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# Visual Eye Tracking Data as Medium in User Dialogue - Service Design's Perspective

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Visual Eye Tracking Data as Medium in User Dialogue  
- Service Design's Perspective

Satu Hyökki  
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Visuaalinen katseenseurantadata käyttäjädialogin välineenä

- palvelumuotoilun näkökulma

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Katseenseuranta on menetelmä, jolla voidaan kerätä tietoa käyttäjän silmänliikkeistä. Yksinkertaistettuna suunnittelija saa katseenseurannan kautta käyttäjän katsepolun avulla tietoa siitä, mikä kiinnittää käyttäjän huomion ja mikä puolestaan ei. Katseenseurannan tuottama lisäarvo on, että sen avulla voidaan päästä kiinni sellaisiin käyttäjän kokemuksiin tai ajattelimiin asioihin, joita käyttäjä ei esimerkiksi tutkimuksen jälkeisissä haastatteluissa enää muista tai tiedosta tehneensä.

Opinnäytetyön tavoitteena oli selvittää, miten visuaalista katseenseurantadataa voitaisiin hyödyntää käyttäjien ja suunnittelijoiden välisessä interaktiossa ja yhteisen ymmärryksen luomisessa erityisesti palvelumuotoilun alueella. Laaja strukturoitu kirjallisuuskatsaus paljasti, että katseenseurantaan perustuva laadullinen tutkimus tosielämän ympäristössä on harvinaisempaa. Opinnäytetyössä perehdyttiin mahdollisuuksiin soveltaa katseenseurantaa välineenä käyttäjien ja suunnittelijoiden välisessä dialogissa eli *käyttäjädialogissa*. Käyttäjädialogin tarkoituksena on synnyttää jaettu ymmärrys käsiteltävästä asiasta. Tosielämän ympäristössä toteutettavaan tutkimukseen sopivat parhaiten liikuteltavat katseenseurantalaitteistot, jollaisella opinnäytetyöhön liittyvä kirjasto-ympäristössä toteutettu pilottitutkimus toteutettiin. Tutkimus testasi katseenseurannan laadullista lähestymistapaa selvittämällä kirjaston ensivaikutelmaa sekä aineistojen löydettävyyttä, ja hyödyntämällä kerättyä aineistoa kirjaston kehittämiseen liittyneessä tulevaisuusverstaassa.

Opinnäytetyön tuloksena syntyi visuaalista katseenseurantadataa hyödyntävä ja empaattista tutkimusotetta palveleva malli (*see eye to eye* eli *ci2i*) jaetun ymmärryksen luomisesta käyttäjädialogissa. Malli peilaa pilottikokemuksia, katseenseurannan, empaattisen suunnittelun ja dialogin teorioita sekä visualisoinnin ja videon hyödyntämistä käyttäjakeskeisessä suunnittelussa. Mallissa käytetään katsevideota (*gaze replay*), jossa yhdistyvät silmänliikkeitä kuvaava video ja käyttäjän näkemää ympäristöä kuvaava video. Tulkinta tapahtuu yhdessä käyttäjien, suunnittelijoiden ja myös asiakkaiden eli esimerkiksi palveluntuottajien kanssa. Huolellisesti dokumentoitu malli kuvaa katseenseurantaa hyödyntävän käyttäjädialogin vaiheet ja onnistumisen kannalta keskeiset elementit. Syntynyt malli tarkasteltiin suhteessa palvelumuotoilun prosessiin. Kehitettylle mallille voidaan nähdä sovellusmahdollisuuksia laajemminkin.

Opinnäytetyö osoittaa, että katsevideo toimii katalyyttisessä roolissa tuoden osapuolet yhteiseen rakentavaan dialogiin. Mallin mukaisesti toteutettava käyttäjädialogi avaa silmät yhteiselle tulkinnalle ja yhteisen näkökulman luomiselle. Dialogin tuloksena syntyy käyttäjätietoa ja ymmärrystä, jota suunnittelijat voivat hyödyntää palveluiden kehittämisessä ja uusien palveluiden luomisessa. Dialogiin pohjautuvassa mallissa ei tunneta oikeita vastauksia, vuorovaikutuksen merkityksellisyys ratkaisee.

Asiasanat: katseenseuranta, käyttäjädialogi, katsevideo, visuaalinen, palvelumuotoilu

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Eye tracking allows us to observe the eye movements of the users, simplified, a scan path of the user reveals us what is drawing the attention or inattention of the user. Eye tracking can bring added value to user research by providing insights that would not be available with more conventional research methods, such as things that user is no longer recalling, or not realising they even took place.

The objective of this thesis was to find out how visual eye tracking data could be used as a medium to enhance the interaction and create shared understanding between users and designers, especially in the area of service design. Thorough structural literature review on eye tracking research revealed that the research papers on qualitative approach to eye tracking in real life context are lacking. Although eye tracking is usually analysed with statistical measures, this study focused on discussing the use of the eye tracking qualitatively as a medium in the dialogue between users and designers (*user dialogue*), for creation of shared understanding. A pilot study was conducted to test the qualitative approach in practice in the library context with a mobile eye tracking device, a type of device suitable for real life context studies. The pilot examined the first impression of the library and how the library materials were found. The findings were used in the future workshop developing the library.

As a result of the thesis a model for collaborative sense making in the *user dialogue* called *see eye to eye (ci2i)* was developed. It is benefitting from the visual eye tracking data and serving the purposes of design empathy. The model was built upon the pilot experiences and the theories in the areas of eye tracking, dialogue, empathic design and user-centered designing with video and visualisations. A medium used in the model is gaze replay; it is a video which combines the eye movements' video and the scene video as seen by the user. Interpretation takes place among users, designers and even with clients, such as service providers. The created model is documented in a well transferable manner and it describes the phases and crucial elements of the *user dialogue* enhanced by gaze replay. The Model yields user knowledge and understanding, benefitting the designers in creation of new services, or improvements of the current ones. Reflection of the model to the process of service design is given. However, wider application areas can be seen.

The thesis indicates that gaze replay serves as a catalyst towards a richer explanation. Applying visual eye tracking data in *ci2i* manner brings various stakeholders together for a constructive dialogue. It has the potential to reveal latent needs of the users and by creating a shared understanding it contributes to the creation of a holistic service experience. *User dialogue* provides possibility for a shared attention, which opens the mind and eyes for mutual interpretations between various stakeholders, and generates a common view point (*see eye to eye*). There are no right answers and no model results in *ci2i*. All what matters is a flow of meaning.

Keywords: eye tracking, gaze replay, visual, user dialogue, service design

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During the first year of our studies we wrote a column with my fellow student Päivi Ylitalo-Kallio concerning the user-centered design and our master studies. One particular line is worth repeating here: "Understanding the essence of a good user experience has changed our world view; it just calls for to learn more". And we certainly have done that! I am happy to be another great and educative experience richer.

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## 1 Introduction

Eye tracking has been broadly used in various areas of research. According to Duchowski (2002, 455; 2007, 205), eye tracking has been applied for instance in the areas of neuroscience, psychology, industrial engineering, human factors, marketing and computer science. What is so interesting in eye tracking then? When we look at something we usually also divert our attention to that particular point. By tracking the eye movements we can follow the gaze path of an observer. This can provide insights on observer's interest, what drew the attention/inattention? It can even give us some clues to how that scene was perceived by the person looking at it. (Duchowski 2007, 3.)

Eye tracking is commonly analysed with statistical methods. The quantitative interpretation of eye tracking data can give researchers a lot of important information on the eye movements and the cognitive processes behind it. Yet, very often what remains unanswered is the question why. A designer with user-centered focus is particularly interested in to find this out. With an eye tracker we can simply record the eye movements and ascertain the user's attentional patterns over a given stimulus (Duchowski 2007, 205). Why should we not use this information to provide insights in the user's point of view for the purpose of design? Especially when we need to find out more information on what is drawing user's attention we can use eye tracking to gain this information, which is hard to collect with conventional methods (e.g. Renshaw & Webb 2007, 239; Sundstedt, Whitton & Bloj 2009, 3; Nahman 2001, 3; Pretorius, Calitz & van Greunen 2005,1; Schiessel, Duda,Thölke & Fischer 2003,2).

The data gathered with eye tracking and interpreted in a dialogue with users could benefit service design. Mager (2004, 355) defines that: "Service design aims to ensure that service interfaces are useful, usable and desirable from the client's point of view and effective, efficient, and distinctive from the supplier's point of view". Even so, Saco & Goncalves (2008, 10) claim that service sector compares 70 - 80 percent of gross domestic products in many developed countries, and the consensus that "service is different" from manufacturing exists. Still tools developed for the factory floor are in use among service culture practitioners. Thus, the field of service design is evolving, and not only accepting that service is different; it employs multidisciplinary collaboration, co-creation and other features for reframing and sustaining change. Vaajakallio, Mattelmäki, Lehtinen, Kantola & Kuikkaniemi (2010, 8) suggest that the role of design in this field is to bring the user's point of view in design process and to support multidisciplinary collaboration. Mattelmäki (2005, 194), argues that user-centered design aims to build a dialogue between users and designers. This thesis discusses this type of dialogue and is hereinafter called *user dialogue*.

This dialogical relationship with users can be built with empathic design approach. Design empathy helps the designer to understand the users and to create an empathic dialogue with them (Mattelmäki 2003, 123; Mattelmäki & Battarbee 2002, 1). Thus, empathy plays a crucial role in design (Wright and McCarthy 2008, 637) and brings a new layer to our understanding of potential users (Mattelmäki and Battarbee 2002, 5).

As Isaacs (1999a, 2; 1993, 3) proposes, the essence of a dialogue is to make the ideas, perceptions and understanding we do not have yet, visible. Hence, visuals can have a major role in the dialogue. This thesis aims to discuss the use of eye tracking data as a medium in a dialogue aiming for shared understanding benefitting the needs of design.

### 1.1 Motivation and background

Eye tracking can provide us insight on the viewpoint of users (also literally) by opening the eyes of the researchers to really see the world with the user's eyes. No matter if the interest is perception of products or spaces, touchpoints of service (touchpoints are the tangibles or interactions of services making up the total experience of it, Moritz 2005, 182), work process, ways to perceive the service environment or analysing the user behaviour in complex packing the product out of the box situation. Eye tracking can provide information on how users see any particular situation, what arrests the users, what they look at when making a decision. From analysing this data new research questions can be found out and a dialogue between users and researchers can open ways to shared understanding.

The assumption based on a pilot study and literature review is that interpreting eye tracking data together with users can bring new insights and be of help when aiming to create new services addressing the needs of users. Correspondingly, Vaajakallio & al. (2010, 23-24) indicate that current service design methods have been developed towards the growth of user involvement along the use of user centered and co-creative methods, but the need for some methods to enhance the dialogue among users and designer exists, together with the need to bring different stakeholders together simultaneously.

This study was born with my interest to see things with other people's eyes. The fascination of being able to see what draws the attention of the viewer is mind blowing. It immediately raised the interest to look at this data as means of communication. By the purchase of the mobile eye tracking device and taking part in a course to learn how to use it, waked the interest to study deeper how it could be used in the user research context, qualitatively. From the first point on, it was obvious that real life context would be the most interesting, yet challenging arena to experiment on. I was amazed by the visual eye tracking data and its potentials in design, so I was interested in to figure out how the user dialogue could benefit



from that data, especially from the gaze replays. Gaze replays are a video format presentation of the gaze path of a viewer showing both the scene seen by the viewer and the eye movements moving along that seen scene, both on the same video.

## 1.2 Research question and structure

The objective of this thesis is to discuss the use of eye tracking data as means for communication in *user dialogue* for creation of shared understanding. Using gaze replay as a medium, not only enhances the *user dialogue*, it can also lead to deeper understanding of users and their needs. How the user dialogue and shared understanding could be used in the context of service design is reflected at the end of the thesis.

The main research question of this thesis is:

*1. Can visual eye tracking data be used as a medium to enhance the dialogue and create shared understanding between users and designers? How can this be done?*

Additionally this thesis aims to reflect to:

*2. How could this model of a user dialogue enhanced by the gaze replays benefit service design?*

The framework of the thesis describing the main idea is presented in figure 1. It shows how within the context of service design, together funnelled design empathy, visual eye tracking data and user dialogue may generate shared understanding helping with the needs of design. When we are conducting a user dialogue enhanced by the gaze replay, we aim for creating a shared understanding. Based on this idea, the model created in this thesis is a model evolving throughout the user dialogue. It is named here as the model of collaborative sense making, henceforward "*see eye to eye*" or in short "*ci2i*". According to the Merriam-Webster dictionary (Merriam-Webster 2011), "*see eye to eye*" means having a common viewpoint: agree. Though understanding is not equal to agreeing, this expression is found suitable metaphorically, especially in the context of eye tracking. It shows well the objective of the study.

This thesis is not a how to - manual on eye tracking methodology. Recommendable reading on eye tracking methodology is the book with the same title by Duchowski (2007). However, as thorough this book and the similar ones are, unfortunately they do not pay much attention to the qualitative approach on eye tracking in natural environment.

The motivation of this thesis lies on the grounds of design empathy. Hence, main principles of empathic design are presented in the chapter 2. Design empathy calls for the user dialogue.

If there is no understanding, there is no empathy and as chapter 2.1 describes, understanding can be gained through dialogue. Chapter 2.2 in turn presents the essential part of any dialogue, reflection. In chapter 3 the framework of service design is discussed for creating an understanding of the context for applying the *ci2i*-approach.

The groundwork of this thesis is two articles written by the researcher; the articles presented in this thesis discuss the use of the visual eye tracking data. The main reason to write these articles on eye tracking in user research was to find out and discuss the qualitative approach of the method, and its potential on user research. The first article provides a rather wide literature review on eye tracking methodology and the latter article presents the pilot study which was conducted in order to test the qualitative method in practice. The articles are presented in this particular part of the thesis, as the theories and discussion of eye tracking they bring in front, functions for understanding the gaze replays in user dialogue discussed in the latter chapters. Chapter 4 gives the foreword for these articles and chapters 4.1 and 4.2 present the articles written.

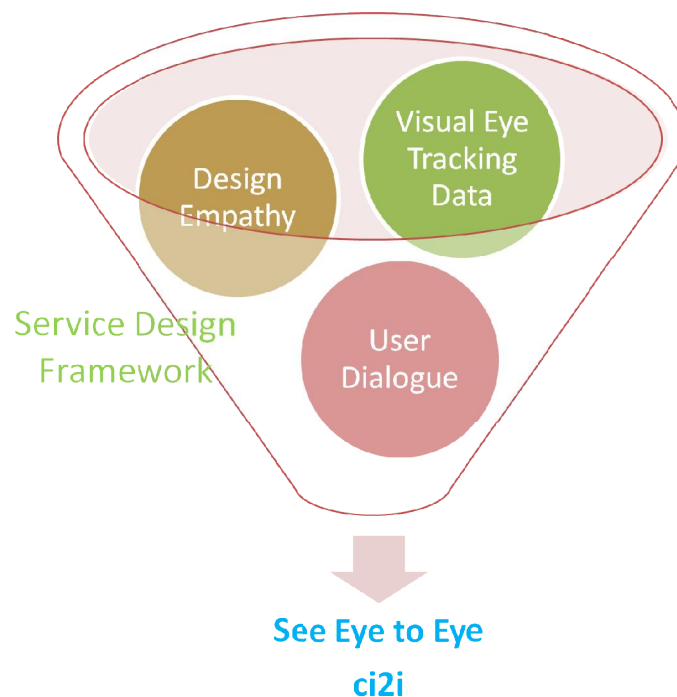


Figure 1: Framework of the thesis

Chapter 5 presents the main findings of this thesis, the discussion on enhanced user dialogue (5.1) In which the chapter 5.1.1 argues the meaning of visualisation in terms of the dialogue and the chapter 5.1.2 presents the nature of gaze replay from the point of view of the dialogue and visualisation. Chapter 5.2 moves towards a model of creating see eye to eye by taking a look at the gaze replays in the dialogue as a form of video. Chapter 5.2.1 goes through

the ideas gathered from the field of designing with video and chapter 5.2.2 in turn discusses the ways to interpret video format data. A closer look at the gaze replay from the point of view of dialogue and interpretation is taken in the chapter 5.2.3. Chapter 5.3 presents the *see eye to eye (ci2i)*-model created based on this research. In order to keep the thesis inside the settled frames, the model (5.3.1) deals with the evolution of user dialogue from the point of view of using gaze replay as means, hence, conceptualising the findings gathered in a user dialogue are not discussed in detail. Challenges with the model are discussed in the chapter 5.3.2.

The reflection and usage of the model in the context of service design is discussed in the chapter 6. Chapter 6.1 reviews shortly service design tools. However, this study excludes to investigate the use of eye tracking as a methodology in service design per se, and instead of it discusses the usage of created *ci2i* -model from the point of view of service design process in chapter 6.2. Conclusions and future research suggestions are given in the chapter 7, personal reflection of the researcher can be found in the chapter 7.1.

## 2 Design Empathy - towards Dialogue and Shared Understanding

Merriam-Webster dictionary (Merriam-Webster 2011) defines empathy as the action “for understanding, being aware of, being sensitive to, and vicariously experiencing the feelings, thoughts, and experience of another of either the past or present without having the feelings, thoughts, and experience fully communicated in an objectively explicit manner”. Simply stated, it is the ability to put oneself into another’s shoes. According to Vreeke’s & van der Mark’s (2003, 179) communication perspective towards empathy; empathy is affective response to other people and their needs, starting from a basic need of affiliation. From the point of view of communication, empathy is much more than understanding of the qualities of the empathic person. In addition we also need to understand the relationship between the empathic person and the person in need. Wright & Mc Carthy (2008, 637-639) argues that empathy is in the core of designer-user relationship. In dialogical approach to empathy, it is important that each person holds on to their own perspective, however, with respect to the perspective of the other. Only this way, it is possible for each person to creatively response to the other from their own perspective. Design empathy and discussion on design methods related to it, is presented here, as it formulates the “emotional background” of the thesis by being an essential issue in relation to the two key terms in this thesis: design and dialogue.

The user dialogue can be created with various methods; empathic design is a user-centered design approach aiming for this. A review on the main principles is provided next. Empathic design is a two-way approach: it creates an empathic and respectful dialogue towards the participant of the study and supports the empathic understanding of the designer (Mattelmäki

2003, 123; Mattelmäki & Battarbee 2002, 1). Koskinen (2003, 7-8) argues that empathic methods always require the interaction with users. The methods are visual and tactile, deliberately cheap and “low tech”, interpretive, playful and fun, tested in reality and targeted at the fuzzy front end. Nevertheless, in this study the design empathy through gaze replay as catalyst is not considered for the fuzzy front end only.

When applying and interpreting user experience empathically, designing for user experience begins with creating a rich, empathic understanding of the users’ desired experiences. This approach aims for a meaningful emotional encounter between user and designer. (Battarbee & Koskinen 2005, 6.) According to Leonard & Rayport (1997, 104-108), empathic design looks for design opportunities and aims to develop holistic understanding of the users. From the designer’s point of view, it demands specific attitude, creative interactions among members of an interdisciplinary team and appropriate methods. Additional to information and facts, empathic approach nourish inspiration and ideas. This paragraph highlights the meaning of interaction and the creativity, this study aims to reach it by creating a new approach of interacting with visual eye tracking data.

One example on methods creating the user dialogue is probes. In Mattelmäki’s & Battarbee’s (2002, 4-5) empathy probes study, the probes provided the way for a more reflective discussion among users and researchers. The researchers learned also that it was possible to use the probes as means of conversation to support the empathic dialogue among designers, in order to understand client company’s designer’s interests and their expectations for the results. Additional methods based on user dialogue according to Wright & McCarthy are (2008, 639-643) ethnography, and other ethnography inspired field work, such as technology biography and scruples, and also methods based on narrative. Although the dialogue differs, ethnography and cultural probes still share the common ground by being interpretative and relying on empathy for understanding the other (Wright & McCarthy 2008, 641; Boehner, Vertesi, Sengers & Dourish 2007, 7.) As this sentence points out, although there are many means available, empathy is the key for understanding the other, a reason to discuss it in this study.

Interpretation is a highly meaningful part of any research; empathic design methods are here no exception, on the contrary, as Fulton Suri (2003, 54-57) argues, no matter which methods are used, their value depends on empathic interpretation. Knowing the users; understanding their situation and knowing who they are, makes it easier for us to get more excited about designing for them. Knowing the users can be achieved in various ways, Fulton Suri suggests at looking at what people really do, asking people to participate and to try studied things our selves. Better than words alone, these visual, narrative and experienced matters can provide us rich meanings and embodied understanding about the users. Methods used in empathic design are aimed for inspire and inform imagination through real encounters with real people.

However, as Koskinen points out (2003, 62-65), empathic design goes beyond inspiration; by interpretation of the data it produces understanding of users. Though, Koskinen argues that the valid understanding of the user is crucial, not the interpretation as such, according to him, a difference in understanding the user prior and after the study measures the success in empathic design. Of course, only reliable and valid interpretation provides solid ground for the designer for sorting out the proper data from. Koskinen also mentions the importance of simple interpretation, as it has better potential to remain "well-preserved" even repeatedly communicated. In this study the meaning of interpreting together with users is highlighted.

## 2.1 Dialogue and Shared understanding

In order to understand the role which a dialogue could have in design, it is important to go the foundations of the dialogue. Conversation is a pathway to create, refine and share knowledge. The term dialogue is of Greek origin and signifies "flow of meaning". Dialogue is the possibility to think together and learn to use the energy of the differences to enhance the collective wisdom. Dialogue takes into account the impact one speaker has on the overall system, it seeks to unveil the ways in which collective patterns of thinking and feeling unfold. On the contrary to conversation which may lead to the dialogue, there are discussions, this word has its roots in "to break apart", when having discussions, people hold on and defend their differences. (Isaacs 1999a, 2; 1999b, 45; 1993, 3.) The essence of dialogue defined above, fits well for the goals in user-centered design, namely revealing the latent needs of the users and creating understanding helping us to meet the needs of design. This is well highlighted also in the definition by Bohm, Factor & Garret (1991) "Dialogue allows a display of thought and meaning that makes possible a kind of collective proprioception or immediate mirroring back of both the content of thought and the less apparent, dynamic structures that govern it. In the dialogue this can be experienced both individually and collectively." They continue that the dialogue provides the opportunity to both examine and share the preconceptions, prejudices and characteristic patterns of the other, which are lying behind of his or her thoughts, opinions, beliefs and feelings. In this thesis, especially the collective proprioception is demanded.

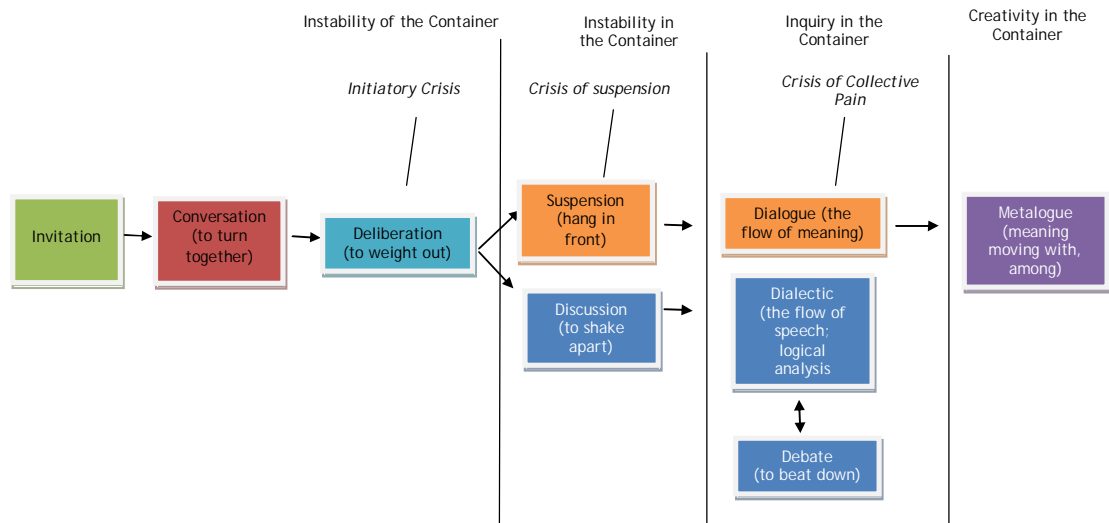


Figure 2: Evolution of Dialogue<sup>1</sup>

Isaacs (1993, 34) visualises the flow of the dialogue, by naming the key elements and identifying the individual behaviours and collective skills composing it as shown in figure 2. Dialogue requires series of increasingly conscious environment, fields of inquiry. These environments, called “containers” can be developed as a group of people come aware of the requirements and discipline of creating them. The container sums up the collective assumptions, shared intentions and beliefs of a group. This partly creates the collective climate. The evolving stages are considered as enfolded with one another. The process is not actually linear, it may include pass through one level, but then returning back to lower level. Passing through from one level to another seems to include meeting different types of individual and collective crises. Individuals bring along their tacit, unexpressed differences in paradigms and perspectives. In the dialogue, the recognition of them and acceptance of it that the purpose of the dialogue is not to hide these differences, but letting them be explored. These settings can make the container unstable, and to begin a dialogue, requires altering the patterns of interaction in a system so that the group of people can directly observe them. (Isaacs 1993, 34-35.) Even though the process of dialogue is not actually linear, understanding of this sequential construction of the dialogue helps for designing the dialogical model of creating shared understanding (*ci2i*).

In the core of the dialogue theory, the premise is that the effect of people’s shared attention can alter the quality and level of inquiry possible at any time. The modes of collective awareness can promote the modes and nature of interaction. The Dialogue begins with *con-*

<sup>1</sup> Adapted from Isaacs, W. 1993, 34 (see for larger figure in appendix 1)

*versation*, from speaking together flows *deliberation*. Consciously and unconsciously different views, points of agreeing, and dislikes are weighed out. Attention is paid selectively. At this point the first crisis, a decision point that can lead either to further refinement and evolution of the dialogue environment, or to greater *instability*, is faced. The crisis appears, because people realize that they cannot force the dialogue to take place. Gradually people recognize that they can either begin to defend their point of view, find others, or *suspend their view* and begin to listen, without caring about the validity of the expressed views. By recognition of this "*initiatory*" crisis, environment for people to seek something different from the usual, is created. Groups start to "*discuss*" the suspending views, analysing the parts instead of listening for the incoherence of the whole. At this stage people may feel frustration due to the appearance of the underlying fragmentation and incoherence in their thoughts. They may defend their views, despite of the evidence that they may be wrong. (Isaacs 1993, 35.) In user dialogue and the *ci2i* -model introduced in this thesis, the starting point of a dialogue; conversation, can be the very first encounter with user and designer, thus it may determine the course of the whole dialogue. It is good to keep this consciously in mind.

In dialogue, we make our general patterns of thought and feeling observable and accessible, and the tacit influences that sustain them. People begin to question the assumptions that are present and feel as if they were in a giant washing machine. This leads to a second crisis, "*crisis of suspension*". Points of views making sense before, no longer do. Polarisation comes up; extreme views are stated and defended. This instability and "heat" is needed, it lets the hidden fragmentation surface. If a critical mass of people stay with the process beyond this point, the conversations begins to flow and in this environment, people begin to inquire together as a whole (*inquiry in the container*). New insights often emerge and energy flows. People notice that they differ in their pace and timing of speaking and thinking, and start to respect it. In this phase, the flow may take on powerful and undeniable intensity. In these later stages of the dialogue, it is more accurate to call the "container" as shared field for exchange of meaning and information. By participating people also become sensitive to the ways, in which the conversation is affecting the participants. They begin to look for the embodied manifestations of their thoughts. This phase may be playful and penetrating. When people realise that deeper themes exist behind the flow of ideas, sense of separateness appears. People may understand that they have had limits to their vision, but they may not yet have experienced the isolation. Such awareness brings *collective pain*. People recognise that their thoughts in the form of collective assumptions and choices create and sustain fragmentation and separation. This crisis can lead to transformation of fundamental patterns of interaction. This crisis though, is not a necessary step in terms of success in dialogue. (Isaacs 1993, 36 - 38.) From the point of view of *ci2i*, sharing the field for exchange of meaning is enhanced by gaze replays.

Next phase, *creativity in the container* opens a new level of awareness. People consciously know that they are participating in a pool of common meaning, because they have explored each other's views. No matter whether they agree or not, thinking takes on an entirely different rhythm and pace, distinction between memory and thinking becomes apparent. Talking together by using categories of previous understanding may feel hard. Lack of adequate words may cause falling to silence. This silence though, is not an empty void, but one replete with richness. The dialogue raises the possibility of speech clothing subtle meaning. This experience is called "*metalogue*" or "*meaning flowing with*". "*Metalogue reveals conscious, intimate and subtle relationship between the structure and content of an exchange and its meaning.*" In other words, the group in the dialogue does not "have meaning" it *is* the meaning. Exchange of such nature leads to breakthrough levels of thought, it leads to the beauty of shared speech. (Isaacs 1993, 38.) In order to co-create the shared meaning and understanding (*ci2i*), the dialogue enhanced with gaze replays aims for nothing less, than to create this creative "space". The gaze replays are the visual form of eye tracking data and as a form of representation of this shared experience between user and designer (the eye tracking experiment), they provide us a reflection possibility. The role of reflection in dialogue and design is reviewed next.

## 2.2 Reflection in the Dialogue

Merriam-Webster dictionary's (Merriam-Webster 2011) description (physical) of reflection: "*the production of an image by or as if by a mirror*", fits well when discussing the use of mediums like eye tracking data in the dialogue (in reflective manner). Reflecting a situation after something is done is called reflection on action (Schön 1983, 61) or as inner dialogue with oneself and others (Wright, McCarthy & Meekison, 2003, 49) where the information is turned into knowledge. Reflection in action (Schön 1983, 50) is happening during the event where the reflection allows the practitioner to redesign what he or she is doing whilst doing it. This seminal work by Schön analysing the ways of how professionals work, has been highly adapted for instance among practitioners of design and human computer interaction (HCI). (see e.g. Bach & Twidale 2010, 2037; Arvola & Artman 2006, 5; Tohidi et al. 2006; Tversky 2002, 1; Ylirisku & Buur 2007, 13; Sengers et al. 2005, 52) Schön (1983, 79), considers design as reflective conversation with the situation.

Reflection is defined by Boud, Keogh & Walker (1985, 19) as "a generic term for those intellectual and affective activities in which individuals engage to explore their experiences in order to lead to a new understanding and appreciation." Sengers et al (2005, 50) refer to critical reflection as "bringing unconscious aspects of experience to conscious awareness, thereby making them available for conscious choice"... reflection is not a purely cognitive



activity, but is folded into all our ways of seeing and experiencing the world". Hence, critical reflection is not simply facts; it opens totally new ways to experience the world and oneself.

In the reflection model by Boud et al. (1985, 27-38), experiences and reflection are having a continuous dialogue. It looks at the process of reflection from the point of view of the reflective learning experience and what learners can do on their own and with others to support this activity. Returning to the experience is an active process. First it is important to return to the experience as such, and recall both positive and negative feelings concerning the experience. Negative feelings are as valuable for learning as the positive ones. In re-evaluating the experience, a critical and holistic self evaluation is conducted. The outcomes of the reflection are seen as new perspectives and readiness for applying the new thoughts into action. New experiences are then again reflected and the process goes on, along with new experiences. It is to be noticed that in practice the elements of reflection are not linear, and as clear and not independent of each other as in the illustration below.

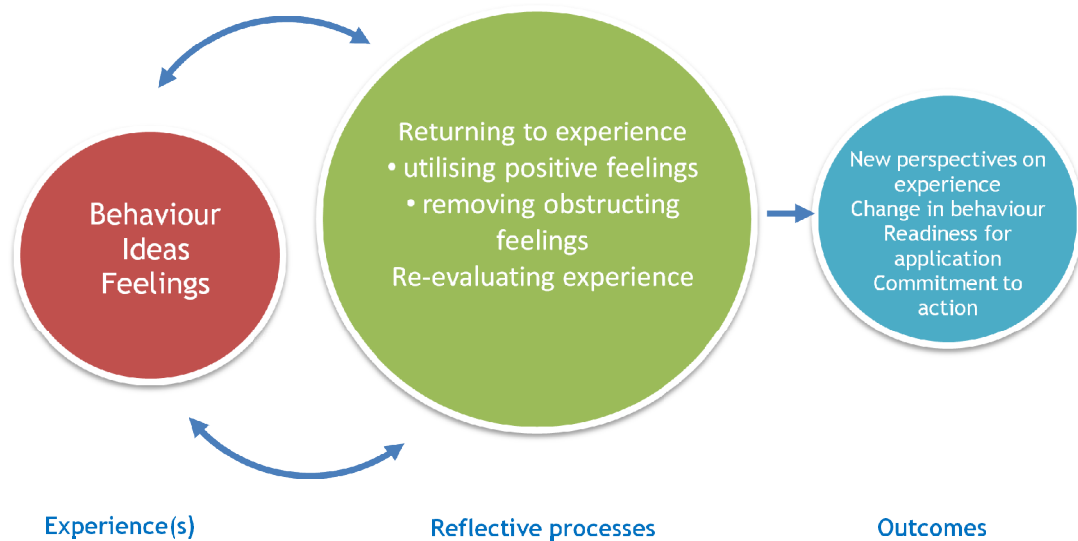


Figure 3: The reflection process in context<sup>2</sup>.

Reflection has been considered important when dealing e.g. with user experience and it has inspired to create methods taking the reflective nature of user experience into account. These kinds of methods take into consideration the importance of shared understanding and cooperative interpretation. (see e.g. Luoju 2010, 85.) Sharing this argument about the reflective nature of user experience, it is important to take notice that reflection is an essential part of the dialogue process. However, in order to keep this study within tight frame-

<sup>2</sup> Adapted from Boud et al. 1985, 36

work, the experience *per se*, is not discussed much further here, but it has been recognised as a vital element of reflection.

Different mediums could be used to facilitate the reflective dialogue. Chapter 5 discusses this in general, from the point of view of visualisation and finally by taking a closer look at gaze replays.

### 3 Service Design Framework

This chapter aims to present the framework this study is experimenting within, or more precisely the context of, in which the results of this study is considered to be adaptable with; service design. It takes a brief look at the origins of service design and reviews shortly the models and processes service design can be implemented with. First and foremost, as nowadays understanding of service design and its components can be considered as a key part of continuous improvement within the processes of any company, therefore this domain is found as an interesting framework to discuss the meaning of user dialogue within. Secondly, as pointed out in the introduction by Vaajakallio & al. (2010, 23-24), this domain could benefit from increased dialogue and methods supporting the creative collaboration.

What does service design actually mean? According to Mager (2004, 355), one of the Service Design pioneers: "Service design aims to ensure that service interfaces are useful, usable and desirable from the client's point of view and effective, efficient and distinctive from the supplier's point of view". It is a field rapidly growing and internationally established in research, teaching and consulting (Mager, 2004, 357). According to Moritz (2005,39): "Service design is the design of the overall experience of a service as well as the process and strategy to provide that service". He uses the theatre metaphor, saying that service is a unique and individual experience, working well only when all factors front and back of the stage are working properly (Moritz 2005, 41). Hollins (2006) has been making the British standard for service design, and formulates the definition as follows: "Service design can be both tangible and intangible. It can involve artefacts and other things including communication, environment and behaviours. Whichever form it takes it must be consistent, easy to use and be strategically applied".

Moritz (2005, 57) points out that service design benefits the organisation and the client at the same time: by understanding the market needs, providing higher value with the resources available, by changing the organisational culture, providing new perspectives on future development, with higher effectiveness, better efficiency & brand affinity, by connecting or-

ganisation and clients, by differentiation against competition and with higher quality service experiences, as basis of success.

One definition matching well with the aims of this thesis is the one by Koskinen (2007, 22), who highlights the communicative point of view, by saying that service design is designing service related communication, which consists of designing of communication related to service environment, service process and service personnel. It is a part of brand development, and links all parties communicatively together. He also emphasises the combination of service design and service quality development from the point of view of individuals buying the service, by ensuring the services delivered just on time and place. This above presented communicative point of view has got an analogue to the implementation of the *user dialogue*, when developing services. According to Koskinen, service design needs better take into account the many senses of human beings, is considered a very interesting point, as this study here is concentrating issues related to the eyesight, on the visuals and using the gazer replays; representation on how the user has perceived the environment as a central means. Unfortunately the author is not deepening this thought of multisensory design of services much further though. (Koskinen 2007, 23.)

In the 90's when the service sector started to grow, the practice and culture of design was still focused on the traditional industry with its tangible outcomes (Sangiorni 2009, 416). Today, service design is an evolving and interdisciplinary approach, combining different methods and tools from various disciplines (e.g. Stickdorn & Schneider 2010, 29 & 308; Moritz 2005, 58; Mager 2007, 355; Saco & Goncalves, 2008, 12). From the designers' area of work point of view, service design has opened new doors for them to bring their competencies into, the entrance to the field of service development (Vaajakallio & al 2010, 42).

In their literature review for eXtreme Design -project, Vaajakallio & al. (2010, 5-6) have noticed that the publications of the area are trying simultaneously to build a bridge and dig a gap between service, design, marketing and management, by distinguishing the area either between service design and other design disciplines, or service design and market oriented service development/service engineering. In fact this can be seen quite clearly in the literature. In line with Vaajakallio & al. above, Blomkvist, Holmlid & Segelström (2010, 310-315) are reflecting the evolution of service design research in past, present and future; arguing that there are two themes in service design research. One is to widen the scope of service design by integrating the practices and ideas from non-design fields. The other is to challenge and explore service design and methods inherited from other disciplines. According to them, current research is about tools and processes in service design, and as a final trend they see the publishing of case studies. They claim though that these case studies have not been academically scrutinised. Among future challenges in service design they propose the establish-

ment of structure, to make service design criticisable and to offer a shared knowledge base. Relevant knowledge can be created only by creating an open playfield for researchers to study, experiment with, and participate in service design projects. Why should the companies invest in developing their services? One answer for this question is that in times of crisis, focus on service design may be organizations key for success. During regression, new needs may be easier to identify and customers seem to be even more choosy than usually (Brown 2009, 176; Real, Orozco & Pérez 2009, 2).

What can we say about the implementation models of service design? Though design of tangible products has numerous process models to choose from; there is not an embarrassment of riches in the models of developing services. Methods for service design are an evolution of the methods in marketing, management and design. Partly they are totally new, and created for the purpose of service design only (Maffei, Mager & Sangiorgi 2005, 6). Koivisto (2007, 43) has been studying the field of service development and done a wide literature review on the current state and models of it. He summarizes five different models for developing services from the point of view of service management and marketing (Gummesson (1993), Edvardsson & Wilhelmsson (1994), Edvardsson & al. (2000), Scheuing & Johnson (1989) and Kinnunen (2003)). He finds following phases on them: *generating and cutting back ideas, project launch, designing service concept, creating service blueprints, testing and taking the service into use and launching the service*. In his thesis Koivisto (2007, 43-46) studied the model by Kinnunen in detail as it successfully combines the existing theoretical frameworks and gives an adequate picture on them.

Koivisto (2007, 71-75) moves ahead and describes the evolving field of service design by presenting seven different models, but ends up using the model by Moritz, as his model is again a type of synthesis of the existing models. In his review on existing models Koivisto presents following models: Mager (2004), Evenson (2006), Live|Work (2005), British standards 7000-3-Guide to Service Desing (2005), DIEC, Design Innovation Education Centre, UK (2006), IDEO Myerson (2001) and Moritz (2005).

Moritz's (2005, 123) holistic approach divides the process of service design in six categories of tasks:

- *understanding* (finding out and learning),
- *thinking* (giving strategic direction),
- *generating* (developing concepts),
- *filtering* (selecting the best),
- *explaining* (enabling understanding) and
- *realising* (making it happen).

Moritz has been developing the six phase model, instead of a four phase one, because he wanted the model to be specific enough, and including all the essential parts to ensure the understanding of the service design. When presenting each task, Moritz provides the list of tools for conducting these tasks (2005, 124-147).

Moritz (2005, 149) explains his framework as one providing an overview of service design tasks, and encourages the use of the model in checklist manner, when implementing service design in practice. Nevertheless, he points out that service design projects are often very different. Thus, the implementation of the framework cannot be done under absolute rules of order, as various tasks overlap and interlink with each other. Moritz also reminds that the nature of service design is iterative and some categories can be used more than once during the project.

Moritz's work is interesting, thorough and with remarkable good visuals. However, this study reflects on resent and more simplified four step model by Stickdorn & Schneider (2010, 122-135). In their model the iterative service design process has been divided into four steps: *exploration, creation, reflection and implementation*. These four steps have been considered to provide a simple base, clear enough for discussing the use of visual eye tracking data in service design. The model is described in detail in chapter 6.2.

#### 4 Qualitative Look at Eye Tracking - presenting the Articles Written

To gain more understanding on the field of eye tracking, structural literature review on eye tracking was conducted, with a special interest on qualitative approach to eye tracking methodology in user research. The first article is "*Eye Tracking in User Research*". Additionally to the literature review, it shortly describes a pilot study conducted in the library settings. The pilot was done from methodology development- and testing point of view. The article was double blind peer reviewed and will be published in *Interdisciplinary Studies Journal*, ISSN 1799-2702, Vol. 2, No. 2, 2011: Customer Focused Services.

The latter article presents the empirical part related to this thesis. The pilot study was conducted parallel to the structural literature review. The main aim was to test the use of eye tracking data in the user dialogue, and combining the eye tracking with other methods. This has been done in library environment with the aim to track the first impression of the library space, followed by task implementation related to perception of signs and finding of materials located in the library. This article "*Kirjasto käyttäjän silmin. Käyttäjäkeskeisyys voimavara kirjaston kehittämisessä*" (Library with user's eyes. User-centered methods in develop-

ing the library) will be published in the issue 2/2011 of a special paper *Signum*, which is a magazine for the Finnish Research Library Association. The language of the article is Finnish. It aims to describe the pilot case, used method and the results for an audience not familiar with eye tracking or user-centered approach.

#### 4.1 Eye Tracking in User Research

Satu Hyökki/ Accepted manuscript for publication in the Interdisciplinary Studies Journal, ISSN 1799-2702, Vol. 2, No. 2, 2011: Customer Focused Services.

##### ABSTRACT

*Eye tracking has been broadly used in cognitive sciences and the data is usually analyzed with quantitative methods. This paper gives insights into eye tracking in general, in its methodology and the specifics within it. The aim is to discuss the qualitative use of eye tracking in user research. This article describes how eye tracking data could play an important role in the user research when aiming at understanding the users and the user experience. Broader study is needed on utilizing eye tracking data in catalytic or reflective ways in interaction between the users, developers and researchers in product- and service development.*

**KEYWORDS:** EYE TRACKING, USER RESEARCH, QUALITATIVE RESEARCH

##### INTRODUCTION

Eye tracking can bring added value to user research by providing us insights that would not be available with more conventional research methods. These insights are related especially to user's visual attention, for instance, in usability testing eye tracking can tell us where the user was looking at when making a decision. (e.g. Renshaw & Webb, 2007; Sundstedt, Whitton & Bloj, 2009 ; Nahman, 2001 ; Pretorius, Calitz & van Greunen, 2005; Schiessel, Duda, Thölke & Fischer, 2003)

Rayner (1998) points out that the eye tracking research is entering its fourth era with the emergence of interactive applications. The first era (ca. 1879 -1920) was defined by the discovery of many basic eye movement facts. The second era (ca. 1930-1958) was handling the more applied research focus in relation to the behaviourist movement in experimental psychology. The third era (ca. 1970 - 1998) is characterized by improvements in eye movement recording systems, their accuracy and easily obtained measurements.

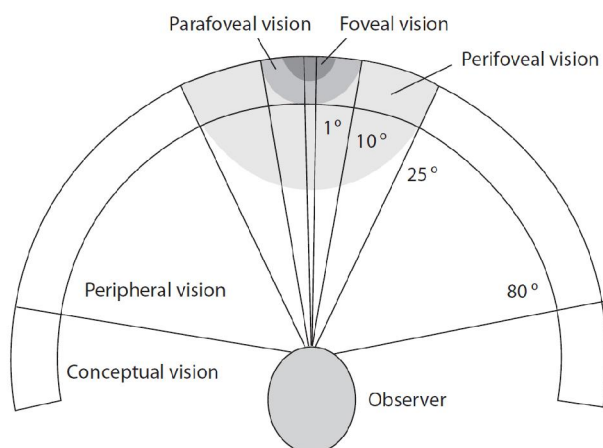
According to Goldberg, Stimson, Lewenstein, Scott & Wichansky (2002), there are two ways to proceed with analysing of eye tracking data. Either top-down, in other words, based on cognitive theory or design hypothesis, or bottom-up, which is entirely based on observation of the

data without predefined theories relating eye movements to cognitive activity. What can be measured then? The commonly used metrics are e.g. fixation (duration, overall, rate and number on each area of interest), area of interest, scan path, gaze duration (% and mean on each area of interest) (Jacob & Karn, 2003 see also for eye tracking metrics used in 21 usability studies discussed in the study.)

The most common eye tracking metrics do not provide the answers to the question interesting many user researchers; the question why? Thus this paper aims to discuss the qualitative analysis of eye tracking data in dialogue with the user. How could the user research benefit from the information gathered via eye tracking in real life environment, in the everyday environment of people? This discussion is based on a literature review and pilot study.

## LITERATURE REVIEW

Our eyes are collecting so much information on the surrounding environment that our brain is not able to process all of it. Only the needed information is extracted by using the selective visual attention. The eyes have limited resolution and the human visual acuity is related to this fact and also to our ability to resolve fine details. (Sundstedt & al., 2009) When gazing an object, the eyes move so that the image of the target object appears on the fovea of the retina. The humans have higher visual acuity in the fovea. As it can be seen from the figure below, fovea covers approximately one degree of visual angle. (Sundstedt & al., 2009 & Lukander, 2003) Visual angle means the measured degree of eye movements, one degree's visual angle spans approximately 1 cm on a distance of 57 cm from the viewer's eye (Lukander, 2003).



Picture 1: Schematic representation of the human visual field (Sundstedt, 2009).

The eyes are moving several times per second containing micro-movements spanning sometimes only a few pixels (Ehmke & Wilson, 2007). To gather accurate information on the sur-

rounding environment, the human visual system has developed a number of methods it needs for bringing the objects of interest to the area of sharp vision in order to be able to stabilize the image on the fovea (Lukander, 2003). The human visual system is using five basic types of eye movements: *saccades*, *smooth pursuits*, *vergence*, *vestibular ocular reflex* and *physiological nystagmus* (Duchowski, 2007). Duchowski describes the eye movements as follows:

- *Saccades* are both voluntary and reflexive eye movements and they last from 10-100ms. During the saccade no visual information is normally obtained. Saccades are ballistic, meaning that the destination of the saccade cannot be changed once it is started.
- *Smooth Pursuits* are used to track visually moving target.
- *Vergence* movements are used for depth perception.
- *Vestibular ocular reflex* movements are used to fixate the eyes on an object even if the head rotates.
- *Optokinetic nystagmus* motions are used to account the motion of the visual field.
- *Fixations* occur between eye movements and they often last for about 200-300 ms.

Approximately 90 percent of viewing time is spent on fixations (Duchowski, 2007). The eyes are never completely still; these small movements in the eye are called *tremors*, *drifts* and *microsaccades*, however, during the fixation the image is held almost still in the retina. Eye movements can be divided into two categories, stabilising movements and saccadic movements. Stabilizing movements try to hold the image on the retina steady and the saccadic movements bring the objects of interest to the area of sharp vision. Stabilizing eye movements include fixations, smooth pursuit movements and vestibular ocular reflex and optokinetic reflex. Saccadic eye movements include saccades and vergence movements. (Lukander, 2003)

### Eye Tracking Research

According to Nielsen & Pernice (2010), eye tracking reveals another level of user behaviour by providing a more detailed level of behavioural data to be analyzed. It enriches the understanding of peoples approach to the sites and reactions to words and pictures in order to communicate better with interactive content. Sundsted & al. (2009) are emphasizing that important objective information can be revealed via eye tracking and it gives the opportunity to take the human observer into account in the design. According to Nahman (2001) user's eye movements can offer additional insights when dealing with design solutions related to various elements on the web site. Eye tracking may give answers to questions such as reasons of failure when using the web, and then design recommendations are not needed to be implemented by trial and error.

Just & Carpenter (1984) have been formulating the so called eye-mind hypothesis, which has been one of the reasons of the growing interest towards today's eye tracking research. In



their assumption the target fixated by a gaze of a user indicates what the user is thinking of, and that there is no lag between what is been fixated and what is been processed under a cognitive task. Following users gaze path allows for the process of observing a subject's visual attention. (Lukander, 2003; Ehmke & Wilson, 2007; Nielsen & Perice, 2010.)

Schiessel & al. (2003) have been discussing the added value of eye tracking in usability studies and media research. They showed that use of eye tracking gives higher validity of usability data by being able to unveil response biases due to artificial testing environment. They also point out the practicability of eye tracking data. By being able to provide insights in the origin of the problem, eye tracking allows analysis of problem stages such as perception or comprehension. On the other hand (e.g. Hyrskykari, Ovaska, Majaranta, Rähä & Lehtinen, 2008; Koivunen, Kukkonen, Lahtinen, Rantala, Sharmin, 2004), gaze direction alone does not provide us the answers why users looked at the point they looked at. In other words prolonged gaze to some object does not necessarily indicate that there are some problems with understanding its meaning, or that this particular object is especially interesting to the user. Something is simply raising the visual attention of the user, but if we want to find out the reason why, we should combine eye tracking with other methods of investigation.

Hyrskykari & al. (2008) have been comparing the outcomes when using concurrent think-aloud and retrospective think-aloud. They state that retrospective think-aloud produces significantly more verbal data than the original think-aloud method. Users are also more relaxed and motivated to talk and provide useful information on improvement of the web sites when using the gaze path playback after the actual task performing stage. The replay of eye tracking data for the users makes it easier for them to recall their decisions and thoughts during the test. This is called Post Experience Eye Tracking Protocol (PEEP), as described further by Ball & all 2006. (Ehmke & Wilson, 2007; Hyrskykari & al., 2008.)

Nielsen & Pernice (2010) encourage the use of head-mounted eye trackers when studying users moving in the real world. Such equipment is useful for shopping behaviour and usability studies of physical devices. Examples are run out-of-the-box studies for unpacking and starting to use some electronic devices.

Visual perception has a significant impact on finding one's way and orientation. In a study conducted in a nursing home for patients with mild dementia and independent in mobility, a wireless mobile eye tracker was used to obtain information on how the signposts were perceived. The eye tracking study provided evidence that the sign information was placed incorrectly for nursing home residents. It also revealed what caused distractions and what kind of signage was more effective. (Schuchard, Connell & Griffiths, 2006.) Wilfinger, Weiss & Tscheligi (2009) studied shopping behaviour in order to deduct design implications for indoor

guidance systems in stores by exploring orientation strategies. They used spectacles camera instead of a mobile eye tracker, though applied in similar manner. In their study pre-structured interviews accompanied the field study with the spectacles camera, think-aloud and observation.

Visualised eye tracking data plays a crucial role in the qualitative approach to eye tracking. The best way to visualise eye-movements is by gaze replay (also known as gaze overlaid video) in real time or in slow-motion (Nielsen & Pernice, 2010). Additional visualisation forms of eye tracking data are e.g. the heat maps (fixations of many users) and scan path or gaze plots (fixation of one user).

### Application Areas of Eye Tracking

From the system analysis point of view the nowadays existing eye tracking applications can be divided into two categories: interactive and diagnostic systems. Objective and quantitative evidence on user's visual and attentional processes can be provided by diagnostic use of the eye tracker. Diagnostic eye tracking involves recording eye movements over time in order to find out user's attentional patterns over a given stimulus. The stimulus does not usually need to react or change to the gaze. On interactive systems, user's gaze is interacting with the application, the eye tracker is serving as an input device. (Duchowski, 2007) This paper focuses on the diagnostic use of eye tracking.

There are two general techniques for studying eye movements; either by measuring the position of the eye relative to the head or by measuring the orientation of the eye in the space. The latter uses video based corneal reflection (also known as Purkinje Reflection or Purkinje Image) system eye tracker, and it is also the one used most commonly today. (Duchowski, 2007.) Video-based eye trackers use relatively inexpensive cameras and image processing hardware and are most suitable for the interactive use. Both table- and head mounted systems are identical in optics with the exception of size. (Duchowski, 2007.) Applied eye tracking research has been getting more common in line with lowering the cost of equipment, easy to use systems and analysing software.

In the industrial engineering and human factors, eye tracking is used e.g. in aviation, driving and visual inspection of goods. In aviation, human machine interaction behaviour studies with the experienced and novice pilots have been conducted e.g. in visual interaction with electronic maps, information selection and management and concerning situation and mode awareness in the modern cockpit. In driving, eye tracking studies help to understand the reaction times, effects on aging, luminance and clutter for driving. Studying the nature of driv-

ing task is useful for developing the driver training and accident countermeasures. Eye tracking can also be used to study the visual inspection of goods and services. (Duchowski, 2002.)

Previously eye tracking has been widely used in neuroscience, psychology, industrial engineering and human factors, marketing and advertising and computer science. The next chapters describe shortly some user research related application areas of eye tracking: marketing, human computer interaction and perception of design.

### Marketing

According to Duchowski (2002), insights of consumer's dispersion of visual attention of advertisement can be provided by eye tracking. Ad effectiveness can be studied in e.g. copy testing, images, video and graphics. Rayner, Miller & Rotello (2001) studied eye movements on print advertisements and came to the general conclusion quite consistent with the classical study by Yarbus (1967); the goal of the viewers matters also when looking at an ad. The given task influenced whether the viewers looked more at the text or at the pictorial part of the ad. They mention that the nature of the ad per se influences looking patterns. Based on the goals - instead of jumping back and forth between text and picture, they gaze at the part of the ad, which supports their goals and after that scan information less relevant to them, or use that information for confirmation.

### Human Computer Interaction

As the Internet has become a part of everyday life, users no longer tolerate poor usability and the demand for usability analysis is increasing (Ehmke & Wilson, 2007). Nielsen & Pernice (2010) have been conducting a major eye tracking study on web usability with more than 300 participants. The goal was to study people's common viewing patterns and behaviour when using purposeful web sites. More specifically, they were testing the theories about usable and unusable web design. They investigated eye tracking data for new usability findings and determine if there are some findings which can be collected with eye tracking only. Good eye tracking usability practices were also collected.

Emke & Wilson (2007) have summarized eye movement metrics and related usability problems from the eye tracking research literature. They pointed out the importance to study not only the metrics related to a single eye tracking measure, but also the combination of patterns reflecting the structure of user behaviour when countering a problem. Through their study they produced an interesting though exploratory table of correlations between eye tracking patterns and usability problems.

The model of visual attention when viewing web pages can be important for both web designers and the end users. By carrying out the study to find out the salient regions of web pages Buscher, Cutrell & Morris (2009) were able to identify general location based characteristics of visual attention for web pages and generate a model for predicting the visual attention that individual page elements may receive. Like Buscher et al., Nielsen & Pernice (2010) are also arguing that eye tracking can be used to improve page layout and meet the requirements of the users. Eye tracking can also be exploited when dealing with cost effective design of virtual characters in virtual environments (McDonnell, Larkin, Hernandez, Rudomin, & O'Sullivan, 2009).

Implicit relevance feedback and the interaction between the searcher and the information retrieval -system was studied by Moe, Jensen & Larsen (2007). In the study they used a qualitative and exploratory approach to identify potentially useful features from eye tracking data. Although the qualitative identification of features of eye tracking data is time consuming, it is possible to identify some features by qualitative inspection of the eye tracking gaze replays. Behaviour involving shorter gazing or small texts were proved hard to observe qualitatively. The reason for using the qualitative analysis and not the algorithmic one was not only the lack of resources. This approach provided a possibility to investigate the value of a number of features without implementing the algorithms to automatically identify these features. (Moe & al., 2007)

### Perception of Design

In the research aiming at developing methods for perception of design products, eye tracking was used for comparison of how designers and non-designers perceive design products and also for comparing 3D design products and their computerized 3D models (Räihä, Koivunen, Rantala, Sharmin, Keinonen, Kukkonen & Lahtinen, 2006). Koivunen, Kukkonen, Lahtinen, Rantala & Sharmin (2004) found out that the task given to users affects their gaze paths even without any predetermined task. According to Kukkonen (2005), relations between gaze and different aspects of design evaluation may be used for the development of combined eye tracking and design of evaluation methods. Application of methods developed for perception of design to real design cases could be helpful when evaluating the visual aspects of the product design. On the other hand, as mentioned in Räihä & al. (2006), there is a lack of research in the domain of using gaze data in the evaluation of perception of design. The area seems to be methodologically challenging, hence, some continuing basic research on the topic will be needed.

## METHODOLOGY

In general, eye tracking has been used especially in the area of cognitive sciences. The data gathered via eye tracking is analyzed by quantitative methods measuring the gaze and eye activities. According to Renshaw & Webb (2007), eye tracking will reliably reveal where people look at in real time and where they don't. The assumption against eye tracking stresses that an expert might easily be able to recall what were the secret shortcuts the expert has used when using the application, or it can be said where the child is looking when being re-read a sentence of a story. In reality tracking where the user is looking at is possible with an eye tracking device, however, it is difficult with more conventional evaluation methods. Sundsted & al. (2009) argue that classical think-aloud protocol or questionnaires can be used to discover what people looked at during the experiment, but they rely heavily on user's memory capacity and the ability to describe in sufficient manner what they see. The classical study by Yarbus (1967) argues that user's scan path is varying depending on the task given, in other words, the eye movements when looking at the scene were influenced by the goal of the viewer.

A structural literature review was conducted with around 50 publications in the area of eye tracking (as presented in Table 1.). The aim was to discover the experiences and findings on qualitative usage of the eye tracking data especially in the real life context user research. The structural literature review concentrated in following possible contents of the publications: qualitative approach used, method used, use context of eye tracking and gained outcomes. This article consists of a rather broad review of the eye tracking literature in general because of the small number of eye tracking literature with the qualitative approach. Reflection to the qualitative usage possibilities of eye tracking in user research is based on the literature review and conducted pilot studies.

### Pilot Study

This paper describes one pilot study conducted by the Laurea User Driven Innovation Centre, testing the use of eye tracking in real life context. The pilot study was conducted in the framework of library development. However, the main aim of the pilot was to test the how the visualised eye tracking data (gaze replay) could be used in the dialogue with the users. The method used in the study combines eye-tracking, think-aloud, interview and future workshop.

The study consisted of three main phases. In the first phase, the first impression with free viewing task followed by task implementation was conducted with naive participants. In the second phase, the post experiment interview took place. Between the second and third

phase, the eye tracking and interview data was analyzed qualitatively and questions for the future workshop were compiled based on the analysis. The third phase contained a dialogue enhanced by the visualised eye tracking data. The gaze replay was reflected and discussed in a dialogue with the users, librarians and developers as a part of a future workshop. The data gathering equipment was SMI iView xHED, head-mounted eye-tracker. The mobile eye tracker records a scene video (the scene as seen by the user) and gaze video (the gaze, as it moves on that seen scene). In this experiment the tracker was calibrated for the stimulus distance of around three meters. The probable parallax error in accuracy when moving freely in the library settings was not considered crucial, as the interpretation of the data was qualitative. Think-aloud audio was recorded simultaneously with the iView xHED eye tracker system. Due to the first impression part of the study, the participants were naive users of the test library, the purpose of the study was not revealed to them in advance either. Other requirements for the selection of participants were not settled. As the pilot was experimental, only two participants of initial three were taking part in the eye tracking experiment. Two additional library users were invited to participate in the future workshop. Also two librarians were engaged with it. In the library study the aim was to track the spontaneous reaction, to find out what raises the first attention of the user when entering the space. According to Flora (2009), our brain makes up a first impression based on signals given off by the new experience. The assessment of this impression and the accuracy of the judgments of people depend on the observer and the people being observed. As Moyersen (2009) states, eye tracking can provide objective data of the consumer behaviour towards products at the very decisive first moment of eye contact on them. He continues that to a certain extent the eye movements reflect what makes an impression on people. These ideas motivated to implement the tracking of first impression via free viewing task as one of the tasks in the pilot study.

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Table 1: Reviewed literature

## RESULTS

The qualitative analysis of the reviewed research literature on eye tracking confirmed the assumption that qualitative data analysis wasn't really present in the eye tracking research. The majority of the research articles written on the area interpret the eye tracking data statistically. In the literature review, only two publications presented directly the usage of eye tracking data in qualitative manner. This did not mean that the qualitative approach would not have been used at all, but encouraged the writer to discuss and test more freely the idea of analysing (visualised) eye tracking data in qualitative manner in dialogue with users. Eye tracking is often conducted in a laboratory environment. According to Duchowski (2007), the main reason is better control of the test situation; also, control increases the internal validity. However, the smaller and portable equipment has become lower in cost and field experiments can be conducted with them. Also the table mounted systems can be transported and experiments conducted "on site".

To test the idea of using the eye tracking for user research in real life context and analysing the data qualitatively in dialogue with the users some pilot studies were conducted. This paper reports and reflects merely the pilot study in the library settings. The case dealt with user centered design of the library space- and functions in dialogue with the users, librarians and the researchers.

Data was collected by eye tracking with think-aloud. Recording contained the scene video with the gaze cursor indicating participants eye movements. Instructions for think-aloud were given without revealing the experiment; also the calibration was done in other location than the library. Post experiment interview was conducted after the eye tracking. The interview was also recorded by using the audio recording of the eye tracker. In the task implementation part the tasks were read out to the participants, the whole process was recorded with the eye tracker. Also a short questionnaire was used to collect the background information on participants; it reflected the usage of library, gender and age. Two researchers observed the eye tracking experiment. Data collection continued in future workshop where ideas for the development of the library space as physical and virtual living room were shared and solutions brainstormed.

The experiment included both free viewing and task implementation tracked with the eye tracker. In the free viewing phase of this experiment the eye tracker revealed what the users were looking at to make up the first impression of the library space; how they look at it and words they used while looking at it. After this the participants were instructed to locate various materials and signs in the library space. Think-aloud method was used in all phases of the experiment.

After conducting the experiment with the naive participants, the aim of the study was revealed to the participants. Then the first impression of the space was discussed in a short post experiment interview. Post experiment interview had also questions related to the experience of taking part in the eye tracking experiment. Recorded eye tracking data was analysed via the gaze replay combined with the think-aloud and interview. The main purpose was to analyse the data together in the future workshop in reflective manner. Therefore questions to enhance the workshop discussion were developed based on the analysed data and workshop theme. The questions were related to the first impression and to the use of library.

The gaze replay was used in the future library workshop as inspiration material and discussion wakening. The test participants attended the workshop as well. It is possible to watch the gaze replay in normal speed or in slow motion, depending on the depth of the needed analysis on different interest areas.

The gaze replay includes the scene video and the gaze marked with the red circle, as shown in the snap shot of the conducted study below. In this workshop the gaze replays were seen in normal speed with some pausing followed by the questions and discussion with all of the participants. This part of the workshop took 35 minutes.



Picture 2: Using the SMI iView xHed in the library



Picture 3: Snap shot from the gaze replay in the library space's pilot study

Using the eye tracker in real life context may influence user's natural behaviour. The aim is to reach as natural behaviour as possible; otherwise the conclusions made by the study may lead to errors. As in the pilot study, participant felt the use of the mobile eye tracker in the library with other people so distracting that it was hard to carry out the initial task, which was free viewing of the library for the first time including the think-aloud protocol. However, when moving ahead to conduct the task viewing part of the study with the researcher on the side, the natural behaviour was easier. This was also verified in the post experiment interview by the user. Another participant stated how wearing the eye tracker was forgotten immediately, already before the actual experiment started. It can be assumed that the character of the participant is relevant when considering the natural behaviour of participants in the real life context carried out experiments. Merely the use of eye tracking alone without think-aloud might affect the feelings. The follow up of the actual experiment with an interview and the joint look at the gaze replay videos gives additional insights in user's normal behaviour.

The ability to evoke and maintain the dialogue between the key stakeholders via the eye tracking data was the main research theme in the pilot study. The visualised eye tracking data and the questions enhanced the dialogue between the stakeholders, lively discussion took place and lot of new insights were gained in the future workshop. All the participants were actively engaged in the discussion and the nature of the data proved to be usable in terms of dealing with the gaze replay in this manner. Brief qualitative comparison of the free- and task viewing patterns brought out similar findings as stated in the previous research; task viewing alters the viewing patterns of the users. As "everything happens" in an instant, we have to be able to determine what we see "at first sight" and what in that "first sight" makes

up the first impression. In this context, when aiming to track the visual attention of the user; eye tracking seems function well combined with think-aloud and interviews.

Results from the point of view of the case of the study eye tracking revealed e.g. eye-catching notices, horizontal instead of vertical eye-movements along bookshelves and unnoticeable shelf signs. In general this innovative pilot produced otherwise unreachable user information and provided a way to understand and develop library services from the users point of view.

## CONCLUSIONS

Based on this paper there is a need for broader study on utilizing gaze replays in catalytic or reflective role in the interaction between the users, developers and researchers.

The visualised eye tracking data enhances the dialogue with the user. Gaze replays or other forms of visualisation of the eye tracking data such as gaze plots of the paper prototype usage, can provide new insights for the researchers. In an interview situation interviewees are usually restricted to memory capacity only. The visualisation of eye tracking data offers information which can enhance the dialogue among the users and developers.

When analysing the eye tracking data together with the users, it is possible to gain deeper understanding of the user behaviour. This can be reached by analysing the findings together, by gathering the comments and feedback from the experiences after the experiment, and by formulating new research questions based on gathered information. After the first data analysis specified questions may be addressed to user(s) in order to reach the additional information needed. The found data can inspire new research questions and areas, and give insights or ideas for the needs of product- and service development.

In the pilot study of the library space, it was possible to gain useful information on the first impression of the library space by the gaze replay with the think-aloud data and the interviews. Conducting the post experiment interviews and watching the gaze replay videos together with the users were complementary to each other and verified the first findings done by the researcher herself when analysing the data.

To get some desired answers on the interesting why-questions related to users and their behaviour, eye tracking needs to be combined with other methods. One method to get more out of the eye tracking is to use so called retrospective think-aloud method (e.g. Hyrskykari & al. 2008). The experiences with the pilot studies were encouraging for analysing the eye track-

ing data qualitatively. The dialogue with the users enhanced by the gaze overlaid video may bring more accurate insights in the user's needs, wishes and grounds for their actions. Especially when combined with the think-aloud protocol and interviews, gaze replay gives detailed information about the issues drawing the attention of the user and his or her thoughts. However, it is also important in user studies to maintain the natural behaviour and patterns of usage in order to be able to make reliable conclusions. In some cases this might be jeopardised due to how taking part to the eye tracking experiment in real life context influences the behaviour of users.

Eye tracking could be used in the area of how people perceive things in their environment and how they understand these. This is the case when researchers aim at, for instance, discovering user's visual perception and attention towards the environment, people and their actions, or products and services as seen by the users in the areas such as ubiquitous computing or 3D modelling. Being able to find out how the users really perceive these would help the product- and services designers in their tasks. Another interesting research area for qualitative approach to eye tracking could be people in their everyday working environment. Interesting cases are how novices and experts work or the possibility to reveal tacit knowledge of experts. First impression is often the lasting one. As this paper indicates, eye tracking is also a way to track the first impression of a certain artefact, environment or even a person. The cognitive biases of each individual affect the evaluation of the user experience. The findings of the first impression study by the eye tracker and combined methodologies can be used to improve the first impression for other users in further encounters.

It appears that qualitative analysis of the eye tracking data reveals adequate information on users. This approach can be used as one of the tools for the researchers when analysing the user behaviour and trying to get deeper in to users' lives' and thoughts. New research questions can be raised from the analysis both via researches own views and via the dialogue with the users. The complexity of eye tracking equipment does not make it possible to use eye tracking in a manner of self documentation. Nevertheless, there is some similarity in the visual nature of the gaze replays as in the pictures taken by the users in design probes studies. It is interesting how these kinds of visual materials help to reflect on earlier experiences and re-live them. It would also be interesting to use the gaze replays as "mirror material" in change laboratories. The change laboratory is a method for carrying out developmental work research to study and develop work practices. With this method problems in daily work at the work place as well as the development of the future vision are identified, analyzed and implemented together. (Virkkunen, Engeström, Pihlaja, & Helle, 2001)

This paper has described how eye tracking can be applied both quantitatively and qualitatively in user research, despite of the small number of articles with the qualitative approach;

the main aim in this study was to discuss the use of the eye tracking data qualitatively. Based on the previously presented research in this article and experiences from pilot studies, eye tracking can be considered as a potential methodology in user research in real life context. Especially combined with other methodologies such as pre- and post experiment interviews, observation, think-aloud and retrospective think-aloud or workshops and other types of group activities with the eye tracking data as stimulation in the process, it appears to provide information unreachable with conventional user research methods. How qualitative approach to eye tracking could be applied in product- and service development needs is of special interest to the writer of this paper.

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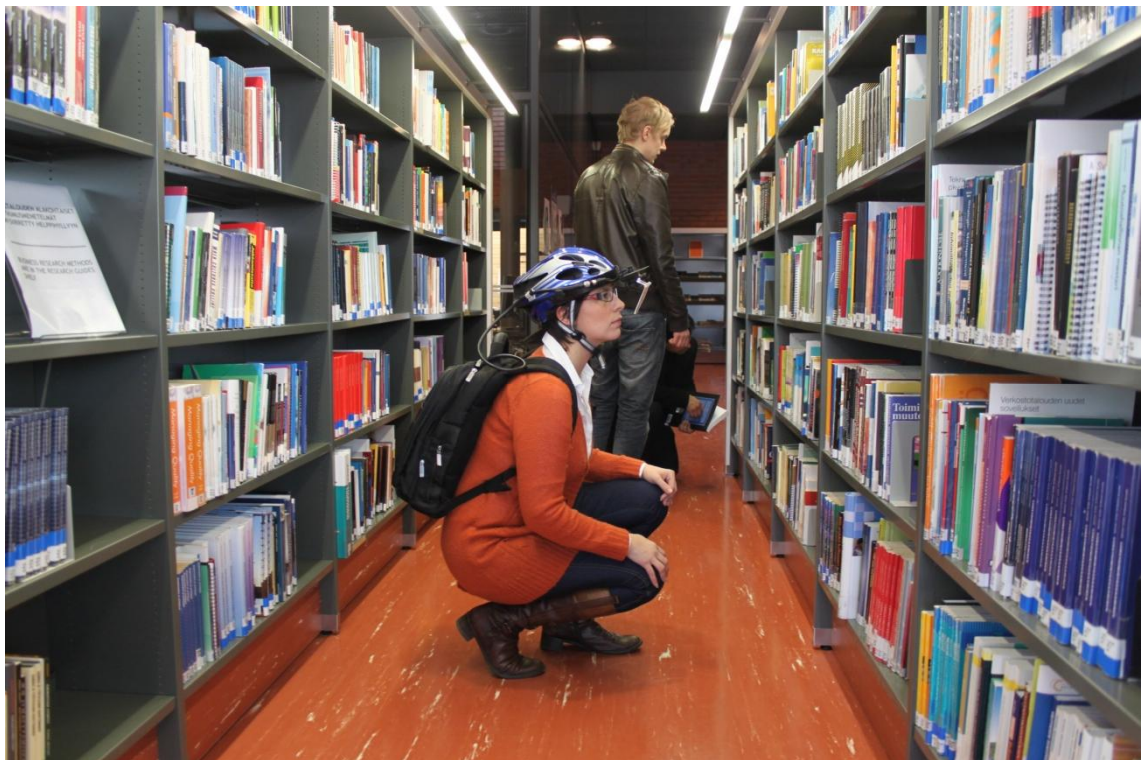
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#### 4.2 Kirjasto käyttäjän silmin. Käyttäjakeskeisyys voimavarana kirjaston kehittämisessä

Satu Hyökki/ Accepted unedited manuscript, published in SIGNUM 2:2011.

*Käyttäjakeskeistä suunnittelua ohjaa pyrkimys saada aikaan käyttäjää mahdollisimman hyvin palvelevia tuotteita tai palveluita. Suunnittelussa hyödynnetään menetelmiä, joiden ytimessä on käyttäjä. Laurea-kirjastossa tehdystä pilottitutkimuksesta katseenseurannalla selvitetiin muun muassa kirjaston ensivaikutelmaa ja aineistojen löydettävyyttä. Katseenseuranta-aineistoa refleктоitiin yhdessä kirjaston käyttäjien, henkilöstön ja tutkijoiden kanssa tulevaisuusverstaassa, jossa pohdittiin kirjastoa tulevaisuuden fyysisenä ja virtuaalisena olohuoneena. Pilottitutkimus loi aineistoa menetelmäkehitykselle, lisäsi ymmärrystä käyttäjakeskeisestä näkökulmasta ja tuotti kirjaston kehittämisen kannalta relevanttia käyttäjätietoa.*



Kuva 1: SMI iView xHED katseenseurantalaitteisto, Laurea Kerava

Käyttäjakeskeinen suunnittelu



Käyttäjakeskeisellä suunnittelulla (*user-centered design*) pyritään saavuttamaan tuotteiden tai palveluiden käyttäjiä parhaiten palveleva lopputulos. Tämä saavutetaan kun tunnetaan tuotteiden ja palveluiden käyttäjät, käyttötarkoitus, käyttökonteksti ja käyttöympäristö, eli niin sanotun käyttäjätieto. Keitä sitten ovat käyttäjät? Käyttäjakeskeisen suunnittelun näkökulmasta käyttäjä ei aina ole sama kuin asiakas. Asiakas voi olla myös välillisesti tuotetta tai palvelua käyttävä ihminen tai organisaatio, kun taas käyttäjä on aina henkilö, jonka käyttöön tuote tai palvelu suunnitellaan. (Hyysalo 2006.)

Käyttäjätiedon keräämiseksi alalla tunnetaan ja sovelletaan monia menetelmiä traditionaalisista haastatteluista ja kyselyistä sovellettujen havainnointi- ja etnografisten menetelmien kautta aina innovatiivisempiin erilaisiin visualisuutta hyödyntäviin ja osallistaviin menetelmiin. Yhteistä menetelmille on prosessin iteratiivinen luonne ja käyttäjien vahva mukana olo suunnitteluprosessin kaikissa vaiheissa. (Esim. Hannington 2003; Hyysalo 2006.) Käyttäjätieto tarjoaa suunnittelijoille inspiraatiota, ohjaa suunnittelun fokusta ja mahdollistaa empaattisen dialogin syntymisen käyttäjien ja suunnittelijoiden välille (esim. Koskinen, Battarbee & Mattelmäki 2003). Tämän päivän kokemuksellisuuteen pyrkivässä maailmassa myös tuotteiden- ja palveluiden ollessa kyseessä käyttäjäkokemus (*user experience*) on merkityksellisessä roolissa. Erityisesti käyttäjakeskeisen suunnittelun innovatiiviset ja empaattiset menetelmät tavoittavat parhaiten juuri kokemuksellisia asioita, jotka edellyttävät käyttäjien tunnetason saavuttamista ja tulkitsemista. (esim. Battarbee & Koskinen 2003, Mattelmäki 2006, Luojus 2010.)

Käyttäjakeskeisen suunnittelun periaatteita ja keskeisimpiä toimintoja määrittämään standardin (uusin 2010 päivitetty ISO 9241-210 *Human-centered design for interactive systems*). Sen mukaan ihmiskeskeisen suunnittelun periaatteisiin kuuluvat:

- a) *suunnittelun perustuminen eksplisiittisesti käyttäjien, tehtävien ja ympäristöjen ymmärtämiseen,*
- b) *käyttäjien osallistuminen prosessiin läpi suunnittelun ja kehittämisen,*
- c) *käyttäjakeskeisen arvioinnin toimiminen suunnittelun perustana ja parantajana*
- d) *prosessin iteratiivisuus,*
- e) *suunnittelun keskittyminen koko käyttäjäkokemukseen,*
- f) *suunnittelutiimi, jolla on monialaisia taitoja ja näkökulmia.*

Keskeisimpiä toimintoja iteratiivisessa suunnitteluprosessissa puolestaan ovat *käyttökontekstin määrittäminen ja ymmärtäminen, käyttäjävaatimusten määrittäminen, suunnitteluratkaisujen tuottaminen ja suunnitteluratkaisujen arviointi.*

Ehdotus käyttäjakeskeisin periaattein toteutettavasta ja katseenseuranta laadullisena menetelmänä testaavasta pilottitutkimuksesta sai Laurea kirjastossa hyvin positiivisen vastaanoton.

Yleisellä tasolla on ollut ilahduttavaa huomata, että käyttäjä nähdään tuotteiden- ja palveluiden suunnittelun näkökulmasta todellisena voimavarana yhä laajemmilla alueilla ihmisen ja tietokoneen vuorovaikutuksen alueen (*human-computer interaction, HCI*) lisäksi. Katseenseurantaa on hyödynnetty käyttäjäkeskeisessä suunnittelussa erityisesti kun arvioidaan käytettävyyttä, mutta vähemmän palveluiden kehittämisessä. Tutkimukseni perusteella erityisesti menetelmän hyödyntäminen laadullisista lähtökohdista on vähäistä.

#### Käyttäjän silmin - katseenseurantamenetelmästä

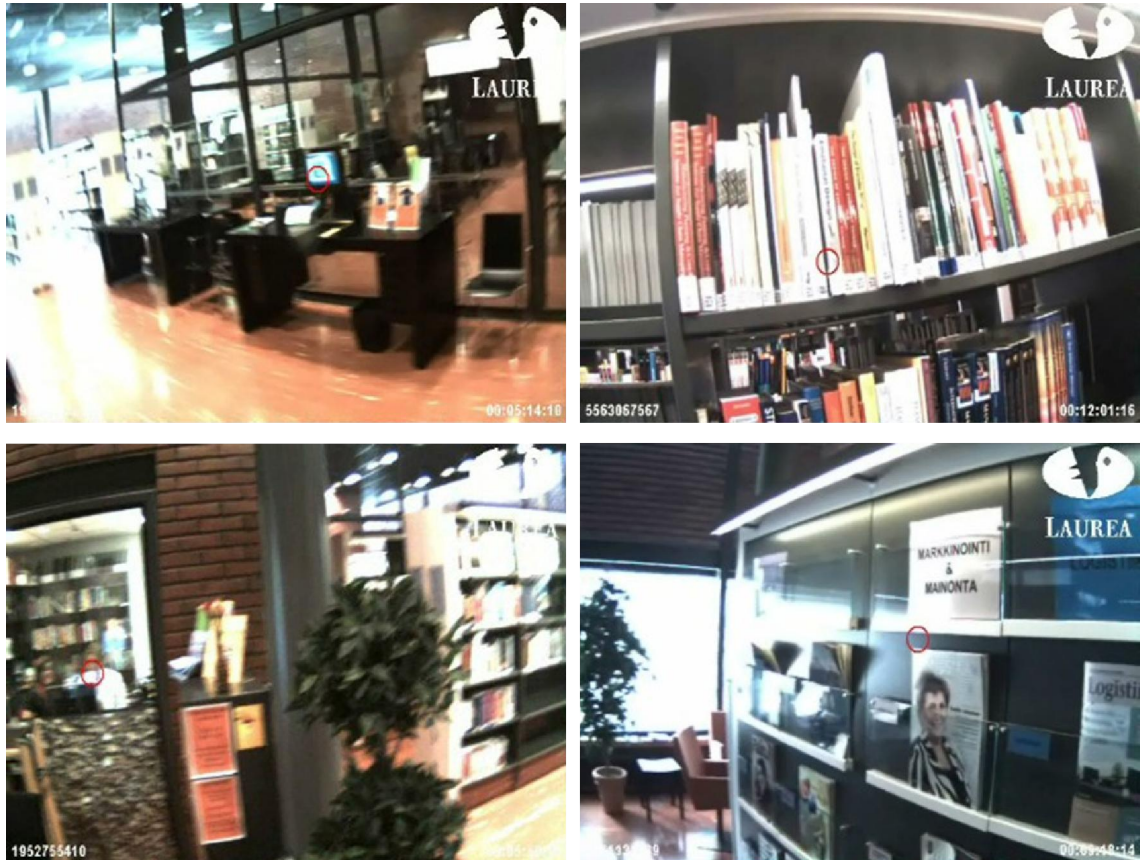
Miksi katseenseurantaa sitten tehdään? Voimakkaasti yksinkertaistaen, katseenseurannan avulla voidaan seurata käyttäjän katsepolkua ja selvittää mikä kiinnitti käyttäjän huomion, sillä hyvin usein kun katsomme jotakin, myös mielenkiintomme kohdistuu kyseiseen kohtaan. Toisaalta katseenseurannan avulla voimme myös havaita mikä ei kiinnitä huomiota, myös tätä tietoa voidaan hyödyntää suunnittelussa. (Duchowski 2007.)

Katseenseuranta on menetelmä, jota hyödynnetään esimerkiksi kognitiotieteiden, neurologian, psykologian, markkinoinnin ja mainonnan sekä ihmisen ja (tieto)koneen vuorovaikutuksen tutkimisen alueilla (Duchowski 2002; 2007). Katseenseurannan tuottama lisäarvo on siinä, että sillä voidaan päästään kiinni sellaisiin käyttäjän kokemuksiin tai ajattelemisiin asioihin, joita käyttäjä ei esim. tutkimuksen jälkeisissä haastatteluissa enää muista tai halua tuoda esille. Fysiologisesta näkökulmasta tarkasteltuna ihminen suodattaa silmillään ympäristössään havaitsemasta informaatiosta tietoa valikoiden, sillä aivomme eivät pysty prosessoimaan kaikkea kerättyä tietoa. Valo kulkee sarveiskalvon ja pupillin läpi silmään, jossa mykiö tarkentaa kohteen verkkokalvolle. Tarkan näön alue sijaitsee fovealla, jossa on valolle herkkiä soluja. Jotta kohde voidaan havaita tarkasti, tarvitaan fiksaatioita eli kiinnittymisiä, joilla näköinformaatio kerätään sekä sakkadeja eli ns. hyppäyksiä, jotka siirtävät silmän liikkeen seuraavaan mielenkiintoiseen kohteeseen. (esim. Duchowski 2007; Sundstedt, Whitton & Bloj 2009.) Tänä päivänä katseenseuranta perustuu yleisimmin videon hyödyntämiseen (*video based corneal reflection*), tekniikkaan, jossa sarveiskalvolta heijastetaan Purkinje-heijasteeksi (*Purkinje Image*) kutsuttava kuva. Tässä tekniikassa mitataan infrapunavalon heijastuman avulla silmän suuntaa tilassa. (Duchowski 2007.)

Käyttäjäkeskeisen suunnittelun näkökulmasta on mielekästä toteuttaa katseenseuranta todellisessa käyttöympäristössä laboratorio-olosuhteiden sijaan. Liikuteltavat katseenseurantalaitteistot, jotka kiinnitetään esimerkiksi lippalakkiin, pyöräilykypäaraan tai laseihin, ovat sopivia tähän tarkoitukseen. Katseenseuranta todellisessa käyttöympäristössä edellyttää huolellista suunnittelua ja saattaa vaikeutua tai olla mahdotonta esim. aurinkoisissa olosuhteissa tai tietyssä valaistuksessa, kun laitteiston oikeanlainen käyttö estyy.

Katseenseurannalla kerättävää dataa analysoidaan useimmiten määrällisin menetelmin, datasta voidaan kuitenkin tuottaa myös erilaisia visualisointeja. Näin muodostuvaa aineistoa voidaan tulkita laadullisista lähtökohdista yhdessä käyttäjien kanssa ja sen pohjalta saada paremmin vastauksia käyttäjätutkimuksen tekijää kiinnostavaan miksi? -kysymykseen. Eli esimerkiksi siihen miksi jotakin tapahtuu, mitkä asiat siihen vaikuttavat ja minkälaisia tunteita siihen liittyy. Mielestäni tämän tavoitteen saavuttamiseksi on kuitenkin usein paikallaan yhdistää katseenseurantaa muihin menetelmiin, kuten haastatteluihin, ääneen ajatteluun, havainnointiin tai vaikka työpajoihin.

Pilottitutkimuksen yhteydessä kirjoittaja teki laajan strukturoidun kirjallisuuskatsauksen katseenseurannan alueen tieteellisiin julkaisuihin. Katsaus vahvisti oletettaman siitä, että laadullinen ote katseenseurantaan ei ole vahvasti esillä alan julkaisuissa. Tämä rohkaisi osaltaan minua testaamaan syntyneitä ajatuksia katseenseurannan hyödyntämisestä osana käyttäjakeskeistä lähestymistapaa palvelujen suunnitteluun pilottitutkimuksen avulla. Pilottitutkimuksessa tarkoituksena oli testata katseenseurannalla kerättävän ja visuaalisen datan, tarkemmin sanottuna katsevideon (*gaze replay*) hyödyntämistä käyttäjä-tutkija dialogissa yhdistämällä eri menetelmiä. Katsevideossa yhdistyy kaksi videota, silmänliikkeitä kuvaava video sekä käyttäjän näkemää ympäristöä kuvaava video. Käytännössä tämä tarkoittaa videota, jossa käyttäjän katseen kulkua kuvaava kursori (esim. punainen rengas) liikkuu näkymässä, jonka käyttäjä on kulloisessakin tilanteessa nähnyt. (Kuva 2. Kuvakaappaussarja pilottitutkimuksen katsevideosta).



Kuva 2: Kuvakaappaussarja pilottitutkimuksen katsevideoista

### Ensivaikutelmaa ja aineistoja etsimässä

Pilottitutkimuksen käytännön kohteena oli Laurea-ammattikorkeakoulun Keravan paikallisyksikön kirjasto. Toukokuussa 2010 toteutettu tutkimus oli kolmiosainen. Tutkimuksen ensimmäisessä vaiheessa selvitettiin katseenseurantalaitteiston ja ääneen ajattelutekniikan avulla kirjaston tilojen ensivaikutelmaa joka syntyi käyttäjille. Toisessa vaiheessa suoritettiin aineiston paikallistamiseen kirjaston tiloissa liittyviä tehtäviä, ja kolmannessa vaiheessa katseenseurantatutkimukseen osallistuneet, kirjaston käyttäjät, henkilökunta ja tutkimuksen tekijät toteuttivat tulevaisuusverstaan. Seuraavassa tutkimus ja sen eri vaiheita käydään läpi hieman tarkemmin.

Tutkimuksessa käytettiin SMI iView xHED katseenseurantalaitteistoa, joka on pyöräilykypärään kiinnitettävä laitteisto, ja jonka repussa mukana kulkeva kannettava tietokone tallioi katseenseurantatutkimuksessa kerättävän silmänliikkeen (kuva 1.). Tässä tutkimuksessa tallennettiin lisäksi myös ääni. Katseenseurannan lisäksi suoritettiin havainnointia sekä haastatteluja, myös haastattelut nauhoitettiin. Pilotin katseenseurantaosuuteen osallistui kaksi potentiaalista kirjaston käyttäjää. Tutkimuslaitteiston kalibrointi ja käyttäjien tutkimukseen ohjeistus tehtiin toisessa tilassa, jotta tutkimuspaikka ja tarkoitus säilyivät loppuun saakka pimen-

nossa. Näin tehtiin siitä syystä, että ensivaikutelmaa tutkittaessa on tärkeää että osallistujat ovat käyttäjiä, jotka eivät tiedä tutkimuksen tarkoitusta eivätkä kohdetta. Näin voidaan todella selvittää sitä, mikä herättää käyttäjien huomion ensimmäiseksi ja minkälainen vaikutelma siitä syntyy. Ohjeistuksessa käyttäjille selvitettiin katseenseurantalaitteiston toimintaa ja ääneen ajattelun periaatteita. Sen lisäksi kerrottiin, että tutkimustilanteessa käyttäjien oli määrä kulkea vapaasti ja havainnoida ympäristöään esittäen ääneen ajatuksia näkemästään.

Tutkimuksen toisessa vaiheessa suoritettiin erilaisten aineistojen löytymiseen ja opasteiden havainnoimiseen liittyviä tehtäviä. Tehtävät määriteltiin yhteistyössä kirjaston henkilökunnan kanssa. Lyhyissä tehtävissä etsittiin määrätty lehti ja lukupaikka, kirjaston käyttöä ohjaavia opasteita ja tiedotteita, hyllyluokkia sekä tietty teos. Tutkimuksen ensimmäisen ja toisen perättäisenä toteutettujen vaiheiden jälkeen suoritettiin välittömästi haastattelu, jonka tarkoituksena oli kerätä vielä aineistojen vertailun mahdollistamiseksi tietoa kirjaston tilojen ensivaikutelmasta; siitä mikä henkilön mielestä kiinnitti ensimmäiseksi huomion. Lisäksi kerättiin tuntemuksia katseenseurantalaitteiston käytöstä ja sen vaikutuksesta omaan käyttäytymiseen sekä vapaata palautetta.

#### Tulevaisuusverstaas - dialogia ja ongelmanratkaisua

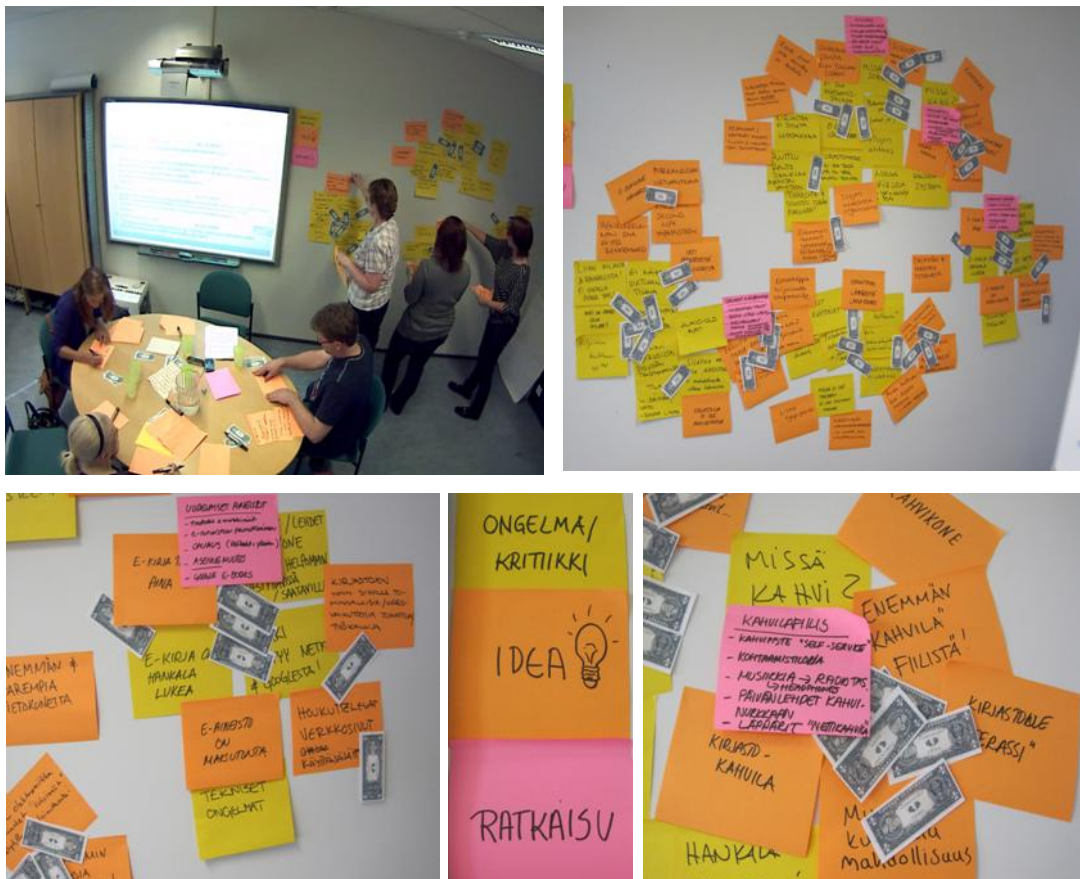
Tutkimuksen kolmannessa vaiheessa katseenseuranta-aineiston ensimmäisessä analyysissä poimittuja otoksia käytettiin tulevaisuusverstaassa (esim. Jungt & Müller 1987, Kiimamaa 2003), johon kutsuttiin kirjaston käyttäjäkeskeisen kehittämisen näkökulmasta keskeisiä tahoja opiskelijoista opettajiin ja kirjastonhenkilöstöstä tutkijoihin. Paikalle toukokuisena iltapäivänä saapuivat katseenseurantatutkimukseen osallistujat, yksi kirjaston käyttäjä, kaksi informaattikkoa, opiskelija-assistentti ja kirjoittaja itse. Tulevaisuusverstaan toimintaperiaatteet ja teema oli kuvattu verstaskutsussa eli *"Miten kirjastossa viihdyttäisiin paremmin? - Kirjasto tulevaisuuden virtuaalisena ja fyysisenä olohuoneena"*. Teemaa käsiteltiin kahden alaotsikon avulla: *kirjaston fyysisen tilan viihtyvyys ja digitaalisen ajattelun kytkeminen osaksi kirjaston "tilaa"*.

Verstaan kesto oli yhteensä noin puolitoista tuntia ja se toteutettiin tulevaisuusverstaan periaatteita vapaasti mukaillen. Perinteisen verstaastyöskentelyn (*ongelma-kritiikkivaihe, mielikuvitusvaihe, todellistamisvaihe*) lisänä toimivat katsevideot, tämän lisäksi perinteisen äänestämisen sijaan ongelmat ja ideat ostettiin "Laurea-rahalla". Jokaisella oli kuhunkin äänestykseen käytettävissä kolme rahaa, joilla saattoi vapaasti ostaa joko yhden valinnan kullakin tai laittaa kaikki rahat yhteen valintaan.

Katsevideot toimivat tilaisuudessa dialogin pohjalla paitsi puhtaasti antamalla inspiraatiota keskustelulle myös luomalla käsiteltävälle asialle yhteisen ymmärryksen pohjaa. Katsevideot katsottiin aivan verstaan aluksi, ja ne liittyivät sekä ensivaikutelmaan että kirjaston käyttämi-

seen liittyneisiin tehtäviin. Katsevideota voidaan katsoa eri nopeuksilla. Todella nopea katseenliike on paremmin tulkittavissa hidastettuna. Verstaassa katsevideot katsottiin normaali-nopeudella ja pysäytettiin välillä tarvittaessa, jotta voitiin kuunnella myös käyttäjän ääneen ajattelua. Katseenseurantatutkimukseen osallistujille esitettiin myös kysymyksiä, jotka oli laadittu analysoinnin pohjalta. Kysymykset liittyivät edelleen niin ensivaikutelmaan ja huomiota herättäneisiin seikkoihin kuin kirjaston käyttämiseenkin. Kysymysoisuuden pohjalta aiheista keskusteltiin yhteisesti. Sekä kirjaston henkilökunta, että katseenseurantaan osallistuneet näkivät tilaisuudessa katsevideot ensimmäistä kertaa. Spontaanit huomiot kuten: "Olin aivan varma ettei kukaan ikinä huomaa noita opasteita!" ja "Minua sitten tosiaan kiinnosti tuo lainausautomaatti :-)" virittivät keskustelua ja saivat aikaan vilkkaan, miellyttävän ja erityäin inspiroivan hetken, jonka pohjalta oli luonteva yhdessä ja yhteisellä "taajuudella" siirtyä pohtimaan kirjaston tulevaisuutta. Tämä osuus verstaasta kesti noin 40 minuuttia.

Verstaassa syntyi tulevaisuuden kirjaston kehittämisen kannalta neljä teema-alueetta. Tutkimuksen tuloksia käsitellään seuraavaksi lyhyesti sekä menetelmäkehityksen että käytännön Laurea -kirjasto casen kannalta.



Kuva 3: Kuvasarja tulevaisuusverstaasta  
Katseesta käyttöön - pilottitutkimuksen tuloksia

Pilottitutkimus antoi kirjoittajalle valmiuksia katseenseurannan toteuttamiseen tosielämän ympäristössä. Se loi lisäksi erittäin hyvän pohjan ja empiirisen aineiston katseenseurannan hyödyntämisen pohtimiseksi osana käyttäjä-suunnittelija dialogia ja empaattista tutkimusotetta. Menetelmäkombinaatio mahdollisuuksia voitiin arvioida ja tarkastella (eri vaihtoehtojen soveltuvuus, aineistojen ristiinarviointi) sekä analyysivaihtoehtoja testata. Erityisesti saatiin varmuutta visuaalisen katedatan käyttämisestä dialogisesti käyttäjien ja asiakkaiden kanssa. Koska kyseessä oli ennen kaikkea menetelmän testaaminen, ei pilotti casen aineiston analyysi kuitenkaan ollut ensisijaisessa roolissa. Osana tutkimusta haluttiin selvittää myös katseenseurantalaitteiston käytön vaikutuksia käyttäjän käyttäytymiseen ja sen luonnollisuuteen, tämä osuus toteutettiin havainnoinnin ja haastattelun kautta. Vaikutus on selvästi käyttäjän persoonasta riippuvaista, mutta yleisesti ottaen voidaan todeta, että tutkimuslaitteiston käyttö unohtuu testitilanteessa yllättävän pian.

Pilottitutkimuksen pohjalta voitiin selvästi havaita miten vaikuttavaa on visualisoinnin hyödyntäminen kokemuksen ja tilanteen jakamisessa. Tämä helpottaa henkilöiden välistä keskustelua ja näin käsiteltävän asian ymmärtämistä ja yhteisen näkemyksen muodostamista. Katseenseuranta-aineisto voi toimia puhtaasti inspiraation lähteenä suunnittelijalle ja käyttäjätiedon keräämisen välineenä, kun aineistoa hyödynnetään käyttäjä-suunnittelija dialogissa.

Laurea kirjaston näkökulmasta tutkimus antoi ennen kaikkea näkemystä käyttäjäkeskeisten menetelmien soveltamisesta ja hyödyllisyydestä kirjastokontekstissa. Laurea kirjaston innokkuus kehittää kirjastoa periaattein, jossa kirjasto nähdään avoimena *living lab* -ympäristönä on otettu ilolla vastaan. Haluan kiittää kirjastoa mukavasta yhteistyöstä!

Vaikka tutkimuksessa testattiinkin ensisijaisesti menetelmää, saatiin testaamisen lisäksi myös kirjaston kannalta konkreettisia tuloksia ja inspiraatiota tulevaan kehittämistyöhön. Katseenseurantatutkimuksen, haastattelun ja tulevaisuusverstaan tulokset täydensivät toisiaan ja olivat vertailun pohjalta pitkälti yhteneväisiä. Kirjaston tila hahmotettiin ensi näkemällä hyvin, yksittäisten aineistojen löytämisessä sen sijaan oli enemmän haasteita. Kirjaston ensivaikutelma oli valoisa ja rauhallinen, hyvin organisoitu ja heti kirjastoksi tunnistettava, vaikkei sitä olisi opastein kerrottu. Tilaan tullessaan käyttäjät seurasivat katseillaan opasteita ja julisteita. Myös aulan lainausautomaatti kiinnitti runsaasti huomiota. Esille käännetty kirjat huomattiin hyvin. Kirjaston henkilökunnan havaitseminen ja ”löytäminen” näkyi selvästi, olivat he sitten näkyvillä tai piilossa. Myös muihin ihmisiin kiinnitettiin huomiota. Kirjaston opasteet myös nähtiin, tiedostettiin ja niitä osattiin hyödyntää kohtuullisen hyvin, toisin kuin ennakkoon oletettiin. Tätä tulkintaa tuki vapaassa katselussa (ensivaikutelma) havaittu opasteiden ”skannaus” verrattuna tehtäväpohjaisen katselun katsepolkujen analysointiin. Tätä tukivat myös asiaa täsmentäneet kysymykset haastattelussa ja verstaassa. Aineiston etsintään liittyi ennakkoidun mukaisia haasteita, kuten lainattavien lehtien löytäminen. Informaatikot yllättyi-

vät myös katseen runsaasta horisontaalisesta kulusta kirjaa etsittäessä, tosin lähestyttäessä oletettua sijaintia katse kulki paikoin vahvasti vertikaalisesti selkämyksissä. Signumeiden hyödyntäminen etsinnässä vaihteli käyttäjittäin. Hyllyn päätyopasteet huomattiin, mutta hyllyjen vaakaopasteita ei hyödynnetty tehokkaasti.

Tulevaisuusverstaan tuloksena tulevaisuuden kirjastossa tärkeäksi nähtiin *uudet ja erilaiset käyttömahdollisuudet* (aukioloajat, korvatulpat, ulkotilat, kokoontumispaikat...), *kahvilafiilis* (lukeminen ja kahvi kuuluvat yhteen, nettikahvilamalli...), *erilaisia toimintoja paremmin tukeva sisustus* (olohuonemaisuus, kohtaamista tukeva sisustus, tilan jakamisen luovat keinot...) ja monentyyppiset uudenlaiset aineistot (*pelit, toiminnalliset ja vuorovaikutteiset web-aineistot, e-aineistojen käytön edellytysten parantaminen*). Tulevaisuusverstaan ideoita jaettiin ja tuloksia käsiteltiin myös Laurea kirjastojen yhteisessä kehittämispäivässä kirjoittajan pitämän alustuksen ja katsevideoiden pohjalta. Katseenseurantatutkimuksen tulosten perusteella Keravan kirjastossa uusittiin opasteita ja sijoitettiin niitä uudelleen, sekä nostettiin aineistojen löytyminen asiakaspalvelun erityisen huomion kohteeksi. Tähän liittyen käynnistettiin osallistuvan havainnoinnin projekti.

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## 5 Visual Eye Tracking Data as Medium in User Dialogue

This chapter discusses the main theme of the thesis, in relation to the use of gaze replays in user studies, dialogue and visualisations have been considered to play an important role. First this chapter aims to present the demand for the dialogue, skills needed when having a dialogue, and additionally some general ideas and cases for the efficient dialogue, from the point of view of user-centered design.

Secondly, visualisation is founded out to be one of the main means for dialogue in the literature review. Visuals and visual representation is a broad area with numerous possibilities. However, gaze replay is assumable the only form of visuals allowing us to follow the gaze path of a user. This thesis aims to create a model for gaze replay enhanced *user dialogue*, taking a look at ideas from designing with video and interpretation of video format data is considered useful. The nature of the gaze replays is discussed at the end of the chapter.

### 5.1 Enhancing the User Dialogue

In chapter 2.1, we have learned from the evolution of the dialogue, now that we know the basic construction of it, it is easier to develop something new upon it. This chapter aims to discuss different ways for enhancing the user dialogue on a general level also by presenting some cases and contexts highlighting the meaning of the dialogue. In the next chapters these findings along with the meaning of visualisation are then reflected in the context of using eye tracking data catalytically between *users and designers*.

In their appraisal of service design, Saco & Goncalves (2008, 18) have been figuring out strategies for the future service design practise. Among highlighted strategies they suggest opening the design process for the dialogue. Prototypes should be harnessed as a "*vehicle for dialogue*" meaning that instead of protecting the design from any interference, it should be opened and available for discussion and dialogue both internally and externally. This thesis emphasises the *user dialogue* as means to achieve this openness.

Dialogue is a way to share experience-based knowledge. However, there is no guarantee that engaging in a dialogue leads to agreeing, yet this kind of dialogue may be successful in terms of knowledge. The main function of the dialogue is to create understanding. (Backlund & Sjunnesson, 2006, 141.) A dialogue, even though usually considered as a shared activity, depends on individual level of actions. According to Isaacs (1999, 29-31), in order to be able to think together via dialogue, we must learn to take three levels of actions: 1) produce coherent actions, 2) create fluid structures of interaction and 3) provide wholesome space for dialogue. In the first level we need to learn to be aware of contradictions between our sayings and doings. According to Isaacs, we need to learn four new behaviours for the dialogue; listening, respecting, suspending and speaking our voice, hence, *capacity for new behaviour* is needed. On the second level we need to learn to understand the forces underlying the conversations such as understanding others actions and the impact we have on others. Isaacs calls the ability to understand these forces and develop ways to manage and anticipate these interaction-blocking issues *predictive intuition*. On the third level Isaacs highlights the importance of an atmosphere of interaction, which each individual brings to the situation. This space for a dialogue is comprised of the origins of one's own ways and habits to think and also from the quality of attention brought along. Isaacs suggests being more conscious of this *architecture of the invisible* atmosphere.

Sengers, Boehner, David & Kaye (2005, 49-50) found in their study related to the design practice in HCI that design practices should support both designers and users to lead an ongoing critical reflection towards the use and role of technology. In their study they discuss especially the importance of designers reflecting whilst designing (see Schön 1983, 49-69 for reflection-in-action), in addition they highlight the dialogic engagement between designers and users through technology. The importance of involving users is emphasised - allowing them to participate in the design process to inspire rich feedback including their reflection.

Related to their study with a Danish manufacturing company Buur & Bagger (1999, 64-66) argue that in usability studies a dialogue instead of the traditional usability test facilitates the reveal of the user priorities and practices otherwise remaining hidden. The study also states that a dialogue with the users helps to anchor the insights to the research and development (R&D) department and enables moving beyond product critique to innovative engagement in design. For constructing the dialogue they have brought together the test facilitator and users, used video communication procedures to both observe and communicate the findings, and involved the R&D personnel in the actions as well as the users in design.

One way to create and evaluate design alternatives is sketching. New ideas may arise through sketching (Arvola & Artman 2006, 4; Tohidi, Buxton, Baecker & Sellen, 2006, 105; Tversky

2002, 3). Additionally, sketch allows a dialogue between sketch and the viewer. Sketches can enhance thinking and be used in the dialogue, but according to Arvola & Artman (2006, 29, 16), only enactments and dramatisations make the sketches behave and enhance the communication. Enacting helps the designer explore the design and imagine the target context of its use. Tohidi et al. (2006, 105) have been developing the idea of sketches even further by involving the users in the process. When enabling users to sketch their ideas, reflection is facilitated and as a result rich medium for identifying and communicating design ideas was provided. Using sketches with users instead of usability testing produced reflective user feedback instead of a reactive one.

Tackling with the challenge to make the invisible visible is hard. Yet, design often aims at this, when trying to reach the latent needs of the users. Haldin-Herrgard (2000, 358) points out that tacit knowledge is stored in human beings and cannot be taught nor managed as it is obtained through experience, reflection, internalisation or individual talents. Ba, as the Japanese call it, is highly personal and hard to formalise, therefore also difficult to share with others. Ba is a shared physical, virtual or mental (or any combination of those) space with knowledge embedded in it. Tacit knowledge can only be exchanged through social activities. In fact, dialogue is the key for making tacit knowledge explicit. Sharing mental models and skills is a route towards a shared understanding, and explicit knowledge is built. This is called *interacting ba*, including not only sharing the mental models and skills of others, but also reflecting and analysing one's own. (Nonaka & Konno 1998, 41-47.) Revealing the tacit knowledge is one reason for developing the model using *user dialogue*.

Experiences are often highlighted in the *user dialogue*. According to Wright et al. this process of reflecting on previous experiences is called an inner dialogue with one's self and with others. It helps us examine the experience by evaluating it and relating it to other experiences (Wright & al.2003, 49). If this inner dialogue is taking place afterwards it can be enhanced with visual data on the actual action. This gives more reflection points by simply recollecting on the experience. Wright, Wallace & McCarthy (2008, 6-8) point out that the experiences are composed of the engagement with the world through multilevel act of sense-making. In their dialogical view of experience, they point out that experience is as much about what the person entails than it is what she/he encounters there. When the experiences are shared with others, a connection between the individual, the social and the cultural is built up. This connection in turn affects our own reflection and interpretation of our experiences. Along with everyone's unique character, understanding of meaning has multiple perspectives. In consequence, the essential foundation of a dialogue is established when one is able to simultaneously see something from one's own perspective and at least to some extent from others. As they argue (2008, 8): "In a dialogical account, the meaning of an action, utterance, expression, or artefact is open because its interaction with others makes its meaning contingent" ...

“with a dialogical lens, recounting experience becomes not simply an act of reporting but rather an act of co-construction of meanings.” With this statement Wright et al. point out the essence of this thesis, the idea that it is possible to create shared understanding and co-constructed meaning through dialogue enhanced by the gaze replays.

According to Luo (2010, 87), deeper analysis of the research data can be gained with joint interpretation of the data by users and researchers. This statement is also behind this thesis and its aim to construct a model of *user dialogue* enhanced by gaze replay. The model of *ci2i* is all about users being engaged in the dialogue. Dialogue is needed in order to interpret and co-create meaning together.

### 5.1.1 Meaning of Visualisation

According to McLoughlin & Krakowski (2001, 1): “The term visualisation is familiar to us from common usage and fundamentally means ‘to form and manipulate a mental image’. In everyday life, visualisation is essential to problem solving and spatial reasoning as it enables people to use concrete means to grapple with abstract images.” Tversky (2002, 1) says that: “Expressing ideas in a visual-spatial medium makes comprehension and inference easier than in a more abstract medium such as language”.

Unlike traditional cognitive psychology practitioners, Gedenryd (1988, 147) has been creating a theory on interactive cognition. He argues that cognition is created in interaction with the environment and its artefacts; the world is a part of cognition: “World makes effective interactive cognition possible; this is the role of physical working materials in design. Interactive cognition relies on mind, action and world working together; its superior performance depends on the immediate presence of those physical materials that it is concerned with.”

According to Agravala, Li & Berthouzoz (2011, 60), visual communication is essential when reviewing concepts and disseminating information. It improves comprehension, memory and interference. At its best, visualisation profits from the way humans process visual information. Maffei et al., (2005, 6) point out the visual nature of service design by claiming that the service design tools are focusing on design, description and visualisation of the user experience by using various tools for interaction and supporting representation. This is supported by Holmlid’s (2007, 5) comparison of interaction design and service design. The comparison argues that service design similarly to interaction design is a highly visual design discipline. As Gedenryd (1988, 200) simply states: “Design is a representation - hungry domain”.

Osterwalder & Pigneur (2010, 148 - 159) discuss the meaning of visual thinking in context of business model generation. According to them visual thinking means using visual tools such as

pictures, sketches, diagrams, post-it -notes etc. to construct and discuss meaning. Visuals, such as pictures, deliver the message instantly and express efficiently the ideas which otherwise require many words to explain. They propose four processes which are improved by visual thinking; understanding the essence, dialogue, exploration of ideas and communication.

Visualisations enhance the dialogue between all stakeholders and can contribute to the development of the project itself and its outcomes by making ideas more tangible, complexity more readable and alternatives sharable (Segelström 2009,1 ; Segelström, 2010, 68 ; Diana, Pacenti & Tassi, 2009, 2). A multisensory stimulus allows analogies, associations and multiple interpretations to take place; this may enhance the results (Jääskö & Mattelmäki 2003, 130). Segelström (2010, 67 -68; 2009, 1 -6 ) studied the use of visualisations in service design in his two-fold study. In the study he has focused on the role of the visualisations as a supporting tool in user research and on the communicative aspects of visualisation. In the first phase of his study he interviewed service designers, and in the second phase he analysed the visualisations in real service design projects. According to his study, "live and movable" visualisations such as drama or video have been mentioned in the first interview -part (with 14 interviewees, 58 visualisation techniques were mentioned) but not found at all in the projects in the second part of the study. Segelström points out that with the visualisations it is possible for the service design practitioners to communicate and articulate insights and keep empathy. The Service design community has taken the leading role in highlighting the use of visualisations because academia has paid less attention to visualisations.

Segelström (2010, 53, 69) has been using and proving the framework used in service design useful for analysing the visualisation techniques in service design (in any stage of the process) by Diana, Pacenti & Tassi (2009, 2- 8). The framework has two main notions for analysing visualisations: *iconicity* and *time*. Visualisations (or representations as called by Diana & al); can be found in the scale with the following contradictory endpoints. *Iconicity* refers to a sort of visualisation material and to how realistic it is (realistic - abstract). *Time* refers to visualisations ability to "give an instantaneous picture of the service -synchronic- or to visualise the sequence of actions and stages that compose the service experience -diachronic". (Diana et al. 2009,3).

Diana et al. (2009, 4-8) argue the potential of this framework to describe all main visualisations types/techniques. They describe the four visualisation types in service design as follows and the framework is illustrated in figure 4. In this figure *maps* mainly describe the structure behind the service; by representing the actors and devices involved and their existing relations, hierarchies and exchanges, such as mind maps, affinity diagrams. *Flows* are abstract representations which determine the orientation and reading path. In service design flows show the steps of the interaction and phases of the experience, such as service blueprint.

*Images* are realistic representations, often photographs of the most immaterial and emotional aspects of the service having the evocative potential to help the imagination work. Images can describe some intangible aspects better than words. Images used in this category are for example moodboards and service images. Images can be used also to support envisioning, this is called evidencing. *Narratives* instead comprehend all the visual storytelling techniques and give their meaning by telling the whole story; by the sequence of the proposed images more than by each single frame. Narratives work well when visualising the (realistic) user experience. Visualising the most intangible sides of the experiences is challenging. When trying to answer the needs of representing the experience in terms of perception, performances, behaviours' and feelings, tools like *filming the interaction* with models, *experience prototype* and *service prototype* are used. Service prototype is claimed to be the one closest to reality.

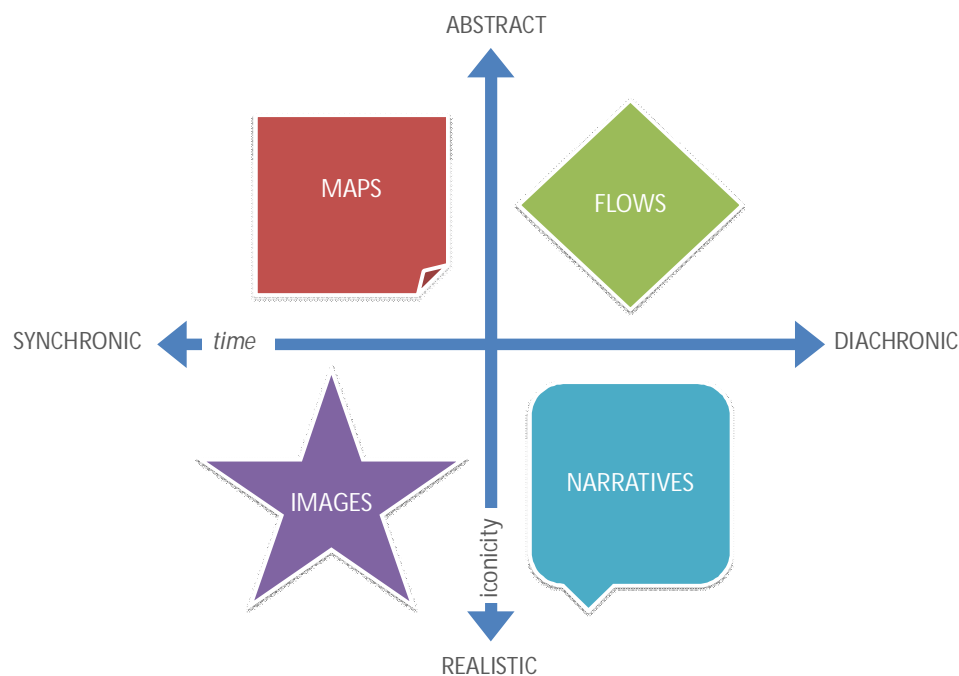


Figure 4: Framework for Visual Representations<sup>3</sup>

Next chapter takes a look at the framework by Diana et al (2009, 2-8) from the point of view of visual eye tracking data. Additionally it reviews the gaze replays from the point of view of the *user dialogue*.

### 5.1.2 Nature of Gaze Replays

<sup>3</sup> Adapted from Diana et. al. 2009, 4

There are three main ways to visualise eye tracking data, heat maps, gaze plots and gaze replay videos (see e.g. Nielsen & Pernice 2010, 10-13). With heat maps the interesting gaze path of the viewer is missing. Eye tracking allows us to record the gaze as it moves along in the scene seen by the user. Revisiting it once more, gaze replay is a video format showing both the scene as seen by the user and the user's gaze moving along in that scene. The movement of the gaze in the scene is indicated with a gaze cursor, usually a red circle or other figure. This study has chosen to use gaze replays as the studied medium, in addition to capturing the gaze path, it is possible to combine gaze replays with other methods (e.g. think-aloud). As a result it produces richer medium to share in the dialogue.

When positioning the gaze replays in the previously presented visualisation framework by Diana et al. (2009, 4) we could conclude that in this framework narratives are the form of visualisations closest to gaze replays. However, it can be remarked that since gaze movements are very fast, one can, and sometimes wisely does, analyse the replays also frame by frame in order to get a more adequate picture on the matter compared to the one only seen by sequence. Gaze replays are trying to answer to capturing the experience of the users' in terms of perception, performances, behaviours' and feelings; hence, eye tracking visuals belong to the group of realistic visualisations. The added value of eye tracking in comparison to any other method is that it is possible to capture the visual perception of a studied service with, for instance, a service prototype. This provides a strong evocative effect which can be used in the dialogue with various stakeholders. In terms of iconicity, gaze replays are rather realistic; in terms of time, more diachronic than synchronic. According to Diana et al (2009, 8), the gaze replays are diachronic as "the meaning emerges from the sequence: the attention is in the narration, as a tool for projecting the reader in living an experience". However, contrary to discussions on visualisations as presented earlier in this paper by service design researchers, gaze replays are visuals produced with the users, not by the designers, which is often the case with visualisations in service design. Albeit designers have a role in the process, when they edit the gaze replays.

Gaze replay can be used and placed in any of the three groups defined earlier by Segelström (2009, 5; 2010, 48 -49) in the context of visualisations in service design. Consequently, visual eye tracking data can be used to communicate insight, articulate insights and keep empathy. Then it is a medium well adapted for communication as it helps to establish a common language and a common starting point. It helps to recall the specifics with the project and review the context any time needed. Gaze replay helps to communicate progress, context or need to any of the stakeholders. Segelström (2010, 48-49) groups the different reasons for visualising the user research information from the point of view of visualisation as a communication tool. The groups for communicating are the following: articulating insights within a design team, keeping empathy with one's own memory, sharing insights with stakeholders

outside the design team. With gaze replays in *ci2i*, the *user dialogue* is emphasised, therefore articulating insights is essential and moves also towards the users.

In line with the thoughts by Osterwalder & Pigneur (2010, 148-159) presented previously, in the use of eye tracking data in the *user dialogue*, gaze replay can provide visual guidance and a general view of the issue. It also delivers the right amount of information to allow the viewers to see the right details objectively. The eye tracking data reduces assumptions and biases by proving facts seen with your own eyes. It provides us a collective reference point; it is always possible to return to the data and think again. Eye tracking data can be described as a common language among the viewers supporting the exchange of ideas, making it possible to discuss issues such as options, situations, context and alternatives from the point of view of users. Visualisation enhances the formation of shared language, it is important in order to achieve shared understanding, *ci2i*.

As stated also by Segelström (2009, 1,) various visualisation tools all serve the purpose of communicating user data to different recipients. "Seeing as" is important for designers (see e.g. Goldsmitd 1991, 131; Schön 1983, 141; Arvola 2006, 4; Tohidi et al. 2006, 106). Gaze replays represent and show things as they really are, without the need to represent the scenario or refer to imaginary objects or settings. According to Goldschmidt (1991, 131), designer is "*seeing as*" when she or he is using figural argumentation in design thinking and "*seeing that*" when proceeding with non-figural arguments based on the current knowledge of the entity that is being designed. Designers shift between seeing as and seeing that, this process is carried out in a cyclic manner. It is called dialectics of sketching. *Seeing as* stimulates new ideas, while *seeing that* prompts assessment of consequences.

Tohidi et al. (2006, 114) present the use of sketching as means of communication producing reflective feedback instead of a reactive one. In line with this, gaze replay can be used as visual representation producing more reflective feedback. In relation with eye tracking, Hyrskykari & al. (2008, 11-14) have been proving that retrospective think-aloud using eye tracking as "playback" produces more and better quality of the data than standard think-aloud.

In comparison to the use of traditional video in design (see chapter 5.2.1) gaze replay is documenting the situation as seen by the user and user's interaction with the situation from the point of view of user's eyes. In case of the need to observe other types of action "from outside", such as facial expression and gestures or other actions out of reach of the gaze replay and the scene video recording, it is recommendable to use other methods combined such as observation, photographing or video recording.



Adapting freely the above presented seeing as -model by Goldschmidt, for the use of gaze replays in the *user dialogue*, the process drawn in figure 5 can be formulated: *The See Eye to Eye Dialogue*. When the figure is examined, conducting an eye tracking study begins from “seeing that” and moves in a cyclic manner from left to right. Gaze replays are created based on current knowledge in “*seeing that*” manner in order to catch the user’s point of view on the studied case. This follows interpreting the representation of the data (gaze replays) together with users in a form of “*seeing as*” -dialogue, which allows us to create new knowledge and a shared understanding, eliciting “*see eye to eye*” or *ci2i*.



Figure 5: See Eye to Eye (*ci2i*) Dialogue<sup>4</sup>

## 5.2 Gaze Replays in Dialogue as Form of Video

Before moving to discuss the use of gaze replays - one could say a particular form of video - as medium in the *user dialogue*, a review on the use of “traditional” video recording in the design process is provided, to get an idea of the possibilities with video in design. With video - no matter of what sort of, capability for prolonged observation is given, and thus it can reveal behaviour that would otherwise remain undiscovered. Additionally issues needed to take into consideration when interpreting materials such as video is discussed. This is fol-

<sup>4</sup> Based on Goldschmidt (1991, 131)

lowed by a short reflection on gaze replays and their interpretation compared with standard video data.

### 5.2.1 Ideas from the Field of Designing with Video

The ability to foresee the situation arising when a new product or service is introduced to its social settings for the first time is essential for the design process. It is important to further understand different point of views to be able to predict the interaction of different elements of it in the new situation. Video is a suitable tool for this, as it can help bring together the study on use context and the participation of the users, and the understanding how the users perceive the environment they are acting in. (Ylirisku & Buur 2007, 7-10.) It is agreeable as Jordan & Henderson (1995, 14) are pointing out that one of the good reasons for relying on video is that it allows us to be responsive to the phenomenon itself, than to the nature of the representation that are reconstructing it, and thereby limiting the analysis.

Video studies can be used as a medium to render the use context visible to design and construct relevant material both inspiring, and informing design process. Video provides possibility to engage people in collaborative learning process and capture real-life activities in real life settings. (Ylirisku & Buur 2007, 41-43.) Video allows capturing and showing activities, holding things as they are, free of de-contextualized explanations or interpretations. (Ylirisku & Buur 2007, 45; Jordan & Henderson 1995, 14). As argued by Mackey, Razer & Janeck (2000, 1) video can be used throughout the design process, from initial observation, to system evaluation. Video can also enhance communication among design team members (Mackey et al. 2000, 5; Jordan & Henderson 1995, 14). An idea, on which the *user dialogue* is partly build upon.

The question how the presence of the camera influences the behaviour of people arises often. According to Jordan & Henderson (1995, 55 - 56), this is an empirical question that needs investigation on each time camera work is conducted. However, as this is discussed also in the articles on eye tracking presented before, the experience shows that when people get involved in the tasks given, they lose conscientious of the presence of a camera and the camera effects; these biases sometimes occurring such as making faces, clean up the speech and other cautiously actions in front of the camera, wear off. Anyhow for the participants themselves, different behaviours occur on different levels of awareness; if and when a notice of a camera is taken, different behaviours are more readily modifiable, talking for instance. Gestures and body language are harder to manipulate, as micro behaviours such as gaze and head turns also. Even if people take notice what they say, it is hard for them to influence on the mechanisms orchestrating talking, such as eye blinks or turn transition. Gaze replay provides the view of the user as presented earlier e.g. in chapter 5.2.1. However, when observing with

video, the designer can choose to either bring the role of the camera in front of the whole recording situation as "fly in the eye" or decide to take the distance with the approach often called "fly on the wall" (Ylirisku & Buur 2007, 48-49; Mackey, Razer & Janeck 2000, 11-12).

In their exhaustive book *Designing with Video*, Ylirisku & Buur (2007, 60 - 78) describe following design with video methods: Situated interview, shadowing, in-situ acting and self-recording. These methods however, are not described in this review, as the focus is more in over all use of the video and how the gathered data is interpreted. More about that next.

### 5.2.2 Interpretation of Video Format Data

Interpretation is needed to extract the relevant data from the huge amount of potentially relevant data. Human behaviour from how people move to how interaction is carried out by talking, calls for interpretation. Video simply repeats what it records. The sensitive and detailed nature of how video preserves the action allows close scrutiny of the events and enables the designer to construct a deeper understanding. (Ylirisku & Buur 2007, 91-92.)

The dilemma in conducting user studies with ethnographic approach is the relevance of the materials collected. It is a matter depending on the nature of the focus in the study. In any case the relevant nature of data is produced in the analysis and interpretation of the material. (Anderson 1994, 157.) This highlights the importance of planning the objectives and research questions of the study prior to it. On the other hand, open focus might be needed, if the aim is in the fuzzy-front end of the design process, and finding inspiration for the designers concerning latent needs of the users. As stated by Ylirisku & Buur (2007, 51) iterative framing of the focus is needed, even if the focus comes partly from the scope of the project.

Interpretation of video needs making sense of digitally reproduced stimuli and description of them in new ways; it is a complex and multi-layered process (Ylirisku & Buur 2007, 93). According to Ryle (1968), a single act can provide many layers of different meanings, even if for the person doing the act, it means just that one act. Meanings are depending on the interpreter. Consecutive interpretations occurring after another formulate the process of interpretation. In Ryle's words this so called thick-description is a many-layered "sandwich of meaning". As stated by Ylirisku & Buur (2007, 93) "Design interpretations calls for the capacity to identify patterns that transcend individual observations of human interactions, the skill to build new ideas on these and the ability to relate the whole to a design project's aims".

The challenge in approaching the video recordings is twofold; to get a conceptual and analytical understanding of patterns and relationships, and still be able to empathically understand the meaningful everyday life context with its stories and images. Collaborative process

of analysis colours the interpretations by our professional and cultural backgrounds. Discussing the observations in the design team, these differences are brought to the light. Thus, it is important to build up a constructive dialogue among various stakeholders. Interpretation can be pleasurable and effective, but it needs additional support to establish environment maintaining the interchange of ideas. (Ylirisku & Buur 2007, 95 -98.) However, in comparison to the created model in this thesis, *see eye to eye, ci2i*, involving the users into this co-interpretation process seems not to be emphasised.

Jordan & Henderson (1995, 16) argue that in the process of analysis, video loses a whole less in the transformation process than other data collection methods. Losses which are due to the video, are either decisions made by camera's operator or characteristics of the technology. According to Ylirisku & Buur (2007, 101-103), the video data is usually analysed either with grounded or framed approach. Grounded approach is an open mode, the meaning and structure must emerge from the data itself. Framed approach uses a prior model to the interpretation, it uses pre-conceived understanding, and thus, it is a more straightforward approach. Ylirisku & Buur (2007, 16) also remark that as video clips do not carry a dedicated meaning, the interpretation is both challenging and rewarding. In analysis, the clips become meaning and categorisation under themes titled in descriptive manner. In *ci2i*-model open mode is suitable.

Ylirisku & Buur (2007, 98-130) describe some methods for analysing the data; *interaction analysis lab* (see Jordan & Henderson 1995), *video card game* (see Buur & Soendergaard 2000) and *methods for designing video artefacts: stories, portraits and collages* (see e.g. Mackay et al. 2000). Next a brief review on these methods is given with reflection to the context of gaze replays in *user dialogue*.

*Interaction analysis lab* changed the way of analysing video from individual activity to collaborative process. It was developed to encourage the use of ethnography in daily settings by Jordan & Henderson (1995). To assist the analysts in their making sense of what they see in the video, Jordan & Henderson (1995, 19 - 79) have generalised a list of foci providing the observer with a way of better understanding the human interactions: the structure of events (beginnings and ends, segmentation), the temporal organisation of activity (rhythm and periodicity), turn taking, participation structures, trouble and repair, the spatial organisation of activities and the use of artefacts and documents. According to Ylirisku & Buur (2007, 101), this may not be an exhaustive list, but it provides a set of perspectives for handling the observation. As previously described in chapter 5.1.2, each gaze replay provides one single user view, thus analysis with the same foci as above suggested is not possible, yet *ci2i*-model is a collaborative one and each case has its determined foci.

*Video card game* developed by Buur & Soendergaard is a method enhancing the collaboration among developers such as consultants and engineers, making sense of the videos together by a card game with its roots in the “happy family” children’s game. The game facilitates the process of selecting the important video clips to be interpreted by turning the video into tangible arguments by using cards. These cards help the developers to create understanding of the design, as they try to collect families of four cards, here presenting various clips of the videos. This game obviously needs preparations where the video materials are analysed, interesting parts selected, and edited into clips and produced further to cards containing a still image of the clip and annotations related to the picture by designer. Additional to the game materials, this method needs suitable work space to spread the materials around and also to watch the actual video clips. (Buur & Sondergaard 2000, 63-67.) This approach could be suitable for the analysis of gaze replays also. However, as the gaze is moving fast and the video is from the point of view of the user’s eyes, it needs even more careful selection of clips and thorough annotations.

*Video artefacts* are video presentations such as stories, portraits and collages. Video artefacts are a format of articulating the understanding gained from the user material in a form of edited data, in order to facilitate the design discovery. In a way video artefacts are bridging the gap between abstraction and detail. They link the field data to design ideas, point out the relevant issues, generalise findings, help to empathise with people, and focus the design to right direction. *Video stories* help ideation, verify understanding, present how things happened and give an overview of the project. *Video portraits* are presentations explaining and getting to know who someone is, capturing the character, providing the context, they are used to create empathy, inspire, inform but also to help evaluate design. *Video collages* are combination of thematic video clips. Collage can be easily produced upon materials created with video card game. Video collage helps people to perceive things differently. (Ylirisku & Buur 2007, 117 -132, see also Mackay et al 2000.) It was delightful to note that at least as a part of one case example on video stories by Ylirisku & Buur, the videos were presented to the users themselves in order to get feedback whether the designers had got it right when interpreting the materials. In actual fact, the sharing process of gaze replays in collaborative sense making sessions has analogies with this, as it deals with sort of video artefacts also.

As stated in the review on video in design above, user studies can benefit from the use of video in design, as it turns the inquiry into a constructive dialogue about what is seen, and how people see it (Ylirisku & Buur 2007, 41). Ylirisku & Buur (2007, 12) argue that without consciousness, design is blind. Using the video enhances to collaboratively create conceptions of design opportunities, it also creates understanding of how the design affects on its future environment, while keeping the feet on the ground of reality. It is important to both conceive

and make sense in order to create new ideas; building a process on the grounds of such a dialogue becomes more conscious. This idea is supported in the gaze replay enhanced dialogue.

To conclude this with, an important note on interpretation by Ylirisku & Buur (101-103), expresses that interpretation combines observations and visions. Yet, this process of interpreting is heavily influenced by the interpreted material, by and with whom it has been interpreted, and by the project context (cf. figure 6). This statement is highly agreeable, yet it must be noted that in *ci2i*-model the nature of the model requires that users are always involved.

### 5.2.3 Taking a Closer Look at the Gaze Replays

In comparison to the traditional video, the gaze replay allows us to go a whole degree deeper in user's point of views, as it provides an addition to the scene video as seen by the user, also the gaze path moving along the scene the user is seeing. It presents the ways to perceive the environment and what draws the attention of the user. Gaze replay provides the possibility to reflect the situation and action, in order to build a shared understanding of it. When involving the users with this process, possibility for their reflection and a dialogue built upon it, is provided. This along with the formation of a dialogue, brings understanding applicable and with great value for the design.

The presence of the users when interpreting the data is missing in the large scale in descriptions of the various methods used in interpretation of the video materials presented earlier. This thesis emphasises the involvement of users in the interpretation of the data in the dialogical ways. Gaze replays are special kind of videos. Similar like Jordan & Henderson (1995, 15) are proposing with video, gaze replay data with its all richness, can be viewed unlimited time, with normal, slow motion or speeded motion. Still images can be made as well. Repeated viewing clarifies the phenomenon and especially the shared understanding of it. They point out that the audiovisual recording can be made available to other researchers and practitioners; here especially the importance of making it available for the users is highlighted. Like Jordan & Henderson (1995, 14) are stating, it has the potential to support true collaborative work, as here is aimed with users and designers.

Jordan & Henderson (1995, 17) point out their concern on the relationship between the recording and the event as experienced by the individual. When the analyst of the video sees or hears something on the recording, it may differ from one seen or heard by the participant. This may occur especially in situations involving interactions among many actors. In comparison to standard video recording, gaze replays provide means to interpret from the point of

view of the gaze path of the observer. That allows addressing the questions in post-experiment interview or workshop, from the point of view on the interesting gaze path.

The general process of interpreting the gaze replays in a *user dialogue* is illustrated in the figure 5 adapted from Ylirisku & Buur (2007, 102). In addition to the parties in interpretation as stated by the authors - one key group is added, namely the users and dialogue carried out with them in order to create shared understanding - to be able to see *eye to eye*. The gaze replays are first pre-analysed and edited by the design team with an approach in line with the goals and context of the particular case. However, the main interpretation arena in this model is the dialogue itself. As Ylirisku & Buur (2007, 132) argue, in video interpretation, shared understanding is constructed in a creative manner. In *ci2i* using the gaze replays as a medium, the understanding builds upon the dialogue carried out enhanced by the use of gaze data creatively.

In addition to the gaze path, (depending on the method selection of the study), gaze replays can include think-aloud audio. Then enriched media gives the opportunity to compare different data for the interpretation purposes. Also other method combinations can be included. These can alter the interpretation possibilities; which is discussed in the next chapter. Even though this study is concentrated on gaze replays, also other visual forms of eye tracking data can be interpreted in similar manner as presented below.

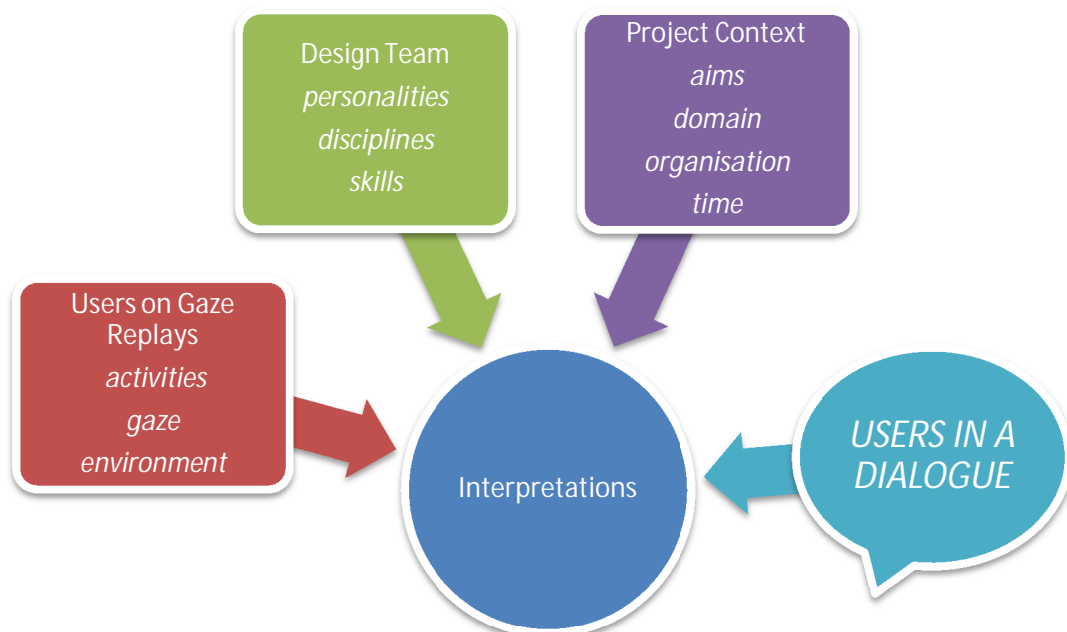


Figure 6: Interpretations of gaze replays in the *user dialogue*<sup>5</sup>

<sup>5</sup> Adapted from Ylirisku & Buur 2007, 102

### 5.3 See Eye to Eye (*ci2i*) - model

As a result of this thesis, a model presenting the *user dialogue* enhanced by the gaze replay is created. This model is constructed based on the theories and eye tracking empirics presented in the thesis and related experiences of the researcher herself. From a theoretical point of view, it is built upon design empathy, theories of dialogue and reflection, meaning of visualisations, and some ideas from the field of designing with video. It aims to give an overview of the evolution of the *user dialogue* and collaborative sense making benefitting from the eye tracking visuals.

First and foremost, the purpose of the *see eye to eye* model is to maintain the *user dialogue*. The main aim with the dialogue is to make sense in collaborative manner, not necessarily to agree on everything, but to be able to create a common view point to see the matter at hand, *see eye to eye*. Drawn from the theories of dialogue presented in the chapter 2, the dialogue is always contextual. This means that the nature of the dialogue depends always primarily on the people participating in it, the case, and on the goals and means in the dialogue.

*User dialogue* is not a linear process. Nevertheless; it is presented here as such to give a better overview of the model. The *user dialogue* is considered to evolve throughout the whole process of interaction between users and designers within the process. Hence, it is important to give an overview of the whole process including several dialogue points. The model cannot be adapted step by step as such, instead it needs to be applied based on the case at hand.

#### 5.3.1 Collaborative Sense Making in Gaze Replay Enhanced Dialogue

An overview of the model from the first step, when starting to plan the dialogical approach with the eye tracking experiment, until the reach of *ci2i* and sharing the results is described in the figure 7. The phases are opened verbally from the point of view of collaborative sense making in the *user dialogue*, taking place throughout the process. In the end of the chapter the model of *ci2i* is wrapped up as the figure 8, aiming to present the essential features of the *user dialogue* enhanced by the gaze replays.





Figure 7: See Eye to Eye (*ci2i*) -model

The description of these steps is given with the assumption, that there is a case existing, where this model is applied into. The case, however, is not given; instead the description given next is a procedural review. Reflection to the library case still takes place.

#### Planning the eye tracking study (-s)

Before starting the preparations of the actual eye tracking experiment, it is important to take care that a research plan taking into consideration of the phases of the *ci2i*-model is prepared (as there are plenty of guides for making a good research plan, this discussion is not carried out here). The demands from the point of view of the dialogue need to be considered in the plan, the collaboration part of the plan considering the user involvement and involvement of other possible parties, such as the representatives of the service provider. From a more practical point of view, research question(s), context, goal and main themes for the inquiry formulate the basis for the design of the actual eye tracking study(-s).

The phases in eye tracking experiment design are: piloting, participant recruitment, calibration, recording, analysing and visualising the eye movements (Sundsted & all 2009, 8). Conducting the eye tracking experiment in real life context needs more preparations, than the one carried out in the laboratory environment. It is fairly adequate to say that more time is needed for the different phases from experiment design to pilot studies, and from participant selection to calibration, and from recording further to analysing the data, due to the non

laboratory environment and the requirements based on it. Light conditions effect both scene video and gaze video (straight forwarded - eye tracking is challenging in sunny weather, cause of reflection problems). The natural behaviour of the user may be jeopardised by the reactions to the environment (on the other hand this may occur in laboratory environments as well). Research permissions in real life environments may need special attention, and task implementation in natural environment can also be challenging. Along with these, user's ability to move freely in the environment may cause problems in recording.

The eye tracking literature provides suggested empirical guidelines for conducting an eye tracking experiment; see e.g. Duchowski (2007, 171-180). However, as pointed out in the article "Eye Tracking in User Research" in this thesis, eye tracking publications seems to concentrate on the statistical analysis. Thus, given suggestions in the literature are mainly made from that point of view.

#### Selecting the method mix

Selecting the methods and tools to support each other in the study is an important decision. In this case the method mix should support the *user dialogue*. Namely it depends on the selected activities and methods, how the dialogue is going to be carried out (see also "planning and conducting the collaborative sense making sessions" phase). For instance if workshops are selected as a dialogue arena, this needs to be taken into account in the collaborative sense making of the gaze replays. Things that need to be considered are such as the amount of participants, their background and relation to the context contribute, for instance on the planning of the activities, in the collaboration and to the ways to create the desired atmosphere for it. From the point of view of *ci2i*, the combined approaches (this is not an exhaustive list) with eye tracking could be:

- think-aloud (to get complementary data and to be able to listen to the "inner voice")
- observation (to get the "outside" view missing from eye tracking; gestures, enactments, turn-taking...)
- remote observation (seeing the gaze replay in real time remotely, to get the real time follow up of the visual attention processes)
- video recording (to support "manned" observation by providing the possibility to recall the situation or as a standalone version, by placing the recorder e.g. in the corners of the experiment location, enhancing the post experiment analysis)
- different variations of interviews and group interviews (to get complementary data, to verify findings, to get feedback from the experiment, to make the interaction among people possible, to conduct a dialogue)

- variations of different workshops (to make possible and enhance (by different workshop manners and tools) the collaboration).

In eye tracking research, the use of concurrent think-aloud is discussed as not suggested approach, because it is likely to alter the gaze patterns. Verbalising the thoughts causes more thorough examination of the studied matter. When studying an interface for example, this is shown as more gaze visits per element, and higher number of fixations per visit. If the fixation number as such, is of special interest in the study (in this case the approach is usually different than the one described here) one could guide the participants to first complete the tasks given in silence, and comment only afterwards (with the same stimulus), or group the tasks given as "silent" and "think-aloud" -ones, or even divide the participants in groups (think-aloud only and eye tracking only). (e.g. Bojko 2005, 6-7.) This could be applied for the *ci2i* approach also. Yet, in real life context studies, this is not easy, as the users may be moving freely in the environment and thus the stimulus is not often a stable or repeatable one, and the changed settings may cause problems with the accuracy of the results. However, when using gaze replays in *user dialogue*, think-aloud gives more possibilities for reflection in the dialogue. One idea though, is to use the retrospective think-aloud approach (see e.g. Ball, Eger, Stevens & Dodd 2006, Guan, Lee, Cuddihy, & Ramey 2006, Hyrskykari & al. 2008).

### Piloting

Piloting for the eye tracking experiment is always needed. Besides, it is also considered as advisable in some cases, to test prior to the study the possible new method combinations selected for supporting *ci2i*. It is especially important, if the data gathered formulates a part of the collaborative sense making process. This could mean, for example, testing the technicalities and usefulness of the remote observation from the data gathering point of view (keeping in mind how it would benefit the *user dialogue*). Or testing the workshop tools, for example how a game alike approach planned to use in the study would work.

Eye tracking pilot study tests the use of eye tracker in the selected context and circumstances cf. the specialities in eye tracking experiment design above. As in any pilot studies, testing of the potential test script of the eye tracking experiment is a part of good preparation.

### Recruitment of the participants

Recruiting of the participants needs to always take the scope of the study in consideration. Depending on it, naive participants may be needed, or ones knowing the context or even being experts on it. Different participant roles may also exist. Some of the participants may be

the ones taking part in the eye tracking experiment, yet some other may present a different role, such as current user of the service or potential user of the service. All participants, however, take somehow part in the *user dialogue*. Clients and/or other stakeholders, who are benefitting directly from the results of the *user dialogue*, are considered as an important stakeholder group in *ci2i*. Their presence needs to be taken into consideration from the start of the process (see also “planning and conducting the collaborative sense making sessions”) as it may often alter the nature of the dialogue. Selection of the participants based on the recognition of real user groups is recommendable. At the very minimum the selection of participants should be made upon criteria based on the aims of the study.

From the eye tracking perspective it is important to note, that perhaps more candidates than in other type of user studies might be needed, as not all candidates are “eye-trackable”, because of certain physiological features of their eyes (Sundstedt et al. 2009, 9). Thus, it is wise to meet the candidates prior to the experiment day, to find out their suitability to the study from this point of view.

#### Pre experiment rendezvous

Meeting the users prior to the study can bring a lot of useful information. Pre experiment interviews are suitable and recommendable for getting the background information on users and to guide the users on the experiment taking place. Looking at this from the point of view of the evolution of a dialogue (Isaacs 1999), this may be the first one-to-one conversation in the *user dialogue*, thus formulating an important *dialogue point* (henceforward DP); creating the collective awareness and the atmosphere for the future dialogue. Background information can be gathered also with a questionnaire, which can be filled as a part of the interview, or in context with the eye tracking experiment guidance.

#### Conducting an eye tracking study

The eye tracking study always follows the experiment design taking into consideration the objectives and research question of the study, yet some remarks on the recording part of an eye tracking study carried out in the planned settings is given here. Rather than concentrating in a certain minimum or maximum length of the study, it is important to think about the progress of the study and the smoothness of the assignments carried out during it. However, the length of the session should not be too long, as if the participant feels tired it may influence the stimulus driven and goal-driven cognitive processes behind the eye movements. Eye movements are task-dependent, hence, the tasks must be chosen wisely and often breaking down the longer tasks to subtasks is needed. As in any other studies, if the trials are short,

the data becomes more manageable. Breaking up the tasks also allows frequent calibration of the eye tracker. (for task selection, see Duchowski 2007, 177-178.)

However, if the user is moving freely in the environment during the experiment, for the best accuracy of the eye tracking measurements, one should decide whether the focus of the measurement is more on the near field, or on the far field. This needs to be done in order to avoid parallax error in the results (difference in the true and measured gaze position); even though the new eye tracking solutions have automatic parallax compensation. Still, when using the eye tracking for qualitative purposes and with not as much interest on the statistical metrics, than to the overall attention and gaze path, parallax error is not considered as crucial. Yet, it is a fact needs to be taken strictly into notice, when interpreting the data; even if it happens in a form of a dialogue, where the gaze replays are considered more of as an inspirational material. If the studied matter needs both far and near field measuring, setting up two or more measurement sections, with a proper calibration in between, may be needed.

Environment of the eye tracking study has an influence on the experiment; hence, a pilot study is needed (see also "planning the study" and "piloting" phases above). Taking part in an eye tracking study in real settings or even in a laboratory may also alter the behaviour of the participant, as written also in the article in this thesis. However, it seems that when getting involved with the task implementation, conscientious of the eye tracker wear off. (cf. Jordan & Henderson 1995, 55-56, chapter 5.2.1 in this thesis)

#### Post -experiment rendezvous

An interview, no matter in which stage of the process it is conducted, provides one of the many dialogue points (DP) in the *ci2i*-model. Post experiment interviews are considered as a very important part of the process. Designer can create general understanding of the user based on experiment and when editing the gaze replays and thus pre-interpreting the data, but an interview conducted immediately after the experiment provides an excellent DP. Not only for gathering feedback from the participation to the experiment, but also for finding answers to the questions that have arisen during the observation of the experiment or for posing the questions pre-designed for the interview. Interviews can take place in later stages of the *ci2i* also. They may take forms like paired or group interviews, or focus group interview modifications; this is decided in the research plan. These interviews are another DP's also. In the interviews with more than one user involved, the added value comes from the interaction among users.

Interviews help to deepen the understanding created based on materials gathered in other ways. Mattelmäki (2007, 128) points out in relation to the probes that a twist can be added to

the interviews if they can be organised on site, e.g. in homes or at the workplace. This is how it was done in the library case, where the post experiment interviews took place in the library context. The recording of the interviews is recommendable. For the further DP's such as workshops, the interviews provide the possibility to gather relevant information for the creation of further questions, and preparations for the new rendezvous.

#### Editing and pre-interpreting the data

For using the gaze replays in the dialogue, preparations are needed. An eye tracking study contains a lot of data, though not all of it is necessarily important from the scope of the study point of view. For taking advantage of the gaze replays in *ci2i*'s various DP's, editing of the videos is needed. This process of coming up with a proper visual eye tracking data varies depending on the equipment and software's used. Video-based eye trackers (such as the iView xHED from the SMI used in this case) provide directly the scene video with gaze cursor, the gaze replay. This recording is raw-data, and needs editing before it is usable.

The process of extracting the potentially relevant data needs interpretation, thus editing the gaze replays for the purposes of DP's is actually a contextual pre-interpretation of the data. As earlier in chapter 5.2.2 presented by Ryle (1968) and Ylirisku & Buur (2007), this complex and multi-layered process is obviously guided by the aims of the study; nevertheless it is always a process influenced by the interpreter and his/her/their ability to make sense of it, in a meaningful manner. It is possible and recommended to keep a list of the observations and insights already in the stage of editing. These are later turned into questions and used in the DP.

From the point of view of the *ci2i*, the gaze replay clips selected should provide the possibility for aim based collaborative sense making. They can be short or long, as long as they have a proper and defined purpose. Long gaze replay clips may be good for conversation awakening, for inspiration. Instead shorter, task based clips can work for more detailed discussion on certain touchpoints of the service for instance. In the library case the clips were selected from the point of view of the future workshops goals, and they were acting mainly as an overall inspiration material, but also for example presenting a task of finding a book in the library. However, the clips were accompanied with questions addressed to the participants, and at the time of each question, pausing/still images were provided as means for the dialogue. Editing and pre-interpreting the data by the designer(s), are a constructive and meaningful part of the *ci2i*.

In the editing stage, if think-aloud is recorded and it needs to be heard, it limits the use of the data to the normal speed, which is, from the point of view of eye movements and eye

tracking, really fast. One way to proceed with the data is that first, a longer wisely selected clip with the think-aloud is looked at, then shorter more detailed clips with slow motion are shown. This provides the possibility to have the overview for general discussion, but still provide the means and possibility for shared attention towards a more important feature of investigation. These clips selected can be edited as any video, thus, music or other effects may be added. However, decisions like this should be based on careful concern, as special effects may distract the thoughts from the actual matter. Nevertheless, one should not stick with simplicity only for simplicity's sake. Editing should be based on the needs of the use of it as a medium in the DP, and sometimes richer medium may be needed. One should use still images, different speeds of the video, aim for good quality clips. Hence, depending on the case, it may be important for the audience to be aware of the speed of the clip, to avoid misinterpretations.

#### Planning and conducting the collaborative sense making sessions (dialogue points, DP)

In the dialogue, collective assumptions, shared intentions and beliefs of people involved, create the climate of the dialogue (Isaacs 1993, 34). All previous described DP's such as the eye tracking experiment, interviews, even email conversations, have an influence on the *ci2i* creation as a whole. This section, however, is described mainly from the point of view of collaborative sense making sessions with multiple participants. Venue of the session such as a workshop might alter the dialogue. As if, by different reasons, such as being too noisy, too hot or by seating the people too far from each other, the environment may not be considered as best to support the dialogue. When choosing a location, one may use approaches such as proximity as determinant factor, by locating the DP in the environment somehow close to the context, or vice-versa by taking more distance to it. These decisions must be based on the aims of the study.

This section deals especially with issues concerning collaborative sense making sessions with multiple participants such as a workshop. Creating a right kind of atmosphere and circumstances for the dialogue are considered important. In any case, more important than the venue, is the people involved and their different roles in the participation. Roles may vary and are depending on the nature of the rendezvous selected. Different types of rendezvous in the *user dialogue* are considered here to be:

- one to one (e.g. user and designer)
- one-to-many (e.g. user and the design team)
- many-to-one (e.g. users and designer)
- many-to-many (e.g. multiple users and multiple stakeholders, even including the client)

In *ci2i*, all of those may take place, even several times, or just one, depending entirely on the research plan and its activities. An interview is an example of the simplest one to one rendezvous, taking place at any point during the study. In one-to-many sessions, this may be just an interview with two or more representatives of the design team. In a workshop where the dialogue is carried out just with one of the users, this may suit in some cases very well. Often the users feel more comfortable in many-to-many or many-to-one sessions, than alone with a group of designers. Many-to-one sessions on the other hand, can also be productive, but it sets the pressure for the one and only designer. Handling both facilitating and documenting the dialogue for further purposes can be challenging. Video recording may come in handy in cases like this. Many-to-many sessions can be real buzz-cases, when a lot of people with different cultural and professional backgrounds join together. The amount of people gathered together notwithstanding, it is important to plan the session in advance, based on the goals settled for the dialogue. Also an open dialogue with very little limitations can be a fruitful option. In fact, a part of the session can be designed to be like that, and other parts may then contain more structure. Sometimes tighter structure is needed in the beginning, for example, when the gaze replays may play the inspirational role.

Despite of the action plan, the session may just go with the flow of its own, and the results can thus be very creative. In a (free) dialogue, this often produces the best results in terms of co-creating meaning (Isaacs 1993, 39). Hence, it asks for on-site decisions, whether turning back to keeping the tight structure of the dialogue is productive, often it is not. Decision-maker is the facilitator of the dialogue, his/her effort is crucial. Isaacs (1999, 331-332) sees the role of the facilitator in the dialogue as somewhat Band-aid -type of a solution, nevertheless, he concludes that real value of a facilitator involved is dependent on requisite skills. These are such as being able to step back when needed, and to avoid the overly structured approach to evoke dialogue, instead of a discussion. For enhancing the dialogue, the atmosphere of the session should be created as near as possible of being "peer to peer", feeling of everyone being responsible equally. The participants of the dialogue should have the feeling that the awareness is shared. Considering this challenging role of the facilitator, it may be wise that the facilitator is not the only representative of the design team, present in the DP, and/or that the members of the team have pre-defined responsibilities in the session.

If the client (for example the service provider) is present, it alters the session completely. However, as may be concluded based on the library case, the presence of the clients can enhance the productivity by creating an atmosphere that communicates to the participants' importance of the session. Above all, it produces a front row experience for the clients themselves, with insights, remaining otherwise often hidden behind the project reports lines. A proper documentation of the results can produce equal understanding, but as the old Chinese proverb says: "Tell me and I'll forget; show me and I may remember; involve me and I'll un-



derstand" (The Quotations page). Depending on the case, ethical questions may need to be considered also, when clients and users encounter like this. At the minimum, the users need to be fully aware of the nature of the study they are participating in, how the results are handled, and what is their role in the process. Proper consent-forms are needed.

Handling the gaze replays as part of the dialogue, starts already after receiving the first eye tracking data, in the follow up interviews and at the latest on the editing and pre-interpreting desk. When the DP is approaching, it is a good idea to sit down and come up with the session plan based on the aims of the study and gaze replays, or other gaze based visuals, such as still images selected and produced for it or heat maps or gaze plots (cf. editing and pre-interpreting the data). Questions and other activating tasks in the DP, concerning the gaze replays are created. Their role is to lead the dialogue in the line with the aim of the session. Such as in the library case, the questions and other activation for the dialogue were created to benefit the future workshop. In this model, the gaze replays are used to create shared attention among the participants. This shared attention formulates the climate for a dialogue. According to Deák, Fasel & Movellan (2001,95) "Joint or shared attention is a foundational skill in human social interaction and cognition. It is defined as reorienting or re-allocating attention to a target *because* it is the object of another person's attention". Deák et al. argue that shared attention facilitates communication, and gaze following is a basic manifestation of shared attention.

In this phase, it is worth thinking about the group cohesion also. It may alter the dialogue if the group is very homogeneous or heterogeneous. Straightforward, the heterogeneous group most probably is more communicative, simply due to their different backgrounds. When studying the library use, the group cohesion was working well; the participants were presenting potential library users (eye tracking participants), current library users, or library personnel.

Also the length and possible iterations of the session should be considered based on the aims. The length depends on so many variables that it is hard to give a direct recommendation on it. Comparing the very intense one hour workshop and the one day one, the results may be as good. It all depends on the choices made in the plan, and the activities carried out during the session, as well as the participants taking part to them. The planned structure, activities in it, and finally the flow of the dialogue on site, determine the duration in the end. However, with different parties involved and for the sake of and as a part of planning the session, the duration is estimated and pointed out in the invitation for the session. Sometimes due to the amount of participants, deviation of them into subgroups or simply as iteration is part of the design of the study; iteration of the DP may take place. If the iteration is done due to deviation of people into groups, the session should usually follow the same structure, and use the

similar gaze replays. However, sometimes the process may include a set of DP's complementing each other. In cases like this, the nature of the DP's may vary.

What about catering then? With the words of nowadays often heard commercial: "*good food - better mood*", is without any scientific approach considered being not very far from the reality. Hence, in some cases at least if a warm up session as a part of DP is considered as important, some beverages and finger food are not a bad idea. If the sessions are long, a brake with snacks may be useful. Some sweets perhaps, and at the very minimum drinking water, are always recommendable.

Wrap up of some kind in the end of the each DP is good. Not only for pointing out the gratitude towards the participants being involved, but also from the point of view of documentation and results. Wrapping up may evoke additional reflective feedback, valuable for the designers. As remarked briefly earlier, a documentation manner of the session should be predefined and manned. One idea is to involve the users by letting them select the best idea, best clip, or using the feedback questionnaires can also be a part of this. User involvement with the documentation can also come through the activities in the workshop. The ideas produced with sticky notes for example, may be grouped as affinity diagram or other grouping manner, and thus, the users taking part to this collaborative sense making, simultaneously take part in the documentation. In fact, designing the workshop in a manner producing different visuals or otherwise tangible outputs helps documenting.

#### Towards conceptualisation

Dialogue is not a discussion, hence, it is not seeking for a closure and completion, as it seeks open possibilities and sees new options (Isaacs 1999, 45). The aim for having the *user dialogue* is first and foremost throughout the shared understanding, to produce insights benefiting the needs of creating new products or services. However, this approach can be applied to certain other types of needs also, such as improving the current services and testing the service prototypes. This is reflected in the chapter 6.2.

The aim of this study is not to go as far as answer the question how to conceptualise the findings gathered with this model. However, some thoughts concerning the phase prior to actual conceptualisation are shared. Sharing the results of DP's is easiest done by taking part in the dialogue. However, for the purpose of conceptualisation and further research, additionally to *user dialogue* per se and produced materials on it, it is recommendable to document the DP's along the road with video (like in the library case, future workshop was recorded with observation camera on the wall, also still images can be made from the session itself and from its results) or with other means, such as field notes by the designer. Along with the gaze replays

and their joint interpretation in the dialogue, these can be then used for supporting recall of the designers and for further development of the insights and ideas collected.

#### About creating *ci2i*, an epilogue

The steps of the model described above are all part of creating the shared understanding that profits design. This means that *ci2i* is not actually any part of the process, it is the process. In reality, however, encountering with the users, the various DP's, do not always take place just like planned. More interaction with the users may be needed, iteration may need to take place, and changes come along during the process. Anyways, in this model of collaborative sense making through the dialogue enhanced by the gaze replays, one could refer to the words expressed by Isaacs (1993,38 ): "medium and the message are linked: information from the process conveys as much meaning as the content of the words exchanged".

Different DP's along the path of *ci2i* work for collaborative sense making. However, the rendezvous sessions with multiple participants, such as workshops organised, often support the nature of collaborative work best.

As revealing as a gaze may be, the users seem not to be embarrassed to see their own gaze replays in a session, on the contrary to the reactions to videos or even still photos used in the design sessions. The gaze replays seem to enhance the dialogue from the point of view of the users, by supporting it and providing "evidence" regarding their statements in the dialogue. This visual presentation related to the experience helps the user to return back to the experience and reflect on it (Boud et al. 1985, 36). Obviously, it is very important to ask for their permission to use the gaze replays as means in the dialogue beforehand. To avoid any ethical concerns, gaze replays can be easily presented as anonymous data; this alters the dialogue, though, as the user has not the support of his/her own gaze replay in the dialogue.

Creating *ci2i* is not about agreeing. It is about opening the eyes and mind for mutual interpretation of the things at hand. It is about creating a common view point. Hence, there are no right answers and no model results in *ci2i*. All that matters is a flow of meaning (Bohm & Garret, 1991). From the point of view of design empathy, *ci2i* is to get to know the users better, to get insights providing means for the designing for the users, with the users.

The model of *ci2i* opened above is turned into a wrap up figure of the model in the figure 8, aiming to present the essential features of the model: *making space for the dialogue, visual eye tracking data, collaborative sense making arenas and sharing the findings*.

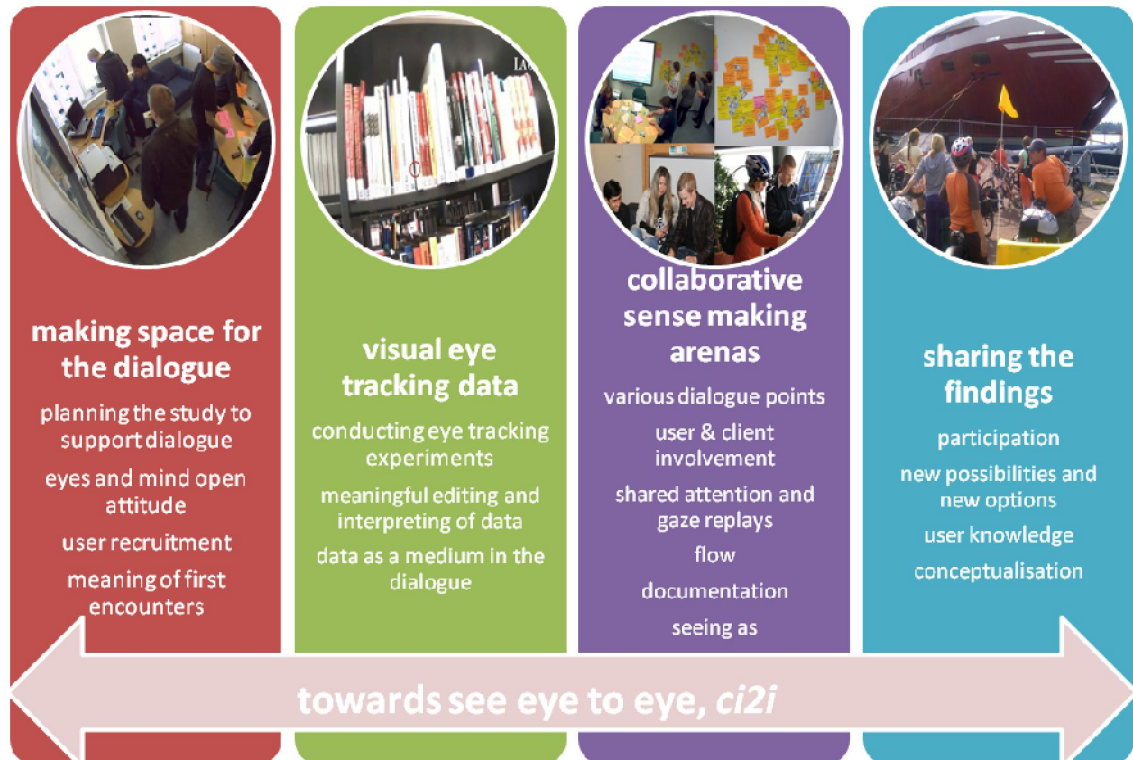


Figure 8: The essential elements of *ci2i*

### 5.3.2 Possible Challenges with *See Eye to Eye (ci2i)*

The gaze replays are playing the main role in *ci2i*, hence, their role regarding the success of the process carried out by this manner, is a major one. If the study is not designed from the step one, to take into consideration the *user dialogue*, and the role of gaze replays in it, things will most probably go wrong.

In a model relying on gaze replays, in case there are problems with eye tracking data gathering, it may be needed to reschedule the process. Thus, it is wise to leave enough time between various phases of the study that depend on each other. As pointed out by Jordan & Henderson (1995, 16) earlier, in the process of analysis of video, less data is lost in the transformation process, than with other methods. In eye tracking, technology plays even more important role. The data may be lost during the experiment, due to problems with the eye tracking settings causing that the tracking of the gaze is prohibited. This can be foreseen with careful planning and piloting of the eye tracking experiment, and also by method mix supporting the study with other means of data gathering such as traditional video, think-aloud or observational notes.

Editing and interpreting the data and preparing the gaze replays for the dialogue points must be done in a meaningful way. It should reflect the aims of the study, yet enhancing the needs of the dialogue. If the gaze replays do not work as they should, the whole dialogue might be jeopardised.

Without an open-minded attitude towards working with users and vice-versa, problems may occur. After all, in this model, it is all about interaction. No matter how well prepared things are, sometimes the chemistry between participants of the workshop, just might not work. For the same reason problems may also occur when different stakeholder groups are brought together. However, from the point of view of the dialogue, a very homogeneous group may still be more challenging than a group of different stakeholders with different viewpoints. These challenges may be foreseen by careful planning and dealing with concerning issues such as collisions that might come coming to surface during the dialogue. The role of the facilitator is very challenging and it needs some practice, to smoothly overcome the possible problems that occur during the session. The facilitator also influences a great deal in whether the *user dialogue*, he or she is facilitating ever reaches the flow of meaning in the dialogue. If the conversation is turning to a discussion instead of moving towards a proper dialogue, difficulties to reach the collaborative sense making may appear. (cf. Isaacs 1999, 35.)

Reflecting on Vaajakallio (2008, 56), some challenges of participatory inquiry may arise in *ci2i*. When conducting the eye tracking studies or workshops enhanced by them, the designer in a facilitators role needs to avoid getting involved in the inquiry, thus, sometimes it happens or is even done in purpose. Conscious looking at the findings "from outside" is needed in this case. Joint interpretation is usually wise from the point of view of the reliability. In *ci2i* the users take part in the collaborative sense making session as a form of interpretation, thus making the results more reliable.

To wrap up: the process carried out in a form of a *user dialogue* like *ci2i* may be challenging, all the same it is considered really rewarding and most probably eye-opening. Yet *ci2i* cannot make magic. As a dialogue, it gives just as much, as you are willing to give back.

## 6 Benefitting from Visual Eye Tracking Data in Service Design

How could service design benefit from the collaborative sense making, *ci2i*? To have some background to reflect the use of visual eye tracking data in the field of service design as a medium to enhance the *user dialogue*, a short review on the state of play, concerning service design tools and their user involvement is given first.

Service design uses a variety of methods adapted from both design disciplines and from management and marketing domain (e.g. Saco & Congalves 2008, 12; Moritz 2005, 48-55; Maffei et al. 2005, 5). Nonetheless the use of eye tracking is not very common in the domain generally. Areas like web design on the contrary have been profiting from eye tracking (see e.g. Nielsen & Pernice 2010). Service design is considered as a highly visual domain (Maffei et al 2005, 6; Holmlid 2007, 5; Gedenryd 1988, 200) hence, it could profit from the visual eye tracking data. Chapter 6.2 discusses this from the point of view of the service design process.

### 6.1 Service Design Tools and User Involvement

Service design is a rather new field and thus, it is understandable that it refers to practices from other fields. What has been aimed at with various methods, and how they relate each others may create confusion (Vaajakallio & al., 2010, 21). In his thesis, Moritz (2005, 184-238) presents over fifty methods for service design. According to Vaajakallio & al. (2010, 15), only three of them actually bring new insights. These three are randomiser (Moritz 2005, 214), retrospective testing (Moritz 2005, 222) and informance (Moritz 2005, 226). Majority of them seem to have their roots in business with more impressive names than the actual method. Unfortunately Moritz provides only a short description of the various methods he suggests for the different stages of service design process. Nevertheless, retrospective testing uses the video for eliciting more feedback when testing services, thus, it has somewhat similarity with *ci2i*. Also Saco & Goncalves (2008, 12) are pointing out that various tools in service design have been developed independently and they are lacking unifying framework. In line with Saco & Goncalves, Sangiorni (2009, 418) says that as a result of practitioners lead area, service design lacks the research direction, which is shown also in the limited number of academic publications on the area.

According to Vaajakallio & al. (2010, 23-24), there does not seem to be a consensus on involved parties or the level of their involvement in design process. They have found out that despite of the number of existing creative techniques such as probes, users are seen as informants instead of co-designers in the design process. One reason they name is the lack of service design methodologies supporting the mixing of different parties. As they say, this is an area that needs more studies. By pointing out the critical need for finding out how to engage different parties in the service design process, they hit the key question behind this study also. In this study, enhancing the dialogue and bringing various stakeholders together in order to get reflective user feedback, improvement suggestions, new ideas and insights, have been seen as crucial. In their literature review, Vaajakallio & al. (2010, 25-37) conclude that service design benefits from the methods developed first for user centered design. Additionally they discuss the possibilities of the following methods in service design: design games, drama methods and ethnography. They point out that these methods could be applied especially

when developing services focusing on user experience. Timing of user involvement also affects. Involving the users as early as possible in the design process, new ideas can be generated instead of eliciting evaluation only (e.g. in prototyping Vaajakallio & al. 2010, 23).

Stickdorn & Schneider (2010, 34-45) outline the way of thinking in service design with five basic principles. Service design should be:

- User-centered (as it offers shared language for communication; service user's language)
- co-creative (as it facilitates the interaction between the stakeholders, provides a chance to add value to a service in partnership and evokes co-ownership)
- sequencing (as service has a rhythm from a touchpoint to another having an influence on customers, visualising, prototyping and iterative testing is needed)
- evidencing (as throughout making intangible tangible, better understanding of the work behind the scenes in form of services may increase customer appreciation of the service experience)
- and holistic (as service experience is a holistic experience taking place in physical environment perceived with all senses).

The next chapter presents one service design process and reflects the use of visual eye tracking data from its point of view.

## 6.2 Eye Tracking Data in Service Design Process

It is a lot easier to figure out the process of designing tangible products, than the one dealing with intangibles, like services. Design process is usually nonlinear, but it is possible to articulate an outline structure. One constructed by Stickdorn & Schneider (2010) is presented next. This process is of iterative nature. A step back to the previous stage of service design process might be needed or even to start from the very beginning again. However, one needs to learn from these steps taken. First of all it is important to design the process itself, as the process depends on the context of the service being designed and therefore varies from project to project. This framework consists of four iterative stages *exploration, creation, reflection and implementation*. (Stickdorn & Schneider 2010, 123 -126.)

During the process, leaps between designing in detail, and designing holistically, need to be taken. Their model is described from the point of view of the designer. When offering these service design services, decisions along the road are taken according to the budget, resources and views of the clients. (Stickdorn & Schneider 2010, 127.) Each of the stages of this process are described in the next chapters and reflected from the point of view of *ci2i*.

### 6.2.1 Exploration

Stickdorn & Schneider (2010, 128) argue that first task of the exploration is to understand the culture and goals of the company, not their customers. Problems in service design usually are organisational; hence, understanding the company's point of view in a certain problem is important. It is about articulating the problem from the point of view of the customer. A company looking for improvements in their services should also be prepared for co-creativity. Second task of exploration is to identify the real problem and gain understanding on it from the point of view of current and potential customers. One should keep the big picture and go beyond customer behaviour, looking for insights, not only empirical data. They emphasise the need to find the real problem prior to the solution. For this, they say, tools and methods from various disciplines can be used. Third task is to visualise these findings and the underlying structure in a form such as a customer journey<sup>6</sup>. By means of these visuals, the design team and service stakeholders get the sense of what might need change in the service proposition to function properly. (Stickdorn & Schneider 2010, 128-129.)

Eye tracking is perhaps not at its best in this stage, at least what comes to the understanding of the culture and goals of a company. Instead, in the part of identifying problems, as far as there are any tangible elements involved, eye tracking can be used to investigate the service or the area of new service creation, from the point of view of the customer. In an imaginary case, where services supporting the green values of the customers in stores is handled, customers using the recycling machine for bottles could be eye tracked, to find out how the systems appears to the customers. Also from the point of view of the service provider, work processes related to the identified customer journey with the same example, but from the point of view of a "bottle boy", could be studied. These gazer replays could then function as visuals, representing the workflow as seen by the worker and vice-versa the customer.

### 6.2.2 Creation

Creation and the next stage, reflection, are closely related in this process. The iterations of the process mostly take place between these two stages. Stickdorn & Schneider (2010, 130), argue that exploring and learning from as many mistakes as possible, as early as possible, is essential in service design. After all, the cost of iteration in the concept creation is affordable, in comparison to failure in launching the service. The obsession with sticky-notes among practitioners of service design is highlighted in a positive light, as they provide a visual support to keep track with quick and iterative approach to development. Sticky-notes can be used for visualising processes, interconnections, and mnemonics for co-creative ideation. In

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<sup>6</sup> Customer journey describes all the interaction a customer is having with service over a certain period of time, Moritz 2005, 178.



this stage solutions are created based on gathered insights and identified problems, generated in the previous stage of the process. According to Stickdorn & Schneider, bringing all important stakeholders together to work co-creatively and in interdisciplinary teams in service design is a key to generating holistic and sustainable solutions. (Stickdorn & Schneider 2010, 130-131.)

This is a stage, where the findings founded in the exploration stage by eye tracking, could be processed through, in *ci2i* -manner. Shared attention on the features related to the various touchpoints on the recycling services, if we stick on that example. Could open the eyes for creation of new concepts and ideas surrounding the green value -related services, or at least if that is the case, help to improve the service.

### 6.2.3 Reflection

In this stage, the built concepts and ideas are tested. Service design applies the same iterative prototype testing approach as the product development. However, distinctive methods are needed. Problems do exist even when applying plain feedback gathering methods, such as interviews or questionnaires, because the customer may not be able to create a picture in his mind to reflect on to. The main task in this stage is thus, to create a vision of a service concept in the mind of the customer. To be able to create the vision clear enough, emotional aspects of services need to be considered. According to Stickdorn & Schneider, comic strips, storyboards, videos or photo sequences do help to generate emotional engagement, but they are not able to provide the meaningful user interaction. Therefore they suggest that service design needs staging and role-play approaches, which are carried out in reality or in circumstances close to it. In these approaches, service situations are played through in playful manner, which supports the emotional engagement for users. Additionally, they are useful for quick interventions with low-cost. Prototyping may also take place in constructed scenery, as they suggest, simple and rough scenery may even be an advantage, a way towards increased imagination and creativity. (Stickdorn & Schneider 2010, 132-133.)

Eye tracking could be used in context with service prototypes. Service prototypes are simulations of a service experience, reproductions of a service experience, in place, situation and condition in which the service will actually take place. They use touchpoints and mock-ups or low-fidelity models. The experience can thus be observed and recorded for analysis. (Diana et al. 2009, 8; Stickdorn & Schneider 2010, 192.) Eye tracking may not be that playful in its approach, but it would provide the literal user's point of view on the studied prototype. For example with the case before, service experience environment on new innovative concept of recycling in stores could be produced, and testing it with eye tracking would produce valuable insights, well sharable in collaborative processes, such as *ci2i*.

#### 6.2.4 Implementation

Implementation of new service concepts demands change. This change should be faced with proper change management tools. An iterative service design process and resultant service concept is the base of this change. Communication plays an essential role in this stage; it can use tools from staff guidelines to visuals produced in earlier stages. Besides communicating with employees, their involvement is considered crucial, in terms of successful implementation of new service concept. The employees should preferably be contributing from the early steps on to the prototyping of service, so that they would have a clear vision of the concept, and thus be able to support it. Service blueprints are a medium to share an overview of the improved processes and deliverables on organisational level. Management should show their support by providing resources for quick and creative problem solving during the implementation, in case needed. Change implementation is followed by evaluation, thus formulating the iterative process of service design thinking, a way of thinking needed, when designing services in the interdisciplinary way. (Stickdorn & Schneider 2010, 134-135.)

This stage of implementation can hardly benefit from eye tracking visuals, besides using them for communication purposes. In cases such as demonstrating the customer journey or demonstrating the change in terms of important changes in work processes from the point of view of the employees. Implementation is dealing with the release of the new service, thus eye tracking visuals could be used to solve operational issues in the iterative process of implementation consisting of multiple activities.

### 7 Conclusions and Future Research

Condensed, this thesis indicates that gaze replay serves as a catalyst towards a richer explanation. Gaze replays, when applied in a *user dialogue* as indicated earlier, benefit the area of service design, among others. The *ci2i*-model created in this thesis describes the phases in the *user dialogue* enhanced by gaze replay: *planning the study, selecting the method mix, piloting, recruiting participants, rendezvous and interviews with the users, eye tracking study, editing and pre-interpreting the data, planning and conducting the collaborative sense making sessions and sharing and exploiting the ci2i.*

In conclusion, applying visual eye tracking data in *ci2i* manner brings various stakeholders together for a constructive dialogue carried out in co-creative manner. It has the potential to reveal latent needs of the customers and by creating an understanding contributing the creation of a holistic service experience.

When looking critically at the results of this thesis with the aim to discuss the use of visual eye tracking data in *user dialogue*, one could say that this approach has nothing new in comparison to use of the video in user centered design process for instance. Nevertheless, this thesis has presented the main principles of eye tracking and the added value gained with it. Eye tracking provides the view of the user, literally. This is something that can't be gained with any other methods. In fact, using gaze replays in the dialogue with the users helps the users to recall the experience they have been having in the session and produce more feedback in a form of a dialogue than with other methods. In addition it also provides means for opening the eyes to see together for creating shared understanding "*see eye to eye, ci2i*". From the service provider's point of view, immediate insights can be gained from participating to the user dialogue instead of waiting for the reports from the designers. From the designer's point of view this approach provides a rich interaction arena to gain insights from. *Ci2i* is about sharing the view of the users and making sense out of it together.

In *ci2i*, visualisations from the user studies implementing eye tracking are used in order to reach knowledge hard to reach with more conventional methods. Namely what is raising the attention of the user when conducting the experiment. When reflecting visualisations together with the users it is easier for them to recall and find meaning for their actions in the particular situation. Reflecting on Nonaka & Konno (1998, 44), through this process of recognizing deeper user needs, it is easier to translate the personal user data into more explicit forms.

Maintaining the dialogical approach throughout the process is essential in *ci2i*. The model utilises similar construction like the probes process as described by Mattelmäki (2003, 121), pre- and post experiment interviews are conducted in order to deepen the understanding of the eye tracked issue. It opens the arena for new questions for design, constructed based on the shared attention for gaze replays. In *ci2i*, the interviews provide users the first opportunity to reflect on the experiment. This must be taken into consideration when planning the interviews. Dialogue points with multiple participants (e.g. workshops); on the other hand, function as the platform for sharing the findings and creating shared understanding among users, designers and even with service providers. In a way *user dialogue* uses the elements of a retrospective think aloud (e.g. Hyrskykari & al.2008, Guan et al.2006, Ball et al. 2006), where the replay of gaze movements is used to lock reflective user feedback. However, an important difference is that *ci2i* is not a one way dialogue to receive feedback; it is about collaborating for sense making.

Similar like Boehner, Vertesi, Sengers & Dourish (2007, 1082-1084) in their critical reflection of how the HCI community has adopted and adapted the probes for more expected results argue, the nature of interpreting the gaze replays together in *ci2i* is seen as response. *Ci2i*

means responding to the user, not ascertaining facts about the user, thus, it is a dialogical approach where the aim is not to find correct answers, but to make sense on the phenomenon studied collaboratively. Hence, *ci2i* is not about data collection, even though, in the end the shared understanding created, can be used for design purposes. It is more a model of a hermeneutic nature.

For next, the model created needs more empirical testing, an iterative process to improve it and to test it in various service design cases and in wider application areas than service design. In the end, when looking at the discussion and results in this thesis, the conclusion is, that *ci2i*, especially if taking the clients and other important stakeholders along to the process, could be considered as a co-design approach, thus for next, something to reflect *ci2i* on, would be co-design principles and publications. This is in line with Vaajakallio & al. (2010, 10-11) as they demand tools for collaborative design processes, tools involving designers and other stakeholders that are capable to transform shared knowledge into practical solutions. Vaajakallio & al. (2010, 11) see co-design like Bucciarelli (1996), as they describe “designing as social process of achieving consensus among participants with different backgrounds and interests, whether they are users or not”. This idea meets the ones behind the process of *ci2i*.

Looking at the weaknesses of the created approach, using the eye tracking system, especially in the real life context needs practice. Skilled professionals are needed in order to make the experiments work and results reliable. The costs of eye tracking have decreased and they have also become easier to use, but eye tracking still needs remarkable investments. The new mobile solutions, however, are suitable for use in almost any environments and activity, and in form of glasses they are really unobtrusive and thus make it easier for the users to use them in natural settings, without effects on their behaviour. Their prices, however, are unfortunately still sky-high. (e.g. Tobi 2011, SMI 2011.) From the point of view of user studies in real life context, the model created in this thesis and the new gaze wear would form an efficient combination.

## 7.1 Personal Reflection

This thesis has been all in all a huge learning experience for me, just irreplaceable. The reflection presented here, is mainly made from the point of view of Laurea University of Applied Sciences Learning by Developing model and evaluation criteria including *authenticity*, *research orientation*, *innovation* and *usability* (Laurea 2009, 7-8).

The *authenticity* of this thesis comes from its approach aiming to discuss the field of eye tracking research from the less applied, qualitative data analysis point of view. Also the idea to include dissemination in form of articles to this master's thesis is, as far as it is in my knowledge, rather authentic on master level studies in universities of applied sciences. The dissemination is done by publishing a referee journal article, a special paper article and additionally by presenting a poster in the upcoming 77<sup>th</sup> World Library and Information Congress, IFLA General Conference and Assembly in August 2011, in Puerto Rico. This way has brought along some exciting moments to my journey, such as waiting for the referee article to be evaluated and in the end finally also accepted, and moments of joy, when hearing from the acceptance of the poster and conference funding.

This approach of dissemination has had an influence on my *research orientation*. Anyway, in the first place, the idea was not to publish any articles related to the thesis work. However, the idea to aim for publishing the articles came a while later through the encouragement of my tutor, principal lecturer Satu Luojus. Even though I was interested in eye tracking already before and got even more excited during the participation in Lund eye tracking academy in spring 2010, it was the process of researching for and writing the articles, that really opened me the wide world of eye tracking. The idea how the visual eye tracking data could be used communicatively interested me a lot from the day one. The thorough literature review confirmed my assumption on small number of papers discussing the qualitative approach to the method, and encouraged me to dive deeper into the field of eye tracking. To my positive surprise in the end of the hard slog of reviewing the literature I did find an article discussing the retrospective usability testing with eye tracking. This article gave me extra support to discuss further the dialogue enhanced by the eye tracking data. This thesis is a result of extended, but not exhaustive theoretical review especially on eye tracking, but also on the areas supporting the creation of the *ci2i* model.

Theoretical approach of this thesis was supported by a pilot study in the library context. The first intention was to continue to conduct the library studies with the same research settings as part of this thesis, but due to the publishing pathway, the empirical part of the study remained to this one pilot. During the thesis process, I kept on searching for academically scrutinised papers on broader use of eye tracking with qualitative approach, especially in the field of my interest, user research. I found a couple of articles more related to retrospective testing, otherwise the findings were unsubstantial. This again influenced on my research orientation, since I needed to look for other areas of research to find a framework to construct upon and reflect my idea on *user dialogue* enhanced by gaze replays with. The area of service design for instance, was a new area of exploration to me, as well as the theories on dialogue largely supporting the model built.

Related to *innovation* criteria, the conclusions of this thesis are made based on the evaluation of the pilot study and its findings, which were reflected on the prior research on eye tracking and on a set of theories supporting the creation of the model and presented in this research. The literature review and the conducted pilot study to test the ideas and theories in real world took place in parallel. This way proved to work very well. I had the major part of the literature reviewed, when the pilot study took place. The pilot was still experimental and I really learned a lot from it. Due to a proper documentation of the pilot study that took place a year prior to the completion of this thesis, it was possible to review all the findings again for the purpose of writing this thesis and the articles. Research plan, video recording in the future workshop, gaze replays, field notes, post-experiment interview recordings, photographs, background questionnaires and invitations were handy and needed when building the model in reflective process relying on the prior research of my own, research from others and the pilot study. The pilot study is described in the articles and reflected in the chapter 5.3, dealing with the model created. Writing the articles was a great way to reflect on the pilot study and get new insights. The process of writing this thesis continued this reflection, and produced these novelty results.

From the *usability* of the results point of view, this thesis has produced new knowledge for practice. An overview of the evolution of *user dialogue* enhanced by gaze replays is given, followed by how to - instructions for implementation of the model. The results of this thesis have been described in well transferable manner and suggestions on the usage areas of the results have been given in a form of reflection to service design. The publications related to this thesis are considered as a way to submit the results of this work for the research community for getting a wider evaluation of the applicability.

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