently communicate with each other using mostly WhatsApp where they have a family group. P4 had her box

installed in her living room beside her TV as shown in Figure 29 where she and P5 spend a great part of their day together.

Family 2 stated that the first days they used mostly to explore the use for the artifact, putting and taking the tokens from the box until P3 realized that whenever they had matching tokens the light would pulse. Then she suggested to her daughter, P4, that they could try play this matching game as a fun way of staying in touch. From that point forward they were constantly trying to match each other's tokens, if they saw a light that wasn't pulsing they would put a token their to match it. Also, quite similar to what happened with family 1, P3 stated that she could tell when her daughter had woken up by the time P4 put her first token of the day or sometimes in the afternoon she could assume P4 wasn't home because the box would stay for hours without any change.

5.5. Reflections

Having provided a summary of each family and individual participant I will move forward by reflecting on the results gathered during testing and the discussions I had with the participants after each of the tests. I will discuss the results individually and I will also make reflections on the similarities encountered in both rounds of testing. Further on, I will present the implication of the results for future designs.

Ambiguity of context

The first thing I would like to highlight is the fact that each family interpreted The Happy Box differently. I would argue that this is a case of Ambiguity of context, one of the three types of Ambiguity defined by Gaver et al., (2003) and mentioned on the section 3.12 of this thesis. Each family used their boxes in quite distinctive manners. First family with P1 and P2 used mostly as a tool to stay in touch and aware of each other's status, which can be define as Affective Awareness (Liechti & Ishikawa 2000). Whereas Family 2 with P3, P4 and P5 used it to play what I would define as a matching game by trying to match each other's tokens. Again both the ambiguous aspect of it and the flexibility of physical object allowed the family to engage in this playful interaction. Although The Happy Box was approached differently by each families it is important to notice that there were some similarities in how the participants felt and described their experience during testing. Both families mentioned that they felt connected when they were interacting through The Happy Box. Except for P5, the child, all participants at some point in the interviews referred to the experience as being personal and that interacting through it brought them the feeling of being closer and connected to each other. Thus, even though they had completely different usages for the box we can see some correlation between the two families' feelings towards the experience.

Intimate and exclusive channel

Kaye & Goulding (2004) state that it is important for an artifact intended to mediate intimacy to be an exclusive and intimate channel between only two people or at least a small group of people such as family. Therefore mobile phones are not suitable to mediate intimacy. I knew both P3 and P4 make constant use of mobile phones and keep regular contact through instant messages so I was curious to know in case they had this artifact for a longer period why would they use The Happy Box instead of a more content driven and less ambiguous medium like the ones they are more use to. I asked them about it, P4 said that she sees this as a more personal way of communicating and interacting with someone you care, "...I would use it to be more personal, maybe closer I think" she stated.

Connectedness and Affective Awareness

Wenger et al. (1996) stated that one of the causes of loneliness is the lack of intimacy and connectedness in one's life. Thus bringing this sense of Affective Awareness and connectedness to one's life can be a powerful way of fighting loneliness. One of the intentions of this project is to support elder adults the feeling of being in touch and connected (Affective Awareness) even when they are remote and away from their loved ones. As noted by Achilleos, et al. (2013) the simple act of calling them and staying in touch can mean a lot to them. P1 stated how important for her it is to receive a phone call, "if a person calls you she cares about you, you love the people you talk to" and her daughter agreed by adding "so the same thing applies for this" referring to the prototypes, "it means you are

thinking about that person and want to know something about her, even if it is just to know if that the person is there” P2 said. As seen in Suzuki & Hashimoto (2004) synchronized acts can enhance the sense of connectedness, which can explain the sense of connectedness experience by some of the participants when they matched their tokens and saw the light pulsing.

Tangible User Interfaces

As seen in Price et al. (2003) TUI have the capability of supporting more playful interactions. Moreover according to Ullmer & Ishii (2000) due to the flexibility of physical objects TUI can support unique and creative interactions. I would argue that combined with ambiguity of the object, the tokens were responsible for supporting a sense of closeness and allowing the development of playful acts between the participants. For instance the matching game played by Family 2.

Allowing the interaction to be done through tangible means also supported better intergenerational communication. P5 saw The Happy Box as just another toy. By exploring the artifact she learnt that she could turn on the lights using her own toys (see *Figure 30*) something that wouldn't be possible with GUI - they don't offer that flexibility. I had a brief conversation with her where I could understand that she was aware that her grandmother had one box in her house as well but her interactions with it weren't to send any intentional message, it was mostly just to play with it. Her mother, P4, said "for her the fun was to see the lights coming on,



Figure 30. Happy Box during User Testing.

that's why she would always put all tokens on it". But for P3, her grandmother the content was irrelevant in this case, just the fact of seeing the whole box lit up satisfied her, she knew it was her granddaughter touching the token on the other side. During the discussion P3 stated "I felt closer because I knew someone there was touching the token". One of my research questions was trying to understand how TUI could be used to support closeness in remote interactions. I would argue that the tangible aspects of The Happy Box played a big role in bringing this intimate feeling of connectedness. As both P3 and P4 stated this object brought them closer, the interaction exchange through this prototype felt much more personal and intimate than through mobile phones which they usually use

to communicate. Giving them the possibility of physically “touching” the interface and moving the tokens around was one of the factors that supported this feeling of closeness.

Presence in Absence

A feeling of Presence in absence according to Vetere et al. (2005) can support intimacy and it refers to feeling each other’s presence and thinking about each other when physically separate. Presence in absence is also related to connectedness and Affective Awareness as mentioned earlier in this thesis and also stated by Dey & de Guzman (2006). Feeling the presence of someone you care about can also bring the feeling of being in touch and connected, thus helping to mitigate loneliness. Most participants mentioned moments where they felt the presence of each other or felt accompanied by just seeing the light filling out their rooms. In fact light is often seen as a sign of presence (Olivera, Rivas & Iturriaga, 2013). I asked P1 how did she feel when she saw the light turning on and her answer was “well, sure, I felt happy “ and then she said “when I saw the light I knew it was my daughter”. P3 statement also adds to this when she says “I spend my afternoons seated on my chair, so when the light would come on I felt like I had company, I felt her company there” referring to her daughter. Another very interesting statement in regards to presence in absence came from how P2 defined the box, “is another way of communicating, it is a way of making yourself present, basically that is what it is” she said. The content it is irrelevant, is the act of

connecting, staying in touch and as P2 said making themselves present that has the power of making one feel accompanied and less lonely. This fits with the concept of Phatic Technologies (Gibbs et al., 2005) mentioned early in this thesis, which are technologies designed to mediate connection instead of the exchange of content. When the participants were turning the light on by putting a new tile on the box they were not necessarily trying to send a specific message but they were sending a token of intimacy and connectedness. The daily message exchanges that happen between intimate individuals frequently have nothing to do with the content, but they have mostly the intention of connecting with each other, it is a way of staying in touch with someone they care deeply about (Gibbs et al., 2005).

Intimacy

One of my major interests in Ambiguity as resource for design was to test if it could be used as way of mediating intimacy. As shown by Kaye (2006) and Riche & Mackay (2010) intimates can interact with each other through subtle and ambiguous ways relying solely on the intimate knowledge they have of each other. Therefore my assumption was that designing the output of The Happy Box to be unclear and ambiguous would encourage the users to interpret that information by using the context and the intimate knowledge that they have of each other. As shown from the results of this test, especially from the case of the family 1 where they could tell by the time that the light was going on what that change of state

meant. They could interpret it because they knew each other's routine and schedule really well, and this I would argue is a compelling example where the ambiguity of a square of light was being interpreted using the intimacy of their relationship. Also, P3 mentioned one case where she saw that the light hadn't changed for while so she started to imagine where her daughter could be, "sometimes I would imagine where she was, well is 4pm she is probably at the pool with P5" she said, based on the time and the state of the light she would guess what P4 could be doing. It is important to note though that just mediating this kind of intimacy through the artifact may not be enough to mitigate loneliness by itself. However, I believe these intimate interactions have immense benefits to support a feeling of connectedness and closeness that in fact are proved to bring relief to loneliness (Fingerman, 2001; Hassenzahl et al., 2012; Schiphorst et al., 2007).

Technology Adoption

Another of my assumptions at the start of this project was that I could facilitate the adoption of technology by elder adults and reduce their learning curve by embedding technology into tangible and analog artifacts. As an effort of verifying that I designed the artifact with aesthetics and functional elements that wouldn't remind anything elders could consider as a technological device, offering them an artifact that they could identify with and not causing them any strangeness. According to Coleman, Gibson, Hanson, Bobrowicz & McKay (2010), "the less new technology "looks" like a computer, and more like an artifact that already plays a

role in the older adult's lives, the more likely it is to be accepted and potentially used by older adults". In order for a technological device to be accepted by elder adults it needs to fit the social context of their houses (Lindley et al., 2008). During the testing with family 1 I could verify that even though the artifact was following Coleman's and Lindley's suggestion it wasn't enough for a rapid adoption, I would argue that P1's mental model of a "communication" device caused her to adopt the artifact in a slower pace. Even though the artifact resembles a wooden box - something that she probably has everywhere at her house or at least have seen it before - and the interaction is quite similar to playing with a chess pawn, her mental model of a communication device is just a phone. She has never seen neither a box or a chess board that helps her to communicate with her family through the internet.

When I asked both participants if they had any major difficulties in using it, P1 stated "it is something different, but I could use it, I put the tile there and it turned the light on and I talked to you" looking at P2, her daughter. Although she didn't have difficulties to use it she is so used to using the phone as way of communicating with her family and friends that she refers to the interaction as "talk". I would say that indeed offering tangible pieces as input and going against the common aesthetics of digital communication devices helped her to better understand and explore the artifact but it wasn't enough to allow a quick adoption. P1 said that she was offered a mobile phone once but she didn't accepted it

because she didn't need one. The Happy Box got through this phase of not wanting to use the device, the next step would be to adopt this object as part of her routine, what in my opinion would be a matter of time. P1 has a well defined routine that hardly ever changes, thus I would argue that it would take much longer than a week (the length of this first test) for the artifact or any other object to be adopted as part of her routine, the fact that there were moments where the connection was interrupted also reduced the total time she spent using the artifact which may have contributed to the slower adoption of it. P1 had a very passive usage of the artifact, most of the time she wasn't the one who would start the interactions, she would only interact with it when she noticed that her daughter made changes to the tiles on her box, she was mostly "answering" instead of sending anything. On the other hand, based on my conversation with P3 I can tell she was much more active in using the artifact, however, I wouldn't be able to state if this is due to the fact that she had The Happy Box with her for a longer period (2 weeks) or it was because she was younger and much more avid with technology.

User Suggestions

During the interview I asked each family if they had any suggestions. I'll finish this section by presenting you some of these suggestion. P3 said that it would be interesting to have a way of identifying who was interacting with the object in cases with multiple family members living in the same house, this would also allow

more than two houses to be connected at the same time. P4 said that sometimes she wouldn't notice that her mother had changed the tokens because she wasn't in her living room so she suggested that it could have some sound notification so she could notice at a distance. I actually tried to avoid using sound notification because I personally think that sound could harm the experience, the idea was the light by itself would help to call their attention to changes. P3 mentioned that she could see the subtle changes on the lighting as they happen because she had the box on her sight of view. I would say that for future designs I would have to consider the differences of mobility of each user and a way of notifying each, after reflecting on this for sometime I thought that using movement to create mechanical sounds instead of digital sounds could be a good solution, so for a future prototype I would play with this concept perhaps through movement and tactile interfaces. Another interesting suggestion that came also from P3, she mentioned that it could have a bigger surface, maybe a third row so she could create more diverse shapes or even play tic-tac toe as she suggested. She mentioned that sometimes when she knew her daughter wasn't home she would just kill time by creating random shapes with the tokens.

Summary

I would like to conclude by making a summary of the findings of this testing, how they helped me shape this research and what are their implication for future designs. Going through the process of designing and particularly testing this

prototype led me to make some changes in my research questions. I previously had an interest solely in mediating intimacy, I thought that by offering intimate interaction would be enough to bring them closer and feel less lonely. I assumed that creating an interface that would allow the users to create their own codes could be a way of mediating intimacy. After going about making The Happy Box and reflecting on these results I came to realize that undeniably their intimacy came into play, but the intimacy wasn't present in the creation of codes but in the interpretation of those light patterns. Additionally this intimate interpretations weren't the main reason for them to feel connected and less lonely but the playfulness of the interaction, the adaptive abilities of the object that allow them to connect and stay in touch on their own unique and personal ways. Which adheres to the idea that Ambiguity and TUI support unique and engaging interactions (Gaver et al., 2003; Ullmer & Ishii, 2000). According to some of the participants the playfulness and ambiguity of The Happy Box - trying to interpret the message and matching tokens - was what brought them the feeling of being closer.

Another interesting finding was that before I started testing this prototypes I had assumed that the only path to mediate intimacy would be through the Ambiguity of information (Gaver et al., 2003) and how this would encourage the users to interpret this information using their intimacy. Indeed this was confirmed by both families, but as previously showed on Rettie's (2003) work intimacy is also related to being aware of each other's status and whereabouts. Likewise feeling

each other's presence can also be defined as expressions of intimacy or yields of intimacy as defined by Vetere et al. (2005, April). As can be seen in the results from both rounds of user testing, there are significant signs of intimacy not just in the cases where the participants were interpreting the messages but when they felt connected and when they felt accompanied by each other's remote presence. These discoveries led me to formulate my current research questions which guided this research not only covering the intimate aspect of the interaction but its potential to support connectedness and Affective Awareness.

Lastly, designing this object without a clear task in mind leaves the users to decide and interpret the object as they see fit. I was aware of the benefits and capabilities of Ambiguity but I was definitely surprised by seeing my design being used as a game platform by one family and a communication device by the other. I was amazed not only by such distinct ways of using the same interface but especially by the fact that they saw a game platform in it when myself, as the maker had never seen it as such.

6. Future Research

As a future step I would like to test The Happy Box for a longer period, and also involve a greater number of families and participants with more diverse ages and perhaps analyzing the data utilizing a hybrid of qualitative and quantitative methods. So as to gather knowledge about the two following matters. First one of the elder participants had a very passive use of The Happy Box, using most of the time just to answer back to her daughter. I designed The Happy Box based on the Lindley, S. E. et al's. (2009) statement that embedding technology into objects that don't resemble computer and other technological devices may help increase the adoption of technology by elders. However I wasn't able to confirm if the low adoption of the prototype was due to a) the connectivity problem that reduced the time that the elder had The Happy Box on her house or b) embedding technology into a box wasn't enough for her to consider it a familiar object as it was something different than her mental model of a communication device (phone). Second and more importantly is that the data collected as part of this thesis is still not enough to confirm the long term benefits of this concepts specifically in helping elders to feel less lonely, hopefully the knowledge here presented may support further researches to answer these questions.

7. Conclusion

Through a qualitative analysis of interviews and user testing results the Emilia project showed that both Ambiguity and Tangible User Interfaces can help improve the sense of closeness and intimacy in remote interactions. This thesis was also able to show that mediating the sense of closeness and intimacy can result in a feeling of connectedness and Affective Awareness. Through the process of making and testing The Happy Box this project resulted in the following key findings. First, applying Ambiguity to the design of The Happy Box allowed the participants to interpret the information using the intimate knowledge they have of each other. Additionally designing the object with no predefined task and use supported the creation of playful ways of staying in touch, in fact the playfulness of the interaction was defined by the participants as one of the aspects responsible for supporting their sense of closeness and connectedness. Second, the tangible aspects of the interface have shown to have great potential of supporting closeness - as shown by some of the participants declaring feeling closer by knowing that their loved ones were "touching" the token as they interact with each other. Moreover the flexibility of physical objects supported the application of Ambiguity by allowing the user to create different ways of connecting and staying in touch. In a likely manner allowing interactions through physical objects demonstrated good results in supporting intergenerational communication.

I would like to restate that this design should not be considered a substitution to visiting and even talking over the phone, even though this design is intended to increase the feeling of closeness and connectedness there will always be the need for a face-face interaction, a hug, a good chat or a simple smile. My prototype is design to perhaps mitigate the feeling of being lonely but not extinguish it. Unfortunately to end this feeling involves many other factors that are not possible to be addressed through this project. It is extremely important to notice that this project was tested with elder adults who have close relatives, but there many cases of elders who didn't have children and don't have any family, maybe due to a partner who passed way or because they have not had a close partner. Unfortunately, these are where the most severe cases of loneliness can happen, and a solution like the one I designed only matters if they have a friend or family to give The Happy Box to. There are many good examples of work being done around helping elders to socialize around their neighbourhood or community, initiatives helping elders to make friends and build a social routine so they don't stay home alone all day, most of this initiatives are non-profits and depend on the help of volunteers, please check the list of initiatives I provided on the appendix of this thesis and find one that is near your city or neighbourhood and try to help however you can, there will always be someone out there that just need someone to talk to.

Based on the results from these research I would argue that designing solutions, such as The Happy Box, that mediate intimacy and support presence in absence, Affective awareness and connectedness can have significant benefits towards mitigating loneliness experienced by not only elder adults but any individual that, for any reason, feels isolated.

8. References

- Achilleos, A. P., Mettouris, C., Papadopoulos, G. A., Neureiter, K., Rappold, C., Moser, C., ... & Jimenez, O. (2013, June). Developing an effective social presence system for older adults: The connected vitality network. In *Information technology interfaces (ITI), proceedings of the ITI 2013 35th international conference on* (pp. 153-159). IEEE.
- Aoki, P. M., & Woodruff, A. (2005, April). Making space for stories: ambiguity in the design of personal communication systems. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 181-190). ACM.
- Baecker, R., Sellen, K., Crosskey, S., Boscart, V., & Barbosa Neves, B. (2014, October). Technology to reduce social isolation and loneliness. In *Proceedings of the 16th international ACM SIGACCESS conference on Computers & accessibility* (pp. 27-34). ACM.
- Blieszner, R. (2001). 'She'll be on my heart': Intimacy among friends. *Generations*, 25(2), 48-54.
- Chang, A., Resner, B., Koerner, B., Wang, X., & Ishii, H. (2001, March). LumiTouch: an emotional communication device. In *CHI'01 extended abstracts on Human factors in computing systems* (pp. 313-314). ACM.
- Channel 4 News [Channel 4 News]. (2015, November 3). *What does it feel like to be old and alone?* [Video file]. Retrieved from <https://youtu.be/V5EsxU84ay4>.

Coleman, G. W., Gibson, L., Hanson, V. L., Bobrowicz, A., & McKay, A. (2010, August). Engaging the disengaged: How do we design technology for digitally excluded older adults?. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems* (pp. 175-178). ACM.

Dahley, A. M. (1998). *Designing kinetic objects for digital information display* (Doctoral dissertation, Massachusetts Institute of Technology).

Dalsgaard, T., Skov, M. B., Stougaard, M., & Thomassen, B. (2006, June). Mediated intimacy in families: understanding the relation between children and parents. In *Proceedings of the 2006 conference on Interaction design and children* (pp. 145-152). ACM.

Davis, K., Hu, J., Feijs, L., & Owusu, E. (2015, March). Social hue: A subtle awareness system for connecting the elderly and their caregivers. In *Pervasive Computing and Communication Workshops (PerCom Workshops), 2015 IEEE International Conference on* (pp. 178-183). IEEE.

Davis, H., Vetere, F., Gibbs, M., & Francis, P. (2012). Come play with me: designing technologies for intergenerational play. *Universal Access in the Information Society, 11*(1), 17-29.

Dey, A. K., & de Guzman, E. (2006, April). From awareness to connectedness: the design and deployment of presence displays. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 899-908). ACM.

- Dunne, A., & Gaver, W. W. (1997, March). The Pillow: Artist-Designers in the Digital Age. In *CHI Extended Abstracts* (pp. 361-362).
- Feltham, F., Vetere, F., & Wensveen, S. (2007, August). Designing tangible artefacts for playful interactions and dialogues. In *Proceedings of the 2007 conference on Designing pleasurable products and interfaces* (pp. 61-75). ACM.
- Fingerman, K. (2001). A distant closeness: Intimacy between parents and their children in later life. *Generations*, 25(2), 26-33.
- Gaver, B. (2002). Provocative awareness. *Computer Supported Cooperative Work (CSCW)*, 11(3-4), 475-493.
- Gaver, W. W., Beaver, J., & Benford, S. (2003, April). Ambiguity as a resource for design. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 233-240). ACM.
- Gaver, W. (2012, May). What should we expect from research through design?. In *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 937-946). ACM.
- Gibbs, M. R., Vetere, F., Bunyan, M., & Howard, S. (2005, November). SynchroMate: a phatic technology for mediating intimacy. In *Proceedings of the 2005 conference on Designing for User eXperience* (p. 37). AIGA: American Institute of Graphic Arts.

Hafner, K. (Sep 5th, 2016). Researchers Confront an Epidemic of Loneliness. The New York Times. Retrieved from <http://www.nytimes.com/2016/09/06/health/loneliness-aging-health-effects.html>

Hassenzahl, M., Heidecker, S., Eckoldt, K., Diefenbach, S., & Hillmann, U. (2012). All you need is love: Current strategies of mediating intimate relationships through technology. *ACM Transactions on Computer-Human Interaction (TOCHI)*, 19(4), 30.

Holt-Lunstad, J., Smith, T. B., Baker, M., Harris, T., & Stephenson, D. (2015). Loneliness and social isolation as risk factors for mortality a meta-analytic review. *Perspectives on Psychological Science*, 10(2), 227-237.

IJsselsteijn, W., van Baren, J., & van Lanen, F. (2003). Staying in touch: Social presence and connectedness through synchronous and asynchronous communication media. *Human-Computer Interaction: Theory and Practice (Part II)*, 2(924), e928.

Ishii, H. (2008, February). Tangible bits: beyond pixels. In Proceedings of the 2nd international conference on Tangible and embedded interaction (pp. xv-xxv). ACM.

Kaye, J. J., & Goulding, L. (2004, August). Intimate objects. In Proceedings of the 5th conference on Designing interactive systems: processes, practices, methods, and techniques (pp. 341-344). ACM.

Kaye, J. J. (2006, April). I just clicked to say I love you: rich evaluations of minimal communication. In *CHI'06 extended abstracts on human factors in computing systems* (pp. 363-368). ACM.

Kowalski, R., Loehmann, S., & Hausen, D. (2013, February). cubble: A multi-device hybrid approach supporting communication in long-distance relationships. In *Proceedings of the 7th International Conference on Tangible, Embedded and Embodied Interaction* (pp. 201-204). ACM.

Liechti, O., & Ichikawa, T. (2000). A digital photography framework enabling affective awareness in home communication. *Personal Technologies*, 4(1), 6-24.

Lindley, S. E., Harper, R., & Sellen, A. (2008, September). Designing for elders: exploring the complexity of relationships in later life. In *Proceedings of the 22nd British HCI Group Annual Conference on People and Computers: Culture, Creativity, Interaction-Volume 1* (pp. 77-86). British Computer Society.

Lindley, S. E., Harper, R., & Sellen, A. (2009, April). 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* (pp. 1693-1702). ACM.

Masi, C. M., Chen, H. Y., Hawkey, L. C., & Cacioppo, J. T. (2010). A meta-analysis of interventions to reduce loneliness. *Personality and Social Psychology Review*.

Monsour, M. (1992). Meanings of intimacy in cross-and same-sex friendships. *Journal of Social and Personal Relationships*, 9(2), 277-295.

- Moss, B. F., & Schwebel, A. I. (1993). Defining intimacy in romantic relationships. *Family relations*, 31-37.
- Olivera, F., Rivas, A., & Iturriaga, F. (2013, December). Subtle interaction for a non intrusive communication. In *International Conference on Ubiquitous Computing and Ambient Intelligence* (pp. 215-222). Springer International Publishing.
- Patel, D. Fostering Human Connectedness: Awareness Over a Distance Using Networked Furniture.
- Perissinotto, C. M., Cenzer, I. S., & Covinsky, K. E. (2012). Loneliness in older persons: a predictor of functional decline and death. *Archives of internal medicine*, 172(14), 1078-1084.
- Price, S., Rogers, Y., Scaife, M., Stanton, D., & Neale, H. (2003). Using 'tangibles' to promote novel forms of playful learning. *Interacting with computers*, 15(2), 169-185.
- Rettie, R. (2003). Connectedness, awareness and social presence.
- Riche, Y., & Mackay, W. (2010). PeerCare: supporting awareness of rhythms and routines for better aging in place. *Computer Supported Cooperative Work (CSCW)*, 19(1), 73-104.
- Romero, N., Markopoulos, P., Van Baren, J., De Ruyter, B., Ijsselstein, W., & Farshchian, B. (2007). Connecting the family with awareness systems. *Personal and Ubiquitous Computing*, 11(4), 299-312.

- Rowan, J., & Mynatt, E. D. (2005, April). Digital family portrait field trial: Support for aging in place. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 521-530). ACM.
- Schiphorst, T., Nack, F., KauwATjoe, M., De Bakker, S., Aroyo, L., Rosillio, A. P., ... & Jaffe, N. (2007, February). PillowTalk: Can we afford intimacy?. In *Proceedings of the 1st international conference on Tangible and embedded interaction* (pp. 23-30). ACM.
- Sokoler, T., & Svensson, M. S. (2007). Embracing ambiguity in the design of non-stigmatizing digital technology for social interaction among senior citizens. *Behaviour & Information Technology*, 26(4), 297-307.
- Sokoler, T., & Svensson, M. S. (2008, July). PresenceRemote: Embracing ambiguity in the design of Social TV for senior citizens. In *European Conference on Interactive Television* (pp. 158-162). Springer Berlin Heidelberg.
- Strong, R., & Gaver, B. (1996, November). Feather, scent and shaker: supporting simple intimacy. In *Proceedings of CSCW* (Vol. 96, pp. 29-30).
- Sundström, P., Ståhl, A., & Höök, K. (2005, October). A user-centered approach to affective interaction. In *International Conference on Affective Computing and Intelligent Interaction* (pp. 931-938). Springer Berlin Heidelberg.
- Suzuki, K., & Hashimoto, S. (2004, October). Feellight: a communication device for distant nonverbal exchange. In *Proceedings of the 2004 ACM SIGMM workshop on Effective telepresence* (pp. 40-44). ACM.

Tapprest, E. (2015). lightbound.

Thompson, A., Friedland, A., & Cargiuolo, J. (2005, April). Rүү: long-distance communication. In *CHI'05 Extended Abstracts on Human Factors in Computing Systems* (pp. 1829-1832). ACM.

Vetere, F., Gibbs, M. R., Kjeldskov, J., Howard, S., Mueller, F. F., Pedell, S., ... & Bunyan, M. (2005, April). Mediating intimacy: designing technologies to support strong-tie relationships. In *Proceedings of the SIGCHI conference on Human factors in computing systems* (pp. 471-480). ACM.

Ullmer, B., & Ishii, H. (2000). Emerging frameworks for tangible user interfaces. *IBM systems journal*, 39(3.4), 915-931.

Weiser, M., & Brown, J. S. (1997). The coming age of calm technology. In *Beyond calculation* (pp. 75-85). Springer New York.

Wenger, G. C., Davies, R., Shahtahmasebi, S., & Scott, A. (1996). Social isolation and loneliness in old age: review and model refinement. *Ageing and Society*, 16(03), 333-358.

Yardley, L., & Bishop, F. (2008). Mixing qualitative and quantitative methods: A pragmatic approach. *The Sage handbook of qualitative research in psychology*, 352-370.

Zimmerman, J., & Forlizzi, J. (2008). The role of design artifacts in design theory construction. *Artifact*, 2(1), 41-45.

Zimmerman, J., Stolterman, E., & Forlizzi, J. (2010, August). An analysis and critique of Research through Design: towards a formalization of a research approach. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems* (pp. 310-319). ACM.

Zimmerman, J., & Forlizzi, J. (2014). Research through design in HCI. In *Ways of Knowing in HCI* (pp. 167-189). Springer New York.

9. Appendices

9.1. APPENDIX A: List of institution and support program for elders

Elderly persons centres in Ontario

A map of available elderly person centres in the province of Ontario. This centres offer social, cultural, learning and recreational programs for elders.

Link: <https://www.ontario.ca/page/find-elderly-persons-centre-near-you>

The Little Borthers

The Little Brothers manages a network of volunteers that offers programs to mitigate loneliness such as matching an elder with volunteers to receive weekly visits. To get more informations about volunteering, please access their website.

Link: <http://www.petitsfreres.ca/en/>