

# A Study of User Experience:

Aesthetic, Tangible User Interface Concepts in the Context of Adaptive Hotel Room

University of Lapland

Faculty of Art and Design

Industrial Design

2015

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**Title:** A Study of User Experience: Aesthetic, Tangible User Interface Concepts in the Context of Adaptive Hotel Room

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**Degree programme / subject:** Industrial Design

**Type:** Master's thesis

**Number of pages:** 90

**Number of attachments:** 8

**Year:** 2015

### **Abstract**

Developing technologies and digitalization are having increasingly bigger role in our lives. We use different gadgets and devices to connect with the digital reality. The technical development and new design directions lead towards new types of user interfaces (UIs), which need to be developed to be user friendly. This master's thesis research studied the user experience (UX) of aesthetic, tangible UIs utilizing nontraditional interactive elements in an adaptive hotel room context.

The process started with ideation and concept design phase for creating an adaptive hotel room concept used as a tool to communicate and evaluate ideas. Within this hotel room concept further five concepts were created, from which two were selected to be developed into user studies. The conducted user studies included concept UIs utilizing water and glass as UI elements.

It was concluded that whereas, the tangible features had a salient impact on the user experience with both concept UIs, the influence of aesthetic features was more prominent with the concept UI utilizing glass. Although, some issues relating to pragmatics of the concept UIs were raised, these were somewhat overrode by the hedonic qualities of the user experience. The users experienced the use of the concept UIs as fun and interesting.

Due to the restricted timespan of the user studies the user experience was presumably influenced by the novelty value of the concept UIs. The future research should conduct a study examining the formation of user experience during a longer timespan and repeated exposure to the UIs.

**Keywords:** Interaction design, User experience (UX), Tangible user interface (TUI), Aesthetic user interface, Ephemeral user interface, Concept design, Ubiquitous computing, User studies

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# Lapin yliopisto, taiteiden tiedekunta

**Työn nimi:** A Study of User Experience: Aesthetic, Tangible User Interface Concepts in the Context of Adaptive Hotel Room

**Tekijä:** Siina Pekkanen

**Koulutusohjelma / oppiaine:** Teollinen muotoilu

**Työn laji:** Pro gradu -tutkielma

**Sivumäärä:** 90

**Liitteet:** 8

**Vuosi:** 2015

## Tiivistelmä

Nopeasti kehittyvä teknologia ja digitalisoituminen vaikuttavat yhä voimakkaammin elämäämme. Eri laitteiden avulla pyrimme pysymään yhteydessä fyysisen maailman rinnalle syntyneeseen digitaaliseen todellisuuteen. Uusien teknologioiden ja muotoilun suuntausten myötä käyttöliittymät saavat yhä erilaisempia muotoja. Tämän myötä myös käyttäjäkeskeisyys ja käyttökokemuksen suunnittelu ovat nousseet yhä keskeisemmäksi teemoiksi vuorovaikutussuunnittelussa. Tässä opinnäytetyössä tutkitaan uudenlaisia vuorovaikutuselementtejä hyödyntävien esteettisten ja fyysisten käyttöliittymien käyttökokemusta adaptiivisessa hotellihuoneympäristössä.

Tutkimusprosessin alkuvaiheessa konsepti adaptiivisesta hotellihuoneesta kehitettiin ideoiden esittämistä ja arviointia varten. Tämä hotellihuonekonsepti koostui viidestä tarkemmasta konsepti-ideasta, joista kaksi valittiin kehitettäväksi edelleen käyttäjätutkimuksia varten. Käyttäjätutkimuksissa käytetyt konseptikäyttöliittymät hyödynsivät vettä ja lasia vuorovaikutuselementteinä.

Kerätyt tulokset osoittivat, että molempien käyttöliittymien fyysisillä vuorovaikutuselementeillä oli huomattava vaikutus käyttökokemukseen. Esteettisten ominaisuuksien vaikutus nousi kuitenkin esiin lähinnä lasia vuorovaikutuselementtinä hyödyntävän käyttöliittymän käytössä. Kokonaisvaltaista käyttökokemusta tarkasteltaessa konseptikäyttöliittymien hedonistiset ominaisuudet vaikuttivat myös jossain määrin syrjäyttävän pragmaattisten ominaisuuksien kanssa mahdollisesti ilmenneet haasteet. Yleisesti käyttäjät kokivat konseptikäyttöliittymät hauskoiksi ja mielenkiintoisiksi.

Koska tätä tutkielmaa varten tehdyt käyttäjätutkimukset toteutettiin rajatulla aikavälillä, voidaan olettaa konseptikäyttöliittymien uutuusarvon jossain määrin vaikuttaneen käyttäjien käyttökokemukseen. Mahdollisessa jatkotutkimuksessa käyttökokemuksen tarkastelu tulisi tehdä pidemmällä aikavälillä ja niin, että testaajat käyttävät käyttöliittymiä toistuvasti yhden yksittäisen kokeilukerran sijaan.

**Avainsanat:** Vuorovaikutussuunnittelu, Käyttökokemus, Fyysiset käyttöliittymät, Esteettiset käyttöliittymät, Hetkelliset käyttöliittymät, Konseptisuunnittelu, Kaikkialla läsnä oleva tekniikka, Käyttäjätutkimus

## Muita tietoja:

Suostun tutkielman luovuttamiseen kirjastossa käytettäväksi: X

Suostun tutkielman luovuttamiseen Lapin maakuntakirjastossa käytettäväksi: X

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# **1 Introduction**

We live in a world where the digital reality and devices have constantly growing role in our everyday lives. At the moment this digital world connects with our physical world through different gadgets that demand our attention and it has become almost a norm to be always online and connected. Although this digital reality and all the devices we use should be made for support and help us, instead they seem to somewhat control us and our behavior. They have created a world of their own instead of being embedded into our physical world as a natural part of it. This gap between the digital and physical worlds created the base for this master's thesis research.

In this Introduction chapter the motivations, and objectives as well as values, and limitations for this master's thesis are presented. Also the research questions are introduced in their own section, after which the structure of the thesis is presented along with the overview of the research process and essential definitions for terms used throughout the thesis.

## **1.1 Motivation and Objectives**

Technology is constantly developing and has become inseparable part of our lives. We carry multiple gadgets such as mobile phones and laptops with us in order to be able to connect to the digital reality coexisting with our physical world. As an alternative for this gadget centric life the research of embedded user interfaces is taking ahold. Instead of creating and designing new digital gadget-like devices, new types of user interfaces are drawing the attention of researchers and designers alike. By embedding the user interfaces into our everyday environments and making the interaction with them more natural, the focus is shifting more to the users and user experience while, in addition to usability, taking also into consideration such hedonic aspects as aesthetics, form and emotion. These topics of user experience and embedded user interfaces formed the scope of this master's thesis.

The thesis was done during an eight months period from March to November of 2015 as a part of the Naked Approach project. As TEKES strategic opening Naked Approach focuses on the research and development of user centric hyper connected world, in which the interaction between humans and digital world is gadget free and therefore "naked". For gaining a holistic overview of this hyper connected world of

tomorrow the project team includes University of Lapland, VTT, Tampere University of Technology, Aalto University, University of Oulu, and Demos Helsinki. Thus providing an insights into design, technical as well as commercial aspects in addition to the scientific research.

I find the idea of gadget-free, “naked” world compelling. For most of the nowadays common user interfaces relying on graphics and text input rarely feel neither natural to use or as a part of the overall surroundings. Instead of utilizing the human senses and meaning formations they rely on the learnt behaviors and symbols to interact, in addition to which, too rarely they are adaptable or context-aware, missing the real connection between user and the digital world leading into “one size fits no one”-situation. Due to this I argue that the importance of user centric and user experience focused approach to interaction design cannot be overlooked.

By the research and concepts done for this master’s thesis the aim was to study the user interfaces from the user centric point of view and bring the emphasis on the user experience. Especially my interests lie in the user experience of tangible user interfaces that are a seamless, embedded part of our daily environments. As discussed more closely in the following Value and Limitations chapter the research of tangible user interfaces as well as the use of nontraditional interactive elements has so far been mainly focusing either on the technical aspects, and usability or on the purely hedonic qualities of the user experience. However this thesis aims to study the overall user experience by bringing the new types of tangible user interfaces into the context of everyday life and therefore taking into account both the value of pragmatic aspects as well as the hedonic ones.

Lastly, I would like to state my personal point of view on industrial design in order to give the reader a better understanding on the chosen approach to the topic. I consider industrial design as an act of creating interaction and communication. Be that the design work is focusing on a service, product or user interface, nonetheless ultimately it conveys some message. This communication can take place between the designer, the user, the designed item, the surroundings or other observers, and it can be transmitted countless ways. Because of this I argue that interaction is a central and crucial aspect of all design work and thus consider interaction design as a natural continuum of industrial design.

As a baseline for the thesis, the design work done regarding the digital, interactive elements is put into juxtaposition with the meaning formation and form factors, centric also in the probably most commonly recognized area of industrial design, product design.

## **1.2 Value and Limitations**

Lots of literature and research material of interaction design and user interfaces already exists. However, great part of this literature, especially educational material and books emphasize the general definition and technical aspects of interaction design. Furthermore, the literature discussing the field from the design point of view still relies heavily on the flat user interfaces that utilize 2D graphics as the main design elements. The new turn towards more tangible user interfaces that seize the possibilities of using three dimensional (3D) elements and different materials is mainly seen in the HCI research articles.

The more unconventional elements for interaction have been typically studied with different approach than the one chosen for this master's thesis. Whereas such interactive elements as water and glass have mainly been studied in more artistic contexts, this study aims to bring them closer to the situations in which we use the user interfaces to control aspects in our everyday lives. Due to that the more artistic contexts, e.g. installations often are purely focused on the hedonic aspects of the user experience they may overlook or forgive possible issues regarding more pragmatic qualities. So by making the connection between ordinary daily tasks and the elements associated to be "experience provoking" this master's thesis aims to provide an overview on the user experience in a situation where these aesthetic, tangible user interfaces have become embedded part of our environments.

This is increasingly important topic due to the constant development of technology. By the development of ubiquitous computing and sophisticated technologies the issues of usability, form, function, and aesthetics familiar from product design are now equally a part of interaction design.

This confluence of the user interfaces into everyday life also presents one of the most notable limitations of this study. In real life setting these interfaces would be used repeatedly and during long timespans. However, in the scope of this master's thesis, testing them in a situation mimicking everyday life throughout a long period of time



was impossible. It is recognized that users' perception could have been influenced by the nature of "one time experience" of the tested user interfaces. Additionally, due to the short contact time with the concept interfaces the users did not get used to them, and therefore the familiarity that would eventually become a part of interaction with any daily used interface or device could have been subsided by the novelty of the experience.

Also the technical aspects of implementation set some limitations to the research process. Due to concept designs being very future oriented by nature, the ways of implementing and testing the ideas was not always available nor feasible. Moreover, the lack of personal knowledge regarding the technical aspects may have led to some unnecessary compromises regarding the implementation of the user studies.

### **1.3 Research Questions**

As stated in the previous sections the research done for this master's thesis was planned on order to study the user experience aspects regarding the use of tangible, aesthetic user interfaces and nontraditional interactive elements. This topic was approached from the point of view of user interfaces more closely related to the everyday life in comparison to the prior art focusing mainly on artistic experiences such as interaction with installations. Two main research questions were formulated for this master's thesis:

**Q1:** *How do users perceive nontraditional tangible user interfaces for controlling actions in an everyday environment?*

**Q2:** *What are the key user experience elements of aesthetic, tangible user interfaces utilizing glass and water?*

## **1.4 Structure of Thesis, Research Process and Definitions**

Including the Introduction chapter this master's thesis consists of eight main chapters. In previous sections of this chapter the motivations, objectives, values and limitations for this master's thesis were presented. Also the research questions were introduced in their separate section. After this short description of the structure of the thesis, the conducted research is presented in the form of a flow chart (figure 1, page 11) in order to help the reader to gain an overview of the process. Furthermore, some definitions regarding the topic are provided, as well as a list of people and organizations contributing to this thesis.

Chapter 2 consists of the literature review and introduction to prior art regarding the topic of this thesis. Firstly, the field of interaction design is introduced. Secondly, the more specified domains of three types of user interfaces are given a closer look. These user interface types are tangible user interfaces (TUIs), ephemeral user interfaces and aesthetic user interfaces. Thirdly a centric element of interaction design, user experience (UX), is presented. And lastly, the prior art regarding the research of ubiquitous computing and adaptive environments is reviewed. In the following chapter 3 the research approach and methodology are presented. In the first section of the chapter the concept design process is introduced, after which the overall research approach chosen for this thesis is addressed. Also the methods used both for collecting and analyzing data are presented.

After these aforementioned more theoretical chapters 2 and 3, the design work done for this thesis is presented starting from chapter 4 Concept Creation for Adaptive Hotel Room. This chapter describes the ideations and concept creation phases of the research process in this thesis. Moreover, in chapters 5 and 6 the two user studies conducted as a part of the research process are introduced and the results from them presented.

The main research questions are answered in the first section of the Discussion chapter 7. In addition, reflections about the results, suggestions for future work on the topic and the reflections about the overall process are addressed in their own sections. Finally, a short conclusion is provided.

As this research process consists of multiple, sometimes overlapping phases a flow chart of it is provided in order to help the reader follow the progress of the research more easily. This flow chart (figure 1) illustrates the main phases and steps taken during the research process in this master's thesis.

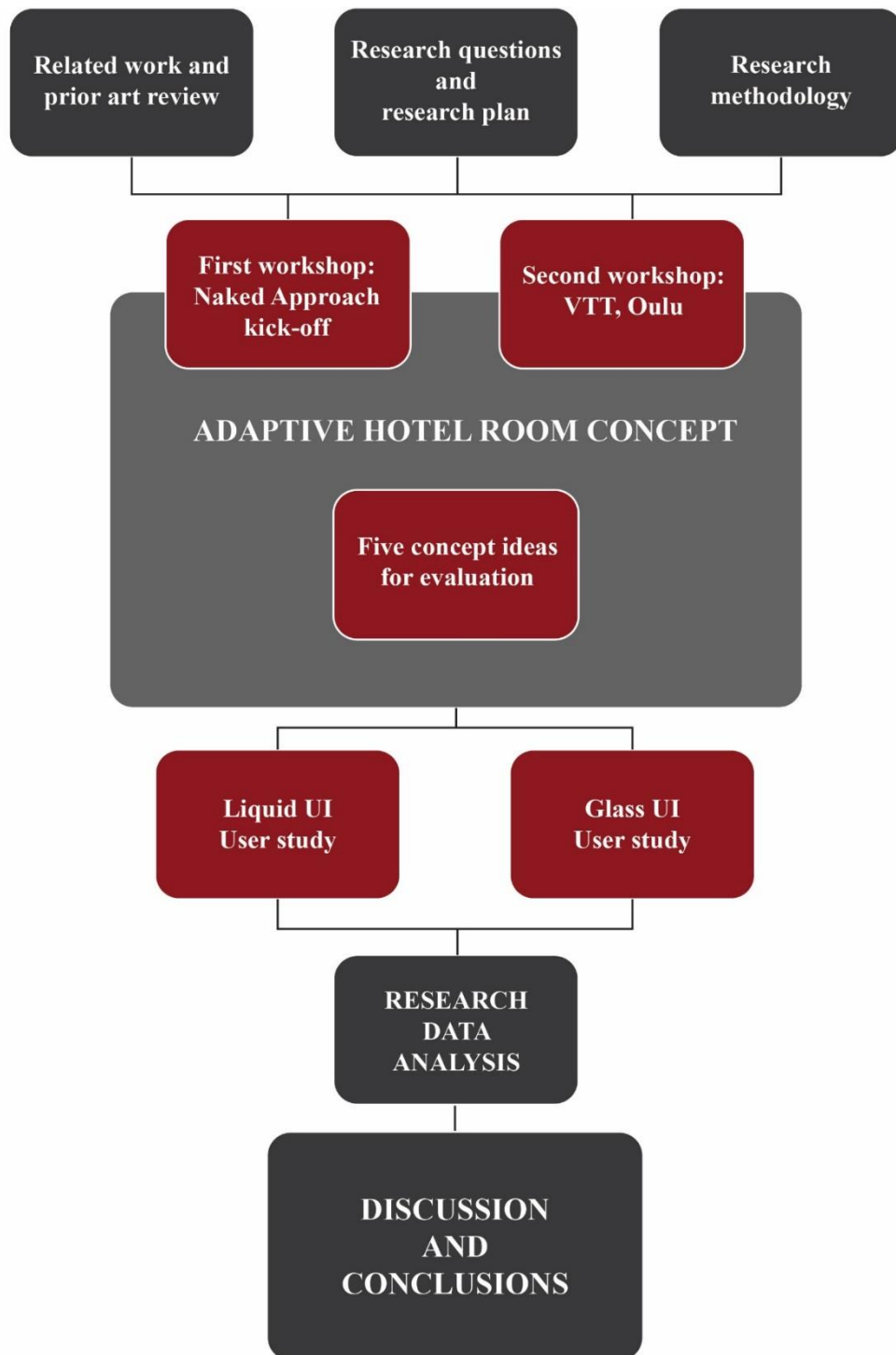


Figure 1. Flow chart of the research process

Additionally to the introduction of the thesis structure as well as the research process, due to that industrial design and interaction design are inseparably intertwined with the constant development of technology, some definitions are required in order to fully bring forth the basis on which this master's thesis was done. The rapid progress of interactive technologies as well as the way they are becoming more and more integrated into our lives make the concept of time somewhat elusive and challenging in regard to them. Whereas in some fields of research e.g. two years could be regarded as a fairly short time period in interaction design it is already considerably long time span, which needs to be taken into consideration. But due to that exact timelines are impossible to draw when talking such terms as nowadays or future the reader must be aware that these references are made from the point of view of the author and based on the review of prior art. In the context of this thesis the term nowadays is used for referring things that are seen relevant and accurate as present day issues at the time of writing this thesis.

In addition to the concept of time being challenging by itself also some other terms relating to it need to be discussed further. In this master's thesis the terms nontraditional and unconventional are referred in various occasions when discussing the interactive elements of user interfaces. Therefore definitions and counterparts for these terms are required. Firstly, the terms nontraditional and unconventional are used as synonyms in the context of this thesis and the choice of expression is based purely on its suitability to the text. Secondly, these terms are used as counterparts for the terms traditional and conventional which in this contexts are used for referring to interactions taking place on flat user interfaces that allow the input and/or output of digital data. Furthermore these traditional interactive elements and user interfaces are considered to represent the data and guide the interaction by 2D graphics.

I wish to also acknowledge that this thesis and the user studies included in it could not have been done without the collaboration with other team members from Naked Approach project as well as the help of coworkers working both in University of Lapland and University of Oulu. The listing of people and organizations contributing to this thesis is shown in table 1.

<b>Name</b>	<b>Task</b>	<b>Organization</b>
Jani Väyrynen	Technical implementation of user studies	University of Oulu, Center of Internet Excellence
Tuomas Lappalainen	Study moderator for the Glass UI user study, User study documentation	University of Lapland
Johanna Korpela	Designing and creating of glass objects used in the Glass UI user study	University of Lapland
Lasse Virtanen	Manufacturing of laser cut and 3D printed components for the user studies	University of Lapland

**Table 1. List of people and organizations contributing to the thesis**

## 2 Literature Review and Prior Art

In this Literature Review and Prior art chapter the terminology, theories and previously made research regarding this thesis' topic have been reviewed. In order to create an understanding of the field of research, centric pieces of prior art such as books used for educational material are cited. Nevertheless, it should be noted that most of the literature references used in this thesis are from research papers. This is due to the constantly ongoing research in the field of interaction design as well as some of the reviewed topics being relatively new as a whole and having limited amount of literature published on them.

### 2.1 Interaction Design

The definition of interaction design can be fairly elusive. Jonas Lowgren (2012) present a very short and simplified description: "*Interaction design is about shaping digital things for people's use.*", whereas Jennifer Preece describes it to be the act of "*designing interactive products to support people in their everyday and working lives*" (2002, 6). In these descriptions both Lowgren and Preece have placed the emphasis to the interactive "things" or "products" that people use. Although neither of the aforementioned descriptions does not exclude the importance of the actual act of interacting, they both approach it from the point of view of the (interactive) objects as well as these objects as a way to make users' lives easier.

This is an interesting notion due to the term interaction design itself referring more directly to the design of interaction, not so much design of "things" or "products" which has been traditionally the field of product design. Whereas this may be seen presenting a contradiction of definitions it also brings forth the vast range of specialized design areas and their interconnections in the field of industrial design.

Often interaction design is viewed as a more precise area of design expertise in the field of industrial design, whereas some researchers like, for instance Jung and Stolterman (2011, 405) talk about it as an overlapping but separate field. Although this is merely an issue of differing points of view and categorizing disciplines it has to be taken into account when discussing interaction design further. As for myself it is natural to think interaction design as a continuous part of industrial design. Nevertheless, in the area of academic research the term interaction design and its

position in the design field calls for more specified and clear definitions of terminology.

In the context of this master's thesis defining interaction design is approached especially from the perspective of the interrelation between interaction and industrial design. When talking about the terms interaction and design we need to be aware of the different distinctions and meanings that they might have depending on the point of view as well as the connotations given to them.

Similarly to the theories of the two well-known semioticians Charles S. Peirce and Ferdinand de Saussure, also interaction design has its focus on the formulation of meaning. Although representing differing approaches Peirce and de Saussure both studied how people formulate and attach meanings in relation to signs and surrounding reality. (Fiske 1992). And even though neither one of them were designers they helped to create the theoretic semantic framework from which also design research has gained a lot from. As industrial design has created values and meanings in non-digital objects (either consciously or unconsciously) at least since the industrial revolution the new form of design objects are now gaining the attention of designers.

These objects of design are the new kinds of user interfaces, devices and interactive objects, or as Jung and Stolterman call them, digital interactive artifacts (2011, 401). The digital artifacts are the key to understand interaction design as it is often referred today. They bring to focus the two important attributes that vocalize the tone difference between much broader field of industrial design and more specified area of interaction design: digitalization and technology. In addition to our material world, a digital, virtual reality has appeared. In order to interact with that virtual reality and manage the digital material we as users are faced with constantly evolving and growing amount of different technologies (Pirhonen et al. 2005, 1) and ever more often we find ourselves interacting with different devices, or digital artifacts, in our everyday lives. So in many ways we have already adapted to this interaction and the term interaction design is often referred concurrently with the research of Human-Computer Interaction (HCI).

Due to technology and digitalization having such a notable impact on interaction design, it is not surprising that probably one of the most prominent feature influencing designers' work throughout the process of interaction design projects is the multidisciplinary nature of domain. Although from the standpoint of designers' the same process of materializing meaning concerns both digital and non-digital artifacts,

it is the link to the digital world and technology that creates the need to work even closer in collaboration with other disciplines than before. Nowadays multidisciplinary approach has become typical to teams working on the field of interaction design and was equally reality while working on this thesis.

Hard as we might to keep up with the constantly evolving technologies it is impossible for one discipline cover all the necessary aspects alone. Moreover, the today's common ways of humans to interact with devices are experiencing a change. Traditional user interfaces such as keyboards and mouse are becoming increasingly inappropriate and will make way for new multimodal forms of interaction. (Weingarten, Blumendorf and Albaryak 2010, 430.) New technologies are attached increasingly more seamlessly to our lives thus creating larger entireties that cannot be brought to reality by any discipline alone. This alone challenges designers who not only need to design the digital interactive artifacts or the interaction itself but also keep in mind the experience as a whole.

So to conclude, interaction design by itself is a field that can be defined many different ways. This elusiveness of the definition is understandable in a world where the ways we are interacting with constantly evolving technologies are changing and taking new shapes all the time. Additionally, more specific areas of the field are starting to capture the interest of the researches as well as practitioner alike. In the scope of this master's thesis some of these areas of research are reviewed more closely. Firstly, the different approaches to user interface design are reviewed in sections Tangible User Interfaces, Ephemeral User Interfaces and Aesthetic User Interfaces. Secondly, the topic of User Experience is reviewed in its own section. And finally, the vision of Ubiquitous Computing and Adaptive Environments is studied.



### 2.1.1 Tangible User Interface (TUI)

The online Cambridge Dictionary <sup>[1]</sup> describes the adjective tangible as *real and not imaginary; able to be shown, touched, or experienced*, whereas the definitions given by Oxford dictionaries <sup>[2]</sup> for the same adjective are *perceptible by touch and clear and definite; real*. So when talking about tangible user interfaces (TUIs) the focus of the discussion is strongly on the materiality, haptics and touch.

Baskinger and Gross (2010, 6) define the design of tangible user interfaces or as they call it, tangible interaction design, as a specialized area of interaction design where physical form and computing are combined in order to create a new paradigm of interaction. As a description I consider this to be both accurate as well as approachable from the industrial designer's point of view. For the design of TUIs provides common and clear touch points between industrial design and interaction design by bringing the latter closer to what industrial design is traditionally considered to be. Whereas industrial design has its roots on product design and creating physical artifacts designing tangible user interfaces adds to this by presenting the opportunity to make these physical artifacts interactive.

Unlike, for example, flat screen displays and interfaces that are often just added onto objects, tangible user interfaces can express values more efficiently by their form and materiality. In our everyday lives we are used to interacting with physical objects even though they may not have any digital attributes. We consider their shape, form, weight, material, and other features to communicate with us. However, with the constantly developing technologies a new demand for designers has emerged to connect the physical, 3D objects to digital information and virtual space (Schmid et al. 2013, 91). The key idea of tangible user interfaces is just that – “*give physical forms to digital information*” (Ishii 2008a, 16). Unlike graphic user interfaces that rely on pixels to provide the interaction the TUIs aim to take advantage and utilize the humans' haptic interaction skills that have evolved through eons (Ishii 2008b, 32-34).

<sup>[1]</sup> Cambridge Dictionary Online  
<http://dictionary.cambridge.org/dictionary/english/tangible>  
(Last accessed Nov 19, 2015)

<sup>[2]</sup> Oxford Dictionaries  
<http://www.oxforddictionaries.com/definition/english/tangible>  
(Last accessed Nov 19, 2015)

This shift towards more complex and multidimensional tangible user interfaces does not only bring limitless new opportunities for designers but at the same time brings them closer back to the questions familiar from traditional field of industrial design, product design. As Hornecker (2011, 22) points out, designing tangible user interfaces could be seen as return to the roots of product design by using more complex physical interaction mechanisms than simply adding screens and buttons on devices.

Consequently, by combining the digital elements to physical objects the designers are faced with the same challenges of affordance familiar from product design - material, texture, shape and form. In fact these challenges are even emphasized. For the tangible objects used for interacting with the virtual environment sometimes offer far less guidance or cues of their use than physical objects without digital connection. In addition to which, we as users are already used to be given guidance in graphical form when dealing with interactive, digital systems.

As an example, we know from learned experience that an object shaped as a drinking glass is most likely meant to be used for liquid whereas a similar glass object that is known to be connected to digital reality does not carry the same kind of learned meanings or affordances but instead might expect the user to rely on his or her association and instinct if instructions are not provided. So if faced with the same glass object and asked to interact with a screen to adjust brightness the users need to also readjust their own mind sets for tackling this task without graphic or textual guidance. As a result of the concepts of tangibility and materiality as well as the affordance (or how well the object communicates its use) of tangible user interfaces it is not surprising that the form has become a centric topic of discussion in the TUI design. And even though this might bring up some challenges, like presented above, it also offers a new freedom for the designers. By moving forwards from the flat screen displays and graphic user interfaces the designers have completely new opportunities to study the interaction between users and objects. The new, wide range of possible materials, shapes and textures provide designers a chance to explore further with e.g. overall design concepts that combine such objects and elements that might have earlier represented totally different styles and therefore be seen as separate pieces.

### 2.1.2 Ephemeral User Interface

The actual word ephemeral originates from the Greek word *ephemeros* which means “*lasting only one day*” (Döring et al. 2013a, 32). This is very descriptive term because ephemeral UIs are time-based. They are transient user interfaces that contain elements that are intentionally created to last only for a limited time (Döring et al. 2013b, 75). Consequently ephemeral user interfaces represent a not so familiar type of interaction for the most of us in our daily lives. They are a research area of interaction design that focuses on the use of nontraditional, often natural materials in user interfaces and human computer interaction.

Ephemeral UIs are also very closely connected to the user experience and semantics. Due to that the ephemeral materials, such as water, fire or ice, are selected to be temporary part of the interaction and user experience, they tend to carry much stronger associations and meanings than traditional user interfaces. In regard to this thesis water as a UI design element is especially interesting example of ephemeral materials. We all have experiences related to water and it carries different semantic meanings to us depending on those experiences as well as the prevailing context. In one context, e.g. monsoon season, water can have negative associations and in another, e.g. in a spa, it can create positive connotations. Similarly, in a same situation the perceived meanings and experiences can differ greatly between different people. So besides the semantic meaning being dependent of the context it is also subjective

The experiences regarding water as a tangible UI element have been studied e.g. by Häkkinen et al. (2015). They present that ephemeral UI elements can carry strong associations to the users and that such elements as e.g. water are perceived playful and fun. Whereas their findings support the notion that the ephemeral UIs are very closely related to the user experience, this connection is emphasized even further by the aspects of tangibility and aesthetics. As Döring et al. (2013a, 34) point out the ephemeral user interfaces are often connected to aesthetics and multisensory perception that are equally a big part of user experience.

By creating multidimensional and experience provoking interactions the ephemeral UIs challenge the designers but at the same time offer great opportunities to explore the interaction design field through new materials and textures. As Döring et al. remark, the ephemeral UIs possess the potential to solve the issues of cognitive overload created by the huge amount of data that we are facing nowadays (2013, 32).

### 2.1.3 Aesthetic User Interface

As reviewed in the Interaction Design, Tangible User Interfaces and Ephemeral User Interfaces sections of this chapter the attitude towards interaction and user interface design is shifting away from traditional graphic UIs and towards more natural feeling, tangible digital artifacts. However, the tangible elements and haptic feedback alone do not guarantee the user interface's capability to engage the user in fulfilling interaction, and generate the affective responses to which are nowadays recognized as increasingly essential aspects of interaction design. In addition to these the widely acknowledged reality of the importance of beauty and aesthetics is gaining ground in the field of interaction design. (De Angeli et al. 2006, 271.) Due to which user studies focusing on the user perception of aesthetics, perceived usability, and affective response have also drawn the interest of researchers. For example, in their article What is beautiful is usable Tractinsky et al. (2000) introduce the study of the post-experimental user perceptions of a system's usability. Based on the findings they present that the user perception of usability was affected not by the actual usability itself but by the user interface's aesthetics. So, the aesthetics matter. Nevertheless it needs to be noted that these aesthetics should not be considered as only the superficial, decorative elements that were seen e.g. in the early work on aesthetic interface designs. For both users and designers aim to strive for a complete and engaging user experience. (Hashim et al. 2009, 70.)

Stating the aforementioned is simple but the actual definitions of beauty and aesthetic aspects of user interfaces can be much harder to make. Due to the experiencing of the user interfaces being subjective and context dependent the perception of aesthetic pleasantness of them is intertwined in this experience. As Reinecke and Bernstein (2011) point out what people perceive as beautiful relates strongly on their cultural background. Furthermore, De Angeli et al. argue that also the use context, including the influence of the use scenario and target group, affects the judgement of aesthetic values (2006, 279).

Dealing with the challenges of context dependency are equally common to all the user interfaces as well as to industrial design in general. Thus, the design of interactive digital artifacts does not present completely new issues but just brings them into a different light. As Reinecke and Bernstein remind the quest for the magic formula of a "perfect design" has been ongoing for a long time as has the discussion of the

definition of beauty as well (2011). Nowadays the shift towards designing more tangible and user centric user interfaces while utilizing unconventional materials has opened up another dimension with which the designers can pursue the creation of aesthetic pleasantness in interaction design. By combining different elements, materials, and shapes the opportunities of designing aesthetic experiences are increasing. As with the user interfaces created for the user studies in this thesis it is now possible to approach the interaction design not only from the point of view of “looks nice” but from the point of view of “look and feel” (Hashim et al. 2009, 70).

## 2.2 User Experience (UX)

As noted in the previous sections of this chapter the role of the user is very centric in interaction design. Evolving technologies as well as increasing number of ways to interact with the digital reality and control the digital material have sparked a new interest in designing the user experience (Redström 2006, 123). While meaning formation, creating values and the idea of experiencing the design products has been around a long time the shift in emphasis from non-digital products to interaction, user interfaces and digital artifacts has provided a new perspective to these topics. And, despite user experience being recognized as an inseparable part of interaction design in this master’s thesis it has been addressed in its own section to bring attention to its significant role in this research.

Whereas, with interaction design on a more general level we can discuss more utilitarian frameworks, models and interactive systems, with user experience we get closer to the more hedonistic aspect of design and the human emotions. Similarly as with more traditional non-interactive design objects, people reflect their feelings, values, and identity as well as affix them to interactive artifacts, thus making the using and experiencing of these artifacts subjective as well as inseparable from societal context (Jung and Stolterman 2011, 402). Hence even though they have common features user experience entails much wider range of attributes than mere usability.

Mark Hassenzahl defines user experience as a “*momentary, primarily evaluative feeling (good-bad) while interacting with a product or service*” and identifies two different dimensions connected to the UX with interactive artifacts: pragmatic quality and hedonic quality. The hedonic quality refers to the object’s perceived ability to help users to achieve their goals of fulfilling basic human needs and provide the tools for

self-expression. Whereas the pragmatic quality can be seen as the dimension that entails the topics usually considered as usability and refers to the attributes that help the users achieve their goal of use. (Hassenzahl 2008) Moreover, according to Eric Reiss (2012) these attributes of usability can be divided further into two categories. The first category includes the physical parameters that ensure that something does what we want it to do whereas the second category consists of the immaterial, psychological parameters that are concerned about how users assume things to work. Ultimately the user experience itself comprises of the combined fulfillment of both pragmatic and hedonic qualities. Even though the positive user experience might be eventually created by fulfilling the users' hedonic need this cannot be achieved without making sure that also the pragmatic needs are fulfilled (Hassenzahl 2008). Although different designers and design approaches tend to sometimes emphasize either the physical or the psychological aspects of user over another it needs to be remembered that neither one cannot be excluded. Thus, it is not enough for industrial design nor interaction design to think of the usability, affordance, or meaning formation as such. In order to create objects or interactive artifacts that provide a positive user experience these perspectives of design process need to be brought together the way that they can complement each other. This to say the least is challenging.

And non-less challenging than creating the user experience is the actual measurement and evaluation of it. Due to user experience being so subjective and closely bind to the cultural and societal contexts it is harder to measure than topics that can be summarized into numerical data. However understanding and evaluating the user experience is crucial in order to create successful interactive artifacts.

For measuring the user experience there is a wide selection of possible methods. For example a range of user experience metrics are introduced by Tullis and Albert (2013). With these metrics they aim to provide the practitioners in the field of user experience a structured way of designing and evaluating UX, give insight into research findings and provide information crucial for decision making (Tullis and Albert 2013, 8). And even though all these presented metrics arguably have their place in the field of user experience research there is no point of addressing all of them in the scope of this thesis. Therefore the metrics seen as most essential for this research are given a closer look in the Quantitative data collection chapters (3.3.2).

### 2.3 Ubiquitous Computing and Adaptive Environments

Along with technologies progressing and developing further the concept of smart environments with interconnected network of devices are becoming closer to the reality (Weingarten et al. 2010, 430). Ubiquitous computing, as defined by Mark Weiser who is considered to be the father of the idea, is a future oriented field that aims to bring wide range of disparate technologies together and thus creating a vision of interconnected world. This interconnection aims further on bringing the ubiquitous computing as part of the human world and shifting the focus from the introverted virtual world to the human interaction by pushing the computers into the background. (Weiser 1991.) According to this vision the human centric digital reality with all its information and computational capabilities would be available constantly, something that Abowd and Mynatt (2000, 31) call quite accurately everyday computing.

We are constantly incorporating devices and interactive artifacts in our lives - usually one by one. Yet this way of connecting physical and digital realities has to be challenged if we want to get closer to the world of ubiquitous computing and truly interactive, adaptive environments. In order to really achieve a well-meshed holistic system for accessing and managing digital reality the way this system is build needs to be studied further.

The top-to-bottom design approach that is suggested by Edwards and Grinter (2001) can be seen as one way of creating holistic system but, as the authors themselves already recognize, it is very unlikely to happen and hard to utilize. This approach would require us to start rebuilding the whole physical as well as digital infrastructure. Alternatively, maybe more realistic vision of the world with ubiquitous computing is the one presented by Bell and Dourish (2007). They argue that the ubiquitous computing is already present in our daily lives, although maybe not globally and in the form that it was expected to take. At least in the highly developed countries many parts of our lives and the devices we use are already interconnected. This connection is just not as smooth, clean and seamless as Weiser (1991) might have envisioned. Weiser's world of ubiquitous computing full of "*invisible widgets*" may not have been realized but nonetheless the world has become interconnected. Hence instead thinking ubiquitous computing as Weiser described it in 1991 we should update our vision (Bell and Dourish, 2007). Consequently we should consider shifting the focus from the vision of top-to-bottom designed world of ubiquitous computing to making the already

existing border of physical and digital realities smoother and less visible. For bringing the design focus thus closer to the concrete, present day issues I consider the term everyday computing by Abowd and Mynatt (2000, 31) to be appropriate and more approachable than ubiquitous computing.

As a holistic system the everyday computing will have, and is already having, a significant influence on our daily lives. Both, on an individual as well as societal level. We need to be aware that as the environments become more and more sensitive to users' actions and provide help with tasks that were used to be done manually they will eventually end up having even social implications. Like the introduction of the washing machine changed the society's overall expectations about the chores at home we cannot really say for sure what the impacts of everyday computing are going to eventually be. (Edwards and Grinter 2001, 264.) Furthermore, in addition to the environment per se the computing can also be extended to the objects and other elements in the space. This possibility to utilize unconventional objects and materials as user interfaces offers designers completely new opportunities for creating interactive and adaptive environments. By embedding the interaction into the environment we can start moving from the nowadays messy and complex ubiquitous computing world (Bell and Dourish 2007) into the calmer and smoother everyday computing of tomorrow.

In addition to everyday computing and ubiquitous computing adaptive environments have emerged as concurrent area of research. As a research topic adaptive environments are current as well as versatile. After all, numerous studies of both adaptive environments as well as adaptive objects have been made, e.g. a study in which a physical environment is affected by human emotions through non-verbal communication (Li and Jianting 2009) and the coMotion concepts that explores the influence of a shape changing bench to social situations (Kinch et al. (2014). But even though these studies present the idea of context-aware adaptive elements they are just that – only elements instead of a holistic system. And even though the range of research and literature focusing on combining both the interactive, adaptive environment as well as the objects with same capabilities is wide the focus of such literature usually lies more on the technological aspect or usability and general experiences instead of systematic study of user experience. Although especially during the past five years the experiential design thinking has been gaining ground in the field of HCI and ubiquitous



computing fairly few studies have focused on the deeper understanding of user experience. (Väänänen-Vainio-Mattila et al. 2015.)

In order to the user interfaces to become able to react to both explicit and implicit inputs by the users as well as the environments become more adaptive, they need to also become more context-aware. Context, as defined by Abowd et al. (1999) is “[---] any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and application themselves.” This definition of context as information is broad but thus very comprehensive. However, for the environment to be considered context-aware it needs to be able to somehow utilize this information. In this master’s thesis a system is regarded as context-aware when it is able to detect and interpret information constituting the context as well as dynamically respond and adapt according to it.

Moreover, Abowd and Mynatt (2000) present the “five W’s” that should be taken into consideration when designing interactive environments that are able to respond to the user. These are *Who*, *What*, *Where*, *When* and *Why*. In order to the visions of everyday computing and context-aware environments to become reality the environment needs to be able to recognize *who* is interacting with it, to interpret *what* the user is doing and *where* the interaction is positioned in relation to the context. Similarly *when* is related to the context awareness by providing the measurement of time, e.g. the length of a visit as well as is *why* that aims to take the interpretation of what even further and explain the reasons behind actions. (Abowd and Mynatt 2000, 37.) And although these five W’s are maybe more closely related to the technical design aspect of everyday computing and adaptive environment they just emphasize the prominence of context also in the work of industrial designers. Before we can design the interaction or the experience we need to understand in which context or environment the user is going to interact in.

### 3 Research Approach and Methodology

In this chapter the research approach and methodology for this master's thesis are presented. In the first section the Concept Design method utilized while working on this thesis is described. After this the Mixed Methods Research approach along with qualitative as well as quantitative data collection and analysis methodology are presented.

#### 3.1 Concept Design

Concept design process is a crucial part of any design project. It is the centric ideation phase where a numerous amount of ideas are created. As Kettunen (2001, 60) describes it, it is the phase in which “*creativity sparks, inventions are made and form is created*”. It is also a phase where those ideas are evaluated.

As for most of the models of concept design process are created from the perspective of product design they have some minor differences in emphasis in comparison to the work done in this thesis. However the illustration presented by Kettunen (2001, 61) summarizes the concept design process well, figure 2.

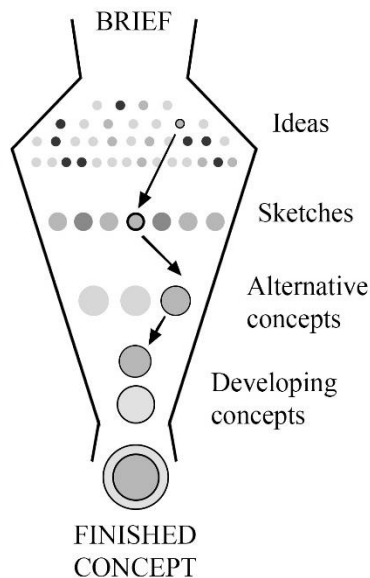


Figure 2. Concept design process by Kettunen (2001), translation by thesis author

As the core idea and starting point of concept design process is to find new possibilities and create vast amount of ideas the initial ideation phase is centric. Especially in this phase designers have a notable role as the scouts of hidden opportunities. In order to create successful outcomes the designers need to be able to read the signals and signs they receive from their surroundings and other people. (Kokkonen et al. 2005, 65.) With the help of these signs and signals they can find the underlying and implicit wants, needs and opportunities that may otherwise go undetected. During this phase the ideas are not yet criticized or evaluated but as much of them are created as possible in order to gather a wide range of ideas as well as enough material for building concepts on (Kettunen 2001, 61).

When a sufficient amount of ideas are gathered the next step of concept design process is taken. By grouping, combining and developing the ideas the vision of which ones should be taken further starts to clarify. In this phase sketching the ideas provides a practical tool for evaluating and developing ideas into draft concepts. During the work on this master's thesis from the vast amount of ideas that were created eventually dozens were sketched and illustrated. By illustrating the ideas it is often easier to discuss them with other stakeholders and start making decisions of which ones to choose for further development. Lastly, as the last step of the concept design process, the final concept or concepts are selected and finalized. For this master's thesis eventually two concepts were chosen from the alternative concept drafts and developed into user studies.

All in all the concept design process as a whole is inseparable part of successful design process. Instead of the old fashioned idea of design being something that happens in the very end of the process of creating new products it is actually an ongoing process that begins at the same time with the overall project. Concept design is the free, fun and non-critical phase of the design work during which the opportunities that otherwise might be left hidden can be found out. As for this master's thesis it was also the driving force behind it. For the free flowing ideation provided the opportunity to create truly future oriented concepts as well as work together with the project members from other disciplines and get their contribution.

### **3.2 Mixed Method Research**

The approaches of scientific research they are divided into two main categories; qualitative and quantitative research. Qualitative research is a research approach that aims to study and understand the qualitative aspects of the research topic such as quality and meanings. Whereas quantitative research is a research approach that aims to find out and present the relations and differences between numerical and measurable attributes (Vilkka 2007, 13).

However quite often the research done in the field of industrial design represent purely neither approach. This is because of the nature of industrial design. Firstly, by definition something is designed - created. This does not need to be a physical product or an artifact per se, but designs made for e.g. concepts, services or user interfaces are equally concrete outcomes of industrial designers' creative process. Secondly, all of the designs, at least in order to be successful and fulfill their purposes, carry both; physical, concrete attributes as well as more symbolic attributes, like values and associations. Due to this multifaceted nature of the outcomes of design process, for instance user interfaces, they can be also studied numerous different ways and with various methods. And this versatility of the available research material further highlights the role and the motivation of the researcher. Even though in some cases it may be beneficial to solely focus either on the quantitative or qualitative aspects of the research, this did not suite very well to the structure or the nature of this master's thesis. In order to gain understanding of the topic it was decided that the research approach should be mixed methods.

Mixed methods research utilizes methodology from both quantitative and qualitative approaches in combination in order to provide a better understanding of research problems than either approach alone. By collecting and combining data gathered with quantitative and qualitative methods a deeper understanding can be found (Creswell and Plano Clark, 2007, 5-7). Thus using mixed methods enabled the use of different kinds of data collecting and analyzing methods for this thesis and further opened up opportunities that using solely quantitative or qualitative approach might have closed.

Moreover a decision was made to use methods most closely related to the *triangulation design* which is the most commonly used mixed methods approach. As defined by Creswell and Plano Clark (2007, 62-64) the triangulation design is a “*one-phase design in which researchers implement the quantitative and qualitative methods during the same timeframe and with equal weight*”, as illustrated in figure 3.

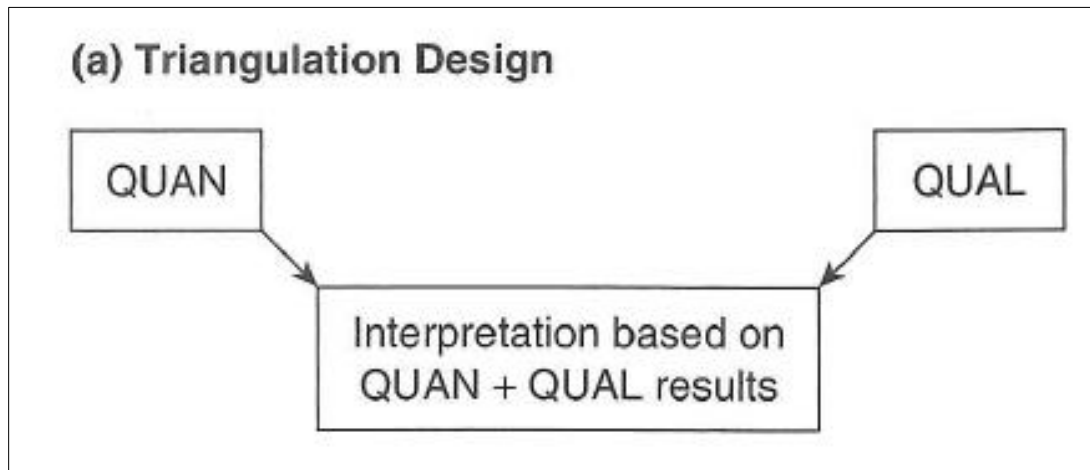


Figure 3. Triangulation design in mixed methods research by Creswell and Plano Clark (2007, 63)

### **3.3 Data Collection Methods**

Due to the mixed methods research approach selected for this master's thesis the types of research data and the methodology for collecting it were diverse. In this section the methods for collecting the research data are introduced. For the clarity this section has been further divided into two parts, *qualitative data* and *quantitative data*. This bifurcation is done based purely on the nature of the data by regarding the numerical and quantifiable results gathered by forms as quantitative data and the answers gathered by e.g. open ended questions and videos as qualitative data. However, the methodology of analyzing such data types, be that either with qualitative or quantitative methods, is reviewed later in the Data Analysis Methods chapter 3.4.

#### **3.3.1 Qualitative Data**

For collecting the qualitative data several different methods were used in the making of this thesis. These methods varied based on the phase of the process as well as later on the user study in question.

In the very beginning of the research process, in workshops organized during the concept creation phase (chapter 4), notes and ideas were gathered as the initial information based on which the work could begin. This data consisted of ideas that were either written down by the participants on post-it notes during workshops or noted by the workshop moderator from the conversation. Later all of this gathered information was crafted into lists and tables.

Arguably even more importantly for the research presented in this thesis lots of data was gathered during the user studies. This was done by utilizing several different empirical methods. Majority of the qualitative data for this research was gathered by different forms and questionnaires. In order to study users' subjective perceptions and experiences these questionnaires included open ended questions to which users could answer in text format. During the Glass UI user study (chapter 6) the users were also encouraged to illustrate their ideas. Notes were also made by the study moderator during both of the user studies in addition to the data gathered with forms and questionnaires. The studies were also recorded either on video or audio for later examination. Furthermore photographs were taken throughout the studies.

### 3.3.2 Quantitative Data

The numerical, quantitative data for this master's thesis was gathered from the two user studies done in the autumn of 2015 (figure 1, page 11). This data was collected with several forms and gathered later into tables and charts. The method of collecting this data could be divided roughly into two types of forms.

Firstly, data that could be easily crafted into and presented in the form of key figures such as average values and percentages was gathered. Such data was collected from both user studies by asking the participants some basic information with the background questionnaires (appendix 1) as well as with different forms throughout the studies. As clear examples of collecting this type of data are e.g. the background questions asking the age and dominant hand of the users as well as the Product Reaction Cards (PRCs) form (appendix 2). With the PRCs form adapted from the Microsoft PRCs method<sup>[3]</sup> the users selected terms to best describe their experience as well as additionally chose their favorite from a limited amount of options. In addition to providing a clear way of handling and reading the results i.e. in the form of percentages and average values, an insight gained from this data could later be reflected to other data and results.

Secondly, notable part of the user study results were also collected in a quantifiable form by utilizing a Likert scale from 1 to 7. This type of approach is referred as one way of collecting interval data. With this data collection method the users are provided with scales that has descriptive terms as end points or anchors and between them a referential scale visualized by dots that allowed them to give a subjective rating for the topic. (Tullis and Albert 2013, 18.) As an example, the scale for rating how natural users felt the interaction between the glass objects and the environment during the Glass UI user study was visualized as seen in figure 4, on page 32.

<sup>[3]</sup>Microsoft Product Reaction Cards <http://www.microsoft.com/usability/UEPostings/ProductReactionCards.doc>  
(Last accessed Nov 19, 2015)

*How natural did this interaction between the glass objects and the environment feel to you?*

En lainkaan  
*Not at all*

Täysin  
*Completely*

*How did this interaction correlate with your expectations?*

**Figure 4. Example of a Likert scale used in the user studies for gathering interval data**

All in all both of the aforementioned methods of collecting quantitative data were seen beneficial. While providing the numerical values and ratings they also gave the users an opportunity to express their subjective opinions without explicit labels.



### 3.4 Data Analysis Methods

Due to the use of mixed methods research both the qualitative analysis and quantitative analysis of the data needs to be presented. In this section, first, the chosen qualitative analysis method, phenomenography, is presented. Second, the methodology used for quantitative analysis is introduced. Nevertheless, it needs to be noted that although the research data might be named to represent either qualitative or quantitative data the methodology for analyzing this data varies not only by the definition of the data type but depending on what the aim of the research is. Even though the quantitative, numerical data is addressed this does not exclude the possibility of the use of qualitative analysis methods for interpreting it when seen fitting.

#### 3.4.1 Qualitative Analysis

The analysis method chosen for the qualitative data in this thesis was phenomenography. The reason for choosing this specific methodology lies on its interest towards experience, for as a research field, phenomenography aims to study the world as the people experience it. More precisely, phenomenography focuses on the relationship between certain phenomena and the ways of thinking. Thus, how we create perceptions of the world. These perceptions are the core study subjects of phenomenography. (Anttila, 2006, 334.)

In order to understand how the surrounding world is perceived by people three terms become centric in phenomenography: *phenomenon*, *experience* and *perception*. By their *experience* of a certain *phenomenon* people create a *perception* of it and therefore that becomes greater than the sum of its parts (Anttila, 2006, 334). Thus perception is the subjective way people see the phenomenon and this subjective perception is the point of interest.

As well as being understandable this interest is also well justified. Due to that we all have our prior experiences, values and opinions it is not possible to get a purely objective view of our world. Whereas each person has their own perception of the world similarly each researcher has their own preconceptions and viewpoints. Because of phenomenography relying on the researcher making observations and conclusions from empirical data it cannot be overlooked that these conclusions are also based on some baseline.

In the end the results gained with phenomenography are conclusions and descriptions of the researcher about the studied perceptions. Despite the aspiration of scientific research to be objective this cannot ever truly be reached, due to which the transparency of the research and its motivations become even more crucial.

### **3.4.2 Quantitative Analysis**

In order to utilize the gathered quantitative data it was firstly crafted into MS Excel tables. From this data key figures were calculated based on which charts could be created later on. With the help of key figures the basic information can simply be brought forth from the research data. In quantitative research such key figures include fractiles, average, mode, median, dispersion, skewness and excess (Vilkka 2007, 118). The calculated key figures for this thesis varied depending on the studied data, e.g. from the background information such values as average age of users were found out whereas the values calculated from results gathered with Likert scales included the average rating and standard deviation.

The second quantitative analysis method utilized in this thesis was the cross tabulation. With cross tabulation the aim is to find possible interdependences between different variables (Vilkka 2007, 129). The results contracted by utilizing this method were simple and univocal numbers that were easy to study. In this research the cross tabulation was mainly used for studying differences between the answers given by men and women.

## **4 Concept Creation for Adaptive Hotel Room**

In this chapter the work done for creating the adaptive hotel room concept is reviewed and the finished concept itself is presented. Five more specific concept ideas, based on which the user studies (chapters 5 and 6) were later planned, are extracted from the adaptive hotel room concept and shortly introduced as well. This chapter and the concept creation process follow quite consistently the concept design process presented in figure 2 on page 26. First, the initial ideation phase is presented. In the context of this master's thesis this phase consisted of two separate workshops organized in collaboration with Naked Approach project members. Second, the phase including the sketches of five alternative concepts and their evaluation is presented. And finally the decision of which two of the five concepts were chosen to be crafted into user studies is addressed.

### **4.1 Collecting Ideas**

Before starting to design the adaptive hotel room concept or the user studies it was important to understand how users felt about the general possibility to adapt their environments, in this case especially hotel rooms. Also an insight into how they would like to do this and if they had any specific wishes of adaptable features needed to be gained. This information was gathered through two workshops presented in the following sections 4.1.1 and 4.1.2. Base on the feedback given by the workshop participants it was also reassessed if it would be beneficial to continue the work with the hotel room context.

#### **4.1.1 The First Workshop: Naked Approach Kick-off**

The first workshop that contributed to this master's thesis was the kick-off workshop of the Naked Approach project organized in Rovaniemi 18.3.-19.3.2015. As a part of this event different workshops were organized by the University of Lapland industrial design team in order to give the participants a push to get going with ideation and team work as well as to gather the first ideas. Altogether 34 participants took part in the kick-off event and workshops.

In the workshop from which the ideas were included to this thesis, the 34 participants were divided into four groups. After this they were given the task to come up with new ideas in four different contexts in which they may encounter problems or challenges in their lives. These contexts were airport, restaurant, shopping mall and home that were selected for the different challenging and needs they may present as well as for the wide range of possibilities they could offer for ideation. Each group had 10 minutes for ideating in each context (figure 5).



**Figure 5. Ideation for restaurant and airport contexts during the Naked Approach kick-off workshop at Rovaniemi**

All of the ideas were gathered on post it notes. Even though in the end of the workshop there were hundreds of ideas and notes presented some main categories could be identified from them (table 2, page 37).

Context	Airport	Shopping mall	Restaurant	Home
<b>Idea categories</b>	<b>Communication</b> (11)	Shopping (21)	Alcohol consumption (16)	Nutrition / Food (15)
	Services (6)	Advertisement (7)	<b>Personal relationships</b> (15)	Time management / Scheduling (11)
	Luggage (7)	Parking / Transit / Exit (7)	Dancing / Music (6)	Household chores (9)
	Guidance (8)	<b>Guidance</b> (21)	Ordering (10)	<b>Smart environment</b> (18)
	Atmosphere / Feeling (4)	<b>Atmosphere / Feeling</b> (16)	Atmosphere / Feeling (11)	Atmosphere / Feeling (10)
	Stress / Relaxation (3)	Other (7)	Other (7)	Other (5)
	Tickets (4)			
	Other (10)			

**Table 2. Categories created based on the ideas gathered from the first workshop and the amount of ideas in each category. Categories chosen for further ideation are bolded.**

These identified categories created the baseline for ideation and the first concepts. Especially the categories *Communication*, *Guidance*, *Atmosphere*, *Personal relationships* and *Smart environments* (bolded in table 2) were emphasized by the amount of ideas relating to them. The further two categories that had notable amount of ideas, *Shopping* and *Alcohol consumption*, were seen as too specific and restricted in this point of the process for further development. Thereby the aforementioned five categories became the starting point from which the topic of this thesis was approached.

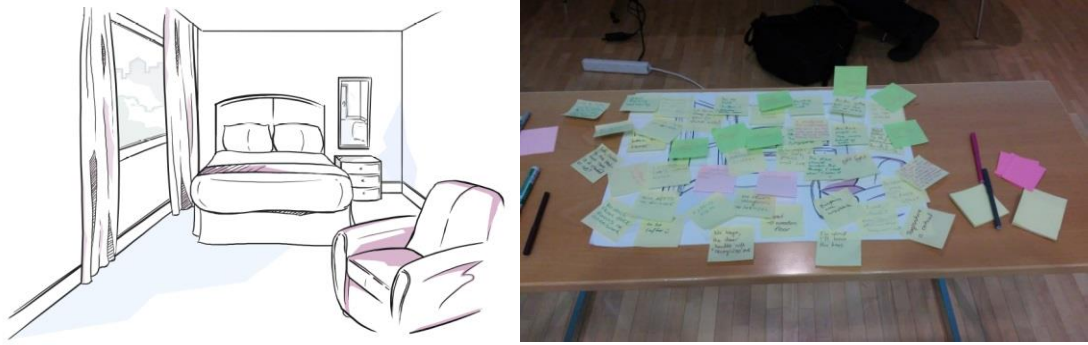
Although the context of hotel room was not included in the first workshop it was later determined to be useful and beneficial in regard to the aim of the research. Due to that hotel rooms can be considered either public or private space depending on the point of view and situation they open up a vast amount of opportunities for design as well as for research. In addition to this, the idea categories found from the outcomes of the first workshop could be further utilized in said context.

#### **4.1.2 The Second Workshop: VTT, Oulu**

After going through the ideas gathered from earlier workshop and notes taken from Naked Approach meetings the research plan for the thesis started to clarify. When VTT as the organizer of the Naked Approach workshop in Oulu 7.5.2015 wished the University of Lapland to contribute some creative input in the workshop it offered a great opportunity to gain more user insight for this thesis as well as for the whole project. By this point the thesis' context had been set on the adaptive hotel room so it was decided that one part of the workshop was related to that.

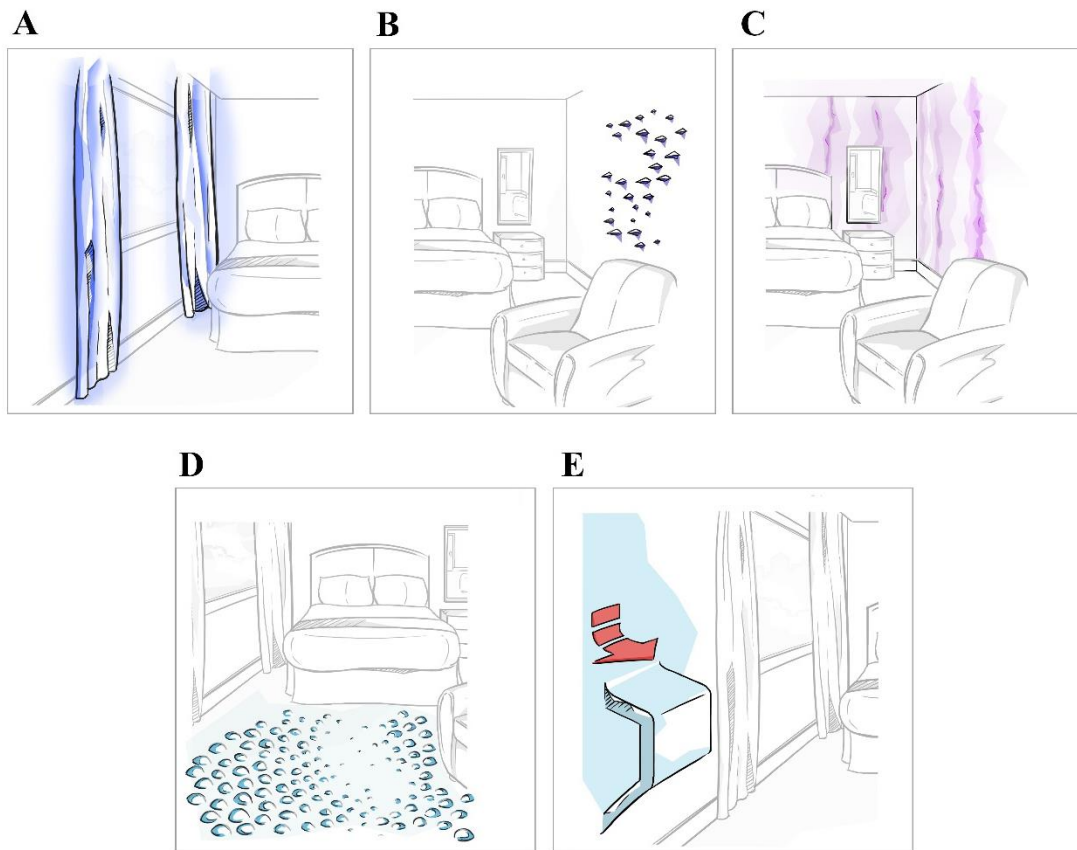
Based on the Kick-off workshop (4.1.1) the categories of *Communication*, *Guidance*, *Atmosphere*, *Personal relationships* and *Smart environments* were emphasized as the most prominent ones when people were ideating solutions for possible everyday challenges. However, in the hotel room context they were expected to have different connotations and provoke different ideas than in the contexts provided earlier. Therefore these five categories were adjusted to fit the selected hotel room context better and eventually workshop participants were asked to come up with ideas and thoughts regarding the *Comfort*, *Being able to adjust the room*, *Communication* and *Being able to control the experience*.

This ideation was done as team work with the help of six illustrations: one of the generic hotel room and five concept ideas. With the generic hotel room illustration (figure 6, page 39) participants were asked of things that they might want to be able to control or adjust in a hotel room. Furthermore, completely new ideas that may not be even feasible with current technologies were encouraged.



**Figure 6. Generic hotel room illustration and ideas gathered on post-it notes**

After ideating around the generic context of hotel room the participants were presented with five different concept ideas on more specific features of the room. These concept ideas were A. *Illuminating curtains*, B. *Morphic wallpaper texture*, C. *Illuminating wallpaper*, D. *Interactive floor texture* and E. *Morphic room / Modifiable surroundings* (figure 7).



**Figure 7. Concept ideas used for ideation during the workshop**

Regarding each of the concept ideas the technological feasibility, knowledge of prior art and further development ideas were asked. Also free-flowing conversation around the concept ideas was encouraged. All the ideas and key words were collected on post-it notes for later study (figure 8).



**Figure 8. Photo taken during the ideation session of the second workshop**

As a result of this workshop altogether approximately 40 ideas or key words were gathered on post-its. These were later categorized into six main categories (table 3).

Use of the room space (8)	Comfort (2)
Overall atmosphere of the room (8)	Human - human communication (5)
Basic features of the room (7)	Human - surroundings interaction (8)
Control (4)	

**Table 3. Categories created from the ideas gathered from the second workshop and the amount of ideas in each category**

These categories, alongside all of the individual ideas, provided a guideline which helped to create the adaptive hotel room concept. Yet these categories still left wide range of opportunities open. The area of human-human interaction was eventually scoped out and the adaptive hotel room concept focused on the interaction with or within the room and environment itself.



## 4.2 Hotel Room Concept

Based on the ideas and feedback gathered from the workshops (presented in sections 4.1.1 and 4.1.2), as well as all the information gained from conversations and notes, the overall concept for the adaptive hotel room with embedded aesthetic, tangible user interfaces was created. This concept was used as a tool which combined, illustrated, and communicated the gathered ideas. Later on the more specific features of the concept were selected to be studied further with user studies.

Altogether the concept of interactive, adaptive hotel room consisted of 5 different ideas. Some of the ideas had come up or been discussed already during the workshops and some of them were created later on based on the more general ideas gathered from the notes and key words. Creating and developing the ideas this way was a great opportunity to both gain input as well as hear criticism from users representing several different disciplines. The ideas finally selected to be included into the concept were *1. Morphic structures*, *2. Universal light source*, *3. Water user interface*, *4. Functional decorative objects* and *5. Flexible user interfaces*. Each of these ideas are marked in the concept visualization below (figure 9) and further addressed more closely in their own separate sections.

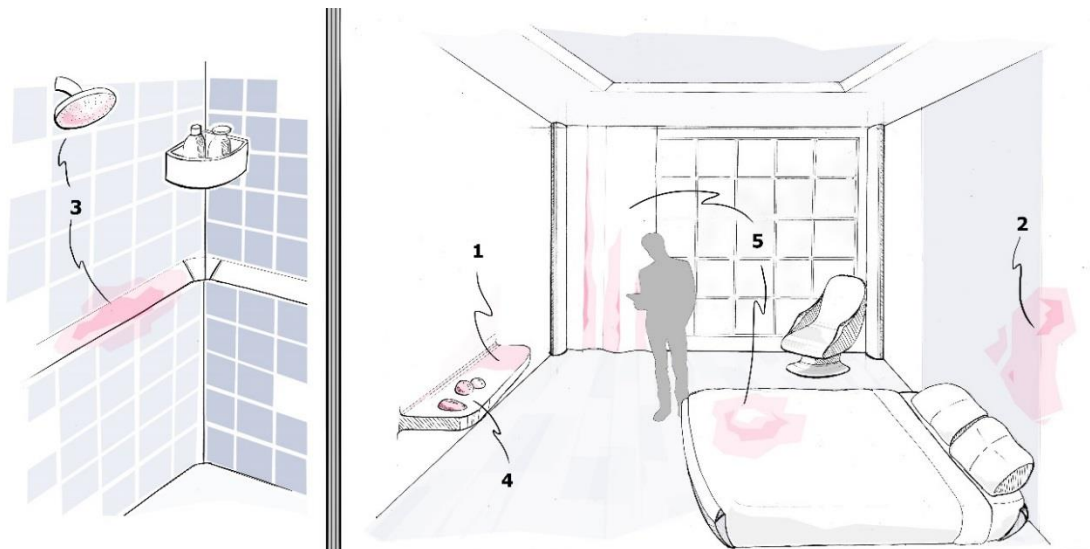
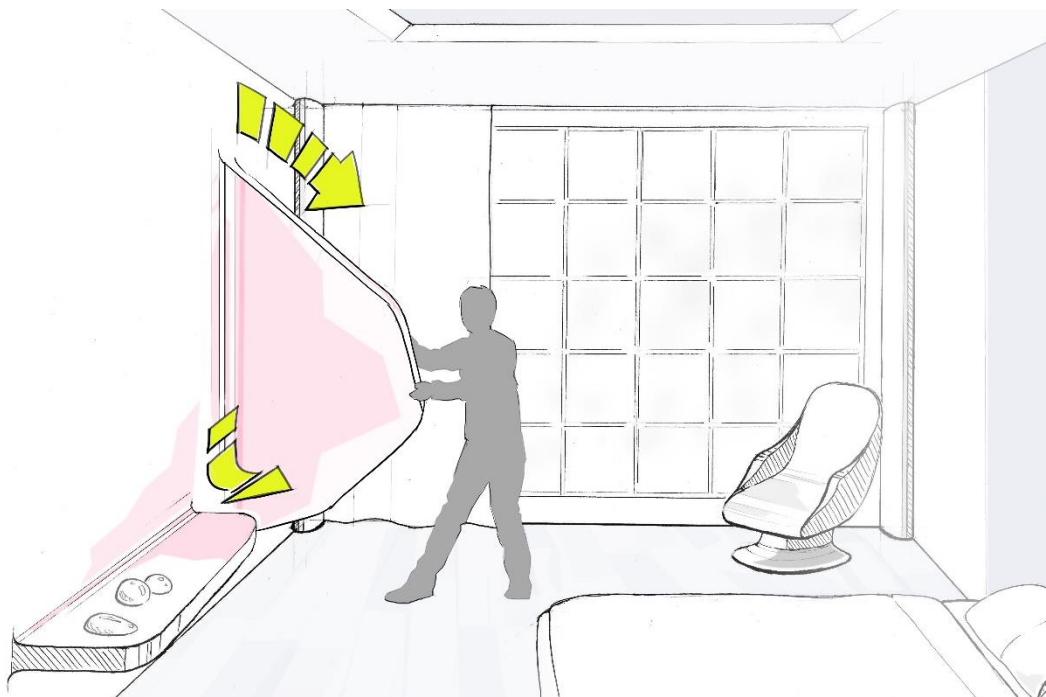


Figure 9. Adaptive hotel room concept

### *1. Morphic structures*

The vision of modifiable and customizable structures was one of the very first ideas when creating the adaptive hotel room concept. The key idea of this concept is that the users would be able to alter the physical features of their environment based on their needs and personal preferences (figure 10). This could either be done by the users themselves, or the environment could automatically adjust itself based on the users' actions or preset settings.



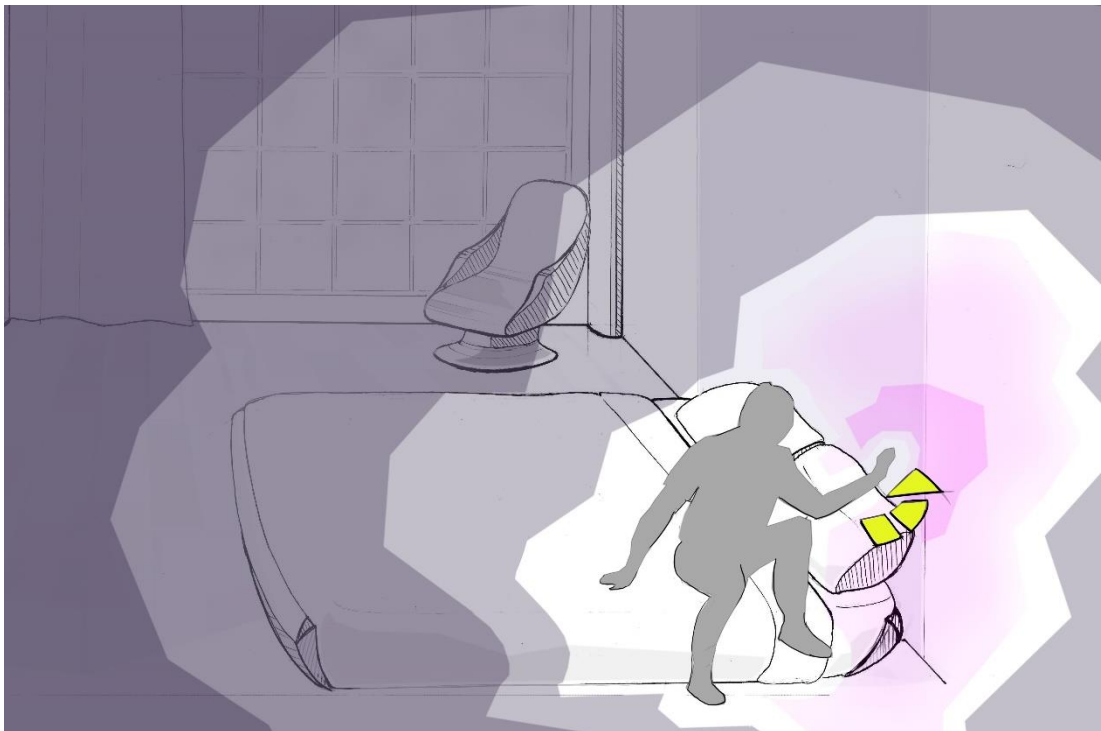
**Figure 10. Concept idea: Morphic structures**

Also, some examples of the prior research on the topic of modifiable and adjustable structures were found e.g. Shape-changing Interfaces by Coelho and Zigelbaum (2011) and the jamSheets concept by Ou et al. (2013). The first-mentioned presents four design probes for creating transformable surfaces whereas the latter introduces layer jamming technology for enabling designing deformable interfaces.

However, due to the complexity of the idea of modifiable structures and the challenges they presented for the technical implementation this concept idea was not taken into further development in the scope of this thesis. As a future scenario this idea could however be developed into a wider concept for it offers numerous interesting possibilities for research as well as for design.

## 2. *Universal light source*

The idea of universal light source was added into the adaptive hotel room concept quite late in comparison to the other concepts. The idea combines several separate ideas and user needs listed during workshops. The universal light source consists of surroundings that can emit light when needed. Thus the source of the light is not restricted to a certain specific point such as it would be with traditional lamps but the light is always available (figure 11).

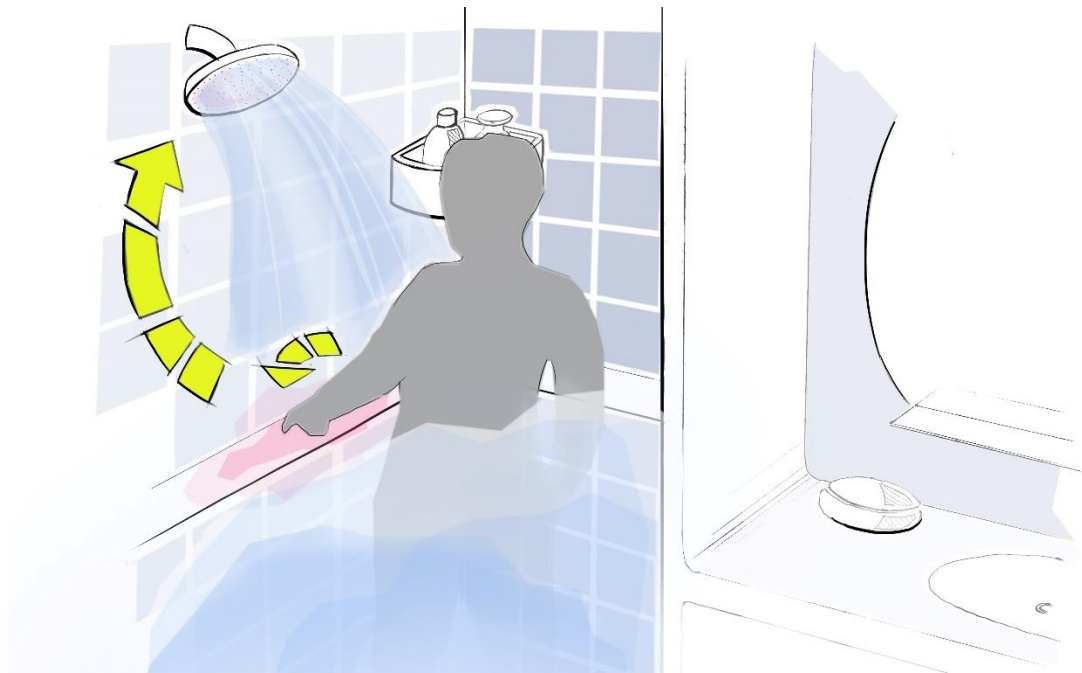


**Figure 11. Concept idea: Universal light source**

A short review of the prior art indicated that some research has been done in the field, such as the LightCloth concept (Hashimoto et al. 2013) which introduces a fabric interface that enables illumination. Nevertheless, due that this idea was presented fairly late in the process and it was also determined to be too laborious to study extensively in a context of this thesis, it was not developed any further for time being.

### 3. Water user interface

One of the key interests for this master's thesis was to discover possibilities that the use of unconventional UI materials could offer in the field of interaction design and user experience research. In addition to more stable and concrete materials a lucid and ephemeral material, water was introduced. Due to the nature of water the user interface utilizing it as an interactive element was placed in the bathroom setting in the adaptive hotel room context (figure 12).



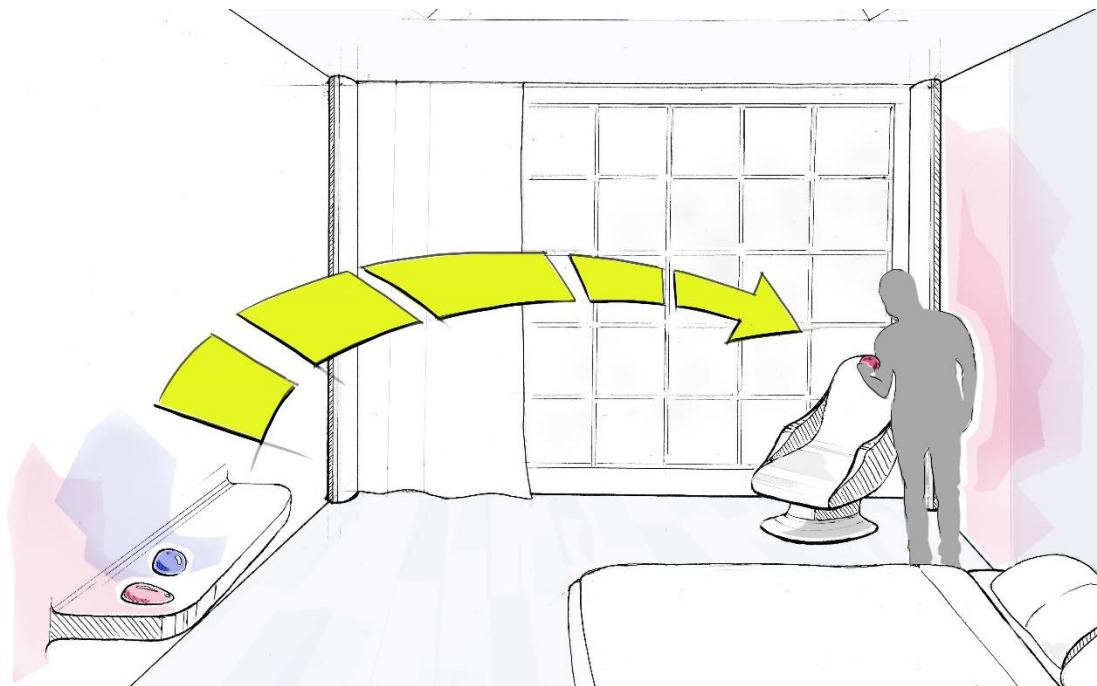
**Figure 12. Concept idea: Water user interface**

In the literature review it was found out that prior art of ephemeral user interfaces and water as an interactive element existed. The prior research included such work as a systematic study of user experience towards natural materials (Häkkinen et al. 2015) and a study introducing software tools created to help design and fabricate fluid based UIs (Campbell et al. 2015).

After deliberating and evaluating the idea of water UI in the light of the prior research literature it was determined that there were attributes worth studying further in regard of water user interfaces. For its interestingness and opportunities for new insights into user experience, the water UI was chosen as one of the ideas to be studied further. The Liquid UI user study (chapter 5) was created and developed based on this concept idea.

#### 4. Functional decorative objects

The idea of functional, decorative objects as elements of interaction differed from the other ideas in the way that the aspects of decorativeness and aesthetics were specifically given an extra emphasis. The interactive objects were also placed in the environment as separate items, instead of physically embedded parts of the room, and the way of interacting happened by physically moving and relocating them (figure 13). The main point in developing this concept was to study the possibility to utilize aesthetic, tangible design objects as part of bigger interactive system.

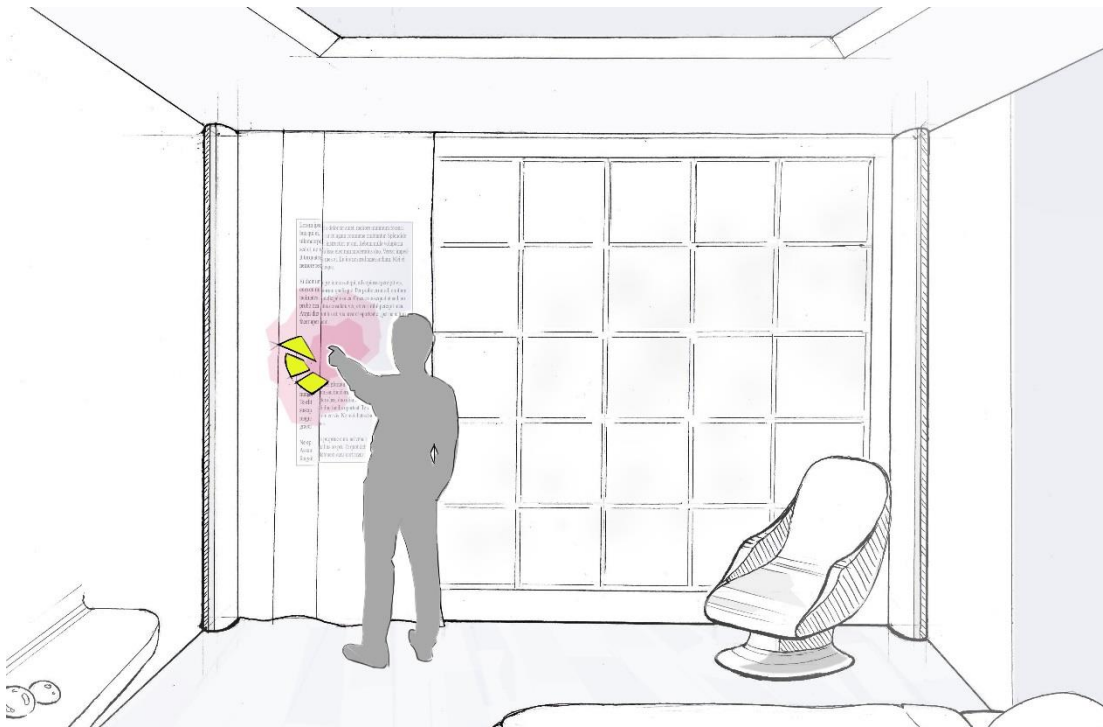


**Figure 13. Concept idea: Functional decorative objects**

Some examples of prior art regarding the aesthetic UIs that were designed to serve a decorative function in addition to a practical one were found, such as the SpectroFlexia concept (Mailvaganam and Bakker 2013) and Bottles: A Transparent Interface as a Tribute to Mark Weiser (Ishii (2004)). Whereas Mailvaganam and Bakker focus on output device combining the information display and decorative functions, Ishii introduces user interface consisting of glass bottles physically manipulated by users. The functional decorative objects concept was determined to provide an interesting opportunity for research and thereby was chosen as the second concept idea to be crafted into a user study alongside the water UI idea. During the development process of the concept into a user study it was renamed as Glass UI (chapter 6).

## 5. Flexible user interfaces

The concept idea of flexible user interfaces originated from the desire to utilize the elements of a hotel room that are not interactive but obtain (and provide) large surface areas (figure 14). Straightforward examples of such elements could be curtains and bed covers. Whereas these aforementioned elements could provide plenty of surface area for UI design they could also facilitate mechanisms for haptic feedback and inputs.



**Figure 14. Concept idea: Flexible user interface**

Prior art in this field has introduced e.g. a study of user preference on using elasticity and deformability as input (Troiano et al. 2014) and the Cloth Displays (Lepinski and Vertegaal 2010) that focuses on the possibilities of utilizing the physical characteristics of cloth in interaction. Although found as interesting research topic the flexible user interface was eventually not included into the scope of this master's thesis.

To conclude, although all of the five concept ideas introduced in this chapter were considered as interesting opening for research, only two of them were selected to be developed further into user studies. These selected concept ideas were the 3. *Water user interface* and the 4. *Decorative, functional objects*. The selection was done based on the concept ideas' novelty value, the information they would provide in answering the set research questions, the technical feasibility as well as on prior research done on the topic.

The user studies are introduced in the following chapters 5 and 6. These chapters are structures so that both studies, including their results, are reviewed individually. The combined results are later presented in the Discussion chapter 7 in which the research questions are answered and results discussed.

## 5 User Study 1: Liquid UI

The first user study made for this master's thesis was the Liquid UI which was based on the *Water user interface* concept idea presented in the chapter 4.2. In this study the users were asked to explore the use of user interfaces where liquid, in this case water, was included as an interactive element. By this the user experience in regard of water as tangible UI element was studied. In this chapter the study plan, and design, the implementation as well as the setup, and participants for Liquid UI user study are presented. After this, the results of the study are reviewed.

### 5.1 Study Plan and Design

The baseline for the Liquid UI user study was to gain an insight into how users experience the use of unconventional user interfaces, in this case as slider switch board with water as an added element. In order to study this three Liquid UI specific questions were formulated:

**q1:** *How do the users experience the liquid slider in comparison to more traditional slider switches?*

**q2:** *How does the expected use experience vary from the actual use experience?*

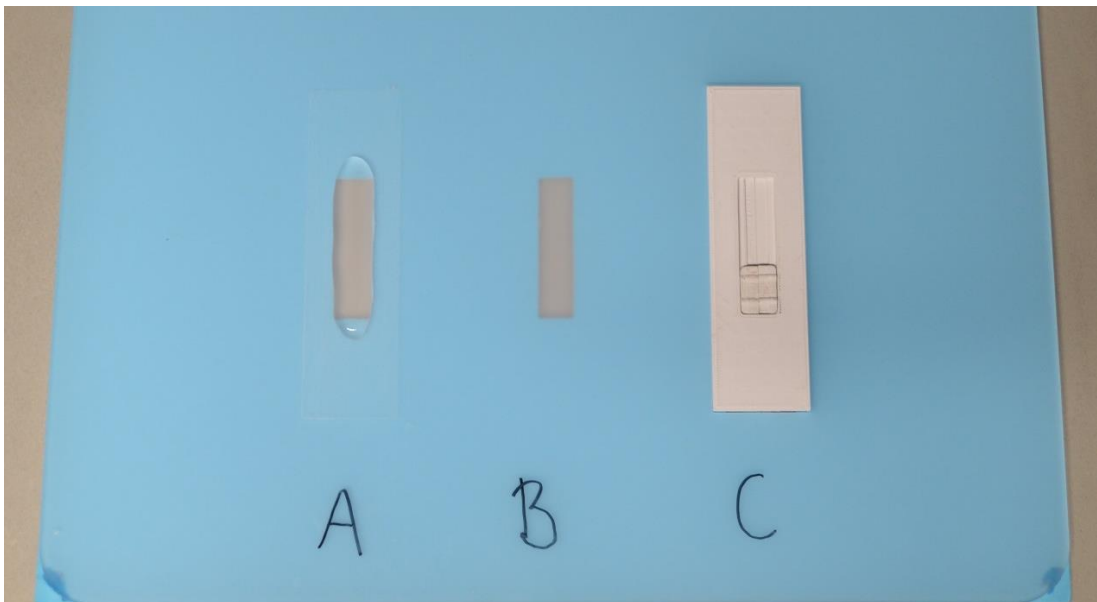
**q3:** *How do the users experience the liquid slider based on how the liquid is placed and/or confined on the slider switch?*

In order to answer these questions the study plan was crafted with two separate tasks, Task I and Task II, that each had their own separate slider switch set-ups. Both of these tasks were carried out in the same test environment one after another. Before beginning the test users filled in a consent form (appendix 3) and a background questionnaire. After this the users started the test with task I.



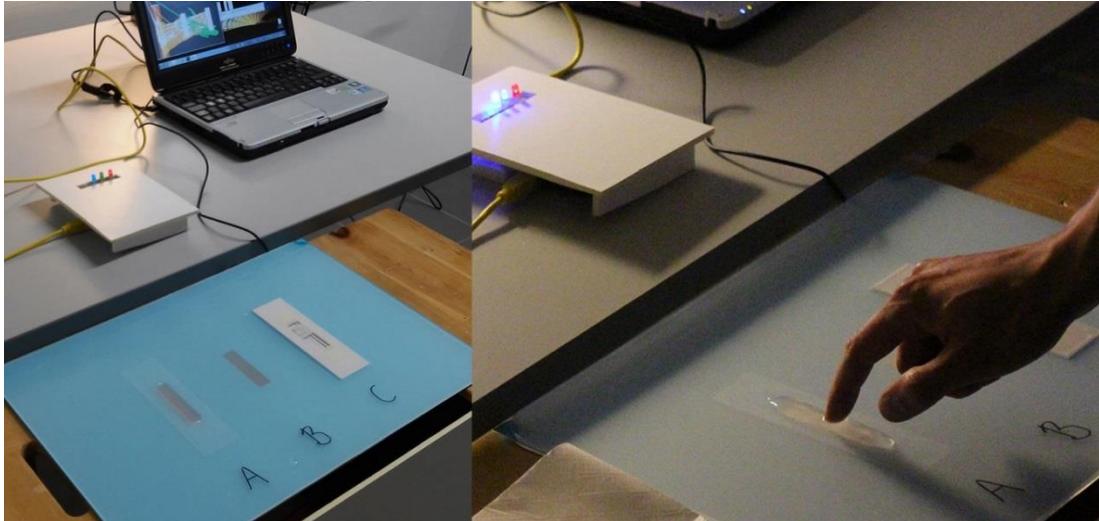
In Task I users were asked to explore the use of three different slider switches. These switches were designed to look visually fairly simple and similar in order to avoid unnecessary variables that might affect the results. The most prominent difference between these switches was designed to be the haptic feedback. The three switches used in the Task I were (figure 15):

- A. Slider input area covered with water
- B. Touch screen slider
- C. 3D printed mechanical slider



**Figure 15. Slider switch designs for Task I**

Each one of the switches was set to control the intensity of a specific LED light. The liquid covered slider switch A controlled the blue LED light, the touch screen switch B the green LED and the mechanical switch C the red LED light. These lights were placed on a table in front of switch board (figure 16, page 50). When user moved their finger / the slider switch forward, away from themselves the designated LED light's luminance and intensity increased. And correspondingly when the finger / switch was moved towards the user the luminance and intensity decreased.



**Figure 16.** Setup for controlling the LED lights in Task I

However, before the users were allowed to experiment with the switches the task was shortly explained to them and they were asked to fill in a form about expected use experience (appendix 4). With this form the users evaluated their expectations of experience for each switch on a Likert scale from 1 to 7 rating the attributes of *fun*, *controllable*, *pleasant*, *easy to use* and *interesting*. After doing this the users were encouraged to freely try out the switches while thinking aloud. The users were also asked to come up with some possible use cases or contexts as well as with possible positive and negative comments for each switch. After testing the switches the users were once more presented with the Likert scale form rating the switches from 1 to 7 based on attributes of *fun*, *controllable*, *pleasant*, *easy to use* and *interesting*. However, this time the users filled in the form from the post-experimental experience point of view.

In addition to this, for each switch the users were asked to select five most descriptive terms from a list of 20 possible terms. These 20 terms were adopted from the Microsoft Product Reaction Cards method <sup>[3]</sup> and are listed in the table 4 on page 51. Finally the users chose their favorite switch A, B or C.

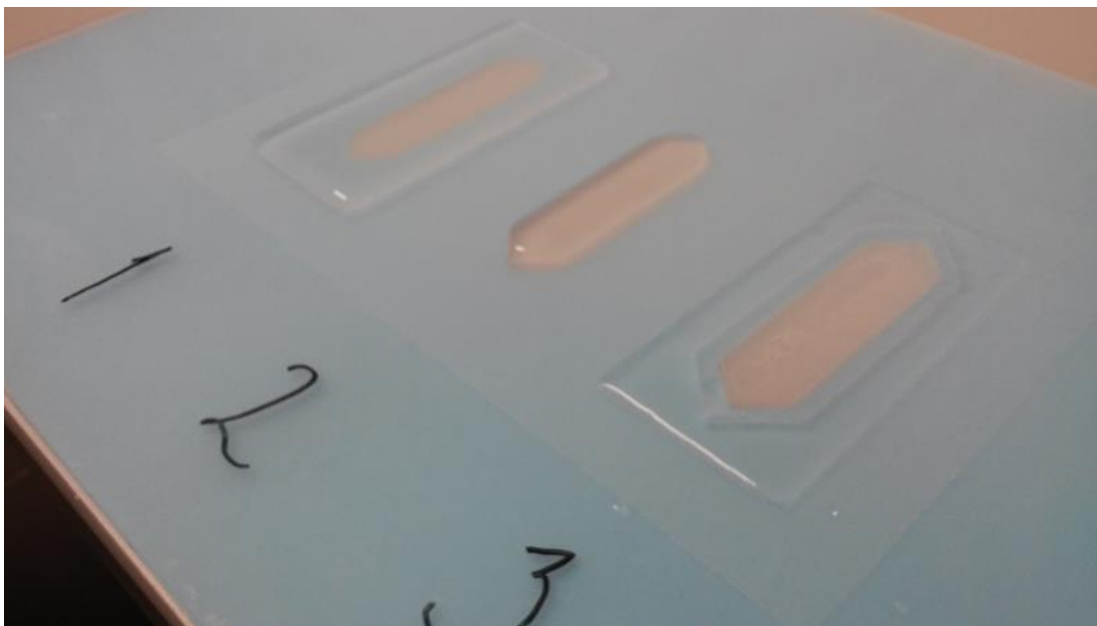
<sup>[3]</sup>Microsoft Product Reaction Cards <http://www.microsoft.com/usability/UEPostings/ProductReactionCards.doc>  
(Last accessed Nov 19, 2015)

Fast	Slow	Inconsistent	Consistent
Responsive	Rigid	Uncontrollable	Controllable
Fun	Serious	Unpleasant	Pleasant
Restful	Stressful	Boring	Exciting
Approachable	Unapproachable	Frustrating	Inspiring

**Table 4. List of PRC terms**

In **Task II** the users were presented with the second set of slider switches only this time all of them liquid switches with different designs. Similarly to the Task I the visual designs were fairly simple and similar. However the differences between the switches were created by the distribution of liquid (figure 17).

1. Slider and its surroundings covered with water
2. Slider input area covered with water
3. Slider input area surrounded (but not covered) with water



**Figure 17. Slider switch designs for Task II**

Unlike in Task I the switches used in Task II were only non-functional mockups and did not have technical implementation. After a short introduction by the study moderator the users were encouraged to again freely try out the switches and to think

aloud. Also during this task the users were asked if they had any further ideas of possible use cases or contexts for the different switch designs as well as if they might come up with some other positive or negative comments.

After testing the slider switches the users filled in a form with a Likert scale rating for each of the switches based on how *interesting*, *practical*, *pleasant*, *calm* and *fun* the use was perceived (appendix 5). The scale used was from 1 to 7. Moreover, the users had the opportunity to describe each of the switches with their own terms and also rank those terms on the same Likert scale. Finally each user selected their favorite switch 1, 2 or 3.

## 5.2 Setup and Implementation

For both Task I and Task II a set of three slider switches was created. A plastic board was used as the base plate for each of these slider switch sets. Yet the eventual design of the slider switches for both tasks was determined largely by the most centric element of the Liquid UI, water.

The ability to control and manipulate the liquid was essential in this user study. For this, a hydro phobic water-repellent was acquired. With this solution, that could be sprayed on the plastic boards used as the interface panels, the movements of the water could be guided due to that water was unable to escape to the coated areas. Also, if the users were to push or dribble any liquid on the coated areas the drops would roll off of the surface to the nearest non-coated spot. With this method it was possible to create a test set up where the water could be confined into specific areas without any physical borders but still be allowed to move freely inside it if touched by the user, see figure 18.

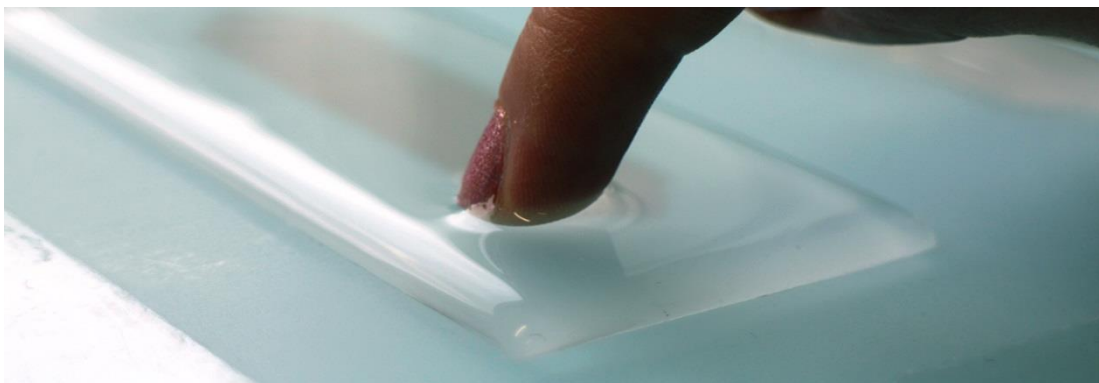
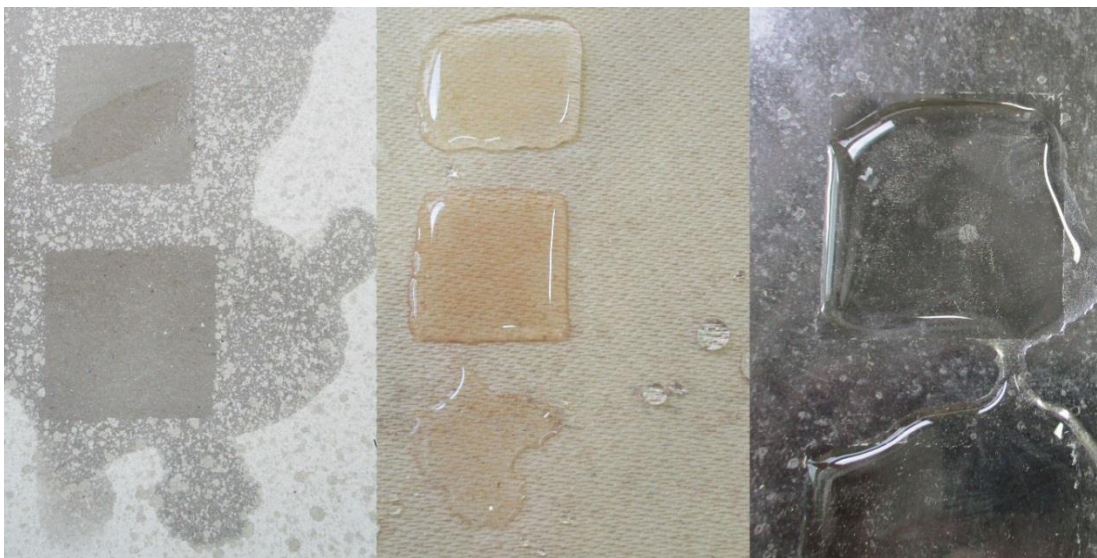


Figure 18. Water confined on a specified area by hydro phobic coating

Before the final setup was selected the hydro phobic coating was tested on different materials and surfaces (figure 19). With e.g. fiber board and cardboard there were issues of the coating not spreading evenly and therefore letting the liquid escape. These materials also turned out to be unsuitable for the final set up due to not being translucent and letting the water to be absorb into the board material. Also some issues with spreading the coating evenly occurred with glass as well. Based on the experiments, the plastic board was selected as the most suitable material for the study.



**Figure 19. Coating test for cardboard, fiber board and glass**

In Task 1, a liquid slider (A), a touch screen slider (B) and a mechanical slider (C) were needed. For the users to be able to compare their use experiences between the switches they were designed as similar to each other in size and shape as possible. To achieve this it was decided that another plastic board needed to be added underneath the actual interface panel so that the mechanical switch created with 3D printing could be placed also on the interface panel's surface level. For this a small opening was cut to the lower board and larger opening to the upper, interface panel board. Thus the lower board provided the slot along which the switch moved and also the printed slider mechanics could be attached to the board surface.

Additionally, since the interface panel was made out of semi-translucent plastic plate the touch screen slider was simply created by limiting the see-through area by adding a piece of blue cardboard between the two plastic boards. This cardboard also provided

the users a visual cue (in addition to the water) on where the active area of the liquid slider switch was by defining the area (figure 17, page 51). The placement for the liquid slider switch was created on the upper plastic board by coating the surroundings of the input area with the hydro phobic coating. Finally the two plastic boards, the cardboard between them, were glued together.

For the Task II only one plastic board was needed because the switches were all liquid sliders and placed on the board surface. Like the switch A in Task I, the three switches 1, 2 and 3 were created with the hydro phobic coating. Only the shape and size of the coated area was different for each switch. Similarly to Task I, a piece of blue cardboard was placed underneath the plastic board to visually indicate where the slider areas were located.

### **5.3 Participants**

The Liquid UI user study was set up in the faculty of art and design premises at the University of Lapland and the user study participants were recruited from volunteers at the university. Advertisements were placed on the university notice boards, and users were recruited also by the test moderator through social networks and in situ. The users consisted of a multidisciplinary sample of staff and students at a university campus.

Altogether 25 participants took part in the study. Here, 12 were female and 13 male between ages of 23 and 65 (mean 34.36 years, SD 12.03). Majority of users, 22 of 25, were right handed, 2 users were left handed and only one user stated himself to be ambidextrous. Also during the test one of the users informed the test researcher that she did not have the sense of touch on their dominant index finger due to work related accident years earlier. However she did not consider this to influence the use experience and continued testing the Liquid UI by varying between different fingers. Also some background information was also asked from the users in order to gain an insight into their previous knowledge and habits of using finger controlled user interfaces. These questions focused on the use of touch screen devices. Based on the answers all of the users used touch screen interfaces on daily bases. The most commonly used device was the smartphone (25/25), followed by the tablet (18/25). Other devices mentioned by the users included e.g. car radio system, kitchen hood, game consoles and a drawing table.



## 5.4 Results

As presented in the section 5.1, the Liquid UI user study was divided into two separate tasks I and II. In this section the results from each of the tasks are reviewed. Furthermore, in the last part of this section the result from both Task 1 and Task 2 are combined in order to answer the set Liquid UI specific questions.

### 5.4.1 Task I

In Task I users were faced with three different slider switches. Switch A was a slider cover in water, switch B mimicked nowadays commonly used touch screen slider and switch C was a traditional mechanical switch. The first part of the task aimed to study the relation between the users' pre-experimental expectations and the post-experimental user experience.

The results shown that the users were highly accurate on their expectations in relation to the eventual experience. As shown in figure 20 the ratings given to the pre-experimental expectations of experience correlated closely with the post-experimental experiences.

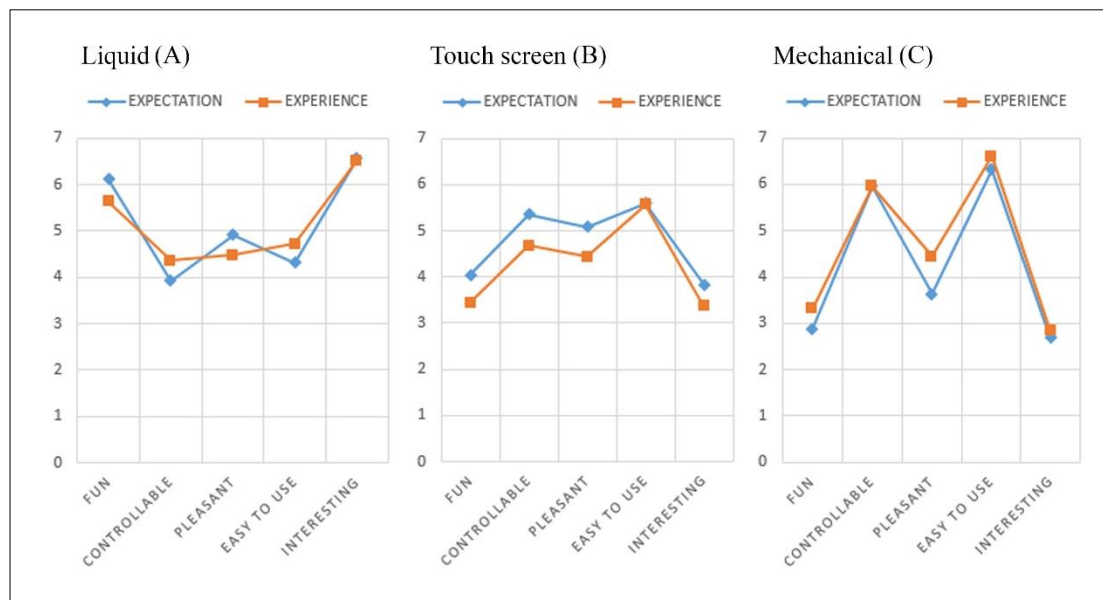
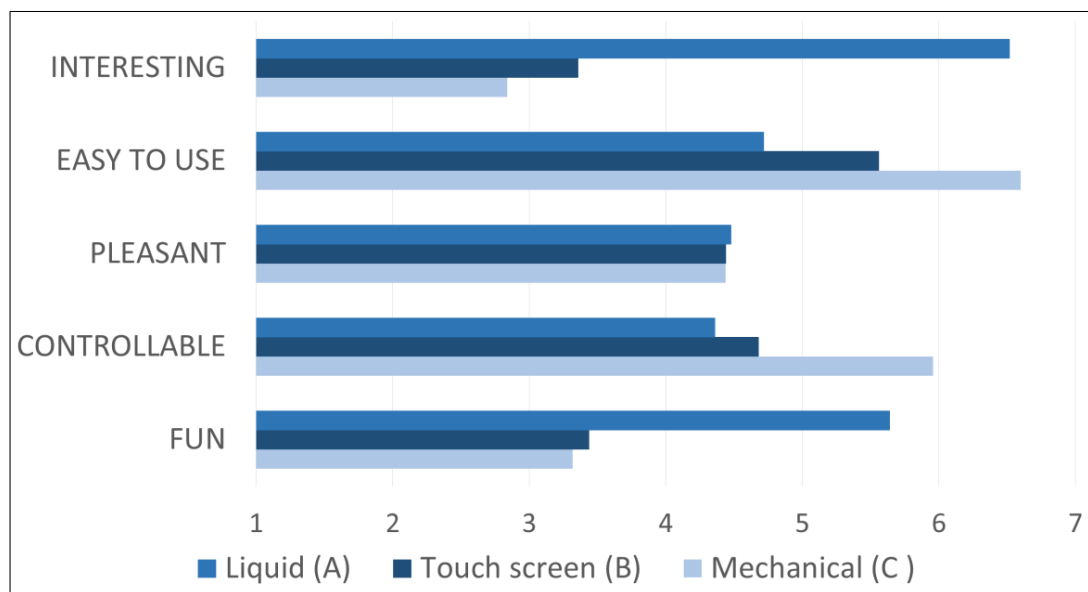


Figure 20. The user expectations vs. user experience

No significant difference between expectations and experiences was found. The differences that can be seen from the figure 20 were too minor to be considered to carry any statistical significance.

Larger differences were found when comparing the post-experimental experience ratings between the three switches A, B and C (figure 21). Especially in the scope of this thesis the findings for the more hedonic attributes of *fun*, *interesting* and *pleasant* were noteworthy.



**Figure 21. Overall ratings for experience in Task 1**

For the liquid switch A the attributes of *interesting* and *fun* got a higher rating than the other two switches, see figure 21. As the switch presented a novel concept of liquid as an element of interaction this was somewhat to be expected. However it was not as expected that for the attribute of *pleasant* all the three sliders got almost exactly the same rating. Even though the switches represented different styles of interacting and therefore the experience of pleasantness could be composed of different features it was unexpected that none of the slider stood out from the rest. Furthermore, the more pragmatic attributes relating to the usability of the switches were scored highest on the most traditional, mechanical switch C, see Table 5.



	Switch A		Switch B		Switch C	
	Average	DS	Average	DS	Average	DS
Interesting	6,52	0,71	3,36	1,19	2,84	1,25
Easy to use	4,72	1,49	5,56	0,96	6,60	0,65
Pleasant	4,48	1,53	4,44	1,42	4,44	1,08
Controllable	4,36	1,68	4,68	1,38	5,96	1,54
Fun	5,64	1,15	3,44	1,19	3,32	1,77

**Table 5. Ratings given to the switches in Task I**

While monitoring and noting the users' reactions during the user study it could be seen that the switch C was perceived as the most familiar and approachable. Users think-aloud comments included e.g.: "*This [mechanical switch] has been everywhere already the past 30 years.*" and "*Traditional, easy, familiar. You know how it [mechanical switch] moves.*" Altogether 13 users out of 25 started the task by trying the mechanical switch C. Of the rest 12 users 11 started by trying out switch A and only one user choose to start with switch B.

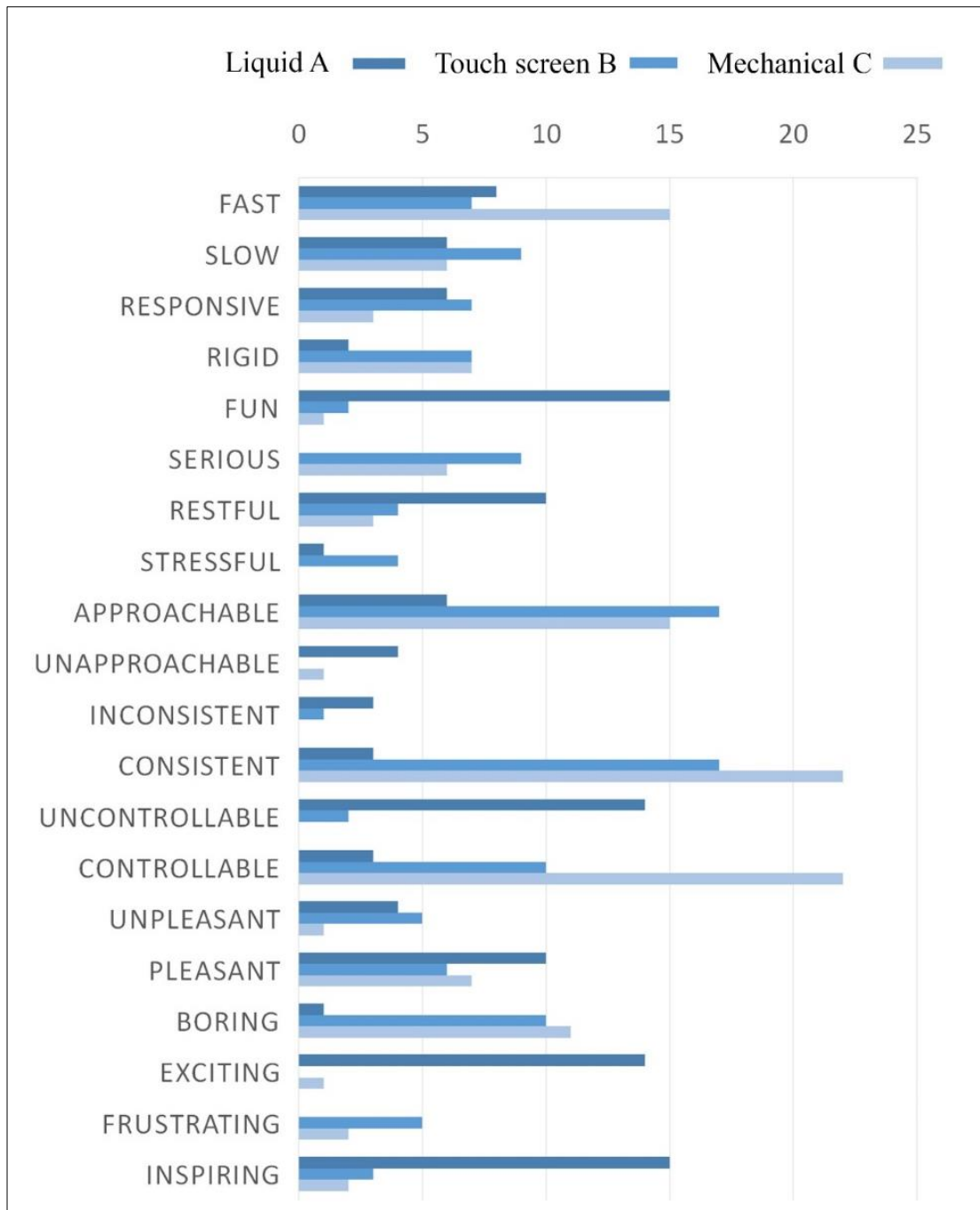
After experimenting with the three slider switches the users were presented with a list of 20 terms adapted from the PRCs<sup>[3]</sup> (table 4, page 51) from which they were asked to choose 5 that best described each switch. The four most often selected terms for each switch are listed in the table 6.

Slider	Most frequent PCR terms
Liquid (A)	fun (15), inspiring (15), exciting (14), uncontrollable (14)
Touch Screen (B)	approachable (17), consistent (17), controllable (10), boring (10)
Mechanical (C)	consistent (22), controllable (22), fast (15), approachable (15)

**Table 6 Most commonly selected PRC terms**

As further supporting the users scoring for the switches with Likert scale these selected terms show a difference of choosing hedonic and pragmatic attributes depending on the switch. Whereas the liquid switch was considered e.g. *exciting* and *fun* the mechanical switch was seen as e.g. *controllable* and *fast*. All of the terms selected and the times they were selected for each switch are presented in figure 22 on page 58.

<sup>[3]</sup>Microsoft Product Reaction Cards <http://www.microsoft.com/usability/UEPostings/ProductReactionCards.doc>  
(Last accessed Nov 19, 2015)



**Figure 22. Terms selected from the PRCs form for the switches in Task I**

Finally, the users were also asked to choose their favorite switch from A, B and C. Of all the 25 users 10 selected the liquid switch A as their favorite. The touch screen switch B received 7 votes and the mechanical switch C 8 votes.

### 5.4.2 Task II

Similarly to Task I also in Task II users were faced with three slider switches. However in Task II these were non-functional mock-ups and all of them had the liquid element added to the design. Switch 1 and its surroundings were covered with water, switch 2 was covered with liquid only from the mimicked input area and switch 3 had the input area only surrounded but not covered with water. Same as in Task I after experimenting with the switches the users were asked to fill in a questionnaire containing a Likert scale from 1 to 7 for evaluating each switch separately on attributes of *interesting*, *practical*, *pleasant*, *calm* and *fun*. The users could also add their own terms to describe the switches.

Switches 1 and 2 that had the input area covered with water received the highest ratings on the attributes of *fun*, *calm* and *pleasant*, see figure 23, whereas the switch 3 surrounded by water received the lowest scores overall.

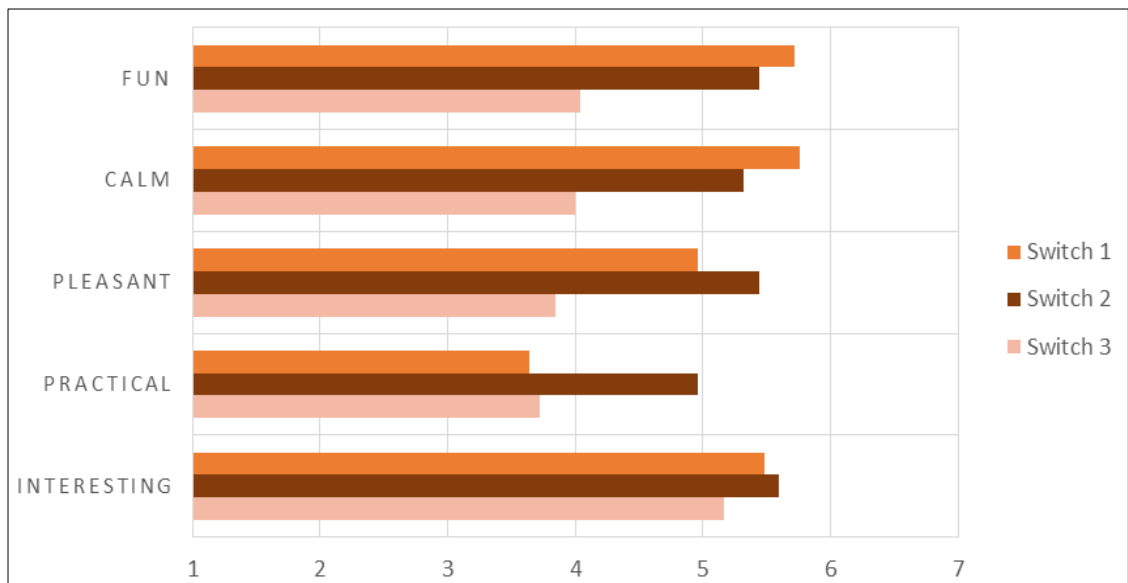


Figure 23. Evaluation of the liquid switches done by users in Task II

In regard to practicality the switch 2 was ranked higher than the other two switches. This was also brought up in the users' think-aloud comments based on which the switch 2 was seen as most exact due to its tight form and the liquid covering only the input area. From the think-aloud comments it could be concluded that the scale of the gestures and size of the liquid covered area were important issues. Altogether 10 users of 25 commented on their wish to make larger gestures without the fear of the liquid

escaping. Additionally, the observations made by the study moderator indicated that the users tended to make calmer and slower gestures when touching the switch 2 that had smaller area of water than the other two switches. All in all, the very issue of controlling the liquid also provoked comments from altogether 16 users. Such comments included e.g.: *”Because the area [in switch 1, Taks II] is bigger [than in switch A, Task I] the fear of splashing the water is not there.”* and *”With switch 1 the gestures are not as restricted.”*

Additionally, altogether 30 terms were added by the users when filling in the Likert scale form evaluating the switches. All of these added terms, times they were mentioned and the rating given to them are presented in table 7.

Switch 1	Rating	Switch 2	Rating	Switch 3	Rating
Easy, does not require great accuracy (1)	4	Accurate (2)	6 ; 6	Friction free (1)	6
Uncontrollable (1)	3	Small (1)	6	Vague (1)	2
Possibility for inaccuracy (1)	6	Uncontrollable (1)	5	Boring (1)	5
Playful (1)	7	Might work (1)	6	Matter-of-fact	6
Easygoing (1)	7	Guiding (1)	6	No sense at all (1)	7
Limited / Restricted (1)	1	Controllable (1)	7	The function of water unclear (1)	7
Uncontrollable, water escapes (1)	6	Inviting / Alluring (1)	7	Inspiring (1)	6
Ambiguous (1)	6	Confusing (1)	7	Serious (1)	5
Inspiring (1)	7			Confusing (1)	7
Glass-like (1)	7				
Confusing (1)	7				
Challenging (1)	7				

**Table 7. Terms added by users and their ratings in Likert scale 1-7 for the liquid switches in Task II. The number of users mentioning the attribute is given after each term.**

The switch number 1 with the largest liquid covered area was considered e.g. *easygoing*, *possibly inaccurate* and *not restricted or limited*. Simultaneously the switch 2 was e.g. described as *accurate* by two separate users and perceived as *guiding*. Also, the depth of the liquid layer as a prominent dimension was brought up by 6/25 users and similarly 6/24 users commented on the temperature of the liquid. Especially the user comments regarding the temperature of the water were very explicit such as e.g. *”Wet, cold, vague.”* and *”This feels cold.”* Also 7 users mentioned that they were either expecting or suggested there to be a film on top of the liquid. This by itself is an interesting finding considering that only 3/25 selected the switch 3 (that did not require

users to touch the liquid) as their favorite. 11/25 users selected the switch 1 and 11/25 users the switch 2 as their favorite design.

Furthermore, when asked about potential use contexts, the environments that already include water were mentioned most often. Such contexts were in private settings e.g. sauna, kitchen and bathroom (6/25) and in public settings e.g. swimming hall and water park (8/25). Other possible use contexts mentioned were e.g. art installations (4/25), lighting (3/25) and clothing (1/25).

### **5.4.3 Answering the Liquid UI Specific Questions**

In order to discuss the results gained from the user study, three Liquid UI specific questions are addressed. In this section these question presented in the Study Plan and Design section are answered.

**q1:** *How do the users experience the liquid slider in comparison to more traditional slider switches?*

Relating to the pragmatic attributes of the use of the switches the most salient issue was related to controlling the liquid. Whereas the touch screen and mechanical switches were considered controllable, the liquid slider switch was seen as uncontrollable and the fear of the liquid escaping was raised as an issue. On the more hedonic attributes the users rated the liquid switch to be the most *interesting* and *fun* of the three switches. Eventually these hedonic qualities seemed to somewhat overrode the pragmatic qualities, as the liquid switch was the most popular option when the favorite switch was selected.

**q2:** *How does the expected use experience vary from the actual use experience?*

It was discovered that the users were highly accurate on evaluating their pre-experimental expected experience. No notable difference was found between the ratings of expectation and experience.

**q3:** *How do the users experience the liquid slider based on how the liquid is placed and/or confined on the slider switch?*

The size and distribution of the liquid covered area had strong effect on how users perceived it. The issues related to the size and shape of the liquid coated area concerned the size of users' gestures and the accuracy of use. Especially, the switch with smallest liquid coated area that covered only the mimicked input area, was considered as the most practical. Also, interestingly although some users were questioning people's willingness to touch the water, in the study Task II 22/25 users preferred either one of the switches that required them to do so and only 3/25 users selected the one that's use did not require them to touch water.

## 6 User Study 2: Glass UI

The Glass UI study was the second user study included in this master's thesis. It was developed based on the *Functional decorative objects* concept that was introduced in section 4.2. Similarly to the Liquid UI study, also the Glass UI study focused on the user experience with tangible user interfaces. However, instead of ephemeral elements in the Glass UI the emphasis was on the aesthetic and visual features. Hence, the tangible user interface used for the Glass UI study was in the form of three glass objects with different colors, shapes and weights. With these objects the users were able to control and adapt certain features of a visualization of adaptive hotel room. In this chapter the study plan, and design, the implementation as well as the setup, and participants for Glass UI user study are presented. Also the Glass UI specific results are presented in section 6.4.

### 6.1 Study Plan and Design

According to the scope of this thesis the focus of the Glass UI user study was strongly on the user experience. More specifically, how the users experienced the aesthetic, tangible user interfaces and the possibility to adapt their surroundings with them. To gain some clarity to the research two Glass UI specific questions were introduced:

**q4:** *How do users perceive the tangible glass objects for controlling their environment?*

**q5:** *What is the role of aesthetics in this user experience?*

For answering these questions the Glass UI user study was designed to include apart to study the users' perceptions on the aesthetic, tangible glass objects themselves, and their perceived use, as well as a part focusing on the user experience while interacting with the hotel room environment. These were not divided into separate tasks like with Liquid UI study but were carried out seamlessly one after another. Before beginning the test users also filled in a consent form and a background questionnaire.

The users started the study by evaluating the three glass objects used for controlling the hotel room environment. These glass objects were selected based on their differing shapes, weights and colors (figure 24).



**Figure 24. Glass objects used for the Glass UI user study**

First, the users were asked to rate the objects based on the attributes of *playful*, *frustrating*, *interesting*, *practical*, *useless*, *pleasant*, and *peaceful*. Additionally the users could add their own terms to describe the objects and give rating to them. The rating was done by using a Likert scale from 1 to 7 (appendix 6).

Second, the users' pre-experimental expectations were asked. For this the users filled in a questionnaire consisting of two open-ended question: 1. *Related to the hotel room, which features of the glass objects especially provoked thoughts?* and 2. *Do you have any expectation on how the glass objects could affect the surroundings? What expectations?*

After answering these questions the users could start testing the hotel room demo and the interaction between the glass object user interface and the environment. The setup can be seen in figure 25 (page 65).





**Figure 25. Glass UI setup with projected hotel room environment on white screens**

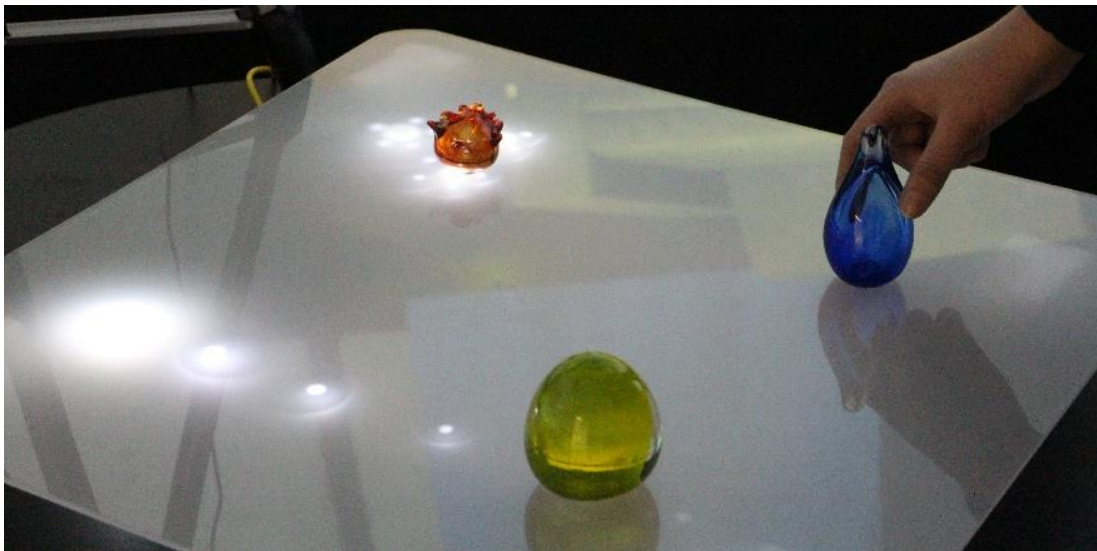
A table top made of semi translucent plastic in front of the screens projecting the adaptive hotel room environment provided the physical area in which the users could move the glass objects and thus interact with the hotel room environment. In order to provide the users with some further visual guidance LED light were placed underneath the table top to mark the different areas on the table according to which the environment reacted to the glass objects. By moving the glass objects on the table the user were able to control the lighting within the projected hotel room environment. The features that could be controlled by the users were the color of the light (based on the color of the glass object) and the display mode of the light (based on the area of table top on which the objects were placed). These features are introduced more closely in the implementation section 6.2.

According to the original study plan the free time of testing the demo was set to 5 minutes after which instructions of the demo's functionalities were provided by the study moderator. After the instructions it was planned for the time to use the demo to be limited to 3 minutes. However these time limitations were soon let go for it was seen as more beneficial to let the users take their time to test and comment the demo. In the end, the users were presented with an end questionnaire (appendix 7). In this questionnaire they were asked to rate the interaction between the glass objects and the hotel room environment. This was done in the form of Likert scales and with open ended questions. In addition to rating the interaction experience itself the users also

reflected it on their pre-experimental expectations and perceptions. Also thoughts that the test may have provoked were asked in addition to possible ideas of how and in which kind of contexts this type of user interface could possibly be used.

## 6.2 Setup and Implementation

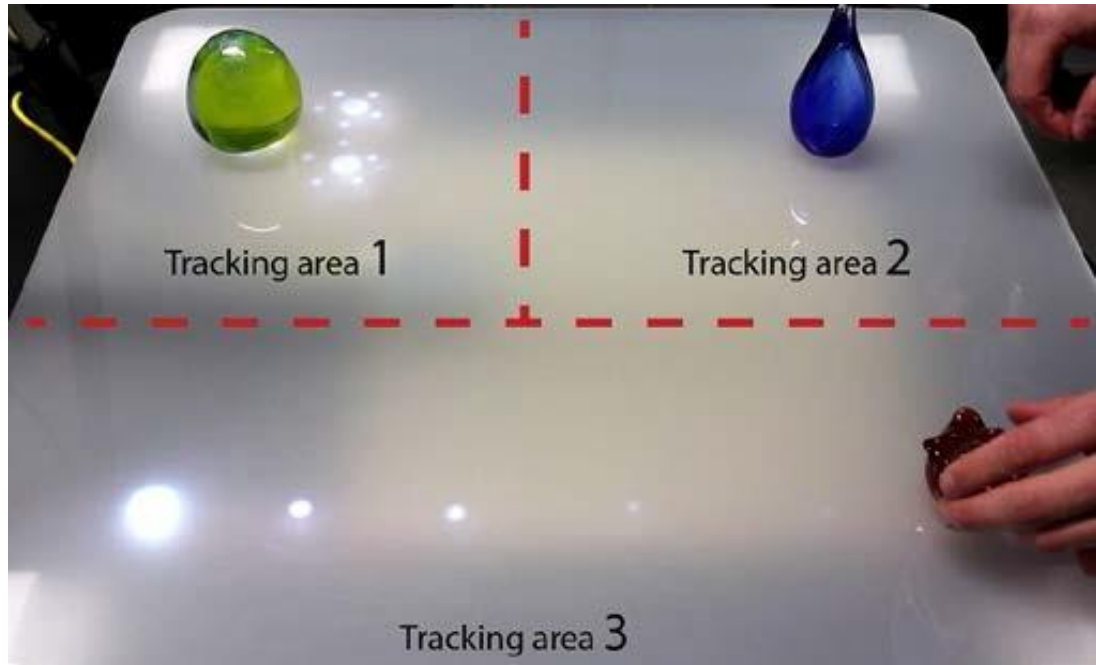
For the implementation of the demo it was decided that the adaptive environment should be a simplified hotel room context without any extra features that might take the focus away from the adaptable elements i.e. color and light (figure 25, page 65). Also it was determined that some concrete, yet aesthetically pleasing design elements and indication were needed also in the physical environment of the user. For this, a simple table top made out of plastic board was crafted (figure 26) and LED lights placed underneath it.



**Figure 26. Table top with LED lights underneath**

As the centric element in the room the table top provided the physical area on which the users could move the glass objects. The communication between the physical features, i.e. the table top and glass objects, as well as the simulated hotel room was done by monitoring the objects with webcam. The information of the positions of the glass objects was tracked according to the color of each object and the information was then utilized to control the LED lights underneath the table top as well as the hotel room. As the users moved the glass object on the table top the LED lights underneath

the plastic board reacted to this movement and provided feedback as well as some additional visual guidance. For this the table top was divided into three separate tracking area, see figure 27.



**Figure 27. Tracking areas on the table top**

The tracking area 1 that took one quarter of the overall table top was set as a home base that neutralized the hotel room environment when all three glass objects were placed on it. This tracking area marked with a cluster of 18 LED lights was also the starting point from which the users began moving the glass objects. Whereas the tracking area 2 was indicated by 7 LED lights while also taking one fourth of the table area. When any of the glass objects were placed on this area the right hand side of the hotel room environment would react by starting to pulsate a light same color as the glass object in question. Furthermore the tracking area 3 that took the rest of the table top was designed to work as a slider switch. This was indicated also by the placement of 6 LED lights in a row that provided a visual guidance to the user. These LEDs differed by their luminance so that the brightest LED was located furthest from the user and the luminance of the lights gradually lowering one by one towards the user. By bringing any of the three glass objects to the tracking area the users were able to control the color and intensity of the overall lighting of the simulated hotel room. In addition, the tracking areas 2 and 3 were allowed to override the tracking are 1 so that

the neutral state of the environment could only be achieved when the tracking areas 2 and 3 were empty.

The color of the lighting in the hotel room environment was determined by the color of the first object to enter the tracking area. In the case that the object was taken away from the area, the other objects in the tracking area would determine the reaction in the hotel room environment's lighting. Users were also allowed to take objects off the table in addition to just moving them on it and thus trying out different combinations.

### **6.3 Participants**

The Glass UI study was conducted at the University of Lapland premises, in the faculty of Art and Design. The users taking part in the study were students and employees of the University Lapland and mainly from the aforementioned faculty. Similarly to Liquid UI the users were recruited through advertisements on University notice boards, social networks of the test moderator and by recruiting in situ.

Altogether 24 participants took part to this study, from which 9 were female and 15 male. The average age of the users was 34.33 (SD 11.94). None of the participants reported having any limitations with their vision. Such limitations as given examples on the questionnaire included e.g. color blindness and limitations on peripheral vision.

Also some further background information about the users' hotel visits was asked in order to gain an understanding of how they related to the hotel room context. The variation in the frequency of hotel visits was wide ranging from 1 to 30 stays per year. Majority of users, 14 out of 24, stated their average hotel visits lasting 1 or 2 day. In addition to this, altogether 17 users said that they would be interested in customizing their hotel room. From these 17 users 5 mentioned moving the furniture as being the preferred way of customization, 4 users reported that they would wish to be able to select or change the furniture, and further 4 stated that they would like to adjust the lighting.

## 6.4 Results

Although the Glass UI user study was not officially divided into two separate sections or tasks, in order to make the result more easily readable I have divided this section similarly to the structure used on the results of Liquid UI (chapter 5.4). Firstly, the results focusing on the glass objects are presented. These include the evaluation of the glass objects themselves and their perceived uses as well as the associations that they carried for the users. Secondly, the results from users testing and evaluating the interaction experience with the hotel room demo are discussed. And thirdly, all of the results from the study are examined together in order to answer the set Glass UI specific questions.

### 6.4.1 Glass Objects and the Perceived Use

Before seeing the adaptive hotel room demo used in the Glass UI study the users were encouraged to look and touch the glass objects and evaluate them on the attributes of *playful*, *frustrating*, *interesting*, *practical*, *useless*, *pleasant* and *peaceful*. The results of this rating regarding the predetermined attributes are presented in figure 28.

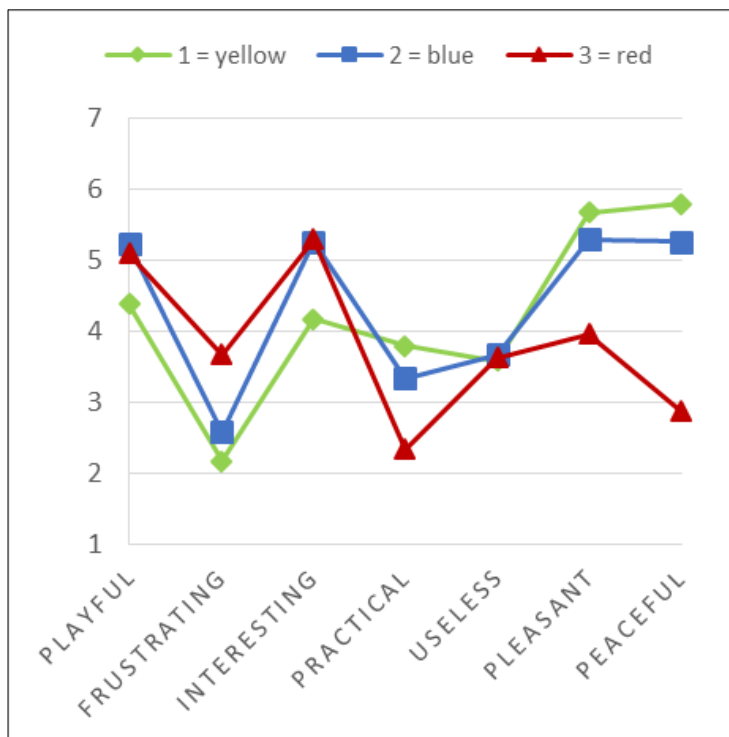


Figure 28. Users perception on the glass objects

Based on the rating given by the users there was some variation between the glass objects but mostly these were not significant enough to provide any conclusive results. The most notable difference in the scoring could be found regarding the attributes of *pleasant* and *peaceful*. For both of these the red object 3 that had the most complex shape with pointy details had remarkably lower score than 1 and 2. It was also considered more frustrating than the yellow and blue objects with smoother shapes (figure 24). Furthermore the only aspect that got almost precisely same score for each of the objects was *useless*. It seems that this was a hard aspect to evaluate and the ratings were placed near the midpoint of the scale (from 1 to 7) being for the object number 1 average of 3.58 (SD 1.61), number 2 = 3.67 (SD 1.71) and number 3 = 3.63 (SD 1.86).

Some of the users also added their own descriptions for the objects. All the terms added by the users are listed in table 8. Although generally, the glass objects were found aesthetic and decorative as also demonstrated by the think-aloud comments: ”*All of these would also work as decorative objects without any function.*”, some differences could be found between them.

<b>1 = yellow</b>	fascinating	pleasant	concentration
	ordinary	stable	decorativeness
	heavy	natural	colorful
	fresh	beautiful	blob
	perky	neutral	stress relief
	organic	functionality what?	
<b>2 = blue</b>	funny	distressing	inspiring
	elegant	light	restless
	beautiful	graceful	cool
	penguin like	standing	confusing
	ergonomic	falling	oceanic
	makes you ponder		
<b>3 = red</b>	disorderly	restless	functionality what?
	non-harmonic	ugly	energetic
	cracked	enabling	strong
	little annoying	confusing	multidimensional
	rough	decorativeness	stress toy
	relaxing when squeezed		

**Table 8** Terms added by users. The glass objects are presented in the figure 24.

The most negative associations were for the red object that was described e.g. as *restless, confusing* and *rough*. Also later during testing the demo users brought up the influence of form factors in their think-aloud comments e.g.: *"This one, I really want to pick this up and hold it [blue]. Like looks really comfortable and maybe nice to hold. [- - -] This one [yellow] is sort of blobby and lazy. [- - -] This one [red] is like more like "wohoo!" like fun times are happening."* and *"The blue object's form fits your hand. There could be some possible pressure point on the surface or something."* Nevertheless, it needs to be noted that most of the added terms (45/49) were mentioned only by one user. To this the term *heavy* for object 1 was however an exception. *Heavy* was added by 6 users. Also *beautiful* for object 1, *ergonomic* for object 2 and *ugly* for object 3 all were mentioned 2 times.

The users also filled in a questionnaire on how they would perceive these objects affecting the hotel room environment. The question presented to the users was *"Related to the hotel room, which features of the glass objects especially provoked thoughts?"*. The complete list of all the features extracted from the written answers can be found in table 9.

Surface/texture (4)	Easiness (1)
Calmness (2)	Shape (12)
Straightforwardness (1)	Color (15)
Being surprising in the context (1)	Size (2)
Value of glass as an element (1)	Position (1)
Interrelationships (1)	Location (1)
Weight/mass (4)	Aesthetics (2)
Pleasant to handle (1)	Harmony (1)
Pleasantness (1)	

**Table 9. Thought provoking features of the glass objects as listed by users**

The most common features of the glass objects mentioned to provoke thoughts were *color* (15/24), *shape* (12/24), *weights/mass* (4/24) and *surface/texture* (4/24). When planning this user study the aforementioned 4 attributes were somewhat anticipated to be mentioned for they arguably can be considered as somewhat basic physical features of the glass objects themselves. More interestingly the terms *position*, *location*, *interrelationships* and *harmony* were also brought up. From the point of view of the hotel room being considered as an interactive unity that can be adapted by the users,

the locations and positions of the objects as well as their relations to each other on the table are very centric and interesting topics.

Furthermore, both the impact of the physical features as well as the interrelationships of the objects and the environment were brought up in user comments. Comments from the participants included e.g. *“The shape talks with the other elements in the room, same colors.”* and *”Calmness [in blue and green objects]. Dynamics in red. Symbolism of colors.”*

For the question of *how the users expected the glass objects to affect the surroundings* the answers varied from exact features e.g. temperature or music to more general issues such as general atmosphere. Most often the expected effects addressed the *lighting* which was mentioned by 12 of the 24 users. *The placement or features of furniture* was mentioned by 8/24 users and *general atmosphere and coziness* by 6/24 users. Somewhat surprisingly only 5/24 users mentioned *colors* to be the changing feature even though 15/24 users mentioned it to be one of the key attributes of the objects.

The topic of the positions of things in relation to others seemed to be also more significant in the surrounding than as a feature of the glass objects. For the possibility of affecting the placement of the furniture was brought up. Moreover, it seemed that the features of the glass objects merely provided the guidance and clues for interacting with the surroundings. Even though the objects were moved and positioned in relation to one another during the test it could be argued that this was seen more as a natural and logical connection between the users’ actions and the reaction in the surroundings than necessarily as a separate feature that should be particularly emphasized. Supporting this argument the comments from the users were e.g. *“The blue one would move the carpet, red one the table and the green one the couch.”* and *”I assume that when I move the objects the order, lighting and temperature of the room changes.”* So the users seemed to utilize the positioning of the glass objects as a way to interact with the surroundings but did not see this as a feature that provoked any thoughts when studying the glass objects by themselves.



## 6.4.2 The Adaptive Hotel Room Demo

After rating the glass object and the pre-experimental expectations the user started to interact with the demo. For this the glass objects were placed on the tabletop in non-specific order, yet always on the same tracking area 1 for each user.

The differences found between different users during the study were quite notable. Firstly, duration on interaction with the surroundings ranged from 2min.25sec. to 7min.35sec. averaging to 4min.20sec. Secondly, the physical way of interacting with the glass objects varied from very slow, calm and peaceful to very rapid and restless ending up one of the users nearly dropping one of the glass object off the table. This may indicate that the personality and the state of mind of the user made a notable difference on how they interacted with user interface, whereas the arguably common association of glass as fragile element that should be handled with care did not guide everyone's actions. This notion further supports the subjectivity of the interaction and the user experience especially as the study situation was identical for all of the users. For further insight on users experience the users were directly asked how the actual interaction between the glass objects and the demo corresponded with their pre-experimental expectations as well as asked to rate this interaction on a Likert scale. To the question of how well the interaction corresponded with the expectations the average score given by the users was 4.33 (SD 1.46). This fairly average rating was also supported by the general scores given to the interaction in regard of different attributes, presented in figure 29.

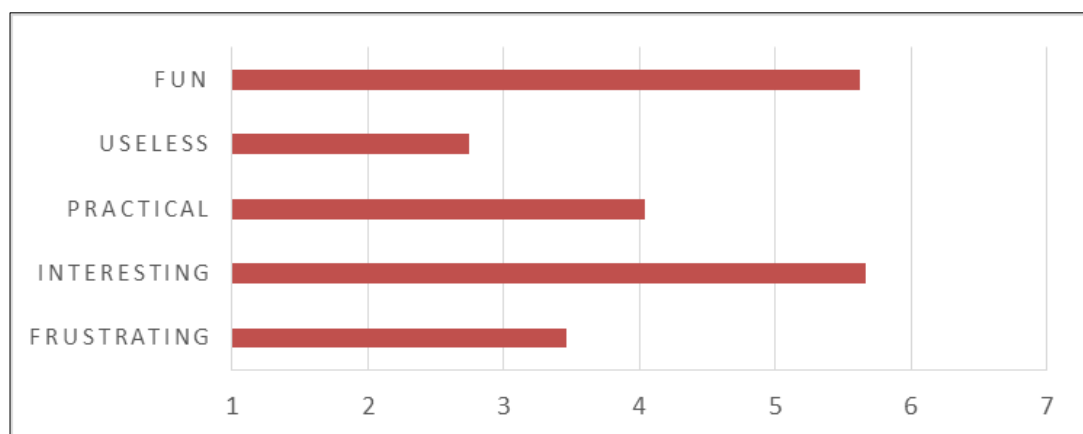


Figure 29. Rating given by users of the interaction between the glass objects and the demo done, n=24

These ratings show that the aspects of *fun* and *interesting* were given the highest score whereas the lowest score was for *useless*. From the written answers of the open ended questions it could be further extracted that the demo was considered *fun* by 8 users and *interesting* by 7 users. Despite this otherwise positive evaluation of the interaction and positive user comments *frustrating* was scored on average of 3.46 (SD 1.62). From written comments it became apparent that this was most likely due to practical issues during the test. Several users mentioned that the connection between the glass objects and the surroundings was hard or took time to figure out at first. Users' comments included e.g.: "*The start and beginning was tricky. After getting my thoughts and mind flowing it felt nice.*" and "*It was a little frustrating at first but was fun once I figured it out.*" These comments further emphasize the importance of pragmatic aspects of interaction in order to support hedonic qualities and therefore create a good user experience.

Finally, the users were asked to come up with use cases or contexts in which they would see this type of interaction beneficial or otherwise suitable. Altogether only 5 users out of 24 thought that this type of interaction and user interface could be used in public or shared spaces. Three of these users further specified their proposed use context to be useful in spaces where people need to wait or queue. Similarly 5/24 users mentioned home as a potential use context, 3 directly and 2 by referring to home automation and home interior design with aesthetic tangible UIs.

### **6.4.3 Answering the Glass UI Specific Questions**

In the section 6.2 the study plan and design for the Glass UI user study was presented. The same chapter also introduced the two Glass UI specific research questions. In this section those questions are answered.

**q4:** *How do users perceive the use of tangible glass objects for controlling their environment?*

The users rated the overall experience of interaction between the glass objects and the hotel room environment fairly average on the aspects of how easy and natural it felt. From the ratings and comments given to the glass objects it became apparent that the form factors have a great impact on the eventual user experience. Based on the user

study, this was due to the multisensory stimulus, i.e. through touch and vision, as well as provoked associations and feelings. These associations were mainly focused on the pleasantness to touch as well as the possible uses of the objects. User comments included notions of preference of which objects to hold as well as what the shapes communicate about their possible affordances. However, whereas the tangible features of the glass objects had a notable impact on the overall user experience and gained positive feedback, it was also found that for some users the interaction by using the Glass UI was not instantly intuitive but required some trialing and mental effort.

**q5:** *What is the role of aesthetics in this user experience?*

Altogether the results demonstrated that the aesthetic features of the glass user interface were prominent in the user experience. Whether these features were related to color or shape, which were the most commonly mentioned thought-provoking features of the glass objects, they seemed to carry associations. For example, the object with the most complex shape and intensive color was considered less pleasant and peaceful by the users than the other two glass objects, further provoking descriptions such as rough, restless and non-harmonic. Some individual user comments also indicated that the visual appearance of the objects influenced their willingness to physically touch them, e.g.: *"This one, I really wanna pick this up and hold it [blue]. Like, looks really comfortable and maybe nice to hold."* However, based on the results of this user study the main impact of the aesthetic features seemed to be on the more hedonic qualities, whereas in regard to e.g. usefulness all of the glass objects received similar ratings.

## 7 Discussion

This thesis has addressed the design of an adaptive hotel room concept, and two user studies on novel type user interfaces, Liquid UI and Glass UI, which were selected from the holistic hotel room concept for closer examination. The Liquid UI and the Glass UI user studies and their results were presented in the previous chapters, which focused on examining each of the user studies separately. This Discussion chapter addresses these studies and their results as a whole in order to gain a greater understanding of the user experience regarding aesthetic, tangible user interfaces, to evaluate the research process in this master's thesis and to discuss the possibilities of future work on the topic. In the first section of this chapter the two main research questions are answered and the second section consists the discussion about these results. After this the research process as a whole is discussed, followed by the last section presenting the possibilities and proposed directions for future research on the topic.

### 7.1 Answering the Research Questions

There were two research questions set for this master's thesis. The focus of these questions was on the user experience of aesthetic, tangible user interfaces and nontraditional interaction elements, especially in an everyday environment. In this section these research questions are answered.

*Q1: How do users perceive nontraditional tangible user interfaces for controlling actions in an everyday environment?*

From the user studies' results it could be concluded that users perceived the use of nontraditional, tangible user interfaces most of all as fun and interesting. These attributes were rated high for both, user interface utilizing water as well as user interface utilizing glass. However, in comparison to more traditional user interfaces the nontraditional user interface element water was regarded less controllable and not as easy to use. Similarly, the ratings given for the glass user interface indicated that even though users did not consider it as useless per se, they did not perceive it as especially practical either. Based on the comments provided by the users it can be

argued that the overall perception of the nontraditional, tangible user interface concepts presented in the user studies was positive. However, it seemed that it was hard for the users to come up with concrete, everyday-life use cases for them. Arguably, the users did not seem to conceive these user interfaces as directly adaptable part to their everyday lives even though considering them interesting as concepts.

*Q2: What are the key user experience elements of aesthetic, tangible user interfaces utilizing glass and water?*

Base on the results gathered from the user studies the key user experience elements of user interfaces utilizing glass and water differed somewhat from one another. Whereas both interactive elements provided some insights to tangible features affecting user experience, the effect of aesthetic features emerged mainly from the user interface utilizing glass as interactive element. The most prominent aesthetic features contributing to user experience were the color and the shape of the glass objects, which seemed to guide the users' thoughts and associations. In addition to these visual, aesthetic features, the tangible features of the glass objects further affected the user experience by guiding the user perception of pleasantness to touch as well as the possible uses of the objects. Whereas, in regard to the glass objects the tangible features considered by users included mainly the physical shape of the interactive elements, for the user interface utilizing water the tangible features consisted of two main factors. Firstly, when comparing different liquid switch designs the users preferred the designs requiring them to touch the liquid, hence gaining a haptic feedback from the liquid. Further supporting the influence of the distribution of liquid on user experience, the size of the switch area covered in water provoked comments on practicality from some of the users. Based on comments and observations, users would have preferred to do larger gestures with the water. Secondly, the issue of temperature was brought up by several users, arguably indicating that also this feature has influence on the user experience when using water as interactive element.

## 7.2 About the Results

Arguably the most centric finding of the user studies conducted was the notion of users perceiving the nontraditional, aesthetic, tangible user interfaces as fun and interesting, although their value on usefulness and practicality was perceived debatable. This finding of the tangible user interfaces' relation to hedonic qualities is consistent with prior reports on tangible user interfaces and user experience. For instance, findings reported from the study of the interactive City Mouse installation combining a stone city landmark and water as interactive elements (Häkkinen et al. 2014, 223) indicate similar user experience when interacting with UIs utilizing water. The City Mouse concept provoked such user perceptions as playfulness, closely intertwined with the notion of fun, and was also reported to draw the interest of people passing by. Whereas, the results presented in this master's thesis reassert such prior findings gained from the topic, they also offer new knowledge. For, they indicate that the same hedonic qualities that influence the positive user experience towards artistic installations utilizing tangible interactive elements are also present when these elements are brought to the context of everyday life. However, the proposed user interfaces represented such a novel approach, that study participants had difficulties on immediately imagining how they could be utilized in everyday environment. Nonetheless, the overall user experience seemed to be considered positive by the users. Whereas this may indicate that the hedonic qualities of said user interfaces can at least partially override the influence of their pragmatic qualities, the possible effect of novelty value of the user interfaces cannot be disregarded.

This possibility of the novelty value influencing the user experience becomes even more crucial to recognize when these nontraditional user interfaces are reflected to their intended use context of adaptive hotel room that was presented in chapter 4.2. Interestingly a hotel room can represent simultaneously a private and a public space depending on the point of view. In addition, the standards set to the room as well as the length and the purpose of the stay in a hotel depend on the user and can vary greatly. Therefore it is impossible to say for certainty how the novelty value would relate to the user interfaces embedded into such environment over time. During short and infrequent stays the novelty value, and therefore the positive user experience relying on the hedonic aspects may last considerably well and not diminish. However, if the

user interfaces are encountered and experienced frequently and repetitively their novelty value could be expected to decrease thus affecting the overall user experience. Furthermore, the differences between users and the subjectivity of their experiences and preferences cannot be overlooked. In addition to somewhat surprisingly 7/24 users stating in their background information for Glass UI study that they would not be interested in modifying their hotel room at all, from users' reactions and answers during the user studies, it was observed that differences arose between individual users' perception of the concept user interface. This observation is also consistent with prior research findings. For example, by comparing the user experience between three different, interactive art gallery websites Hart et al. (2013) conclude that different user types can be detected. These user types, determined based on the study participants' self-reported user experiences regarding the chosen interactive websites, represent differing attitudes and perceptions towards interaction with user interfaces. Although, the study was conducted by utilizing 2D graphic user interfaces instead of a tangible 3D UI, the notion of subjective differences between users and their perceptions towards interaction with user interfaces and technology are arguably valid also in the context of this master's thesis.

Moreover, the results gained about the more specific aesthetic and tangible features of the concept user interfaces also left some unanswered questions. It should be noticed that while the findings provided new information in regard to user experience in the context of the conducted user studies, these results may not be always directly applicable to other contexts. User interfaces and their context form a holistic entity in which the user experience is created. The wide range of factors constituting the context of use and, thus influencing the user experience has been also remarked in the prior art. For instance, a listing of UX study practices including the context characteristics has been presented (Roto et al. 2011) in order to help researchers account the complex issue of context in the user experience studies. Consequently, the glass objects were experienced as a combination of features adding to a greater entirety. Thus, describing and rating the user experience with somewhat general collection of attributes (e.g. *frustrating, interesting, practical and peaceful*), is not easy. Here, the think-aloud comments were perceived very useful.

Based on the results gathered from the conducted user studies, as well as from the brainstorming of the concepts, it is evident that designing such nontraditional, aesthetic, tangible user interfaces to a hotel room context is a complex topic. Whereas

the studied user interface concepts were considered fun and interesting their ability to maintain these qualities over longer periods of time and repetitive use may be a challenge, and also utilitarian design aspects should be emphasized. All in all, if these types of user interfaces would be embedded into a hotel room their potential user group and contexts, as well as the different hedonic and pragmatic qualities influencing the user experience creation should be assessed carefully.

### **7.3 Reflections about the Research Process**

Working on this master's thesis was a long process that was at least equally teaching in regard to the research work itself as to the chosen research topic. The work done, the methods utilized and the amount of research material reviewed for answering the research questions was rather extensive.

Although I consider the research process successful regarding the results and the answers found for the research questions in hindsight I would make some modifications and improvements both to the research plan as well as to the user study plans. A more specific and clear research plan would have made the process smoother and easier to control. Moreover, the aims of the research process could have been stated more precisely from the beginning. Even though the looser plan enabled the examination of various different aspects and provided an overview on the research topic it also created some challenges for identifying the key findings and centric results due to the wide range of available data. Consequently, a more structured study plan would have made it easier to bring the two user studies closer together and thus creating even more concrete entirety of the results whereas now the studies supported each other but still remained somewhat separate.

Regarding the research approach I argue that the mixed methods approach chosen for this master's thesis served the research well. By utilizing purely either qualitative or quantitative data and analysis the overview of the results would have not been as comprehensive as it was now. I hope that by reflecting the results gained with both methods to each other further reliability is provided to them. Although I admit that choosing this approach was calculated challenge due to that the educational approach to design research during my studies has mainly focused on qualitative research.

Whereas, in regard to the design of user experience in the context of the adaptive hotel room concept I argue that the results were satisfactory. All in all, the user interface



concepts received a positive feedback from the users even though they did not necessarily create a huge “wow-effect”. And, even though the suitability of said user interfaces to the hotel room environment is debatable due to the probable influence of novelty value to the results and the Liquid UI being tested separately from the context, the users perceived both of the studied UI concepts as fun and interesting.

Lastly, by bringing the findings of this research process forth I argue that their value lies as much on the newly found further research opportunities as on the findings themselves. To conclude, I consider the aim of this particular research process to be achieved. In addition to reaching the aims set for this master’s thesis research-wise, I consider it as a successful learning process from which I gained a great deal of knowledge.

#### **7.4 Future Work**

In this thesis the nontraditional aesthetic, tangible user interfaces were studied from the point of view of user experience, especially in everyday contexts represented by the adaptive hotel room concept. Although some interesting findings were made, in order to gain a deeper understanding on how the users might experience the use of these types of tangible user interfaces in their everyday lives, further research would be required.

Firstly, the timespan for the user studies was too short for gaining a fully reliable results on how user experience is formed when user interfaces are integrated into an everyday context. Therefore a research done within a longer timespan should be conducted in order to exclude the effects of novelty and surprise to the study results. In addition to gathering more information on the pragmatic and utilitarian aspects the long term research setup would also require the users to get familiar with the user interface, thus shedding a new light also on how the repeated exposure to the UI affects the hedonic aspects’ role in the formation of user experience. Secondly, different study contexts and tasks should be explored. While the contexts and the tasks in the user studies were fairly simple, a more versatile approach might help the users to more easily formulate their opinions of the experience. Also, by testing contexts differing from one another, such public versus private space, a deeper understanding on how strongly different elements affect the user experience could be obtained.

The location of conducting these further user studies should also be considered. In order to create a situation mimicking real, everyday life setting a lab like environment used in the research for this thesis is most likely not the most suitable. For the results to really reflect the real user experience the settings should feel familiar and realistic. Also, the studies are limited by the participant sample, which consisted of employees and students of the faculty of art and design. In future studies, it would be desirable if the target group could be determined more precisely and the studies could be conducted in real life settings.

Related to this master's thesis topic, some further ideas are proposed. Firstly, for the Liquid UI and research done relating to the use of liquid as an interactive element, it would be interesting to explore the dimension of the water depth. Secondly, the issue of the temperature of the liquid could be addressed. In the conducted user study the possibilities of temperature changes were overlooked. Thirdly, also in regard to the Glass UI user study, the aspect of three dimensional (3D) use should be taken into consideration. Whereas, the glass objects were now merely moved on a table top in future studies the possibilities to use the whole room or environment as active area for interaction could be considered. Restricting the movement on a 2D surface with a restricted area in which to move arguably had an impact on the user experience. A study setup in which the users would be free to move the objects inside the room without such restrictions could be interesting option in the research of adaptive environments and tangible user interfaces. Furthermore, the possible differences between men and women as users of tangible user interfaces could offer an interesting angle, as the data gathered from the Glass UI user study brought up some indications of differences between genders. However, due to the limited number of participants, these were not sufficient enough to gain a statistical significance.

## 8 Conclusion

Nowadays more and more sophisticated technologies and digitalization are having increasingly bigger role in our everyday lives. Although we have somewhat adapted to this immaterial reality coexisting with our physical world, the ways we connect to it are still very concrete and physical. We use numerous different gadgets and devices to stay online and connected. The technical development and new design directions lead towards new types of user interfaces, which need to be developed to be user friendly.

The scope of this master's thesis was based on this notion of the gadget centric world we now live in. Along with constantly developing technologies the focus of interaction design is shifting away from the gadgets and devices but instead the domains of ubiquitous computing and embedded user interfaces are emerging. The aim of this research process was set to study the user experience of aesthetic, tangible user interfaces utilizing nontraditional interactive elements in an adaptive hotel room context. After reviewing the prior art regarding the chosen topic and identifying the value for the research two research questions were created. These questions were: *How do users perceive nontraditional tangible user interfaces for controlling actions in an everyday environment?* and *What are the key user experience elements of aesthetic, tangible user interfaces utilizing glass and water?*

These research questions focused on examining the user perceptions and experience in regard to nontraditional aesthetic, tangible user interfaces in a context close to everyday life. Aiming to answer these questions the research process was started by conducting two workshops for ideation in order to create the adaptive hotel room concept that could be used as a tool for presenting, illustrating and evaluating ideas. Within this hotel room concept five more specified concepts were created and presented. The concepts were Morphic structures, Universal light source, Water user interface, Functional decorative objects and Flexible user interface. From these concepts two were eventually selected to be developed further into user studies. The user studies conducted and presented in this master's thesis were Liquid UI, utilizing water as an interactive UI element, and Glass UI, utilizing glass objects as interactive elements.

The main finding gathered from the studies were that the users experienced the use of aesthetic, tangible user interfaces as fun and interesting. The tangible features of both

of the concept user interfaces had a salient impact on the user experience. The aesthetic features affecting the user experience, as concluded from the Glass UI results, were mainly focused on the color and shape of the glass objects used as interactive elements. Furthermore, even though some issues relating to pragmatics of the concept UIs were raised by some of the users, these were at least partially overrode by the hedonic qualities of the user experience.

The future research should conduct a user study examining the formation of user experience during a longer time span and repeated exposure to the UIs. Due to the limited time frame and the “one-time-experience” feeling of the studies conducted for this thesis, the user experience most likely was at least somewhat influenced by the novelty value of the user interfaces. Additionally, some features of the user interfaces, such as the temperature of the interactive elements and the utilization of 3D spaces as input areas, are suggested as potentially interesting topics for future research.

Although the limitations of this research are acknowledged and admittedly some missteps were taken during the process, I argue that the outcome of this master’s thesis was successful and novel knowledge on aesthetic, tangible UI design was obtained.

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## **Appendices**

Appendix 1: Background information form, Liquid UI

Appendix 2: PRCs form

Appendix 3: Consent form, Liquid UI

Appendix 4: Expected experience form, Liquid UI

Appendix 5: Likert scale form, Liquid UI

Appendix 6: Evaluation form, Glass UI

Appendix 7: End questionnaire, Glass

## Appendix 1: Background information form, Liquid UI

### Taustatiedot Background information

Nro: \_\_\_\_\_

Pvm / Date: \_\_\_\_\_

1. Ikä  
Age \_\_\_\_\_

2. Sukupuoli  
Gender

Mies Male	Nainen Female	Muu Other
--------------	------------------	--------------

3. Koulutusaste / ammatti  
Educational level / occupation

\_\_\_\_\_

\_\_\_\_\_

4. Oletko oikea- vai vasenkätinen?  
Are you right- or lefthanded?

Vasen Left	Oikea Right	Molemmat Both
---------------	----------------	------------------

5. Käytätkö kosketusnäyttöisiä laitteita?  
Do you use devices with touch screens?

Kyllä Yes	En No
--------------	----------

Mitä laitteita?  
Which devices?

\_\_\_\_\_

\_\_\_\_\_

Kuinka usein?  
How often?

Kuukausittain Monthly	Viikoittain Weekly	Päivittäin Daily
--------------------------	-----------------------	---------------------

## Appendix 2: PRCs form

Nro: \_\_\_\_\_

**Valitse 5 sanaa, jotka mielestäsi kuvaavat kutakin kytkintä parhaiten.**  
**Choose 5 words that in your opinion describe each switch the best.**

Kytkin / Switch	A	B	C
Nopea <i>Fast</i>	Hidas <i>Slow</i>	Epäjohdonmukainen <i>Inconsistent</i>	Johdonmukainen <i>Consistent</i>
Herkkä <i>Responsive</i>	Jäykkä <i>Rigid</i>	Hallitsematon <i>Uncontrollable</i>	Hallittu <i>Controllable</i>
Hauska <i>Fun</i>	Vakava <i>Serious</i>	Epämiellyttävä <i>Unpleasant</i>	Miellyttävä <i>Pleasant</i>
Levollinen <i>Relaxed</i>	Stressaava <i>Stressful</i>	Tylsä <i>Boring</i>	Jännittävä <i>Exciting</i>
Helposti lähestyttävä <i>Approachable</i>	Vaikeasti lähestyttävä <i>Unapproachable</i>	Turhauttava <i>Frustrating</i>	Innoستava <i>Inspiring</i>

**Mikä kytkimistä oli sinulle mieluisin?**  
**Which one of the switches do you prefer?**

A                      B                      C

Miksi?  
 Why?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Nro: \_\_\_\_\_

**Vertaile kytkimiä keskenään.**  
**Compare switches.**

**Valitse 5 sanaa, jotka mielestäsi kuvaavat kutakin kytkintä parhaiten.**  
**Choose 5 words that in your opinion describe each switch the best.**

Kytkin / Switch	A	B	C
Nopea <i>Fast</i>	Hidas <i>Slow</i>	Epäjohdonmukainen <i>Inconsistent</i>	Johdonmukainen <i>Consistent</i>
Herkkä <i>Responsive</i>	Jäykkä <i>Rigid</i>	Hallitsematon <i>Uncontrollable</i>	Hallittu <i>Controllable</i>
Hauska <i>Fun</i>	Vakava <i>Serious</i>	Epämiellyttävä <i>Unpleasant</i>	Miellyttävä <i>Pleasant</i>
Levollinen <i>Relaxed</i>	Stressaava <i>Stressful</i>	Tylsä <i>Boring</i>	Jännittävä <i>Exciting</i>
Helposti lähestyttävä <i>Approachable</i>	Vaikeasti lähestyttävä <i>Unapproachable</i>	Turhauttava <i>Frustrating</i>	Innoستava <i>Inspiring</i>

**Mikä kytkimistä oli sinulle mieluisin?**  
**Which one of the switches do you prefer?**

A                      B                      C

Miksi?  
 Why?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

### Appendix 3: Consent form, Liquid UI

#### Suostumuslomake

#### *Consent form*

Nro: \_\_\_\_\_

Pvm / date: \_\_\_\_\_

Tervetuloa osallistumaan tutkimukseen, joka on osa Naked Approach hanketta. Tässä tutkimuksessa selvitetään vaihtoehtoisen käyttöliittymän käyttöön liittyviä huomioita ja reaktioita. Tutkimus suoritetaan vertailemalla käyttökokemuksia nestekäyttöliittymän ja perinteisen käyttöliittymän välillä. Tutkimuksen suorittaa Lapin yliopisto (yhteyshenkilö: Professori Jonna Häkkilä, jonna.hakkila@ulapland.fi) Allekirjoittamalla tämän lomakkeen hyväksyn seuraavan,

-Ymmärrän tämän tutkimuksen sisällön ja tarkoituksen sekä hyväksyn osallistuvani tutkimukseen

-Ymmärrän, että voin keskeyttää tutkimuksen milloin tahansa

-Sallin, että tutkimus tallennetaan tutkimustarkoitusta varten. Materiaalia voidaan hyödyntää tutkimukseen liittyvissä presentaatioissa

*Welcome to participate in a study that is part of Naked Approach project. In this study we examine reactions and perceptions of alternative user interfaces. The study is done by comparing user experiences regarding the use of liquid interface and traditional interface. Study is run by University of Lapland (Contact: Professor Jonna Häkkilä, jonna.hakkila@ulapland.fi) By signing this form I agree,*

*-I understand the nature of this study and I agree to participate*

*-I understand that I can withdraw from this study at anytime*

*-I allow the study to be recorded for research purposes. The material can be used in research presentations*

\_\_\_\_\_  
Päivä  
Date

\_\_\_\_\_  
Osallistujan allekirjoitus  
Signature of the participant

\_\_\_\_\_  
Päivä  
Date

\_\_\_\_\_  
Tutkijan allekirjoitus  
Signature of the researcher

## Appendix 4: Expected experience form, Liquid UI

Nro: \_\_\_\_\_

**Ennako-odotus ennen testin suorittamista.**  
*Expectation before doing the test.*

Kytkin / Switch **C**

	1	2	3	4	5	6	7	Erittäin Very
Hauska <i>Fun</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hallitu <i>Controllable</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Miellyttävä <i>Pleasant</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Helppokäyttöinen <i>Easy to use</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mielenkiintoinen <i>Interesting</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Ei lainkaan  
Not at all

Nro: \_\_\_\_\_

**Ennako-odotus vs. kokemus.**  
*Expectation vs. experience.*

**Ennako-odotus ennen testin suorittamista.**  
*Expectation before doing the test.*

Kytkin / Switch **A**

	1	2	3	4	5	6	7	Erittäin Very
Hauska <i>Fun</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hallitu <i>Controllable</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Miellyttävä <i>Pleasant</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Helppokäyttöinen <i>Easy to use</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mielenkiintoinen <i>Interesting</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Ei lainkaan  
Not at all

Kytkin / Switch **B**

	1	2	3	4	5	6	7	Erittäin Very
Hauska <i>Fun</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hallitu <i>Controllable</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Miellyttävä <i>Pleasant</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Helppokäyttöinen <i>Easy to use</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mielenkiintoinen <i>Interesting</i>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Ei lainkaan  
Not at all

## Appendix 5: Likert scale form, Liquid UI

		Nro: ____							
<p>Mitä ajatuksia kytkimet herättävät?  <i>What thoughts switches provoke?</i></p>									
<b>Kytkin: 1</b>									
	Ei lainkaan <i>Not at all</i>	1	2	3	4	5	6	7	Erittäin <i>Very</i>
Mielenkiintoinen <i>Intresting</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Käytännöllinen <i>Practical</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Miellyttävä <i>Pleasant</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rauhallinen <i>Calm</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hauska <i>Fun</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Muita, mitä? <i>Something else, what?</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
_____		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
_____		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

		Nro: ____							
<p><b>Kytkin: 2</b></p>									
	Ei lainkaan <i>Not at all</i>	1	2	3	4	5	6	7	Erittäin <i>Very</i>
Mielenkiintoinen <i>Intresting</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Käytännöllinen <i>Practical</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Miellyttävä <i>Pleasant</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rauhallinen <i>Calm</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hauska <i>Fun</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Muita, mitä? <i>Something else, what?</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
_____		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
_____		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

		Nro: ____							
<p><b>Kytkin: 3</b></p>									
	Ei lainkaan <i>Not at all</i>	1	2	3	4	5	6	7	Erittäin <i>Very</i>
Mielenkiintoinen <i>Intresting</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Käytännöllinen <i>Practical</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Miellyttävä <i>Pleasant</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Rauhallinen <i>Calm</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hauska <i>Fun</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Muita, mitä? <i>Something else, what?</i>		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
_____		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
_____		<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
<p>Mikä kytkimistä oli sinulle mieluisin?  <i>Which one of the switches do you prefer?</i></p>									
<b>1</b>	<b>2</b>						<b>3</b>		
<p>Miksi?  <i>Why?</i> _____</p> <p>_____</p>									





