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Synchronized Dining

Tangible mediated communication
for remote commensality

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Dedication

I dedicate this thesis to the loving memory of my mother.

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I would like to express my gratitude to my supervisor Anne-Marie Hansen for useful insights and guidance. Furthermore I would like to thank my IxD colleagues and other participants for all their help. Special thanks to two of the most precious people, my dear sister Petra and my husband Alamgir for all their encouragement and support.

Abstract

This thesis discusses commensality as a significant social activity, that helps to maintain and strengthen social bonds. It also examines the sense of touch as a communication channel, and provides an insight to how it can be used to communicate affect. Touch as contextualized medium and its relevance to interaction design is investigated. Based on studies made in psychology, physiology, sociology and communication it aims to find an answer to the question: *"How may we create togetherness -with the help of an interactive device- between loved ones separated by distance during dining, through remote communication?"* In order to meet the objectives of the above question this research followed the Research Through Design methodology, with series of workshops and prototyping sessions.

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ABSTRACT

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1. Introduction

Eating is a social practice that everyone engages in on daily bases and for many it's most gratifying when done together with others. Studies show that mealtime is not only about nourishment and necessity but a way of bonding with others. Commensality is a unique social activity, in creating and strengthening connections between loved ones. Sharing meals also means sharing experience, establishing basic social attachment and feeling togetherness. (Sobal and Nelson, 2003). Dining together with loved ones is however not possible for everyone. For geographically distributed families, friends and loved ones sharing meals is made impossible by the distance and thus they miss out on the benefits of togetherness that commensality has to offer.

Togetherness is an emotion that people feel while dining together. Hatfield (1965) explains Emotional Contagion as a process, where people emotions are transferred to each other through visual cues between people who are co-located. Studies show however, that emotions can be transferred not only through visual but other different modalities, such as the sense of touch. The sense of touch comprises both sensory and kinesthetic systems. Through touch we can sense temperature, vibration as well as feel movement. Based on these studies, this project attempts to design an interactive system that traces different modalities (sound, temperature, movement,) and renders them into a haptic display, thus enabling the communication of emotions between distant locations.

In order to answer the main design question: *"How may we create togetherness -with the help of an interactive device- between loved ones separated by distance during dining, through remote communication?"*, this project will be guided by the following design questions

1. How do you sense togetherness while geographically separated?
2. How do you sense it through touch?
3. How can it be mediated through an interactive device?

The aim of this research is to investigate how we can enhance interpersonal communication by adding physicality to remote communication, in the form of mediated touch. Fueled by the

findings of the studied literature, one of the main criteria of this project is to create a physical link, a real-time joint interaction between distant users. Another important aspect is to enable affective communication through the sense of touch as a non-symbolic channel, "immediacy", as Wang and Quek puts it (2010). With these criteria in mind the objective is to enable a sense of togetherness, a subtle connection through mediated touch, between loved ones separated by distance. This research is fostered by psychological, sociological, physiological and communicational studies. The goal is to synchronize two locations based on the definition of emotional contagion.

The goal is not to try to imitate 'real-life', 'face-to-face' touch that might or might not take place during commensality. The goal is to gather all the different types of non-verbal communication 'elements' (e.g. a gaze of the eyes, a nod of the head, a smile, etc.) that takes place during the act of sharing meals, and turn/convert them into tangible actions, movements that can be forwarded through remote communication – namely remote touch. Instead of aiming at developing and implementing a final working prototype, goal of this project is to propose some design alternatives. Based on the exploration of the design space and through iterations, in form sketches and low fidelity prototypes, try to answer the main design question stated earlier.

Some of the main research areas this project entwines that will be presented in the following sections are commensality, touch and mediated touch. Followed by additional topics that it touches upon are nonverbal communication, and emotional contagion.

Keywords

Tangible interaction, haptic feedback, commensality, sense of touch, nonverbal communication, emotional contagion, digitally mediated touch, immediacy, joint movement

2. Background

2.1. Commensality

Commensality, as defined in sociology by researchers Morrison (1996) and Sobal (2000), is the act of eating together. Mealtime, as a special experience with its distinctive characteristics, compared to all other social activities, invites itself to be the prime design space to be investigated in this project.

2.1.1. Vital part of human life, universal medium

Szatrowski (2014) explains that mealtime, as social activity "is a very central part of human life; without food we could not exist". Despite of different factors such as age, gender, etc. everyone can relate to their mealtime experiences through previous encounters. "Food is a universal medium for expressing sociability" (Fieldhouse et al. 1996, p.83)

A survey shows that commensality is in fact the most frequently repeated social activity. As Fiese and Schwartz (2008) puts it "There is no other daily activity that families share as a group that is practiced with such regularity" (p. 3.). As Ochs and Kremer-Sadlik (2013) explains "sharing a meal is a universal opportunity for strengthening the ties that bind a family" (p. 63).

Although different economic and cultural elements have influenced and reshaped it over time, mealtime continues to be a significant opportunity for loved ones to bond. While it "remains a symbol of unity and stability for the family", it comes with great health benefits as well as an opportunity for socialization (Hamilton and Wilson, 2009, p. 346). A study demonstrates that despite of work overload and having not enough time, families have a desire to eat together. A CELF research reveals that "the desire to "break bread" together continues to be valued in many households" (Ochs and Kremer-Sadlik, 2013, p. 63).

2.1.2. Shared experience, togetherness

Sharing meals is a common way of creating and maintaining social ties. Gathering over a meal is a great opportunity for closed loved ones to keep their relationships 'alive', create a strengthen a sense of belonging and feel connectedness. Commensality is a shared experience where important social bonds are formed (Grevet, 2012). According to Sobal and Nelson (2003) even though there is a trend of "friends eating together at a restaurant", or colleagues joining each other for lunch, the most basic entity for commensality is family (Sobal and Nelson, 2003. p. 181).

Eating together with others is a personal experience, like Fieldhouse (1996) puts it "offering to share food is to offer to share a bit of oneself" (p.84). This is one reason why "not everyone is invited to dine together" as Szatrowski et a. (2014) explains. In order for people to allow entry to the table they need to have a special affiliation with each other. Hence for those sharing a meal, is a special social event. Despite of what kind of food is served, commensality has a great significance for humankind. Being aware of the fact that sharing meals form social bonds, people invite for at least a drink or a snack, although in tight economic situations when they can hardly afford it. "Sociality and commensality are clearly linked" (Szatrowski et al. 2014, p. 32). With its simplistic, informal or intimate nature, commensality's power to dramatically change social relations is apparent.

As demonstrated in the studies above, it can be concluded, that eating is a unique and important social practice that everyone engages in on daily bases. It's most satisfying and beneficial when done together, in the company of loved ones.

2.1.3. Remote commensality

Dining together with family, friends and loved ones is however not possible for everyone. There are several factors that contribute to the hindrance of sharing meals. The effect of globalization on the job market, which in turn has a major impact on everyday life. Studies show that today's societies where work plays a central role, family members are often on business trips, "it forces employees to travel constantly and even to live apart from their loved ones" (Hassenzahl 2012, p. 32). Due to current lifestyles and living conditions people are often restrained from enjoying meals together. Thus many are unable to enjoy the benefits of this

basic but essential social activity. For geographically distributed families, friends and loved ones, sharing meals is made impossible by the distance.

Today's remote communication allows mostly text-, voice and video messages, voice and video-conferencing. According to Ogawa "Remote communication methods (email, pagers, instant messaging, video-conferencing, and telephones) are not designed to convey subtle nonverbal signals. A device that conveys touch might allow for more expressive interactions." (Ogawa, Ando & Onodera, 2005). As pointed out above, what's missing from currently available communication platforms is warmth and intimacy. To fulfil these demands - to enable a more eloquent contact - introducing physicality to remote communication in form of tangible interaction might be a solution. Physicality is crucial for allowing more expressive communication. By creating a physical link and incorporating the use of tactile sense to the interaction, would open up new possibilities for people to convey affect and emotions remotely. The most effective way to express emotions is through nonverbal communication, namely touch.

2.2. Communication

2.2.1. The basics of communication

As the main purpose of this design project is to enable communication between remotely located people, it's important to define the basics of communication. According to Berlo (1961) communication is a means of forwarding messages between two or more people, while demonstrating how they affect each other, how they see themselves and the setting, and the content of the messages.

2.2.2. Nonverbal communication

Much of the communication during commensality is nonverbal. It is therefore important to define it here. Nonverbal communication relies on all of our five channels, such as visual, auditory, touch taste and smell. As Knapp et al. (2013) pointed out: "touch is an especially powerful of nonverbal communication" (Knapp et al., 2013, p. 182) which is highly relevant to this project.

According to Knapp, Hall and Horgan (2013) "the term *nonverbal* is commonly used to describe all human communication events that transcend spoken or written words" (p. 27). They further explain, that the same events make also sense through verbal symbols. We conceal and reveal different nonverbal behaviors with different level of control and consciousness. Sometimes when we are well aware of our actions we are able to plan our responses. On the other hand, when we don't plan ahead, we respond more spontaneously and thus we're less aware of these actions. When the brain processes the nonverbal signals it occurs on the right hemisphere, while a substantial overlapping of actions takes place. Knapp et al. (2013) explains that nonverbal should be viewed as a significant part of the total communication process. Theoretical studies on nonverbal communication focus on three major aspects. First, the physical and spatial communication environment. Second, the unique physical characteristics of the communicator. Finally, the different body movements and positions, such as touching, gestures, posture, facial expressions, eye-, and vocal components. To conclude, the significance of nonverbal communication is due to its vital function in the overall communication system. Nonverbal communication facilitates an enormous amount of informational cues of different situations, thus a fundamental part of our daily life (Knapp et al., 2013)

2.3. Emotional contagion

Emotional contagion is defined by Hatfield, (1965) as an inclination to "automatically mimic and synchronize expressions, vocalizations, postures, and movements" with others' and as a result to converge emotionally (pp. 153-154). A number of different mechanisms have been proposed for emotional contagion, among these many that involves automatic transmittal of emotions between people. The automatic transmission includes both unconditioned and conditioned emotional responses as well as "interactional mimicry and synchrony" (Hatfield et. al, 1965, p 155). The focus in this project is on the primitive emotional contagion that can evolve from interactional mimicry and synchrony.

Since mediation of emotions is in the main scope of this project, it is important to examine how emotions can be transmitted. As Hatfield (2011) writes, among the several earlier theories that suggest the different possible mechanisms of emotional contagion were conscious

reasoning, analysis and imagination. In this project however the focus is on the primitive emotional contagion, which is more of an automatic, subtle and ubiquitous process. Evidence supports the three stages of emotional contagion process: mimicry, feedback and contagion. Among the mimicry there are facial, vocal, postural. There is numerous evidence that shows that people likely to mimic the emotional expression of others. Likewise mimicking and synchronizing vocal articulations, postures and movements were shown through different studies. This happens automatically. There is substantial amount of data that shows that people can mimic and synchronize their facial expressions, vocal sounds, postures and movements, do all that through a fast unconscious process. (Hatfield et. al, 2011).

The second stage of the process includes facial, vocal and postural feedback. Evidence of several studies show that "people tend to feel emotions consistent with the facial, vocal, and postural expressions they adopt." (Hatfield, 2011, p. 10). A specific link between facial, vocal and postural expressions have also been pointed out by Hatfield et. al (2011). She means that when people express different emotions such as fear, anger, etc., they are not just going to feel any but most probably will feel those 'specific' emotions. The third stage of process is contagion. As Hatfield et. al (2011) explains "consequently, people tend, from moment-to-moment, to 'catch' others' emotions" (p. 10). Evidence supports the three stages of emotional contagion process: mimicry, feedback and contagion. It means, that people usually imitate others' facial, vocal, postural expressions and instrumental behaviors automatically. As a result of such feedback, they're able to feel the reflection other's emotions. Thus people 'catch' each other's emotions (Hatfield, 2011)

Empathy is an important element when talking about emotional contagion. Definitions that used and relevant to this project are presented below. Most psychologist agree with Decety & Jackson (2004) that there are three specific abilities are necessary for having empathy. The capacity to share the feelings of the other person, the cognitive ability to perceive the other person's feeling, and to be able to respond to the other person's distress with compassion. In this project the focus is on second process: "the ability of people to 'feel themselves into' another's emotions via the process of emotional contagion" (Hatfield, 2011, p. 1).

2.4. The power of human touch

“Touch is worth a thousand words”

Several significant psychological, sociological, physiological and communicational studies have been dedicated to human touch. Some of these studies, that are relevant to and motivates this research, are reviewed in the following part of this paper.

First a brief summary of the significance of human touch in early development, followed by an insight into touch as a powerful modality for expressing emotions and intimacy. Second, the essay will dive into another important aspect, context, which is pivotal in understanding human touch. The third part will talk about touch as physical phenomenon.

2.4.1. Affective and immediate communication channel

According to psychologist Gottlieb (1971) among all the human senses touch is the one that develops first in the embryo. Harlow and Zimmermann (1959) points out that for mammals, touch is crucial in the beginning of social development and for their healthy growth. Based on his classical experiment about the role of touch in love, which was done on infant monkeys, Harlow (1958) concluded that touch is an essential part of development. In the study infant monkeys were separated from their mothers shortly after birth. Monkeys whose cages were covered with clothes not only established a strong bond with the cloth but they also had a much higher degree of survival than the one who grew up uncovered behind a bare cage wire. Harlow pinpointed the instinctive need for physical contact as he applied his findings to human infants.

Touch is a special sensory system in expressing intimacy, impact and feelings. Argyle (1988) points out that touch is one of the earliest ways of communication between newborn babies and their parents. He notes that “the most basic meaning of touch is that an interpersonal bond is being offered or established” (p. 226). Interpersonal communication is mostly non-verbal with the initial meaning to convey feelings. Among the several other non-verbal communications such as gesture, facial expression and prosody, touch is the dominant channel for expressing intimate feelings. (Field 2010; Morrison, 2010; App 2011). Touch innately has the potential to evoke feelings of social presence since it involves direct physical

interaction and co-location (Morrison et al. 2010). As Löken and Olausson (2010) puts it, "touch can mediate social perceptions in various ways" (p.305).

A phenomenological study on intimacy by Register (1992) also shows that touch is a special attribute for expressing emotions and closeness. His research points out that for encountering intimacy non-verbal communication is crucial. In this study participants were asked to illustrate and explain a situation that they remember and they consider intimate. Most of the participants explained that it's very difficult to convey intimacy using words. They commented that "a touch of the hand...the meeting of our eyes, a kiss, conveyed our intimacy better than a thousand words" (p. 473). The study concludes that intimacy is hard to pass on or describe using words. Certain components of intimacy can be more precisely conveyed nonverbally "in the absence of language" and through other sensory channels such as touch (p. 473). When exploring the different aspects of touch in relation to emotional expressions Collier (2014) emphasizes that it's not possible to pass on love entirely on a conceptual level, it can only be "felt". As he puts it "without touch our affection for others remains a private experience" and that "touching turns a private experience into a social one and changes the expression of joy into one of affection" (p. 31).

In face-to-face communication touch can convey a wide range of feelings and meanings. Communication studies with the focus on emotion have been done on touch not only as the carrier of affection on love but also its ability to convey meanings and emotions. A contextual research by Jones and Yarbrough (1985) were carried out to explore the meanings of touch where roughly 1500 touches were recorded by participants. The recordings included not only contextual information but also a list of related body parts the touch involved and the corresponding verbal expressions. The outcome of the analysis demonstrated that there are twelve different meanings can be expressed through touch, among them support, appreciation, inclusion and affection.

Further studies by the emotion communication community indicates that touch can express distinct feelings. The pressure dimension as an output modality of seven fundamental emotions of touch was investigated by Clynes and Menuhin (1977). In their research participants were asked to respond with an action to a specific feeling by pressing a key. After

the force and the direction of the fingertip movement was measured, the results revealed that the vast majority of participants produced analogous dynamic shapes for each of the seven primary emotions. These researches mentioned above demonstrate that through touch as a non-verbal communication channel it is possible to pass on a great range of feelings and messages.

2.4.2. Physiological phenomenon

Healy and Proctor (2003) defines touch as a physiological phenomenon that “encompasses several distinct sensory systems” (p. 148.). Based on the basic neural inputs Loomis and Lederman (1986) classify touch in three sub-systems: cutaneous, kinesthetic and haptic. The cutaneous system refers to the various receptors of the skin. It receives sensory inputs from nerve endings that can be found in the skin, by responding to mechanical stimulation. The kinesthetic system relates to the movement of the body. It acquires sensory inputs from mechanoreceptors that can be found in muscles and joints enabling the recognition of force and the awareness of limb position. The haptic system utilizes a mixture of inputs from both the cutaneous and kinesthetic systems. The term haptic is affiliated specifically with active touch which is applicable in everyday context (Klatzky & Lederman, 2003). The kinesthetic system relates to active or passive modes of touch (Loomis & Lederman, 1984). When designing a system for digital mediation of touch both active and passive perception should be addressed as a combination (Wang and Quek, 2010)

2.4.3. Immediate channel

Another important proposition by Wang and Quek et. al (2010) regarding human touch is that “it carries unique affective information.” (p. 14). This is made possible only if the information is passed on without a symbolic transformation. Wang and Quek (2010) presented the idea of “immediacy” to the concept of touch. With that they mean, that when someone is trying to express affect through the sense of touch, the person is not trying to convey a concrete message or a statement. There is no message present and to be translated by the person who is receiving the touch. Thus the affective information doesn't go through a process where it is converted into a symbolic expression. Hence the touch is immediate. In the figure below the sense of touch both as immediate and mediated channel illustrated and compared-contrasted (Wang and Quek, 2010).

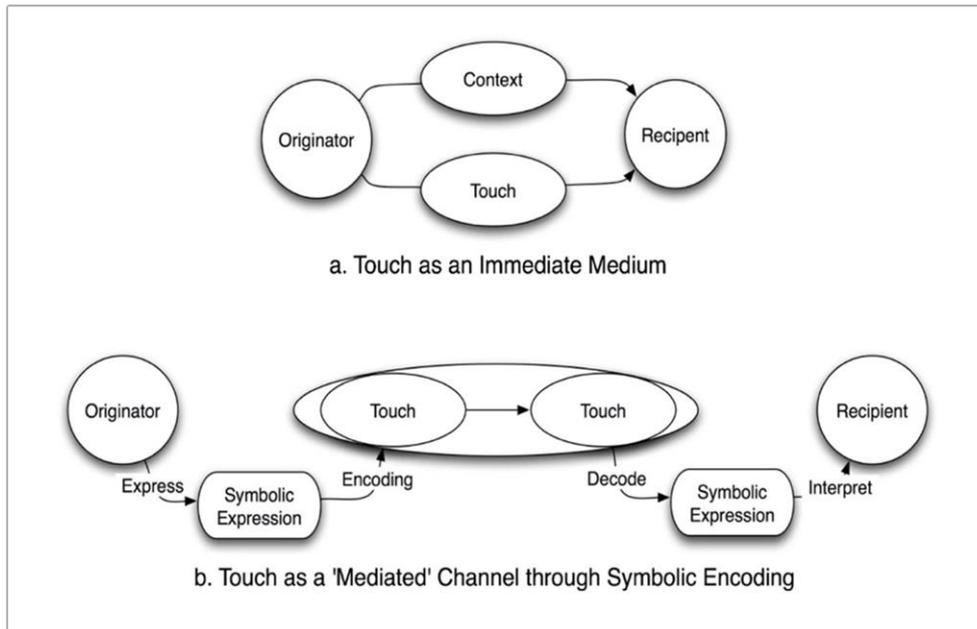


Figure 1 "Immediate Expression Vs Symbolically Mediated Channel" (Wang and Quek, 2010 p. 14)

2.4.4. Contextualized medium

In order for touch to be able to serve as an intimate and rich communication channel for conveying affect and emotion it needs to be in connection with its context. Touch, similarly to other communication forms might evoke different kinds of responses based on the people that are involved and the context that it takes place (Knapp and Hall, 2013). Examples of such context are people's age, gender, relationship, status, environment, cultural background etc. (Jones and Yarbrough et. al 1985). Collier (2014) examined the emotional aspect of touch from the recipients' point of view, with focus on their physiological response, considering the different contextual factors. He concludes that touch should neither be broken into individual components and used separately, nor should it be disconnected from its original context where it takes place (Collier et. al 2014).

In accordance with psychological and sociological studies context is key when it comes to the meaning of touch. There are a number of different types of touch behaviors with same meaning, as well as identical touch behaviors with a variety of meanings. Jones and Yarborough et al. (1985) explain that the meaning of touch may vary depending on which body part is involved in the process. They categorized body parts based on the level of vulnerability of these areas. They introduced so called 'non-vulnerable' (NVBP) and 'vulnerable'

(VBP) body parts. Examples of the first category are hand, arm, shoulder, elbow or upper back. To the second group belongs head, chest, thighs and genital area. According to Jones and Yarborough et al. (1985) in order to be able to differentiate touch from its similar or identical meanings it's crucial to examine the context. As (Wang and Quek, 2010) puts it "The role of context in shaping the meaning of touch cannot be ignored" (p. 14).

2.4.5. Physical link, joint movement

Creating a physical link, through joint movement, between remotely located people, is key in achieving a sense of togetherness (Brave, Ishii and Dahley, 1998). They describe a method, for enabling and improving remote communication, which accentuates physicality and the use of sense of touch. They mean, that in reality being able to touch and manipulate things physically contributes significantly to how we understand and affect our surroundings. They also explain that physicality, such as a handshake, influences our daily communication profoundly. Thus, they suggest that these issues should be considered when designing mediated communication (Brave et al., 1998). In turn, their approach described in their article had a great impact on creating of one of the main criteria's of this project.

3. Related work

Digitally mediated remote touch

As a result of today's globalized lifestyle, where families are geographically spread out, there has been an increasing interest and several attempts in designing technologies that allow people to convey and generate the notion of belonging while being apart. A great collection of work is designed, with the goal to enable a sense of togetherness, for physically separated people. This collection along with a brief analysis, is presented by Hassenzahl (2012) in *All You Need Is Love*. This review pinpoints six different approaches, based on the way designers pursued achieving a sense of togetherness through interactive devices. In regard to this, in his review the examples are divided into different categories based on "strategies for relatedness": Awareness, Expressivity, Physicalness, Gift Giving, Joint Action, Memories (Hassenzahl et. al 2012. p. 30:3). Among these strategies that are most closely related to this project are physicalness which is described as "artifacts that mediate a feeling of physical intimacy"

(Hassenzahl et. al 2012. p. 30:5). They mimic e.g., body heat, heartbeat or gestures such as hugs, strokes, as it is further explained.

Presented below an overview of related works, describing artifacts that aim to express a sense of togetherness and communicating feelings remotely. Most of these projects contributed a great deal to the understanding and defining the design space this project is aiming to design for. Some other works are even more closely related to the main objectives of this project and aided in setting up the criterions.

In selecting these examples that are presented in the following section, four basic aspects were taken into consideration that are associated with the findings of this research. These are togetherness in commensality, immediacy, contextualization, representation of movement and joint action, all in line with the field of tangible interaction. Since each of this related work, which will be presented here, touches upon the core facets of this project, they have been a great source of inspiration and strongly influenced in setting up the primary design goals.

Friendl

Marie Rosa Beuthel, Frederik Gottlieb, Roy Martens & Miguel Navarro Sanint



Figure 2. Friendl

Friends is a pair of interactive candles that was created for remote communication during dinner activity. The result of the project was a working prototype which was tested on some users. The device was designed with the intention to allow people, who are not physically located, e.g. couples in distant relationship to keep in touch. The candles are placed on the dinner table on both users' side. When touched, the candle lights up near the area the touch occurred. When a person interacts with a candle on one side, the other candle imitates the interaction on the other side. The two candles act identically and synchronously -at the same time. Participants who tested the object reported feeling the presence of others and managed to communicate through the device. During testing they found that the candles also had an effect on the surroundings as the users got a sense of eating together. Synchronous behavior is an important aspect of the design and because it is also one of the main criterions of this project this example of related work was selected for review.

inTouch

Scott Brave and Andrew Dahley, MIT Media Laboratory

inTouch is a pair of interactive device that enables interpersonal communication through haptic feedback technology. Each device consists of three cylindrical rollers that are sitting on a base. It employs the "Synchronized Distributed Physical Objects concept", the rollers on each base are haptically coupled" (Brave, Ishii, and Dahley, 1998, November), thus it appears for the

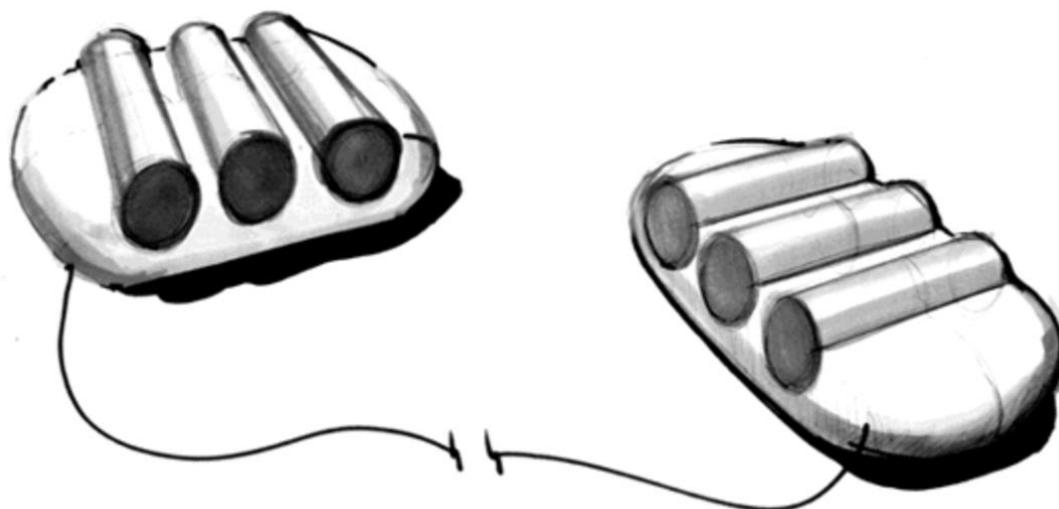


Figure 3 inTouch concept sketch

users as if they are “interacting with a shared physical object” (Brave and Dahley, 1997, March). Simultaneous manipulation is made possible by using two-sided force-feedback technology with position sensors and high precision motors which enables close link. Although the rollers are manipulated independently on separate sides by two different users, if one is scrolled on one side, the other is also affected at the same time. The user who in passive state can still feel the other user’s movements and the resistance.

One of the main distinctive features of InTouch is that instead of focusing on representation of physical forms like in most of the haptic technology, it represents movement. Instead it provides a physical link, thus a rich interaction between the distant users. Since inTouch uses bilateral interaction, it is integrated in both directions, thus it simulates the notion of Kinesthetic Constructions very closely (Brave et al.,1998). With these unique features in focus, this work example was selected here as it’s closely relates to the objectives of this project.

Touch & Talk

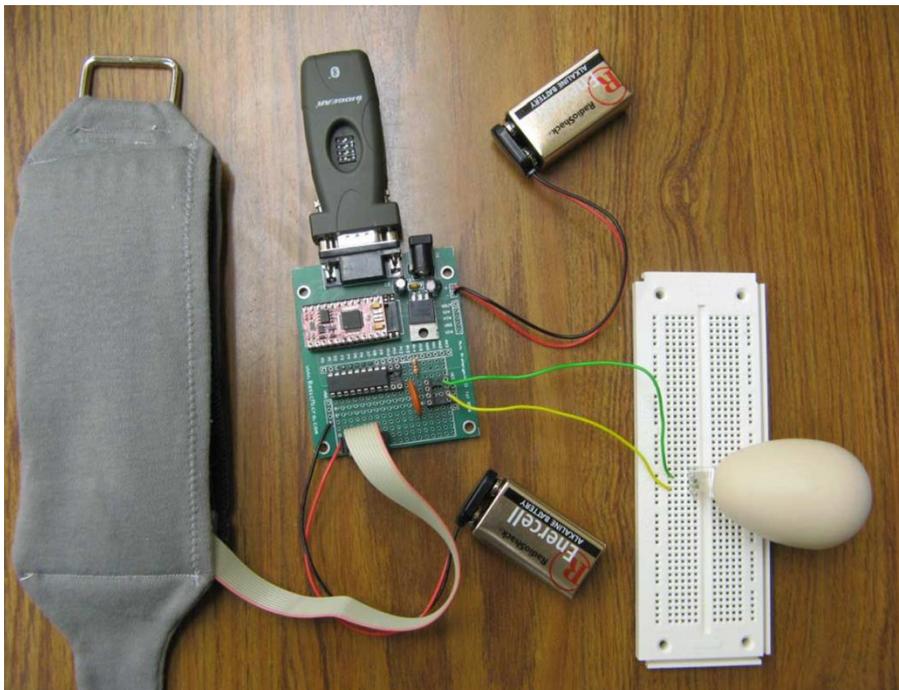


Figure 4 Touch & Talk system prototype

Touch & talk is a haptic interactive device and a great example of remote touch technologies that allows the expression of affect. This project was chosen among the related work examples, because it has taken into consideration some important issues, that sense of touch as a contextualized medium. As the discussion on the reviewed literature in psychology and communication suggests, touch based interaction can facilitate direct transmission of affect, as long as the information is presented along with its context (Wang et al., 2010). the Touch & talk prototype is using Shape Memory Alloy technology, force sensor. The device consists of an armband, a hand-sized squeezable object and a microcontroller board. Different touch effects can be triggered by the input device, enabling the user's squeezing force. Through the armband, touch and haptic affects are generated simultaneously.

Frebble

The wireless electronic interactive device Frebble was created by Holland Haptics, founded in 2012. The project was launched in 2014. The device is supposed to be paired with other device with internet and Bluetooth connection – such as laptop, tablet or smartphone. It device allows users to hold hands remotely as well as to send and receive squeezes. The product was created with the intention to help family members and friends who are physically separate to be able to keep in touch. It's a mediated social touch product with tactile experience.



Figure 5 Frebble interactive accessory

As the shape of the product naturally follows the form of the hand users feel as if they are holding hands with their distant loved one. By creating this product, the goal was to open new possibilities of tangible communication on the Web. Several features of Frebble is related to this project. Frebble is not only addressing the issues of togetherness via remote tangible communication, it also considering simultaneous action, similarly to this project presented in this paper. Among the other common facets are that it's targeting people in close relationships without narrowing it to couples only, characteristics that are in the scope of this project. In spite of their distinctness, the work examples discussed here are similar to this project as they all focusing on creating a sense of togetherness for geographically distributed people. They all allow touch based, real-time interactions and synchronized movements.

4. Methodology

4.1. Research Through Design

This project is carried out based on the method of Research Through Design (RtD). It is described by William Gaver (2012) as an approach where one of the ultimate goal of the designer is to manifest the different opportunities and problems, by constructing a relevant topic and theory. To create a theoretical background, research in psychology, physiology and sociology were carried out, which built a ground for this thesis and conclusively placed it in the context of interaction design. In order to place RtD in the context of interaction design several significant measures must be taken into account. Documenting the research and design process with attention to its delicate details are one of them. The other is that both through the research and the design process should result in a substantial innovation. Another very important measure is that the method of RtD should be applicable to the interaction design community, by presenting a visionary idea or design solution, that will fuel a transformation and cultivate a desirable condition. (Zimmerman, Forlizzi and Everson, 2007).

4.2. Workshops

Workshops are defined by Hannington and martin (2012) as a form of constructed sessions where together with participants, through the creative co-design methods a significant amount of insight are generated. During this design process, workshops were used as one of the main methods, with the aim to explore different interaction forms. Workshops also helped

in exploring how emotions can be communicated through the sense of touch. In addition to that, the different qualities of sense of touch was collected and investigated.

4.3. Experience prototyping

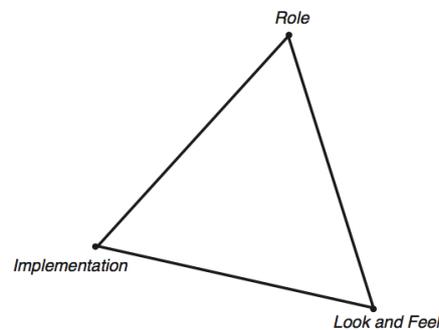
Fulton and Buchenau (2000) defines "Experience Prototyping" as a type of prototyping that allows both members of the design team and clients as well as users to acquire first-hand experience of current or forthcoming conditions by allowing direct engagement with prototypes. These prototypes might be sketches and various levels of models that "looks", "behaves" or "works like", in order to "explore and communicate propositions about the design and its context" (Fulton and Buchenau, 2000, p. 424).

Fulton and Buchneau (2000) gives us an overview of the current interactions, that are mostly complex and dynamic and usually involve the combination of different hard- and softwares, digital communication devices, spaces and services, etc. According to them, in order to design such mixture of products, with "sensitive product behaviors", require new design approaches and explicit considerations. Thus the focus is not on the devices and its elements but a holistic experience in context. As Fulton and Buchneau (2000) explains, what the designer need to take into consideration is e.g. not the physical lamp itself but the experience of the light. In order to fulfill this requirement, the designer need to focus on "exploring by doing" (p. 425) and actively experiencing the minor differences that may exist between the different design solutions.

As suggested by Fulton and Buchneau (2000) this project was carried out using "Experience Prototyping" as one of the main methodology. The prototypes in this project were given to participants who could experience these objects in different settings based on possible user scenarios. Thus in these settings some low fidelity prototypes were "in dynamic relationship with other people" and objects based on the suggestions by Fulton and Buchenau et al. (2000, p. 424)

Likewise, Houde and Hill (1997) propose the different aspects of prototypes by raising three fundamental questions. What are the role that the artifact will play in users' life, what is the look and feel and the implementation of the product. By fine-tuning our intention of the prototype, namely to "what it prototypes" (Houde and Hill, 1997, p. 1) we may be able to build

prototypes will a clear purpose. Thus it'll enable us to communicate our design ideas to the users. The relationship of these three factors are shown below in the model of "what prototypes prototype" (Houde and Hill, 1997, p. 3)



Based on the triangle model by Houde and Hill et al. (1997) the prototypes in this project were created with these aspects in mind. However, since the project aim is not to design a finalized and implemented artifact but to suggest design solutions, the low fidelity porotypes mostly fall between two of these aspects, the role and the look and feel.

4.4. Scenarios

As defined by Nardi (1992) a scenario is "a set of users, a work context, and a set of tasks that users perform or want to perform" (p. 13). He also suggests, that with help of creating different scenario sketches, clues of possible technological solutions might emerge. As suggested by Nardi (1992) use scenarios are beneficial mainly during the early stages of the design process. Thus during the early stages of this design process, scenarios were used to help to imagine and visualize the concept of this project. Consequently, three main scenarios were created, one focusing on couples in two different situations, dining alone, and dining with other loved ones, while geographically separated. In the other scenario the focus is on a family of four, inclusive two children a mother and a grandfather.

5. Design process

5.1. Design activity 1: Togetherness during mealtime

As the first step of the design process a series of dinner workshops were organized, with the emphasis on three particular scenarios: a couple, a family with children and a couple with close friends. The goal was to identify features of fact-to-face communication that create a sense of

togetherness during co-dining. The main attention was on the non-verbal elements, which are the central topic of this project. As advised by the studied literature, non-verbal communication is delicate, emotive and is significant for close relationships (Hassenzahl et. al. 2012). The main purpose of these workshops were to find out what kind of nonverbal communication and other elements are present during co-dining. Observations were made on different components, such as interaction between people, interaction between people and objects, movements, sound of people talking, noises, etc.

During a brief post-dinner discussion, participants could reflect on their thoughts and feelings. These dinner settings that involved people in immediate relationships are presented below.



Figure 6 Dinner workshops

5.1.1. Workshop dinner no1: Couple

Workshop description: Dinner with a couple was the first dinner workshop. Although it was video recorded in home environment the participating couple were guests at another home. The guest couple were familiar with this home. The table were set prior to the couple's arrival and the food served at their arrival. In order to minimize any distraction, the camera was attached to an object next to the table. Thus the couple could eat alone without a presence of anyone else. There was a soft and moderately slow music played in the background. At the dining area it was mainly the melody that could be heard not the lyrics. The lights were moderately dimmed for allowing just enough visibility for the recording. The goal of the workshop was to observe all kinds of nonverbal communication, behaviors, actions, movements etc. that takes place between the couple. During the ca 20 min. recording several types of elements were noted. Based on the findings it can be concluded, besides the act of eating, mostly nonverbal communication, among them smiles, touch on hands, gazing at each other, etc. dominated the dinner.

Observations: The overall speed of the dinner was slow, with a slightly faster tempo at the end, when the couple remembered they need to get home to their kids soon. Soft music was the dominating sound, which was constantly playing in the background. Other mild noises that were created by the utensils, glasses were also observed and noted.

Participants' feedback: Through a brief post dinner interview the couple could comment on their overall dinner experience. The focus was on finding out about the participants' emotions during the dinner. They explained that the soft music and the dimmed lights made them feel very pleasant, relaxed and created a sense of calmness. As they explained it was a "lovely, slow, romantic and private time", which was "much needed" and they'd like to repeat more often. One of them noted, that she usually eats faster at home, but here she picked up a slower tempo, "not sure why but it felt good". She explained that after they started the dinner she "kind of loosened up" and "stopped worrying about the kids". The same person also mentioned that despite of being here on several occasions, she felt slightly more conscious of her actions this time. "Probably because of the camera" she added.

5.1.2. Workshop dinner no3: Family dinner

Workshop description: The four participants of this dinner were immediate family members, a mother of forty-one with two children, a six years old girl and a twelve old boy, and a grandfather age seventy-six. The grandfather lives separate and far away from his daughter and grandchildren but have a close relationship with them. Mealtimes such as this is common between them. The workshop took place in home settings. For minimizing the interference, the camera was attached to an object near to the table, trying to allow a more natural atmosphere. Despite of the effort to try to make them feel less observed, the girl demonstrated that she was indeed very much aware of the camera. She turned towards it several times to make funny facial expressions.

Observations: During this twenty minutes long video recording a variety of nonverbal expressions were noted, among them facial expressions, nodding, gazing of eyes. Besides the movement of picking and spooning food, one of the most frequently occurred movements, that were observed, were arm crossings over table. This took place mostly in conjunction with adults helping children serving food. Other actions noted were moving some object on the table, e.g. passing the salt or pickle bottle, replacing utensils or napkins, just to name a few. Tapping the children on the shoulder occurred several times as the adults were encouraging children to concentrate on their food. Overall it was a very dynamic dinner with lots of movements, voices and noises.

Participants' feedback: During the post dinner interview adults expressed that they were satisfied and felt "fairly relaxed". The adults also described their overall feelings as "connecting, caring, warmth, belonging and joy". The children explained that it was 'ok, one of them saying that' this lunch was more "enjoyable" than regular, because their favorite food was served. The boy was "missing" his smartphone from the table. Both of the children mentioned that they usually have some sort of small toy or device on the table during mealtime at home. Here they didn't have it with them.

5.1.3. Workshop dinner no2: Two couples – friends

Workshop process: During this dinner two couples participated, two females and two males, ages between 35 to 51. Although each of them knew each other well, and used to get together

for similar dinners on regular basis, three of them have been friends for ca twelve years. The dinner was hosted by one of the couples. In order to reduce any interference, the camera was placed next to the table, thus allowing the diners to be 'on their own'. The table was already set when the guest couple arrived, with the food placed on the middle of the table. The guest couple with shorter length of relationship chose to take seats first, next to each other, followed by the other couple on the other side of the table. Opposite sexes were sitting face to face. The first dish that was served was a soup with bread. On the table there were also drinks in bottles, glasses, spoon, napkins, candle and some flower in a vase. One smartphone that belonged to one of the guests was placed close to her plate. The self-serving of food started after one of the hosts invited them to do so, verbally, which was accompanied by a hand gesture and a smile.

Observations: The self-serving of the soup from the common bowl to the individual plates gave opportunity to more actions and interactions over the table. Similarly, since the bread was served as a whole and everyone had to cut a slice for themselves it created more movements, and interactions. Most of the time the knife was only close to one person, unreachable to others. Thus others had to ask this individual to pass it so that they can cut bread. They turned the bread loaf several times to adjust to their sitting position, so that they can comfortably cut a slice. Sometimes guests helped each other by cutting a slice bread or pouring drinks for each other.

The most frequent action was the spooning of the soup, which was also the fastest but movement observed. The next frequent action was the breaking of bread followed by the lifting and putting down the glasses. This happened in a much slower tempo than the previous actions. Drinking was often accompanied by slowly leaning back to the chair and taking a short break. The overall speed of this dinner was moderate, with a faster start while serving and during the first bites. At the end during serving and eating desert the overall tempo slightly slowed down. Longer breaks and several leaning back to the chair were observed.

There was no music or other background sound. The sounds observed and listed were talking, laughing, other nonverbal vocal expressions of diners. Other sounds were the different noises of dinner table objects, such as clink of spoon with plate and glasses, etc., were also registered.

One of the mildest least intense sound was the spooning of soup, the 'sound of the liquid' which could only be noticed when nobody was talking. (See detailed observations and descriptions in Appendix)

Participants' feedback: During a post dinner interview diners expressed their emotions, as they explained they felt "fun, warmth, friendship and closeness".

One of the main findings of these dinner workshops were, that nonverbal communication was dominating between participants. The other important observation is that people expressed their dining experiences in form of emotions. Partakers disclosed that the sense of connection they felt was because of "doing an activity together", and the "atmosphere itself" made them feel united. Similar comments were collected from an online survey conducted prior to the workshops. See collection of quotes in illustration below.

5.2. Design activity 2: Exploring tangible possibilities

In this step, participants recorded their mealtime in their natural home settings. The goal with collecting these video recordings were to get a glimpse of the mealtime activities of people, while eating alone. Similarly, to the dinner workshops, the goal was to identify and collect all kinds of touch points, surfaces, movements, sound elements that takes place.

5.2.1. Video recording no1: 'Left over lunch' alone

Activity description and observations: The first participant's recording was a 12:23 long video showing her eating lunch alone at home, starting with adjusting the camera. It included the setting of the table, eating and removing most of the objects after completing the meal.

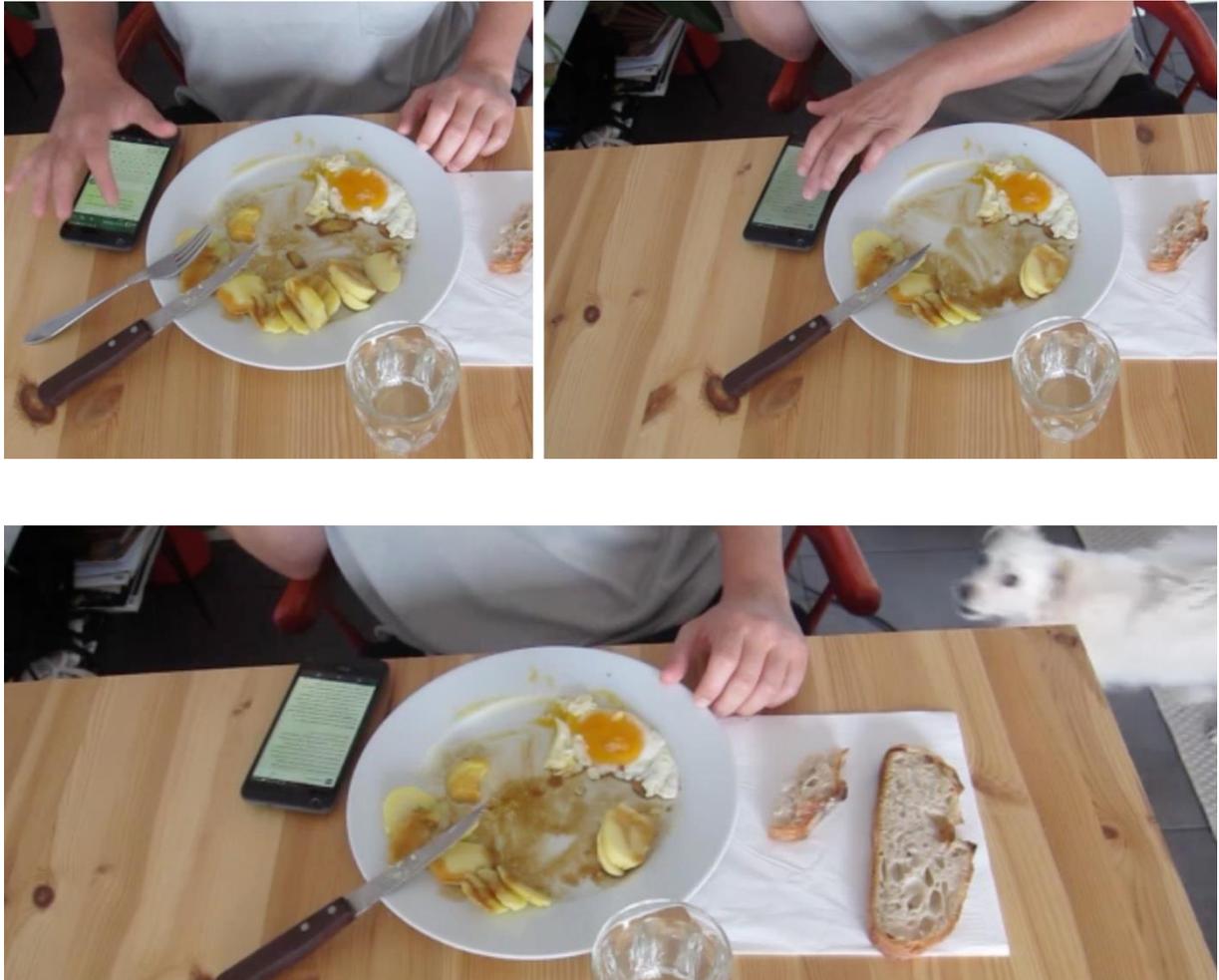


Figure 7. "Left over lunch alone"

After the camera was turned on, while the table was still empty the sound of plates, utensils could be heard from the background. Setting the table, placing the food, utensils, napkins and a glass of water took place in several stages. She stepped out of the camera's view a couple of times. While she was not visible the different background sounds gave some clues to what she might be doing. E.g. the sound of metals - taking out utensils, running tap water - getting a glass of water. After returning she sit down and started to eat. About a minute later she moved away for bringing some napkins.

Additional activities besides eating were: browsing on phone and talking to pet, were some of these extra actions that took place that filled up the space between bites. Different background sounds, e.g. a dog barking could be heard, coming from outside. As a reaction to this, the participant's dog barking has become an important part of the overall sound. One of

the conclusions that can be drawn from this is that e.g. an unexpected sound might influence the overall atmosphere.

Participant's feedback: The participant was asked to describe her emotions she felt during eating. Despite that feedback was requested sometime after the recordings took place, she provided a vivid description of her mealtime, using expressions like "meaningless" "bored" and "lonely".

5.2.2. Video recording no2: A quick & busy lunch break

Activity description and observations: This was a 2:45 min long footage showing the participant's lunch break. When the recording started, the food was already on the table with the participant sitting, facing the camera. At first there was only a bowl and a spoon on the table. Shortly after the participant placed some papers on it, slightly pushing the bowl aside and tried to read and eat simultaneously. She also looked up, looked to the side, grabbed some other smaller piece of paper. Then she took small notes, took another bite and so on. The lunch time was spent with a mixture of briefly performed activities. There was no background sound so the crunch of the food, the flipping of paper and the sound of her movement on the chair dominated.



Figure 8. Quick & busy lunch break

Participant's feedback: In this case a feedback was also requested a while after the meal took place. The participant gave a detailed description, explaining that it was a "not wanted but

needed" busy lunchbreak with a lot on her mind. She explained that she felt stressed, had a lot to do and tried to "read or 'work'" while eating. It was like to "kill two birds with one stone".

5.2.3. Results & Conclusion

Both of these videos contributed a great deal in collecting and analyzing the different touch points, touch surfaces, hand movements, etc. that takes place during mealtime. Different types of noises, such as the sound of spooning and crunch of food, flipping papers, taking notes (sound of pen on paper), cutting with knife, breaking bread, picking with fork, etc. were also observed and noted.

As a result of the dinner workshops and video analysis, different touch points and touch surfaces were identified and collected. The illustration below shows these areas where most touches took place. The discoveries of these touch points and surfaces were a great source of information during the ideation process and it inspired the design of the different prototypes. They are each described under the corresponding item.

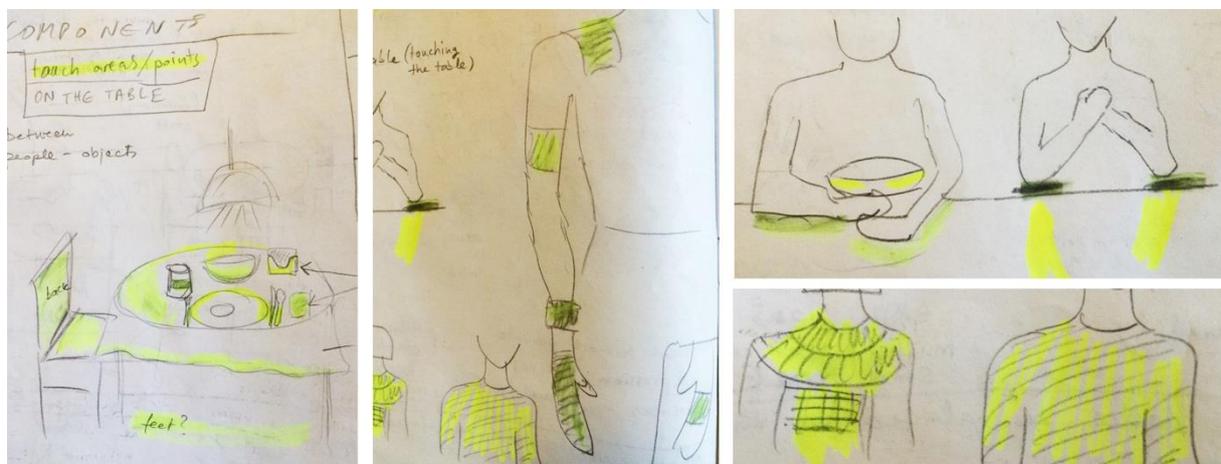


Figure 9. Touch points & surfaces

5.3. Design activity 3: Creating scenarios

Based on the analysis of dinner workshops and video recordings, different scenarios were created. The three main scenarios are presented below, describing the background of each situation, and explaining their needs and desires.

Scenario 1: A couple are having dinner while geographically separated.

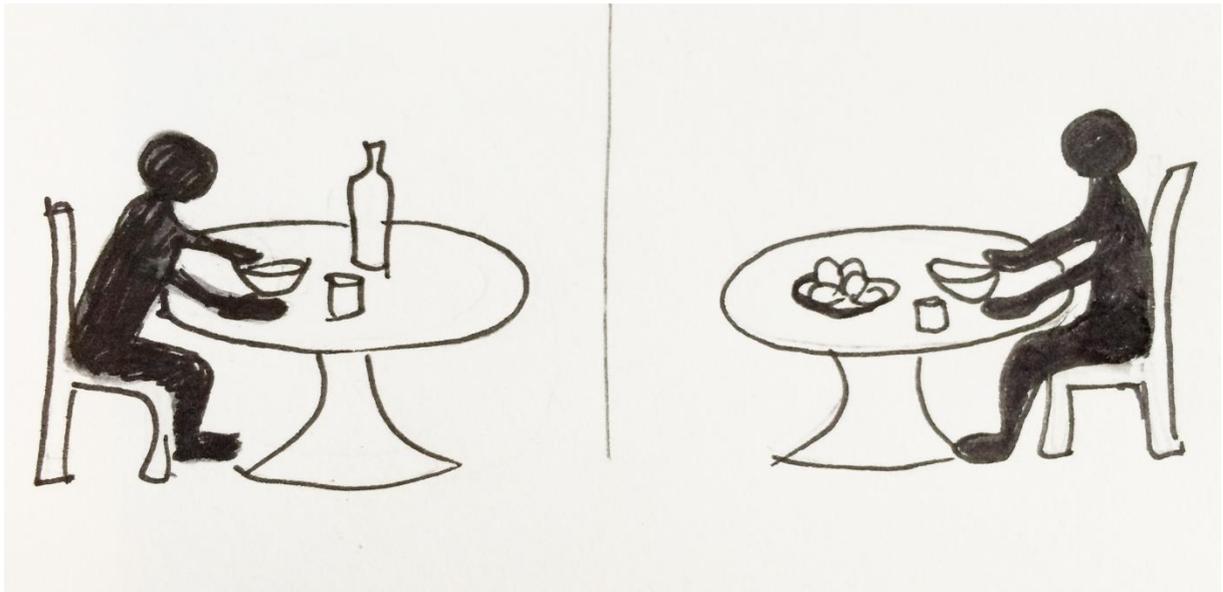


Figure 10. Scenario1. Couple alone

Background: The two of them are often separated because of work. One of them takes business trips on regular bases, thus they are forced to eat dinner alone frequently. They can't enjoy the benefits of eating dinner together when they are separated.

Needs and desires: A device that allows them to communicate and feel close to each other while they're dining separately. They want something cozy and feel like they are together despite the distance. Since both of them are alone, the actions could be more "expressive" that a private setting allows. The desire is to be able to communicate each other more affect but also to feel a sense of warmth.

Scenario 2: A parent with two children together, and a grandparent at a distant location are having dinner.

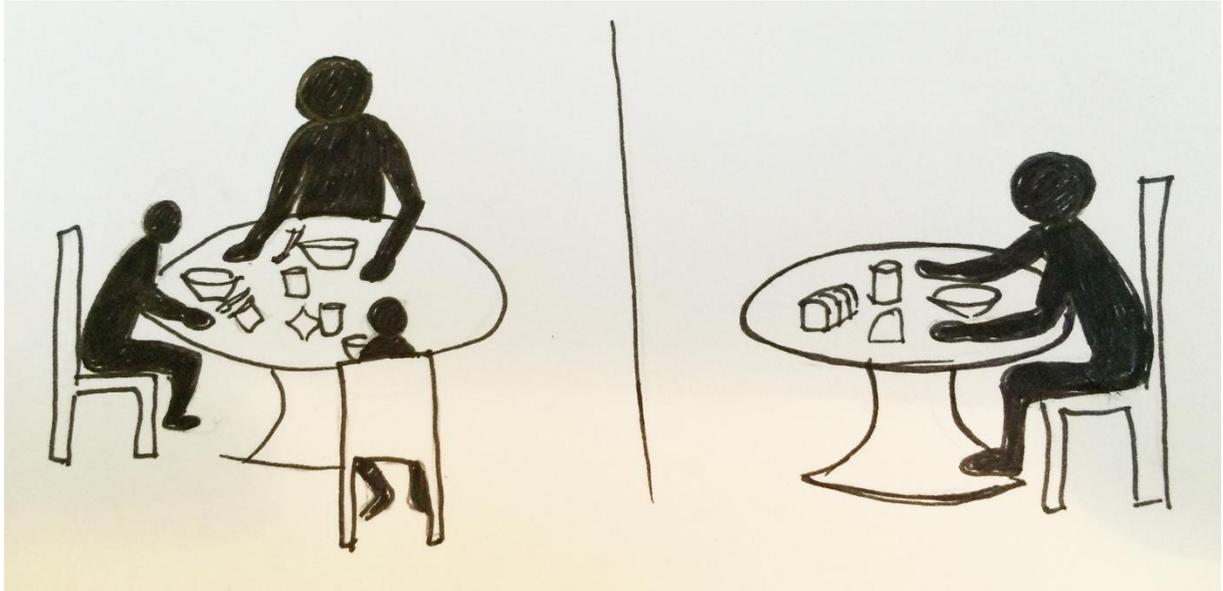


Figure 11. Scenario 2. Family

Background: Two children, ages six and twelve live with their mother (41 y/o) and the grandfather (76 y/o) elsewhere. The family can only enjoy meals together a couple of times a year, when they meet. Although dining together has always been an important activity for them, - a way of connecting, they can't fulfill their desire as often as they wish.

Needs and desires: The family wants to be able to communicate during dining and feel as if they were sitting around the same table. They want to feel as if they all are 'there' and strongly connected. They want to communicate and 'come together' with help of a device, that make them feel united as a family.

Scenario 3: A couple are physically separate; both of them are eating dinner with close friends or family members at two different locations.

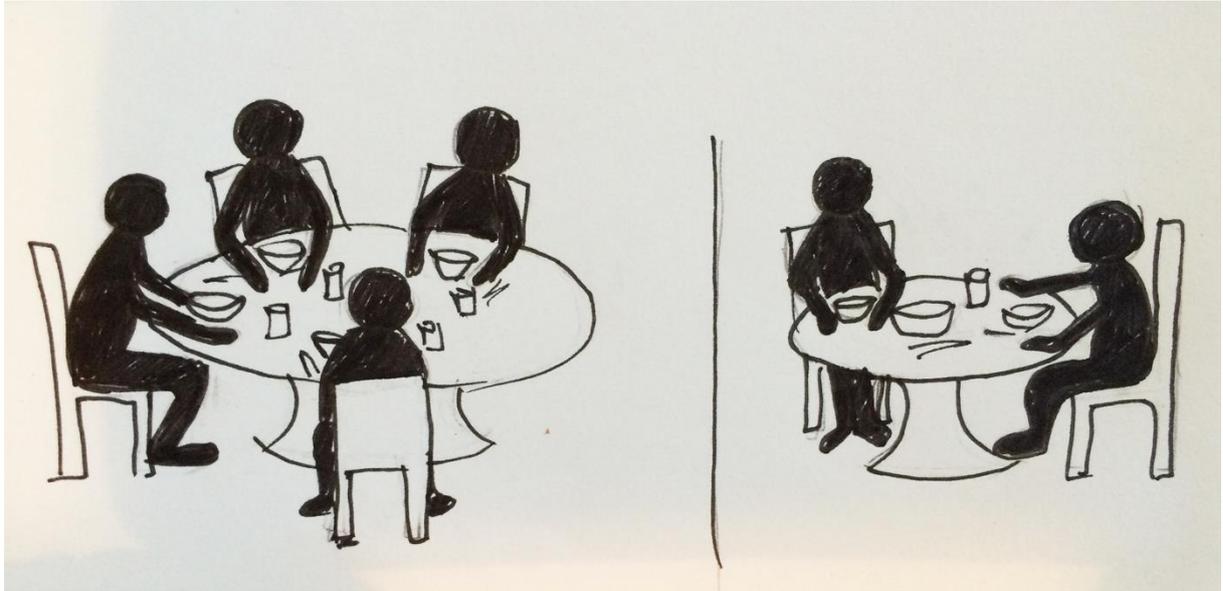


Figure 12. Scenario 3. Couple with friends

Background: The couple regularly takes separate trips to their own families who live apart. Thus they attend the family dinners without each other very often.

Needs and desires: The couple wants to be able to communicate while they are eating with their own families at two distant places. They want to feel like they are there with each other during dining. It's important for them to have a discrete communication that doesn't draw others' attention to the action. They want to express warmth, closeness and a sense of presence, without having to involve or disturb others around them. For them the most important is to feel merely close to each other, similarly to when they are at a joined family dinner.

5.4. Design activity 4: Rapid prototyping – Inflated Gloves

Inspired by the responses, to the question 'what togetherness mean while co-dining', of dinner workshop participants, a rapid prototyping session was arranged. Respondents revealed, that being involved in an activity at the same time, made them feel like being connected and feel close to each other.

Based on this finding, and with one of the main criterions of this project in mind, a rapid prototype was created, which was made of two inflated plastic gloves connected with a straw. The goal with creating this prototype was, to demonstrate to participants, how joint action or

movement might be possible through interacting with an object. The aim was to create a simulation of an experience based on the three scenarios. The exercise also hoped to find out if it's possible to feel connected, while being at two different locations, through interacting with an object at the same time.

At this point, working with air seemed like the fastest and simplest way in trying to demonstrate the idea of 'joint action' to participants. The idea was that the flow of air, from one end to the other, will allow them to feel their actions on both ends of the artifact simultaneously. One of the expectations were to validate the idea, that joint action makes them feel connected. The other goal was to find out how they'd use such artifact to communicate with each other.

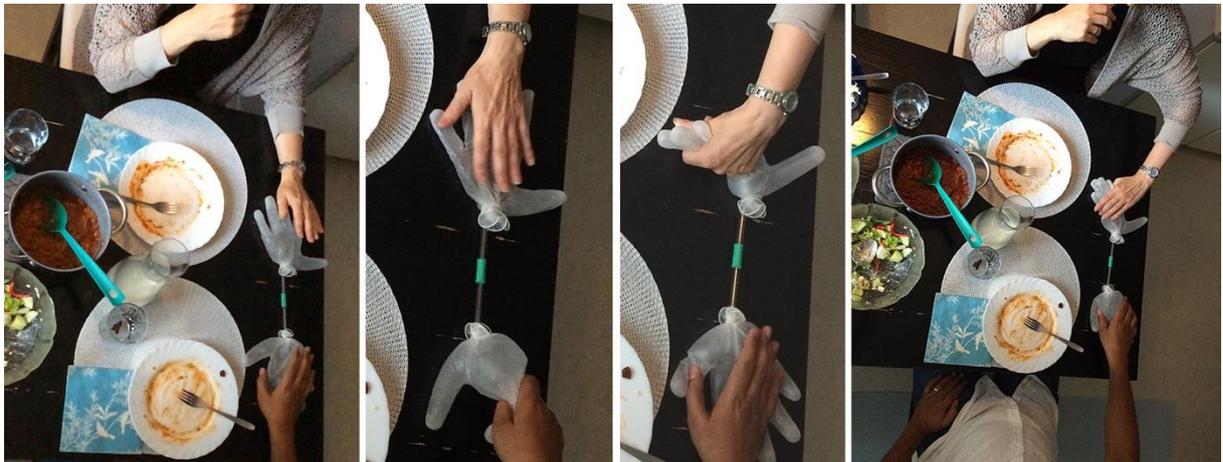


Figure 13. Rapid prototyping

Four people took part of the rapid prototyping session. The first two was a couple who were also part of the first dinner activity. Based on the affordances of the prototype, -a fairly short straw, the couple was asked to sit face to face, so that both could get a grip of the ends of the artifact. The couple were divided by a panel, and were asked not to talk to each other, trying to simulate that they're at separate locations. After touching and pushing the inflated gloves they reacted when they felt the air moving simultaneously in both hand gloves. The reaction was positive and they both expressed interest in the object. They explained that it made them feel "physically close" during the movement. In describing their experiences with the prototype, each of the participants mentioned different 'emotions' they felt, several times. They told that touching of the gloves made them feel "joyful" and "close to each other". One of them also

commented “could I also hug this thing”, thus indirectly suggesting to use it on other body parts. Inspired by the observations and comments of this session the idea to the following exercise was born.

5.5. Design activity 5: Body, touch and context

Several studies in psychology and sociology show that context shapes the meaning of touch considerably. Jones and Yarborough (1985) suggest that context includes “people’s age, gender, relationship” as well as “environment, timing of touch” etc. In line with their theory, and with another important criteria of the project, the next workshop was conducted. The goal was to explore the relationship between touch, body parts and context, and to find out, which body parts would people most likely to touch, in different scenarios, when they want to convey a sense of togetherness.

5.5.1. Color-in

The *Color-in* exercise was inspired, among others, by the couple’s comments during the post dinner interview. They said that because they were at someone else’s home, they felt it was only appropriate to touch each other’s hands. They also explained that the fact that the camera was rolling made them more self-conscious and less free, than as if they were at home. In order to find more, about out how context influences touch, this exercise was set up. This workshop aimed to explore which body parts are most likely to be touched, for conveying togetherness in different scenarios.

Twelve people participated in the *Color-in* exercise. Participants received an illustration depicting the human body, and hands slightly enlarged, separately. They were asked to choose a color that represents the person they want to touch, and color in the areas of the body, where they’d touch the person to convey togetherness. The colors represented six immediate relationship types, such as significant other, child, parent, grandchild, grandparent, and close friend. Participants were also asked to add different scenarios to a particular touch they choose to illustrate.

Study by Jones and Yarborough et. al (1985) showed that non-vulnerable body parts such as hands, arms, shoulders and the upper back are most likely to be touched by people in close

relationships, to convey togetherness. Alike the results of the study, this exercise gave similar results. The most touched body parts, in public settings, were hands, more precisely the palms. Shoulders, upper back and neck were the next-most touched, mainly in more private settings, in closer relationships. Both the reviewed studies on touch and context, as well as this exercise also demonstrated that context strongly affects the way people communicate through touch. A weakness of this exercise was, that it could only measure one dimensions of touch, its location.



Figure 14. Color-in exercise

5.6. Design activity 6: Brainstorming

After the Color-in exercise and the rapid prototyping a brainstorming session was a necessary step. Based on the findings of these two activities, some prototype ideas were sketched out. When sketching these ideas, several different things were taken into consideration. The size, shape and placement of artifact on different body parts were in focus. As the result of this session, a collection of sketches, showing the possible shapes of the object, the potential actions, grips, squeezes, with the hand positions.

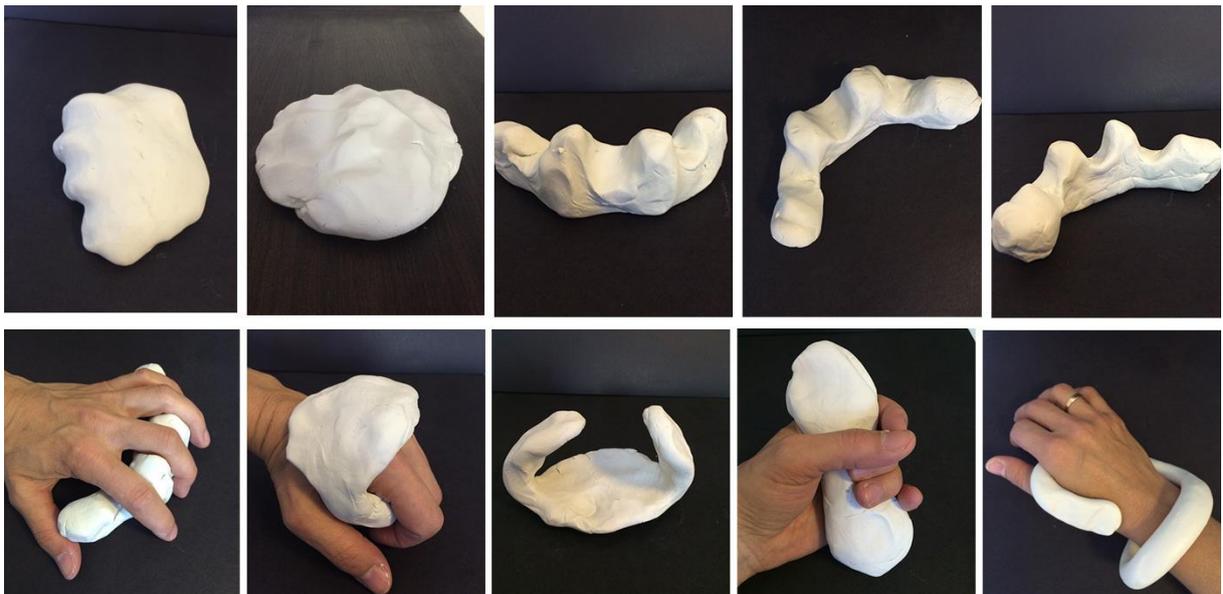


Figure 15. Exploring forms and movements

5.7. Design activity 7: Emotions & touch

5.7.1. Togetherness through touch

During the post dinner workshop interviews and after the rapid prototyping session, participants described their dinner experiences as emotions. Inspired by their comments, the next workshop was planned. The goal was to find out if it's possible to convey different emotions via touch, and if so how. During this exercise short sequences of video recordings were made of people expressing togetherness, to their loved ones. Participants were asked to express closeness through touch. The goal with the recordings were to examine the qualities of touch through collecting and observing different movements. The focus was on collecting touches that convey closeness and togetherness.

Seven participants were recorded during this workshop, a couple ages 35 and 45 with a child age 7, two sisters of 20 and 13, and a close friend of the mother, a woman age 28.



Figure 16. Emotions and touch exercise

The workshop results were evaluated, based on a method that is used for analyzing the sensory properties of touch in interpersonal contexts. Tactile behavior can be interpreted based on different dimensions of touch. Research by Weiss (1979) had demonstrated the five essential dimensions of touch: location, intensity, action, duration and frequency. These dimensions were taken into consideration when studied the different touches.

5.7.2. Mealtime, feelings and touch

Setting up this workshop was inspired by a research by (Bakalar, 2009). One of the aims of this exercise was to find out if people share feelings when they eat together. The other goal was to see if they can communicate these emotions to each other through the sense of touch. This

workshop also set to explore other dimensions of touch, intensity, duration, complementing the *Color-in* exercise. A 25 minutes long video recording was created.

Three volunteers agreed to come for an afternoon snack where some refreshments were served. The participants were left to mingle for a short moment, before some instructions were given to them. After some bites of food and exchange of words, they were asked to describe their emotions they felt during the mingle. Each of them had to write down the emotion without saying it out loud or showing it to each other. Next, one of them was asked to volunteer to be blind-folded. The two others were told to communicate the emotion that they felt, by touching the blind-folded person. In order to conceal who the toucher was, they were not allowed to talk during touching. After both touches were completed participants were asked to reflect on the activity. During a short discussion the blind-folded person explained what emotions she thought the touches conveyed. The two others mentioned that it was fairly difficult to communicate through touch, especially a particular emotion, which here, in both cases was 'relaxed'. They thought, that other 'basic' emotions such as joy, anger, etc. would probably be easier to convey.



Figure 17. Mealttime, feelings and touch

Important observations on the different properties of touch were made and noted. E.g. both 'touchers' chose to touch the shoulders and upper back area, one of them slightly extending downwards on the arms. Later they pointed out that it was mainly because of the affordances: the blind-folded person was sitting facing the opposite direction. Thus it felt natural to approach her from the backside.

Among some learning outcomes of this workshop were regarding the different modalities of touch: location, intensity, action, duration and frequency could be observed. This exercise also confirmed, that it's possible to communicate emotions through the sense of touch. Other important findings of this workshop, are also the importance of carefully formulating the instructions. Since 'touchers' weren't told that they can move around the person, thus apparently, they performed the touch only on the shoulders and back, that was closer to them. As a result, touches on hands could not be explored.

Extra design activity: Ideation

Inspired by music

While attending a live concert recently, where the vibration could be felt not only in my chest but also under my feet, it made me think of a 'bouncing' speaker, that I used to be fascinated with in the past. I was eager to go home and listen to the sound of the dinner workshops again, but without watching. The sound of the dinner recordings seemed like a piece of 'music'. I wondered what if this 'music' could be captured by sensors and turned into movements. What if it was played on a 'silent' speaker that could be felt through touch only? It inspired me to experiment and illustrate this idea.



Figure 18. Bouncing speaker – inspired by music

5.8. Design activity 9: Experience prototyping – scenarios

Modalities of expression

Built around the desires and needs of each scenario defined earlier, this experience prototyping session was planned. It was a necessary step, during this stage of the design

process, in order to explore interaction alternatives that each scenario requires. The goal was to explore the variations of design possibilities around the dining situations, bodies, table and objects. According to Houde and Hill (1997) prototypes may include a wide range of execution, such as sketches or 'ready' objects, in order to illustrate a concept. With that in mind some low fidelity prototypes were created, as well as already existing objects, with an improvisational attitude were used for the exercises. The information produced by the *Body, touch & context* and *Emotions & touch and Mealttime* workshops were a great contribution in creating the prototypes and formulating the exercise.

5.8.1. Couple

For this scenario, the couple was allowed to explore different modalities of expression, with help of low fidelity prototypes and materials. They were presented with some 'what if' situations, while allowed to experience some modalities like heat and pressure. One method was to apply heat to the participant's shoulder by warming up a piece of soft material, thus trying to simulate the feeling of togetherness 'touch' in form of heat. With help of other materials, they could explore some other alternatives of sending and receiving touch, by placing the material on different areas of the body.

Among the important insights gathered during this exercise were, that the couple expressed their preference for heat over pressure, and the shoulder, neck, arms and knees for placing the object. Some of their suggestions for the interactions were stroking and a position that mimicked crossing fingers. They also demonstrated light pushes and squeezes, that according to them resembled a "comforting massage", which they could imagine having while dining remotely with each other.

5.8.2. Family

Here the main goal was to find out how several members of a family could use an object to communicate togetherness, while they're eating. One of the aims were to find out if a shared object would be appropriate and if so, how would they interact with it.

While the family was dining an object was given to them which was made of soft elastic material filled with air. It was a round shape divided into three sections. The object was placed on the table in front of them, among other objects belonged to the dinner. This object allowed pushing. Next it was an elongated soft object filled with soft silicon pearls, that could easily slide inside when pressed. This object allowed pushing and squeezing. For the third experiment Rubik's snake was used. The idea was born while exploring the previous object. Because of the position of the object on the table there was an uncomfortable distance between the participants and the artifact, not allowing them to touch it together. Thus the need for a longer object was apparent. The snake could be twisted and turned into a half-circle shape, which allowed them to more comfortably reach out to it and grab it without less effort.



Figure 19 Prototypes for "Circle of Hands"

One of the conclusions that can be drawn from this exercise is that using different materials and objects, despite of their 'sketchiness', can contribute a great deal in shaping ideas. The presentation of several different objects, materials and in this case an existing, well-known object served well as a prototyping tool. It also helped in confirming, that a shared object is more likely to help in communicating, if placed in a comfortable distance on the table. Playful movements were strongly suggested. During this prototyping session participants were actively exploring movements, positions of object on the table by readjusting it several times. With children involved, the session was intensive and productive, inclusive touching and

feeling textures. Overall it was a playful activity that helped in the ideation process followed in next section.

5.8.3. Couple with others

This session involved a couple who were accompanied by other members of their families. It was a family event, similar to the scenario described in the previous sections. The goal was to help the couple to imagine, what it would be like to communicate through a device while dining together with others. The expectations were to gather some ideas for possible placements on the body and find some potential interactions that are appropriate in this setting.

First the focus was on finding the right place for the object on the body. The couple was given some materials to try on and freely place where they considered comfortable. With the use of a stretchable material different placements, wrists, elbow, forearm, upper arm, waist, etc. were explored. Among the explored items were hand gloves, which proven to be an uncomfortable and odd thing to have during dining.

Through discussions during the exercise the participants revealed that the most preferred placing of the stretched material was the wrists and lower arm, right under the elbow. According to them it would be a place least noticeable for others, which was therefore favored. The couple's comments on the actions and movements were that simple and discrete stroking while holding a napkin or a drink in their hand would be desirable. The emphasis was on being discrete and allowing an interaction that is not very noticeable by others, which doesn't interrupt the overall flow of the dinner. The challenge of this exercise was the setup, which was very similar to a real scenario where such interactive device would be used. It was fairly difficult to allow the participant couple to explore these items while taking part in the dinner. On the other hand, it was a natural setting, and thus the feedback received were based on real situations.

5.9. Design activity 9: Ideation

5.9.1 Concept development

Guided by the reviewed literature and the experiments on commensality, togetherness, sense of touch as communication medium, this essay touched upon, a final ideation process was performed. Focusing on the needs and desires of the scenarios, and based on the main criterions of the project: representation of movement, joint action, immediacy and sense of touch as contextualized medium, three different design directions are suggested as follows.

5.10. Design activity 10: Design suggestions

5.10.1. "Cuddly" - Coziness

"Cuddly" was inspired by participants during workshop, while scenarios describing their interpretation of sense of togetherness. The idea was also motivated by the *"Mealtime, feelings and touch"* workshop, where participants performed touches resembled massage, in order to communicate emotions. Although these emotions expressed were "relaxing", it relates to this scenario, where the couple is eating remotely 'together'. This design suggestion focuses on 'warmth', 'cuddling', as formulated by the couple. "Cuddly" is an interactive device that enables physically distant couples to feel a sense of togetherness, using haptic feedback.



Figure 20 "Cuddly" concept sketch

The device consists of two parts, a sender and a receiver. The input device (sender) is a small flexible object with force sensor, comfortably fits in the hands, that allows pressure. The receiver is a blanket or scarf-like object that receives the pressure and displays a massage-like movement, through SMA wire contraction (Wang and Quek, 2010). It can be placed on the upper back, arms or shoulders. By suggesting this design direction, the aim was to answer the

desires of this scenario, create a sense of togetherness and a cozy feeling between the couple. By allowing pressure, squeezes, the couple can perform touches simultaneously, that resembles caress or a light massage.

5.10.2. "Circle of hands" - Playfulness

"Circle of hands" was inspired by different circle games, where children hold hands while standing or sitting in a circle. The family dining is a similar setup where adults and children placed likewise.

"Circle of hands" consists of a composite interactive object that can be assembled in multiple parts, depending on the number of family members. Once the family comes together for dining, the individual members build a 'unit'. Likewise, when the different parts of the object are assembled, it acts as one single artifact.

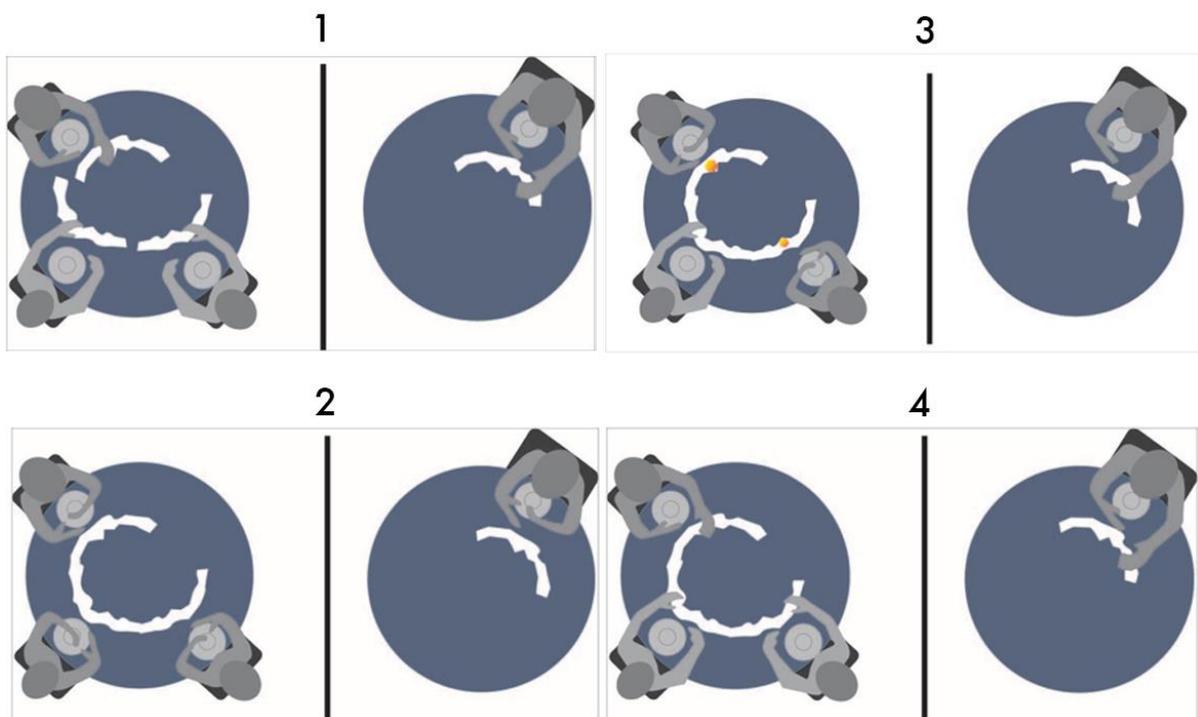


Figure 21 "Circle of Hands" concept sketch with scenarios

"Circle of hands" relies on haptic feedback technology to build a physical link between distant family members. Each part looks alike and allows same kind of interaction. After each family member attaches his/her part a half- or full circle can be formed, depending on the number of people sitting around the table. Due to its flexible material the shape can be adjusted to follow

the curve of the table. "Circle of hands" enables distant family members to communicate through touch, by twisting, pressing and squeezing. The object allows real-time joint action. When pressed or twisted at one location, the same movement occurs on the distant object, giving the illusion of interacting with the same object. When pressing an area light indicates the movement on the receiver's side. For more playful interaction it has a shared sender and receiver area. Thus multiple actions may take place at the same time when several people manipulate it.

The design direction suggested here was based on the findings of the workshop experiments and the feedback from the participants. "Circle of hands" was created considering the need that the children's focus should be on the table, preferably on a collective object. The circle shape enables to place it near the edges of the table where each part is easily reachable. The circle can be disconnected from its parts and combined flexibly, used in different variations. An example in 2-3's, when 2 respective 3 members of a family are dining in different locations.

There were several challenges in finding the right design direction for the family scenario. One of them was to allow playful movements, while not distracting the children during the meal. The other challenge was to create a shared object, easily reachable from everyone's angle around the table. Also, the object needed to be adjustable based on to the number of family members, for different dining arrangements. To meet these requirements, based on the findings of the workshops and experiments throughout the project the above design suggestion was created.

5.10.3. "Dinner companion" – Discreteness



Figure 22. "Dinner companion" inspiration

"Dinner companion" was inspired by a workshop where couples expressed togetherness by entwining their arms. This gesture was also observed during a family dinner. "Dinner companion" is an interactive device that allows remote communication between geographically distributed couples during remote dining, through haptic feedback. The device consists of two parts, a sender, which is a wristband and a receiver, a band placed on the forearm, slightly above the wristband. The intention with this placement is to resemble the couple's entwining arms.

As concluded by the reviewed literature and workshop sessions, a sense of togetherness is created by different nonverbal elements during co-dining. In attempting to create a sense of togetherness between distant diners, this project proposes the following solution. Gathering and rendering some of the nonverbal elements, such as movements during dining, and display it in form of tactile display, vibration and heat. With that in mind the following design direction and use of technology is suggested.

The sender uses EMG, located in the wristband. The EMG sensor traces the user's arm movements (muscle tensions), thus relying on the kinesthetic system of sense of touch. These are rendered and displayed as vibration on the receiver's side. Heat as an additional modality is used, allowing a continuous 'passive' interaction, relying on the sensory system of touch. Even if the user's arm is not moving, thus there are minimal or no muscle tension observed,

the two people can still feel each other's warmth, with a help of heat sensor. It traces the sender's temperature and displays it on the receiver's side. Thus allowing the distant couple to feel a sense of closeness and warmth. Considering the two modalities, vibration and heat used as display form, the placement of the band is best suited on the forearm.

This design solution was created with the aim to enable the couple to feel a sense of togetherness, while being apart, by feeling each other's warmth and movements. With the main desires of this scenario in focus, presented in the earlier 'scenarios' section, this design solution focuses on discreteness. "Dinner companion" enables the couple to enjoy their dinner on separate locations, while discretely 'being there' with each other. They sense each other without interrupting or drawing others attention. Through transferring nonverbal elements, temperature and movement, that constitute the emotions of their surroundings, it's an attempt to synchronize emotions of two distant locations.

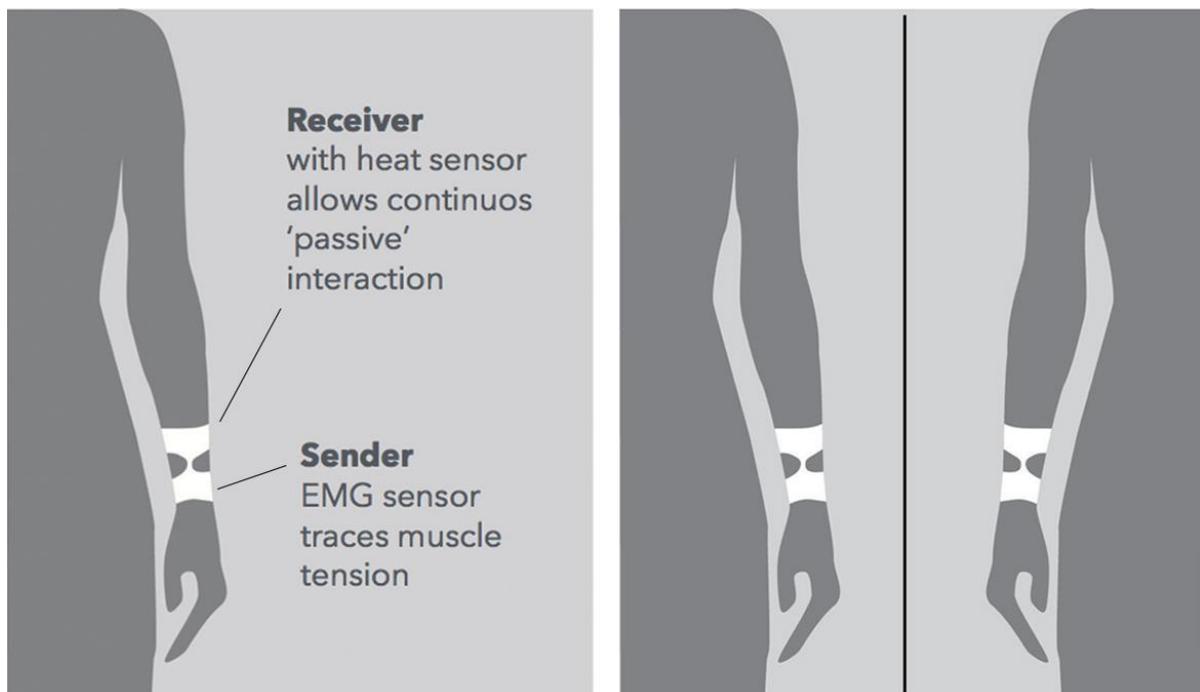


Figure 23 "Dinner Companion" concept sketch

6. Outcomes

By posing the main design question: "*How may we create togetherness -with the help of an interactive device- between loved ones separated by distance, during dining through remote communication?*"; and based on previous studies that demonstrate the significance of commensality in maintaining and strengthening social bonds, a design space was constructed through this research, that connects interaction design, commensality and the sense of touch as a communication channel.

During the first series of dinner workshops important elements of face-to-face communication were identified. This was the first step in trying to answer the first design question: "How do you sense togetherness while geographically separated?". Supported by the reviewed literature and with the findings of the workshops it could be concluded, that togetherness in co-dining situations expressed mainly through nonverbal communication. When people are physically separated however it's necessary to introduce physicality in the communication, in order to create a sense of togetherness. Supported by the analysis of studies completed in this project, and through the results of the experiments done in the workshops, a brief answer to the first design question is the following. Creating a physical link by allowing joint action, it's possible to create a sense of togetherness while being geographically separated. This is supported by the studies reviewed during this research project.

Through several workshops and experiments this project attempted to answer the second design question: "How do you sense togetherness through touch?" In form of tangible communication, through the of sense of touch, affective communication could be achieved. With the contribution of participants' different exploration sessions, expressing emotions through touch, were executed. The results demonstrated, that it is possible to mediate different emotions, and thus create a sense of togetherness, through the sense of touch.

To answer the third guiding question "How can it be mediated through an interactive device?" workshops and prototyping sessions were organized. With help of a rapid prototype, early in the design process, the goal was to inform the participants about the design idea. Rapid prototyping allowed them to explore how it'd feel like communicating through an interactive device that enables touch. The findings of these sessions pointed at a key aspect, joint action,

that was set up as one of the main criteria of the project. Thus the answer to this third question is, by creating a physical link and (simultaneous) joint action between distant users, a sense of togetherness can be created. It was accomplished by using tangible interaction and through haptic feedback.

7. Discussion

The purpose of this project was to design an interactive device that creates a sense of togetherness, between geographically distributed loved ones, through remote communication, during dining. In order to answer the main design question there are several goals and criterions were set up.

Based on studies made in psychology, physiology, sociology and communication this research has explored different topics. One of them was commensality, which is a unique and essential daily social activity, that helps to establish and maintain social bonds. The elements of face-to-face communication during mealtime proven to be discrete, affective and simple but strong. In order to allow equally affective remote communication, these face-to-face elements were given a tangible characteristic. By adding physicality to remote communication -in form of remote touch, synchronized and joint movement, a physical link was created. As a result of the design process three design directions were suggested, based on the needs and desires of three different scenarios.

This thesis project introduced a new approach for using haptic feedback technology, for enabling interpersonal communication. Thus encouraging to explore new possibilities for haptic interactions. However, the design process is incomplete, requiring several additional stages, for understanding and fine tuning the final designs. More work, to additionally fine-tuning the design and conducting user testing, would be necessary steps.

Despite that there were some crucial learning outcomes of this project. Among them are the usefulness of rapid-, and experience prototyping, which allowed participants to learn about future design ideas. It also provided them a chance to explore and evaluate user context. Another learning outcome regarding designing haptic devices, that it's challenging to get across the ideas of future haptic events. Another challenge was to propose different directions

that fulfill the desires of the scenarios, and combine design traits such as playfulness while creating a sense of togetherness. The three design directions could be further explored through more experiments, by creating high fidelity prototypes. It would enable participants to try the interactions described in these final suggestions.

When designing for similar haptic interactions, there is a great opportunity for exploring the sense of touch as communication medium. As of today, a great collection of work addressing the issue of remote communication, but a few uses its immediate characteristic. Also, today's communication allows mainly for text, audio and video, ignoring the power of sense of touch as and affective communication channel. This project attempted to point out this issue for future consideration.

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