# Self-expression with a mobile augmented reality product – The Design of Colourwheel

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The Design of Colourwheel
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# Abstract

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Augmented reality, where virtual content is mixed with the real-world, is increasingly more popular among different areas of academic studies and consumer products. It can provide a more versatile approach for creating experiences and using everyday products, as virtual content can contain a lot more information and interaction than physical, static objects. This master's thesis studies possibilities for self-expression using a product and a mobile app. The mobile app uses augmented reality when used to scan the product, triggering augmented reality content on the app's camera view. This is a qualitative study in the field of Industrial Design, using case study as a research strategy and focus group interview and observation as data gathering methods to study the target group. The study contains background research on studies regarding mobile augmented reality, design process of the product and mobile app including interview and observation. The final chapters describe the results regarding both mobile app and the product itself, summarizing the study to conclusions.

**Keywords:** Industrial design, interaction design, mobile augmented reality, self-expression

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Lisätty todellisus, jossa virtuaalinen sisältö sekoittuu todellisuuden kanssa, on kasvavassa määrin suositumpi eri tutkimusalojen sekä kuluttajatuotteiden keskuudessa. Sen avulla voidaan mahdollistaa monipuolisempia kokemuksia tuotteiden käytössä, sillä virtuaalinen sisältö voi olla huomattavasti interaktiivisempi ja informatiivisempi kuin fyysiset, staattiset esineet. Tämä pro gradu -tutkielma tutkii itsensä ilmaisemista tuotteen ja mobiilisovelluksen kautta. Mobiilisovellus käyttää lisättyä todellisuutta, kun sitä käytetään tuotteen skannaamiseen mobiilaitteen kameran avulla, jolloin kameranäkymään ilmestyy virtuaalista sisältöä. Tämä on kvalitatiivinen tutkimus teollisen muotoilun alueelle, käyttäen tapaustutkimusta tutkimusstrategiana ja kohderyhmähaastattelua sekä havainnointia tutkimusmateriaalin keräämiseen käyttäjäryhmältä. Tämä tutkielma sisältää aiempien mobiilia lisättyä todellisuutta tarkastelevien tutkimusten esittelyä, tuotesuunnitteluprosessin jossa kehitetään tuote sekä mobiilisovellus ja haastattelu sekä havainnointimateriaalia. Lopuksi tulokset käydään läpi kuvaillen niitä sekä tuotteen, että sovelluksen näkökulmasta.

**Avainsanat:** teollinen muotoilu, vuorovaikutussuunnittelu, itseilmaisu, mobiili lisätty todellisuus

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# 1. Introduction

Industrial design is present everywhere. It is included in product and service design and development, both material and immaterial properties and it evolves as the world around us does, too. A good example is the development of virtual and augmented realities called mixed reality. The number of applications used to harness this technology is growing, moving from bulky, big computers and helmets towards an ubiquitous solution, where the technology blends into things around us or even disappears from our sights. As a designer, this kind of breaking points are extremely interesting as there are possibilities to study number of matters. From user-experiences to ergonomics, from user-interfaces to human behavior in such contexts and the list goes on and on. We have got the tools, but how we harness them in meaningful and, for example, user-friendly manner is up to us. This calls for research, too.

## 1.1 Personal motivation

The contact point between physical artefacts, as in products, and the digital, mobile world is evolving quickly. More and more things are being connected to one another through this digital space. This is an interesting area in the field of industrial design which acted as a huge factor when narrowing down the subject and the research problem. In the light of the master's thesis, the product gets most of the attention as it has to be created from nothing comparing to the digital side of the work which can be done with less iterations. This thesis concentrates on (Chapter 1.2) the field of interaction design and mobile augmented reality and how can these two areas be used for self-expression. Interaction design is related to a variety of areas and in this work it is handled in the context of industrial design.

Augmented reality has been widely covered in research regarding its use with head-mounted displays (HMDs) and recently, due to the advances in mobile technology also regarding mobile augmented reality. The intersection between mobile augmented reality and products has not gained as much scientific interest. There are products in the market (Pokémon Go and Pokémon Go Plus-bracelet, HoloTats and Metaverse Nails) which proves there are some market for such work. Whether there is demand is another matter. This master's thesis will address the mentioned intersection between mobile augmented reality and products examining what kind of reactions it will get from the targeted users.

The personal interest towards developing interactive experiences in a social manner were formed nicely into the subject. It harnesses both product design knowledge and expertise into interaction design in an emerging, growing field of mobile augmented reality. This way it does not only meet the personal preferences but also the demand, current and upcoming one.

The personal motivation aside, it is also in University of Lapland, Faculty of Art's interests to stay on top of the different aspects of the design industry. The university also has a strong knowledge and research in the field of interaction design, human-computer interaction in addition of the long background in product design. Having made the bachelor's thesis regarding a mobile game in a collaboration with students majoring in nutrition field, it deepened my knowledge about both interaction design and gamification related to the project, aiming to get kids eat healthier teaching them via a game. As a designer, my focus was on the game design from the plot to illustrations and planning the general game mechanisms.

## 1.2 Theoretical framework

This research consists of three fields; interaction design (in industrial design), mobile augmented reality and self-expression. It examines the relations between the fields to create an innovative product using mobile AR for self-expression.

### Interaction design

Interaction design means design of interactive products and services to support users' tasks and behavior. In this work, interaction design is handled as a disciplinary of industrial design, therefore involving the both fields but concentrating on the interaction. Interaction design is defined as designing interactive products and services supporting the way people communicate and interact in their daily lives (Preece, J. et al. 2015).

### Mobile augmented reality

Augmented reality is the use of technology which allows its users to see virtual objects overlaid in the real world (Azuma, R. 1997). Mobile augmented reality (also shortened as MAR in this work) is about using the same technology on mobile devices. On mobile devices, the virtual content is added on the phone's camera view. MAR is mainly due to the advances in technology quickly shaping itself as a trending field amongst the field of computer science. It has been around for some decades in certain, generally military and scientific institutions and due to the growth of mobile technology it has since been applied to a variety of mobile devices making wireless applications possible for the mainstream as well. In the context of mobile AR, the applications currently researched and released to wider use contain computer-generated graphics from 3D-models to 2D-content (videos, photos and such). (Kourouthanassis, P. et al. 2015)

## Self-expression

Self-expression, in the field of social psychology, is examined here in a relation to interaction design and mobile augmented reality. The ways of expressing oneself via mobile devices, to be exact. Self-expression often refers to letting individuals make choices based on their personal preference (Hazel, M. and Schwartz, B. 2010). Merriam-Webster dictionary summarizes the term 'self-expression' as the expression of our personality, continuing that if often happens through artistic activities such as writing, or for example via photography (Merriam-Webster).

In this work, interaction design is examined in a relation to mobile augmented reality and industrial design. The product itself has interactive aspects, as does the mobile app which contain augmented reality content. Mobile augmented reality requires a mobile device, which requires more from the user, too.

Self-expression and social psychology are briefly described to provide an understanding of how the design is supposed to take personal needs or expectations to account. This master's thesis does not aim to thoroughly cover self-expression as it is not necessary in this context, nor is it an area of expertise of the researcher.

## Related research

Related research by Russell Freeman and Anthony Steed (2006) presents an interactive way of modelling and tracking for both mixed (a combination of virtual and augmented reality) and augmented reality. Markerless tracking for augmented reality has been studied for example in a context of using hand gesture recognition as the triggering element in order to recognize when the virtual content should appear to the camera view of the device (Lee, B., Chun, J. 2009). This subject closes in on the idea of having markers which the users would be able to change, launching pre-defined content on the camera view. A similar study also used human hand as a pattern, instead of specific

markers (Lee, T., Hollerer, T. 2007). Initial user perceptions of augmented reality in a home setting has been studied by an online survey. In the study, augmented reality information is overlaid on a mobile device's camera view providing knowledge on everyday items, for instance (Colley, A. et al. 2014). Another study focuses on hybrid interfaces for posters with augmented reality content, providing a solution using augmented reality game with zoomable interfaces for a mobile device (Grubert, J., et al. 2012). Additionally, on-product advertising using mobile augmented reality in a form of a game to build customer satisfaction and engagement has been studied (Nazri, N. et al. 2015). Also, different kind of ways to present ubiquitous mobile augmented reality information have been studied, showcasing ways of overlaying context aware content on a mobile device (Henrysson, A., Ollila, M. 2004). Flying Cake by Anjin Park and Keechul Jung (2009) is another take on mobile augmented reality, presenting a way to capture face region instead of typically used markers, providing virtual content on user's face in a fun and engaging game-setting. A study related to photo-sharing and creation using a mobile augmented reality technology has been published in a context of an artistic photo collage application (Marzo, A., Ardaiz, O. 2013). There has also been research regarding 'light-weight' markers for augmented reality, where the marker would blend in the background making it almost invisible compared to the virtual content (Korkalo, O. et al. 2010).

May Day Masks for mobile augmented reality is a playful mobile app created for the celebration of May 1st in Finland. Using face tracking, the app added a layer of virtual content on users' faces, representing masks and hats and disguises popular for the May Day celebration. (Woordward, C., et al. 2008) Wearable AR markers as a self-expression tool presents ways of wearing markers which others could scan with a mobile app, providing information about their personality or other related content. This study is closely related to the research problem of this master's thesis due to the focus on self-expression. (Roinesalo, P., et al. 2016).

The possibilities and design challenges for mobile interaction design using mobile

augmented reality were studied with three different prototypes providing information about each of the prototype's benefits and drawbacks (De Sa, M., Churchill, E. 2012).

These studies examine a wide range of solutions for augmented reality and its use on mobile devices, too. Nevertheless, there was less concentration on modification of the markers used to trigger the virtual content on a device's screen, overlaid on the real-world view. Although numerous studies focus on markers as such, how to modify a markers shape creating another marker out of an existing one is lacking of those studies. In addition of that, the users' views and experiences regarding such a product need to be addressed in order to find out its implications, possibilities and general data about such interactions.

# Literary review

The literary addressed and used in the thesis consists of papers, articles, books and research material related to the theoretical framework and the field of research in general. The main source of information regarding interaction design comes from the book Interaction design: beyond human computer interaction (Preece, J. et al. 2015), which is an extensive work related to the field of interaction design. The book consists of widely accepted methods, information and a thorough considerarion of the different aspects of interaction design. It is in the nature of interaction design that it can be applied to many kind of fields differentiating from one another, yet they all have something in common. The book is addressed to these common elements and it is made especially for those who work in the design industry.

Designing interactive narratives for mobile augmented reality by Yanghee Nam (2014) is a research article published by Springer Science+Business Media. The paper presents design factors and goals to take to account when designing interactive narratives for mobile augmented reality. In the next phase of the study, three prototypes were built to demonstrate the interactive narratives. The prototypes were exhibited and studied in an empirical study in a form of a questionnaire, a semi-structured interview and an observation at Incheon Digital Art Festival, South Korea.

Design Through Research: From the Lab, Field and Showroom (Koskinen, I. et al. 2011) is a book which examines and showcases constructive design research and how it is utilized in various examples. It emphasizes the impact of design as a verb in the context of research which is done in the field of design. It is an overview to different type of design research in different environments, different settings. Since the book focuses on constructive design research, it excludes other type of design research, including mainly industrial design and interaction design, as the former especially is a product-orientated discipline where several steps must be taken in order to get to the final design.

You are (not only) what you choose: A self-expression account of post-choice dissonance by Michail Kokkoris and Ulrich Kühnen (2014) is a study in the field of social psychology at the University of Cologne. The paper looks into the means of choice and how it is bound to expresses ourselves one way or another. Our choices, but also not choosing something, defines and strengthens our identities and are a way for self-expression. The publication presents two experiments where the participants were given alternatives for voicing their opinions. As a result, it was noticed that this reduced an effect called 'spreading-of-alternatives'. The effect means the way we tend to reduce conflicts after a difficult choice we have made by decreasing liking for the opinion left behind and increasing the likeability of the chosen one.

Does choice mean freedom and well-being by Hazel Markus and Barry Schwartz published by Oxford University Press in 2010 is a scientific article where choices are examined in relation to their affects on both our mental and physical sides. The article takes mainly North American people in consideration but, because of the nature of the human being, it can be read as a part of most of the known cultures.

# Terminology

**Augmented reality, AR** Using specific devices, for instance computers to mix virtual content with the real world

**Industrial design** Field of product design, including product and service development among other areas

**Interaction design** Design and study of interactive systems in products and services

**Marker** A 2D-image or 3D-object used with AR and MAR. Device recognizes the marker, causing the virtual content to appear on or around the marker.

**Mobile augmented reality, MAR, mobile AR** Use of augmented reality on mobile devices

**Virtual reality, VR** Technology that allows to create and experience a reproduction of reality in a virtual form, usually used with headsets that can produce both 360-degree video and sound

## 1.3 Research questions

This thesis has two main research questions, which both are aimed at a slightly different context. The first question is about the possibilities for one to express oneself through a mobile app which uses mobile augmented reality and a physical proudct. A marker on the product will activate virtual content (augmented reality) in the app's camera view. The second question is about the design of the product, examining an optimal solution which works with the mobile app and creates meaningful interaction between the mobile app and the product itself.

**Research question 1**

How to enable self-expression with a mobile augmented reality app connected to a product?

**Research question 2**

Does the Colourwheel's design support the use of mobile augmented reality for self-expression?

The research question 1 is studied during a focus group interview, while the second question is studied in an observation in the field. The second question is related to the final product, the outcome of the design process presented in this work.


# Keywords

Interaction design, self-expression, mobile augmented reality, industrial design

# 2. Methodology

This is a qualitative study in the field of industrial design. Using widely approved methods based on the exercises related to design science. The work includes quantitative data gathered at the interview and observation as background- and experience-questionnaires which is why qualitative content analysis was selected as the analysis method, because it enables working with both qualitative and quantitative types of data (Anttila, P. 2006). The research strategy of the thesis is a *case study*, which aims to collect empirical feedback on the subject, a design process in this case (Blaxter, L. et al. 2006: 72). The research material will be collected out of the information gathered during the design process, focus group interview and an observation, all commonly used in industrial design.

## 2.1 Case study in Industrial Design

Researchers in case studies usually observe an individual unit. The goal is to analyse and understand a phenomenon within the selected unit (a school, a class, a teen) and to generalize the result to a wider population to which the unit belongs, too. As a beginning and a small-scale researcher, case study is a suitable research strategy. Its features are very well suited for design research, too, where the focus is on a group of individuals or even one individual. The case could be within a researcher's place of work, organization they're connected to (companies, schools or perhaps a voluntary organization). Case studies are often done to address and illustrate problems or good practices. In this work, the design process related to the research is considered the case for this case study. (Blaxter, L. et al. 2006)

Academic research for the field of industrial design often belongs to the field of constructive design research. It is about the intersection of design and research, here within the industrial design field. Industrial design provides this research concrete artefact, a product to study. (Koskinen I., et al. 2011)

Because this research includes designing both product and an app and its functionalities, the data must be captured in ways suitable for both. Material from the design process includes written, drawn or 3D-modelled ideas, photographs and benchmarking on current solutions in the field. Focus group interview-material will be recorded and written down. Observation will be documented as either/or photos, videos and written notes. The research material will be analysed using themes and categories related to the research problem and research questions.

Interpretation of the research material will be based on the information from each of the three parts, design process, interview and observation. Conclusions and interpretations from the findings of the analysis and comparison of them to research problem and the research questions reveals whether the work is relevant to those or not.

Ilkka Niiniluoto (1999: 162-163) summarizes the pragmatic success of science in a following norm: believing you are in a situation B and want to to achieve A, you should do X. Which leads to causal explanation of X playing an important role in the B -situation. While implementing this in practise can be difficult depending on the scientific field, it seems to cover the practical, everyday life of design as a scientific discipline and design sciences in general. Creating something out of nothing (or nearly nothing) requires action in order to proceed forward. Niiniluoto (1999) describes these as technical sides of the norm, typical in applied sciences; predictive sciences as they aim to foresee a situation emerging from an action and design sciences as they aim to harness technological or technical activity in action.

The contribution industrial designers bring to scientific research has been widely studied despite of the profession being brought to academic world relatively late (Driver, A. and others (2011) and Cross, N. (2001)). A study of designers' input and how other scientists see it was studied in a form of interviews, case

studies and literary reviews resulting in an overall positive result from industrial designer's point of view (Driver, A. et al. 2011).

Naturally, as always when one or more professions intersect, there are risks and challenges, for example differences in the professional language. Even design professionals often struggle seeing the connection of design research to the daily reality of their professions, as Kees Dorst (2016) points out, answering this critique stating that the knowledge of design is included both in design practice and academic research.

## 2.2 Design process

Industrial design, as a discipline of product design, follows a specific process during which a product or service is defined from a mere idea to a functional product or service. The design process, creating products or services, contains the paradigm (Niiniluoto, 1999.) of doing something in a certain situation to achieve something. Design practice, of course, also has several additional steps which are often iterative by nature.

John Fox (1993: 36) refers to design process as an architectural process, summarizing its stages in five steps which are definition, concept generation, concept reduction, concept evaluation and output. A dear child has many names, just like design process does. Despite of that, every definition of the process has similarities, nevertheless the process is never the same. It depends on the nature of the product of service being developed as well as the team working on it.

Definition is the initial phase where the requirements for the development are set, either by a client, customer or the team itself. It contains all the necessary information considering the given task, aiming for a successful production. The team(s), necessary tools, budget and stages of the development are set at this stage. Concept generation contains the first freely creative work related to the process. Based on the required functions, ideas are created and discussed to identify the relevant functions. Different kind of tools and methods are recommended to be used, for they let us better control our work and the people we work with. Fox (1993: 38) presents a 7-step check-list to be used at this stage. Making sure

that the product theme and specifications are understood, critical design issues identified, the competition benchmarked, relevant standards are known and minimum level of detail for ideas set. The check-list ends with a task of recording evaluation criteria as the process goes on and the criteria gets clear.

Following the concept generation, Fox (1993: 39) presents a concept reduction-phase, where the ideas are analysed and unnecessary ideas eliminated. Filtered by the required functions and features, only the most essential ideas are taken for further development. There are countless of methods to achieve a successful process for eliminating vain ideas and identifying the most relevant ones. One is simply to check whether an idea has the key functionalities for the product or service set at the definition phase.

Concept evaluation is a thorough method of analysing the features of the ideas. In a nutshell, it requires a specific method weighting the criteria for the designs in a comparison between the whole set of ideas or concepts. It is crucial to have a suitable set of evaluation criteria, in order to successfully go through this process. Therefore, the criteria should be noted in the early stages of development, too, as they are recognized. Lastly, the design process includes the output-phase, which takes the development further, to the finalized design. (Fox, J. 1993: 39-41)

Another look at the design process, differing from the architectural take on it, is presented in a book Research Methods for Product Design by Alex Milton and Paul Rodgers (2013). The methods used in design process vary on the stage of the process as well as the project. Before a design process begins, there are usually activities relating to the following process. This could be scientific research, exploratory activities that later on continue to form a defined brief. The background stage can involve observatory studies where information is gathered based on observing people, items, for example. The methods for gathering such information include ethnography, photo and video diaries, sketching or perhaps product autopsies. It can also involve activities where information is gathered by purposely looking for ideas. This can include analysis of competitors, web searches, role playing, mind mapping and similar activities. Ideation is a creative activity in which the initial ideas are created leading

to market research and comparative study of similar products, for example. This refers to benchmarking, a study of existing and related products or services. Going out and asking people is another learning-by-doing example, where information is gathered from various sources in a form of questionnaires and surveys, focus groups, interviews or marketing research. Following the background research stage is the brief, similar to the definition stage presented in the architectural design process. It has activities related to looking at information from and in the real world, learning by finding out about things from the background stage and asking people, for example the target group, their opinions and views on the matter. Concept design is a stage where ideas become more tactile. Depending on the type of design project, there are activities which as well include different ways to look for information, asking for opinions and general feedback. Design development includes more constructive work, creating prototypes, mock-ups and sketches further defining the design. Prototypes are a way to showcase and test the design before it has got its final form (Buchenau, M., Suri, J. 2000). This phase can similarly have user interviews and user tests or focus groups where prototypes, for one, can be tested. User research as a part of a design process brings user-centered approach to action. It considers the target group's needs, desires and thoughts taking them into account for the development. Detail design is about tuning the product, service or whatever is in the making. Usability tests help to refine the ergonomics or usability, testing the design and user experience. The final stage in this version of the design process is production, but it does not necessarily always go in this order. Iterations may be needed to refine the design, which means going through certain stages again as many times as the design is impeccable. (Milton, A., Rodgers, P. 2013)

## 2.3 Focus group

Focus group interview is a conversational data-gathering method carried out with selected participants that represent the target group. The participants can be either informed about the topic or selected randomly. Each decision about the content of the focus group interview will influence

where the participants stand with the subject and therefore their opinions as well. The idea of the method is to make the participants focused on an activity (films, political views et cetera) and to spark discussion on it. Focus groups are oftentimes used in empirical studies that cover people's views, opinions and experiences aiming to get valuable data for the research from a larger group of people. (Kitzinger, J. 1994)

Focus group interviews are a common group interview method in marketing, political campaigns and social sciences research. Usually it involves three to ten people and the discussion is moderated by a facilitator trained for the occasion. Participants represent the target population providing a sample of the whole target group. If the target group consists of different kind of user groups, the focus group interviews can be divided each of them offering a sample of the groups they represent, for example students, teachers and parents. (Preece, J. et al. 2015)

Interviews may contain stimulus, photographs and videos as mentioned, to spark discussion. They may also take place in a neutral ground, or at a specific setting like the interviewer's or interviewee's home or workplace. It is also worth of noting that the interviewee may be given a warning or a detailed briefing about the interview in advance. This briefing can be quite detailed, gathering data necessary for the background of the interview for example, as well as letting the interviewees mentally prepare for the topic beforehand. The event can be recorded in a number of ways, from audio- to video-recording as well as illustrating the events and writing notes. There can also be an assistant who takes notes while the interviewer concentrates on the interview itself. (Blaxter, L. et al. 2006)

Preparation of an interview requires a thorough planning of questions or topics which the data is wanted from. There are two types of questions, open and closed ones. Closed questions are the kind which answers are already known beforehand and open ones are for an exploratory goal. Open questions are typically used in unstructured interviews, and closed ones in a structured one. It is important to avoid asking about many features or things at one sentence. This could cause confusion among the interviewees as well as trouble for the recording. The

language should be universal, avoiding professional terms. (Preece, J. et al. 2015)

In addition, the ways of recording the events should be decided in a consideration of the participants as well as the nature of the interview and the topic examined. Whether it will be recorded as a video, audio or written notes, each of them have their implications. Recordings may make the participants anxious and unwilling to share their view or confidential information. The amount of work that goes in the analysis also depends on the method. Recordings can take a long time to analyse or transcribe. (Blaxter, L. et al. 2006)

## 2.4 Observation

For collecting data systematically without necessarily affecting the results by own actions, observation is a useful and widely used method for data gathering across the scientific fields. This method allows researchers to get data which can not be collected with others forms of research, for example interviews, as the participants are being watched without interrupting them or placing thoughts in their heads. Every action a researcher does or does not do can change the reliability of the results and therefore affect the outcome. Because of the flexible nature of observation as a scientific method, it can be applied to different type of contexts from event and behavior to physical artefacts and to quantitative and qualitative material. (Anttila, P. 2006: 189)

As Anttila (2006) points out, an observation that is scientific by its nature will be done in a systematic way to collect scientifically relevant data.

This approach requires preparation from the conducting researchers. It should be clear what will be observed and why, reflecting the objectives of the observation to the research questions and the research. Because of the nature of this master's thesis, where something is being produced, observing the use in real-life plays a major part in understanding the user's point of view. Observing is about letting the users speak by their actions, or as Anttila (2006: 189) summarizes: it is about seeing what people do, how things look and feel and how all of this differs from what they say.

Direct observation in the field can be used when it is in researcher's interests to observe

the attendees without necessarily indicating their own presence. It can be arranged either on field or in a controlled environment. If wanted, the observer does not have to be anonymous or hiding from the participants' view. Because it is unlikely that a researcher will get all the necessary information from questionnaires or interviews, especially in the field of interaction design, observation will help describing how accurately participants perform specific tasks, for instance. Even though every data gathering method should have a clear goal, this is even more emphasized when using observation as there can be much more activities going on simultaneously. There is a little room for modifying and refocusing the study if it seems relevant. This, however, requires the observer(s) to be aware of the whole situation. There are commonly used methods, such as frameworks to be used for observations in the field. They contain a set of questions regarding a person, a place and a thing for example. For each of these, the observer has easily rememberable questions to ask when observing. (Preece, J. et al. 2015: 253-254)

Unstructured observation is used when wanted to gather foreknowledge of a subject. When the phenomenon, the event being observed is not known, it is not possible to be coded beforehand either. In a structured observation, it is crucial to prepare for the observation beforehand creating a coding method which defines what will be observed. In a structured observation, it is also required to classify the research problems which are aimed to be examined during the event. Therefore, there must already be information and knowledge about the researched subject, as you will need to know what will be observed. (Anttila, P. 2006: 189-192.)

Different types of studies require different levels of participation of the observing party. There are both ethical and practical issues which set guidance, varying from observer as an insider to as an outsider and everything in-between. An observer as an outsider is passive, meaning she will not take any part to the observation environment. Because observations in the field can be unforeseeable and may force the observer to participate, it is easier to act as a passive observer in controlled study environments such as laboratory settings. (Preece, J. et al. 2015: 255)

Direct observation in controlled environments are studies that happen in so

called laboratory settings which are built for the sole purpose of studying specific things. It is more formal and, like in interviews, the participants must be briefed accordingly about the goals of the study and their part in it; what is expected from them and what rights do they have. The techniques for recording in this kind of study settings are similar to others including written notes, recording video and audio and photography, however the focus in these settings shift from how people interact with each other and technology towards what they actually do. If suitable for the study, it may be recommended that the observer encourages participants to think aloud about their decisions and the thought process they go through. (Preece, J. et al. 2015: 260-262)

## 2.5 Analysing and interpreting data

The data gathered during the research process will be analysed using methods from qualitative research, using content analysis of the data from the focus group interview and similarly the data from the design process itself. Same kind of approach is suitable also to observation data, where, depending on the need, both spoken and unspoken actions are necessary to be taken in account. The analysed data will be reflected to the research problems, questions, aiming for a successful approach on the context. Qualitative content analysis is a manual or computer-aided method of analysing written material gathered from a wide array of sources. Other research methods used to analyse text data include history research, grounded theory, ethnography and phenomenology. Content analysis is a suitable method for any kind of documents. It aims to create a solid understanding based on disassembled material making scientific interpretation and deduction possible. Direct content analysis focuses on validating or extending a theoretical framework or theory. This method harnesses prior research or existing theory to identify key elements for coding of the data. It is more structured comparing to conventional content analysis, which goal is to describe a phenomenon. (Hsieh, H-F., Shannon, S. 2005)

Identifying repeated patterns or themes will become viable as the researcher gets more familiar with the data. Finding patterns in

users' behavior, for example, may sometimes be a key for the analysis. Sometimes they lead to different ones, forming a solid foundation for the analysis. A widely-used method for qualitative analysis is affinity diagram, where ideas and insights are organized hierarchically showcasing themes and structures common for each hierarchy. Depending on the project, the findings are grouped to represent a certain theme, like user groups, common events, or places that were noted during a data gathering. The depth of analysis should be considered in a relation to the research. Whether interviews or observations are analysed in fine details where every word, gesture and happening is analysed, or at a higher-level which seeks general themes, for instance. The categorization of the elements found is usually made using a specific categorization scheme. The scheme can be formed from the data. It can be set for the requirements of the activity beforehand or be related to another known categorization scheme or alternatively be a combination of the two. The categorization scheme must be definite, making a replication of the analysis possible. The reliability of the scheme can be tested letting a person perform the activity and analysing that data by two people, for example. If there is a high variance between the analyses, either the activity was not performed accurately or the categorization does not work. (Preece, J. et al. 2015: 291-293)

Discourse analysis is another way of analysing transcripts. Its focus is not in text, but dialogs and how they are formed. It pays attention to what is said and how words form meanings, basing the analysis on interpretation. Because discourse analysis focuses on language, the assumption of it is that it has no objective scientific truth. It lets researchers focus on how language is used by people to build their realities, their worlds. (Preece, J. et al. 2015: 297)

# 3. Interaction Design and mobile augmented reality

The amount of devices that are and can be used for mobile augmented reality is relatively large. There are countless of devices capable of handling the technology needed (mobile phones, tablet-PCs and other handheld, wireless devices). The varied nature of the devices set some challenge for interaction design in order to make the user experience the best possible. Kourouthanassis P. and others (2015: 1050) present some interaction design principles for developing mobile augmented reality applications in a paper published by Springer Science. The analysis of literature on mobile AR applications presented in that study leads to five design guidelines that should be taken to account during a development process of such applications (Chapter 3.2).

## 3.1 What is Interaction Design?

William Middendorf (1997: 4) describes design as an iterative decision-making operation, which uses both scientific and technological information to produce systems, devices or processes that, to some degree, differ from what the designer knows has been done before.

Interaction design is, as in this context, an interdisciplinary field which studies and designs interactive systems. Interaction design is involved in a wide variety of professional subfields, bringing the expertise needed when doing product design, user interface design, user-centered design, experience design, software design and more. Interest towards the ways to communicate with software and hardware is in the foundations of the field but it is not only

about that, rather all kind of products that are used by people, whether they include technology or not. There are an endless amount of products people are interacted with on a daily, even hourly basis: from computers to smartphones, printers to toothbrushes and even books or board games. The paradigm (a widely adopted approach amongst researchers and designers within the field including shared assumptions, practices and values) of interface design includes generally user-centered applications for both technological and non-technological contexts. Since the introduction of ubiquitous technology, a new paradigm has emerged as computers are increasingly being embedded in everyday objects. The use of analogic methods for inputs can be automated, making our surroundings aware of us, acting autonomously. (Preece J. et al. 2015: 1, 8-9, 55)

An increasingly common type of interface are natural user interfaces, which contain those ways of interacting with products and services that are the most natural for us. This refers to touch, gestures and voice, for instance. The aim is to provide easy-to-use, therefore natural user experiences. This kind of interfaces are designed to support wider range of ways to control things, suitable for different kind of people with different kind of preferences. Natural user interfaces seem especially relevant now as technological advances bring new solutions, products and services in the hands of users. With each new approach, it is important to consider the users' roles. We have seen internet of things, connected devices bring for example voice-controlled devices (Amazon Echo, Google Home and smartphones) to the markets. Even though hands-free systems have been available for quite a while for cars and cellular, later smart-phones, new applications bring them to new environments. (Mortensen, D. 2017)

When designing interactive products, it is necessary to think about the user they are designed for, how will they be used and where or when. Ever-evolving technology brings new products to markets and research as well, challenging designers and engineers to think about their usability, contexts they are used at and, of course, the implications the products or services have. For example banking must be and feel secure and trustworthy, whereas a keyboard of a computer or smartphone must

be convenient and easy-to-use. Due to the advances in technology we are also moving from human to human transactions towards interface-based ones. (Preece J. et al. 2015: 1, 8-9)

In this thesis, however, it is not necessary to develop a whole new app but rather to use existing solutions that leads to the final outcome. Already a widely used plug-in for Unity called Vuforia allows developers to apply mobile augmented reality solutions in an orderly fashion, to a ready-made solution in which they only need to provide the content. In this study interaction design will be in a context of following works: Design of a mobile application using Unity + Vuforia plug-in and designing and creating a product including physical marker(s) which trigger the virtual content on the app.

The combination of these aims to create a natural experience to support one's needs or desires to digital self-expression through visual material (photos, screenshots, sharing).

## 3.2 Basics of mobile augmented reality

Augmented reality (AR), where computer-generated content is overlaid on the real world, goes back to 1992 when researcher Tom Caudell of Boeing started to use the term (Siltanen, S. 2012). The market of it is predicted to be a 150-billion-dollar market combined with virtual reality by 2020 (Digi-Capital, 2015). This speaks volumes about the market opportunities and the demand of services and researches related to the field. Unlike in virtual reality applications (which are often overlapping with the ones of AR), augmented reality does not require similar hardware or, as currently, a certain environment to be used. Mobile devices and different kind of projectors, for instance, can be used to mix computer-generated content with real world. This content can be either two- or three-dimensional, characters, artistic effects, art, videos, filters and more, your imagination being the only limit. As the field grows and technology advances, sci-fi-like features will become more and more mainstream. (Azuma, R. 1997)

Mobile augmented reality (MAR) is about using mobile devices for augmented reality, overlaying computer-generated content on the real-world using device's camera. It provides a wireless augmented reality experience and due to the millions of available devices, it allows people, regardless of their socioeconomic background, to explore the apps and games designed using the technology. (Kourouthanassis P. et al. 2015)

There are different ways to enable the computer-generated content appear on the device's camera view. Whether an app or a game, developers are able to choose between specific markers that are scanned or an entirely markerless way (Lee, B., Chun, J. 2009). A marker connects the experience to a time and a place, depending where they are placed at whereas markerless applications are free of such limits. It is important to take these differences into account during the development phase.

Panos Kourouthanassis and others (2015) present five design principles for the development of mobile augmented reality applications. The results are based on an extensive investigation of existing literature on interaction design for the context and analysis about the properties of interaction design of mobile augmented reality applications. The design guidelines presented in the work were tested in field study in a form of a travel application for mobile AR. The results from the field study suggested that the design guidelines contributed for high usability and performance. The guidelines proposed were (1) context awareness for providing content, (2) delivering relevant content for the task in use, (3) informing about content privacy, (4) providing feedback about the behavior of the application's infrastructure and (5) supporting semantic memory reducing the amount of distractions. (Kourouthanassis P. et al. 2015)

Mixing virtual data with the environment does have its fair share of challenges. One way to address this challenge is using markers which are recognizable 2D or 3D images and objects which are harnessed to use with computer vision technology. Alternatively, the mentioned markerless technology harnesses technologically advanced solutions to recognize features in the environment, often requiring additional sensors. (Siltanen, S. 2012)

Other kind of marker types include template markers which are simple black and white markers placed inside a thick black border to get added constant and readability. The detected images are samples from a variety or similar image templates. The system recognizes them by comparing the detected marker to a library of the template markers. 2D-barcode markers are as well black-and-white consisting of a variety of black and white boxes, pixel-like features. Circular markers provide accuracy comparing to square-shaped markers, as the center of a circle is easier to be detected in perspective, which is often the angle markers are scanned from. Image markers use coloured images which are tracked by an application. The can additionally have a border, frame to make the detection easier and more accurate. (Siltanen, S. 2012)

Mobile augmented reality can add to different aspects of learning, according to Edgar Dale's theory on the Cone of Experience which represents activities as a key for memorable experiences. It shows the development of experiences from concrete (bottom of the cone) to abstract (top-half of the cone) experiences. On bottom half of the cone is saying and doing, which leave a stronger mark in our memory than reading, hearing and seeing. Augmented reality can therefore, depending on its applications, leave a memorable experience as it oftentimes include doing things. Mobile augmented reality applications could include games or gamified (for instance services with game-like elements) experiences, social networking, talking and doing things together. (Davis, B., Summers, M. 2015)

## 3.3 User-Centered Design

A specific area of industrial design, user-centered design (UCD), has been formed due to the demand of learning about the initial user base of a designed product or service. It is difficult if not impossible to address their needs, desires or wishes if we do not involve them in the process in one way or another. This field belongs to the area of human-centered design (HCD), where users are considered more humanly as people. Whereas user-centered design aims to create user-friendly experiences, human-centered design focuses on people addressing human needs, capabilities and behavior first before going into the design. One valuable way to ensure the design works for everybody is to set the focus on when things go wrong, instead of focusing on when everything goes as planned. (Norman, D. 2013.)

Generally, at least their opinions are asked regarding ideas, for example. It would be a waste of investment if no one wants the outcome. As De Mooij (2005) and others point out, the product must have some elements that satisfies the users' needs. It has to know which desires to fulfill. For example, even the most technologically innovative products fail to success unless the consumers like them. A good example is Google Glass, augmented reality glasses with which you could record videos, see computer-generated content on real-world view and more. Regardless of the company's investment in development and marketing it never reached the masses (Bilton, N. 2015.). It has, anyway, had many spin-offs and companies have not given up on the idea. Currently, Microsoft and Meta to name a few, are making something similar with their products, so called head-mounted displays (Image 1). They aim to the same market with a different approach but it remains to be seen how well consumers adapt to them.

*Image 1 Head-mounted displays. Jukka Aittakumpu 2017.*

There are different ways to find out what the targeted users want. User research aims to understand the users and their lifestyles, aiming to successfully create seamless, positive experiences and bonds between them

and the products or services designed for them. Usability studies measure and evaluate the created solutions comparing them to the requirements set for the design. It is a thorough approach calculating the risks and the possibilities of, for example, false use. Knowledge, in user-centered design is indeed power. (De Mooij, M., et al. 2005.)

Where there are users for designed products and services, there has to be a user-centered approach to it. Taking the end-users, the target group, in consideration while deciding how, when and where the product being designed is used. If it, for one, does not appeal the users, they will end up ditching it and moving on to the next, better one.

## 3.4 Mobile augmented reality connected to a product

Mobile augmented reality (MAR) is generally used in a context of 2D markers, QR-codes, images as markers and increasingly as markerless applications as well as recognizing objects and overlaying information in the real-world view of the mobile devices. The use of products as markers has been studied and discussed in a context of product design, where augmented reality could be used parallelly with rapid prototyping methods, overlaying computer-generated content, for example a finished 3D-prototype on an unfinished prototype (Purdy, T., Choi, Y. 2014.). There are limitations, even as technology and devices get more advanced (Jung, J., et al. 2012) reducing the amount of data mobile devices can store and, on the other hand, how fast they can process the data. In this work, one specifically for this occasion designed product contains a couple of markers to be used in the mobile augmented reality app. Limiting the amount of markers reduces the amount of free memory required to store the app, and on the other hand to process the information when the application is used. Because visual tracking (images as markers) does not require specific extra devices, it is suitable for this work.

A fine example of using MAR with products is by having markers attached to clothes. In a demo on augmented self-expression (Roinesalo, P., et al. 2016) black-and-white markers were used to demonstrate ways of adding personal information and represting

one's identity on clothes using AR technology. This approach presented predefined virtual content when the marker on the clothes was scanned. Technology could already let developers come up with solutions where the virtual content could be user-generated, letting users truly express themselves as they want. Moreover, having wearable markers would require users to come close to another and point their mobile devices to one another, perhaps making it difficult for some to scan such markers.

In this work, the designed product and MAR app will let users use it either personally or share it with others. For example, the product can be placed on a table and everyone who has installed the mobile app designed for it can enjoy the experience at the same time. This is one of the perks of having a physical object in a connection to the mobile app; it ties the experience to the time and space.

## 3.5 Physical markers

Having an object as a marker has potential for meaningful interactions. Ashley Colley and others (2014) studied initial user perceptions of using augmented reality in a home environment, overlaying content on three dimensional (3D) objects. This kind of an approach, considering objects as markers which trigger the virtual content on a mobile device is similar to the approach chosen for this work. It combines industrial design with technology creating a new, less examined way for one to express oneself. Other examples of studies with products as triggers for augmented reality content have been widely made in tourism settings, for example a mixed reality interface for outdoor use (Schnädelbach, H. et al. 2002) and an augmented reality telescope for heritage valorization (Chendeb, S. et al. 2013).

Objects can be used as markers in Vuforia development platform, for instance. It allows to detect and track 3D-objects. It can be used to add interactive experiences to otherwise static objects, such as toys or other consumer products. To track objects using Vuforia, developers need to add an object target, a digital, 3D-representation of the features of a real object. Having a product as a marker enables the user to be in control of the use. The product can be a mobile or a static object, depending on the use case. This work concentrates on the use of the technology and

product design as a tool for users to express their personality aiming for an useful and appealing solution.

Markers (Image 2) for AR use should be created with several factors on mind. One is its readability, so that computer vision system can detect it accurately. Lighting conditions also affect how well the marker is recognized. Black and white markers are often used because of their good contrast in comparison to image markers for example. In addition, because markers are often tracked from small angles in order to see more of the real-world view of a mobile device for example, it might cause losing the virtual content as the marker is lost by the computer vision, or causing trouble detecting it in the first place. (Siltanen, S. 2012)

*Image 2 A black-and-white marker, image marker and object marker. Jukka Aittakumpu 2017.*

# 4. Self-expression via a mobile app and a product

The way people do express themselves via mobile devices is mainly either by text, voice, photos or videos. There are estimatedly billions of photos shared daily on different social networks (Facebook, WhatsApp and Facebook Messenger each have over one billion users. Statista, 2017). This speaks about the volumes that could harness a solution for sharing and experiencing content that is more like you.

One aspect of self-expression is the freedom to choose as Michail Kokkoris and Ulrich Kühnen (2014: 34) note, but that is only one of the many matters related to the subject. In the light of mobile augmented reality, self-expression will mainly consist of the choices the users make. Each choice is a way to express their personal identity to others.

The research question 1 (How to enable self-expression with a mobile augmented reality app connected to a product?) is examined as a way to capture your surroundings with added, computer-generated content on top of the camera view of user's device. The mobile application is used to scan a marker laid on the surface of the product in order to activate the content which will appear on the camera view. Keeping the design unpretentious users are left with much more room for imagination and self-expression, as designer Dieter Rams has said (Rams, D.). This kind of an honest approach does not take the users for granted, nor does it offer them anything more than they need in the context. Creating universal design suitable for many and emphasizing the mobility and usability, the product can be used in different kind of places by different kind of users.

## 4.1 Defining self-expression in the context of the research

Allowing users to make their own decisions and therefore express themselves the way they want is an essential part of the research.

This is summarized by giving the users several kind of alternatives in terms of content to choose from and an ability to share content to people they choose to. The work consists of design of a product which has different kind of markers, triggers that active virtual content on the mobile app designed to work in a connection with the product. The expectations and experiences are studied in a form of a focus group interview and a structured observation, which have proven to be effective methods for this kind of empirical research (Nam, Y. 2014).

Choice is ultimately different, having different significance for everyone. It has its roots deep in our lives, where we have been and what we have done, including cultural matters (Markus, H., Schwartz, B. 2010). In the case of this research, choice is limited to a couple of alternatives in the context of sharing digital content to social circles. A network of one's close relations to other people, linked to freedom, choice and autonomy, is a significant factor for one's well-being. It constrain, rather than liberate our behavior. The more close relationships we have, the more we have to think about our actions in a relation to them. Modern Westerns are lacking this constraint, according to research, which has caused a rise in depression, anxiety disorder and suicide at increasingly younger age. (Markus, H., Schwartz, B. 2010)

This work aims to add a remote, digital way of creating content from users' physical world, letting them share the content in a way they choose to, networks they want to.

## 4.2 Implementation of self-expressive elements to the research

In this research, the ways for self-expression are included in the app which is used with the product, unlocking fascinating or plain useful content to the device's camera view. The designed product allows user to modify it. Letting users make decisions is part of the freedom of choice and therefore part of their identities. By changing the marker on the product, the content they get on the mobile app will change, too. Users can take photos with the app, decorating them with virtual content.

The main function of the mobile app is to serve as a tool for photography. The product

will support this function by giving the mobile app a place to add the virtual content on. The app is designed to recognize the marker on the product causing the virtual content to appear on the screen. The virtual content will be different for each of the markers users can choose to use. In this context, there is a limited amount of alternatives, because a certain amount of options are enough to give necessary feedback for the research. Users are able to take screenshots of the device's camera view including the virtual content they get on the screen. They can share these screenshots to the social networks they want to. Or perhaps print the photos from the device.

# 5. Product design process

The design process follows the widely-used methods described in chapter 1.3.1. Once the brief had been summarized, the bigger picture began to take shape in terms of which direction the work will go and which problems is it thought to address related to the research. It is necessary to define the objectives and cornerstones via which the process will go, providing a smooth and systematic progress.

## 5.1 Ideation and redefinition of the objectives for the design

Four product ideas with possible use cases were established, each with different context, criteria and appearance. In order to explain them and to get constructive, empirical feedback from the target group, the use cases were illustrated as vector-based drawings elucidating the use. The work started with a brief, a definition of the project.

**Design brief**

A mobile augmented reality app with a physical marker (where the marker is placed on/in a product)

- How to support the need for self-expression
- Is there a need for that?

**Target group**

- 13- to 30-year old mobile phone owners
- Speaking of the AR LESS and making an interesting way to interact more attractive

**Description:**

Design of a mobile application using Unity + Vuforia plug-in

Design and creating of a product including physical marker(s)

The combination of these requirements aiming to create a natural experience to support one's needs or desires to digital self-expression through visual material (photos, screenshots, sharing).

The ideation (Image 3) went towards a thought of changeable stickers on surface of a product. Users could change the sticker when they feel it's necessary and, at the same time, change the content they will get to the mobile app when they scan the sticker. It sums up with the research problem, self-expression in a context of mobile augmented reality and a product.

Since the sticker idea seemed to fit perfectly to the research, it was taken further and product ideas were developed around that idea. The product ideas were designed to have slightly different use cases- how and when they are used covering both personal and group use.

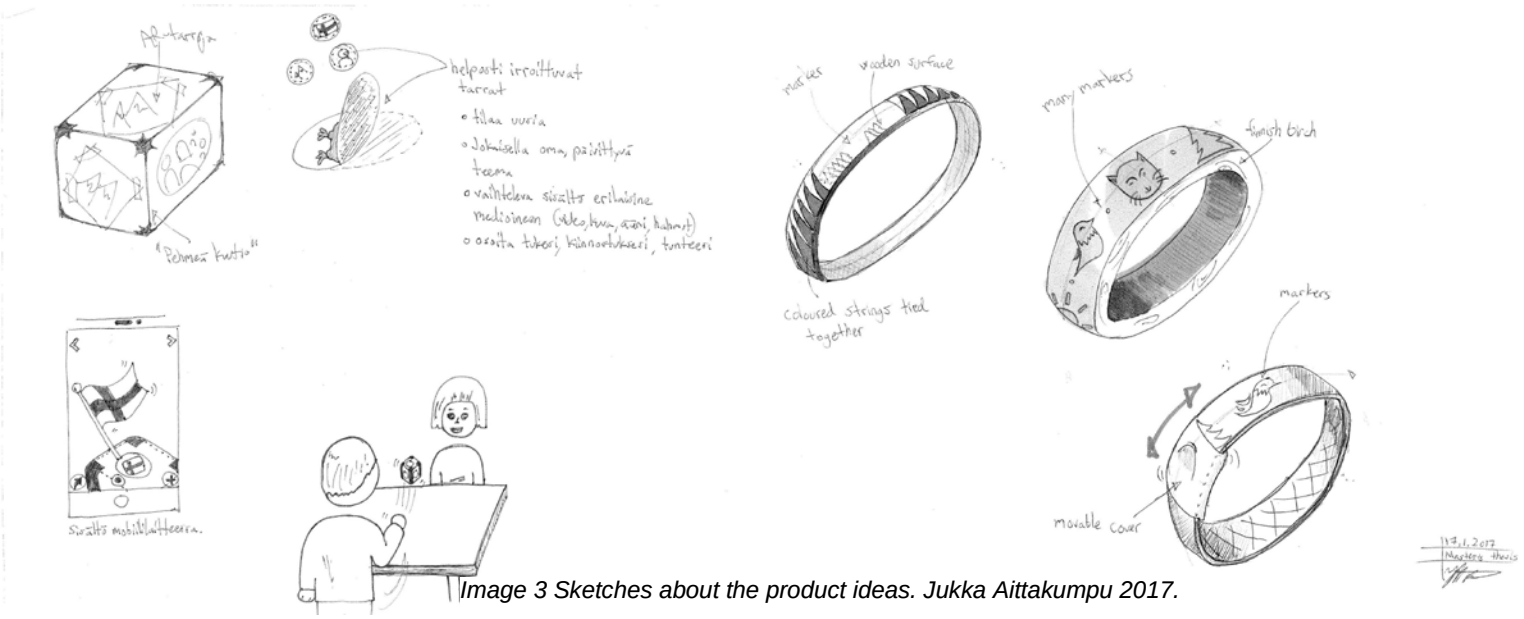


*Image 3 Sketches about the product ideas. Jukka Aittakumpu 2017.*

As far as the mobile app goes, it uses Vuforia plug-in for Unity which can be used to develop apps that show mobile device's camera view and adds computer-generated content on it. The content can be 2D-based images, videos, effects, stickers, emojis or animated 3D-models.

These use cases and the products related to them prefers, at the first phase, functionality over the form factors. The markers attached to the artefacts define the form. The product is a way for the mobile device and app to interact with each other. The markers must be visible in a clear and working combination in order to get the augmented content to the screen of the device. Related to the geographical location, arctic Lapland, the product design and the markers are, in one way or another, related to the location and the Nordic design scene (Sommer, I. 2003).

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Sweden, Norway, Denmark and Finland in particular have been vital in the formation of the style called 'Scandinavian design', which is about practicality, craftsmanship and simplicity in an aesthetic form in everyday products, furniture, glass and handicrafts. Architects have had their impact as well as designers, including Gunnar Asplund, Alvar Aalto, Wegner, Kaj Franck and Arne Jacobsen. (Sommer, I. 2003)

Because of the user-centered nature of the design process in a context of interaction design, the focus group was involved early in the process. They were presented an illustrated slideshow of different use cases with different products aiming to receive feedback relevant to the research. All in all there were five use cases, four of them being the most likely to be produced at the time, and one being more of a probe into the future. The probe, a futuristic concept, was brought to the focus group interview to get views and opinions for the future research and to bring variability to the work. This way the interviewees could better imagine the whole set of use cases as something that is still under development. Nothing is final at this stage.

A brief description of each of the ideas:

Sticker Box

A round box which multiplies as a storage for stickers you can place on top of the box. Scan the Box and one of the stickers placed on it using a mobile device to get virtual content on the mobile app's camera view. The Sticker Box has a lid, under which several stickers are stored letting users change the sticker placed on the box when they want.

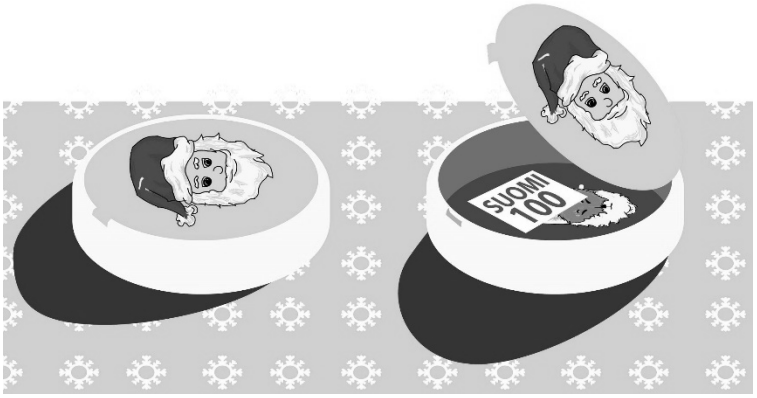



*Image 4 Sticker Box illustration. Jukka Aittakumpu 2017.*

Bracelet

Mobile devices are often wherever we are. A design for a wearable artefact which includes the sticker was necessary in this section, as the focus group might want something similar, something to have with themselves ready to be used when wanted. It is a more personal aspect to AR, could be shared with people too, on your own choice. Scan the Bracelet and one of the stickers placed on it using a mobile device to get virtual content on the mobile app's camera view.

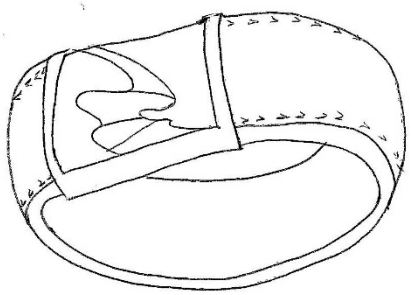


*Image 5 Sketch of one bracelet-idea. Jukka Aittakumpu 2017.*

Cube

A mobile physical marker, place it, scan it, share it. Each side of the cube has a sticker you can change. Scan the Cube and one of the stickers placed on it using a mobile device to get virtual content on the mobile app's camera view. Think: throw the cube to your near-by friends so they can use the app to scan the stickers and to get content on their device's camera view.

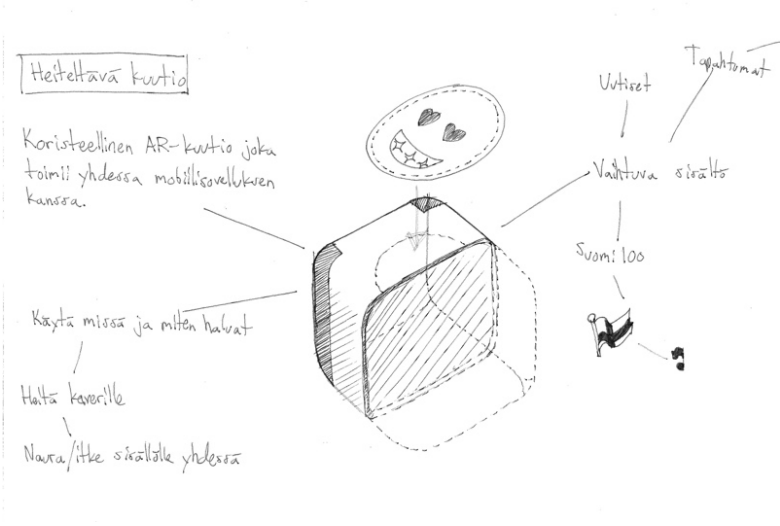



*Image 6 Sketch of the Cube. Jukka Aittakumpu 2017.*

Colourwheel

A round box with modifiable marker, about the size of a face powder box. Same functionality as the former, but instead of stickers, there would be a colour-wheel which you could adjust and change for different content for different colour combinations.

*Image 7 Illustration of the Colourwheel-product and app. Jukka Aittakumpu 2017.*

The idea for the Colourwheel was one of an item which users could modify and adjust. Change the scannable marker themselves. It seemed clear that a colour wheel-like round, pocket-sized item could be usable for this use case. By changing the colour combinations users can change the marker and get different content to the app.

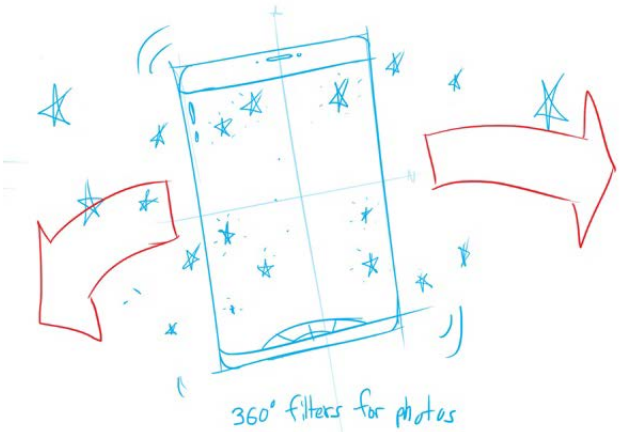



*Image 8 Sketch of a 360-degree view for virtual content. Jukka Aittakumpu 2017.*

Following products and digital solutions are in the consumer markets today. They are presented here as benchmarking, showcasing competition for the designed product. The apps and the products related to them are briefly described here giving a general idea about them and how do they overlap with the product and app designed in the design process of the research.

**Snapchat** + **Spectacles** by **Snap Inc.**

Mobile app and video-recording sunglasses

A popular mobile app for sharing short videos and photos which are only displayed for a maximum of 10 seconds each. Users are able to use filters adding layers of information on their faces or use stickers in the photos before sending them along to their friends or public. Although the content is mainly two dimensional (2D) it can be seen as augmented reality. The company behind the app, Snap, released a wearable device similar to Google Glass-project, sunglasses with a camera which they can use to take 10 second circular videos and share them to the network via their mobile devices. It is speculated that this will bring more augmented reality (Terndrup, M. 2016) to the app, adding new, meaningful ways to express yourself. At least, it is setting the company ready for a wider range of content mixed with real-life scenes.

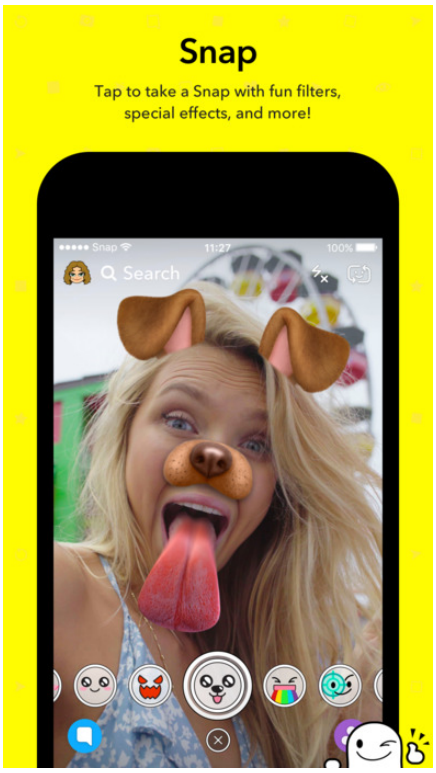


*Image 9 Snapchat screenshot. iTunes.*

**Pokémon GO / Pokémon GO Plus** by **Niantic** and **The Pokémon Company**

Mobile app and a bracelet

Hunt Pokémons in the real-life. After you find one, clicking it will turn on an AR-mode showing the Pokémon in the camera-view, unless you turn AR-feature off. Pokémon GO Plus-bracelet works with the app, saving you from holding your phone in your hand, as you can click the bracelet when a Pokémon is found and it will be captured. Bracelet alerts you whenever you find Pokémons as you walk.

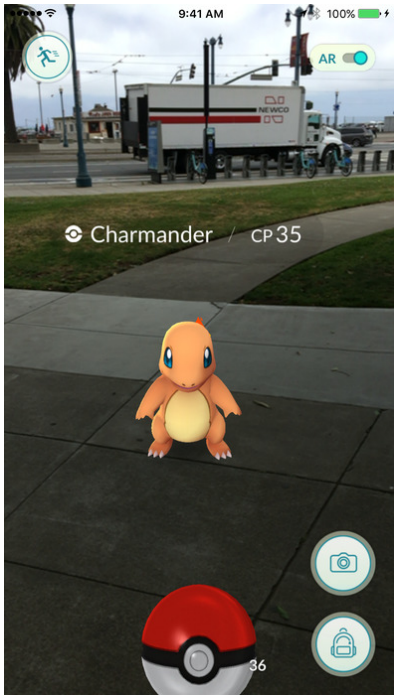



*Image 10 Pokémon GO screenshot. iTunes.*

**HoloTats** by **Balti Virtual**

Mobile app and temporary tattoos

A way to express yourself in a form of tattoos connected to a mobile application which shows the digital content on your mobile device, integrated to the view of your device's camera. The developer publishes content related to events like the U.S. elections. Users were able to scan the "I voted!" -stickers they received once they had voted. This brought the country's flag into the camera view along with the national anthem of the United States.


*Image 11 HoloTats screenshot. iTunes.*

## 5.2 Focus group

Focus group interview took place at Kuusamo High School. The targeted user-group was teenagers. Six persons with no preferred ages, three females and three males were invited in a random manner to participate. Four of them showed up, limiting the participants to two persons of each gender aged 17 (amount: 1) and 18 (amount: 3). The interview lasted for approximately 40 minutes. A recording of the interview was done using a mobile device. The participants filled a background questionnaire asking about their habits, thoughts and experiences regarding mobile apps and both augmented and virtual reality, both of which include computer-generated content. This was also planned to act as an introduction to the topic, asking questions related to the research. Based on the interview, a closer examination of the results was done, looking for ways to meet the target group's desires.

Interview content

- Background questionnaire
- Relation to mobile devices and apps
- Most popular apps used
- Views on physical product connected to an app

The population, interviewees

- How many? 4 persons
- How long is the interview? 40 minutes

Time and place

Interview takes place: Kuusamo High school

Where: empty classroom with a projector

When: week 50 (2016)

How: facilitated by me, audio recorded

The following images were presented during the interview, asking questions regarding each of the products and use cases.

Bracelet idea focuses on a personal experience. A sticker is placed on top of the bracelet and when the bracelet is scanned with a mobile app, the app recognizes the sticker making virtual content appear on the screen of the device. The sticker is a marker which is linked to the application so that the app knows where the virtual content should be placed.

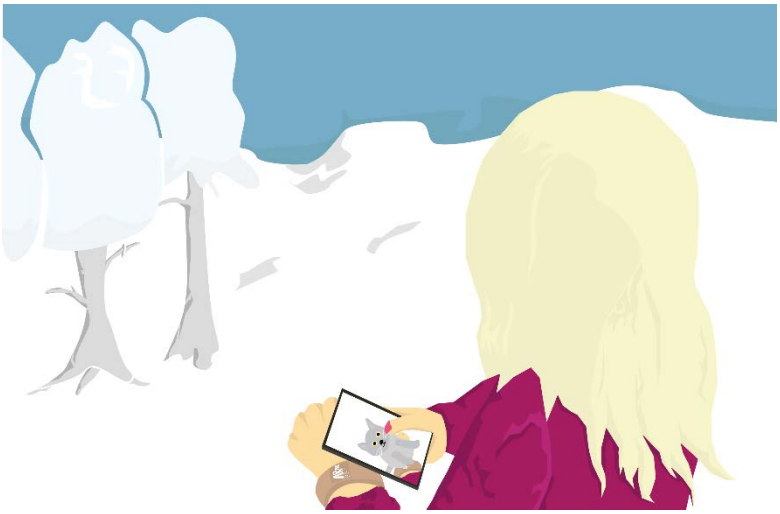


*Image 12 Bracelet-idea illustrated. Jukka Aittakumpu 2017.*

The bracelet is a wearable product, which you can easily carry with you. It can be used for photography, decorating photos with virtual content because the mobile app shows the device's camera view (Image 13). You can change the sticker to another if you would want different kind of virtual content.

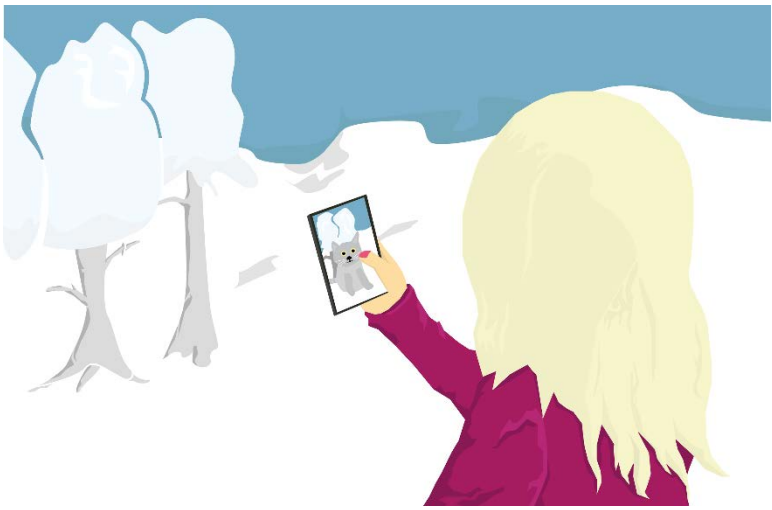


*Image 13 Bracelet-idea illustrated. Jukka Aittakumpu 2017.*

The Cube idea is a product which has sticker on each of its six (6) sides. Each sticker has different kind of virtual content when they are scanned with the mobile app. This idea is designed to be used together with several people, letting people scan the stickers and take photos with the virtual content on the device's camera view.

The Cube is made of a soft material allowing different kind of use cases, for example throwing it to a friend nearby and letting them use it with the mobile app. Each sticker could also contain different virtual content (Image 16) from 3D-objects to 2D-images.

*Image 16 Cube-idea illustrated. Jukka Aittakumpu 2017.*

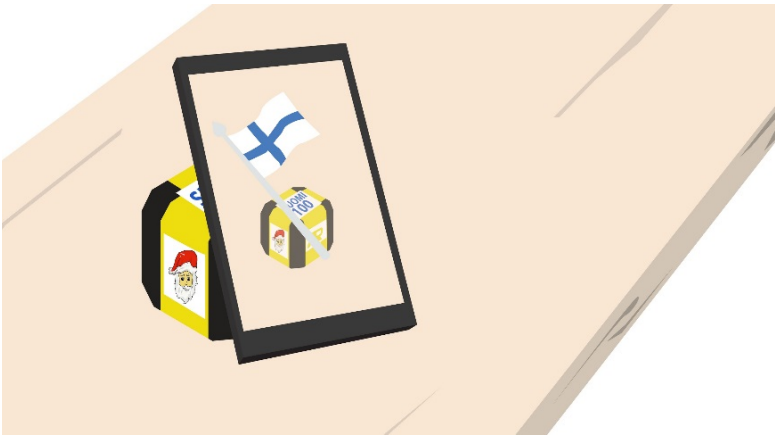


*Image 15 Cube-idea illustrated. Jukka Aittakumpu 2017.*

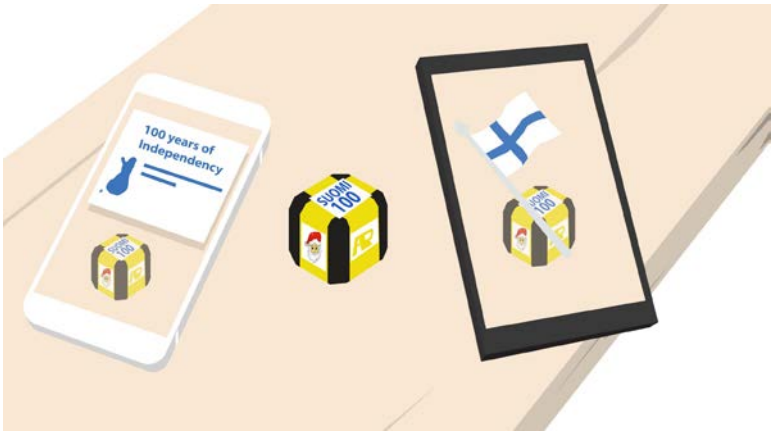



*Image 14 Cube-idea for illustration with two kind of virtual content. Jukka Aittakumpu 2017.*

The Sticker Box-product has a sticker on the lid of the box and several different ones inside of it. Each sticker has its own unique virtual content when they scanned with the app. The Santa Claus (Image 17) and Fox (Image 18) are an example. Just like the two previous ideas, this can also be used for photography, decorating the photos with the virtual content.

Users can remove the sticker on the lid of the box and change it to any of the stickers inside. This lets them get specific virtual content in a specific environment or a situation.


*Image 17 Sticker Box-idea illustrated. Jukka Aittakumpu 2017.*

*Image 18 Sticker Box-idea illustrated. Jukka Aittakumpu 2017.*

The Colouwheel idea differs from the others as it does not have stickers, but a colourwheel you can interact with. The wheel can be circled (Image 21) to form different kind of colour combinations, each combination having its own virtual content when they are scanned with the mobile app. In other words, each colour combination is a marker the app recognizes and that makes the virtual content appear in the device's camera view.

Just like the Cube and Sticker Box, this product can be used with more than one person simultaneously. It is also light and easy to fit in your pocket or bag, allowing you to use it during your daily activities, outside or inside.

Each of these product ideas and the mobile app related to them presented products that allow you to take photos with them and a mobile application. The products are visible in the camera view, meaning that they will be visible in the photos you take using the app, too. There are possibilities to do extended tracking where the marker (stickers and colour combinations in these ideas) does not have to be visible in the camera view the whole time, but they were not used in this case. The products play a major role in this research so it was rational to study their use, too.

There was also a fifth idea which was a messaging app that could be used with any of these product ideas. In that case, there would be 3D-characters you could use to chat with people who are using the app. The text would appear in speech bubbles on the screen.

*Image 19 Colouwheel-idea illustrated. Jukka Aittakumpu 2017.*

*Image 20 A close-up of the interaction. Jukka Aittakumpu 2017.*

*Image 21 How the Colourwheel is used. Jukka Aittakumpu 2017.*

## 5.3 Analysing and interpreting the results from the focus group

In this section, the materials from the focus group are analysed summarizing the main points that were learned. The interpretation of the results follows the analysis.

**Analysis**

As assumed, 4/4 of the participants agreed to share visual content on different apps and, additionally, they all use Snapchat on daily basis. Snapchat has gained the attention of especially the generation of millennials making image sharing quick and convenient allowing users to either spend time going through public or private stories (Novet, J. 2017). Alternatively they just share photos before leaving the app again, only to return when they have something to share or if people they care about share content to them. Each of the five presented ideas were discussed, some of them sparking more conversation than others. Since the technology is still new to people living outside of the technology world, the results can be seen affected by difficult terms and glossary in general, even though the participants got thorough explanations when seen necessary. The interview material was written down and classified in categories consisting of ***content***, ***design*** and ***usability*** in the context of self-expression, reflecting them to the research problem. Three-dimensional (3D) content gained interest as well as compelling content that would be upgraded regularly according to seasons, events and such. In addition, video-content and two dimensional (2D) images; emojis and sticker-like content were seen as functional. The idea of being able to change the look of the artefact attracted the participants' imagination. This applies to both the stickers on a product's surface and the colourwheel which colour combination you would be able to change. One participant described the 'Colourwheel'-idea as '***playful***'

and '***multifaceted***'. The same participant showed the most enthusiasm and shared personal views during the interview which can be deduced to tell of a personal knowledge related to the topic.

**Interpretation**

The background questionnaire revealed one mutual factor between the participants: they used a photo-sharing app every day. Their desire for similar, yet wider range of content, can be explained by the worldwide use of apps that have included augmented reality content on mobile devices. The participants' views were in association to the trend of developing different, usable content for both research and consumer markets. There certainly is demand for right kind of solutions connected to the trend.

As a deduction from the interview, two types of content were chosen to be implemented to the mobile app including 2D and 3D-designs of location based objects. These are related to the area of Rovaniemi, Finland where University of Lapland is based. Since the interview was also done in the northern Finland, this is assumed to fit the context (the illustrations presented in the focus group interview included elements from the North such as snowy scenes).

The sample of the focus group had an understanding of virtual and augmented realities, although they are still a long way from being mainstream technologies. They also agreed almost completely that technology provides them with means for self-expression. These two factors considered, it strengthened the initial idea of using augmented reality for photo-sharing as a tool for self-expression.

## 5.4 Development of the design and interactivity related to the product

Based on the focus group interview, the 'Bracelet' and the 'Colourwheel'-ideas drew the most attention and seemed, in the eyes of the interviewees, as the most successful product candidates to be developed further. After an examination of the two ideas, in presence of professor Jonna Häkkilä and researcher Ashley Colley, the 'Colourwheel' was selected to go on to the next development stage. As an idea, it was different from static markers. It integrates the marker as a part of the product and lets users change its shape, the colour combinations. The colour combination acts as the marker for the mobile app to know when to display the virtual content on the device's screen and depending on the colour combination the virtual content changes. The Colourwheel also works in personal use, but it can be used by more than one people simultaneously.

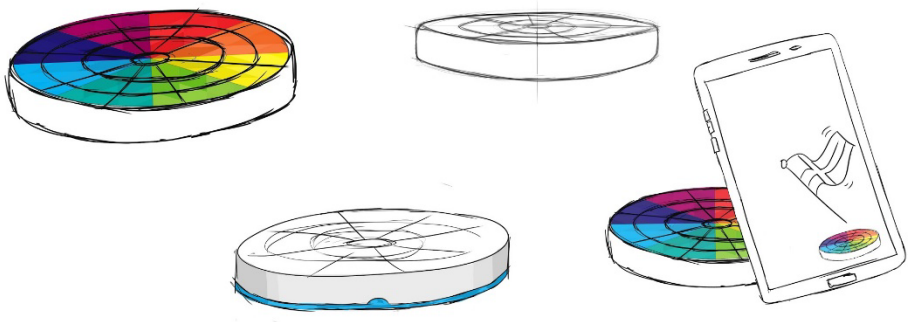
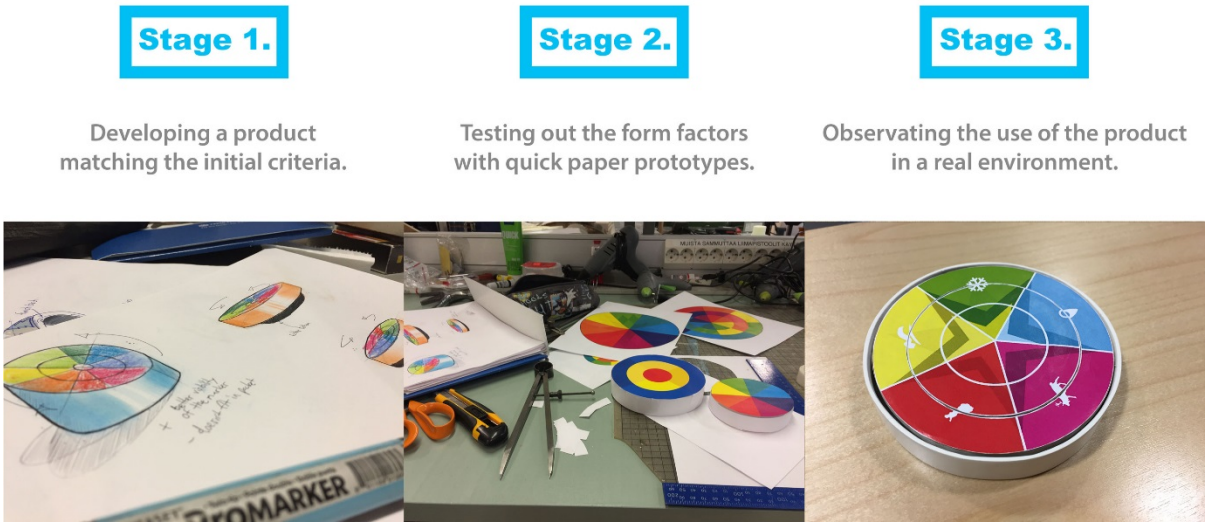


*Image 19 Sketched versions of the Colourwheel product. Jukka Aittakumpu 2017.*

The next stage includes both prototyping different designs (Figure 1) and interactive elements considering the product and mobile augmented reality. Because of the self-expressive element the product and the app have, the hypothesis of the app is that it is needed to contain some elements similar to social media-based apps and web-services. Especially supporting the sharing culture, letting people reach out to others in an engaging manner (Rhee, Y., et al, 2007).

The conceptual model of the Colourwheel is based on the same ideology as how colourwheels are being used in painting software for example. By changing the combinations which will always give a different output. In this case, the output will be seen when the product is scanned with the related mobile app. This will overlay digital information on top of the view of the real world. Metaphors are oftentimes proved to be an efficient way for making the use of both interfaces, services and products easier and natural. (Preece, J. et al, 2015: 41, 45.)

*Figure 1 Stages of the design process. Jukka Aittakumpu 2017.*




Once the attributes for the product had been set, the next step was to create illustrations and make them tangible using paper prototypes, as well as trying out different kind of sets of the colourwheels, aiming for a clear and working design considering the colour combinations has to work as markers.

A paper prototype was created in order to demonstrate the size and functionalities- how it would work. The final product was then created with leftover pieces of wood reusing materials people no longer needed, reducing the environmental effect of the work and representing the ethical values of the researcher. It was also considerably more efficient. The wheels on which the colourwheel design would be attached on, were cut and carved out of plywood, precisely to the shape needed. The inner circle was meant to go inside the middle circle, and both

of them inside the outer circle creating the whole colourwheel which then was placed in the shell which was cut and carved out of an MDF-piece.

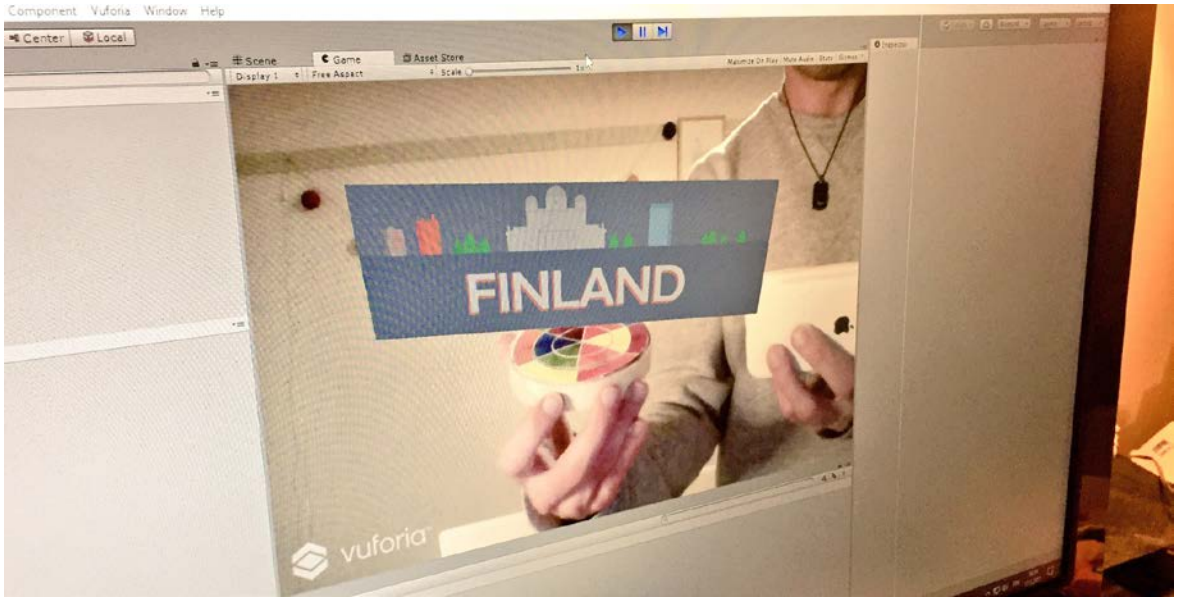



*Image 20 A test of the unfinished product in use, with a desktop version of the app. Jukka Aittakumpu 2017.*

The digital content for the app was created in Cinema 4D (Image 24) at the same time as the product itself. Different designs for the colourwheels were tested using a HP Pavilion 23 All-In-One computer and its web-camera. The development platform was Unity and its Vuforia plug-in by Qualcomm. Vuforia sets some requirements for the 2D markers to be used in an augmented reality context, such as contrast and general readability of the marker. First, initial designs were not providing enough information, leading to added saturation and contrast between the colours.

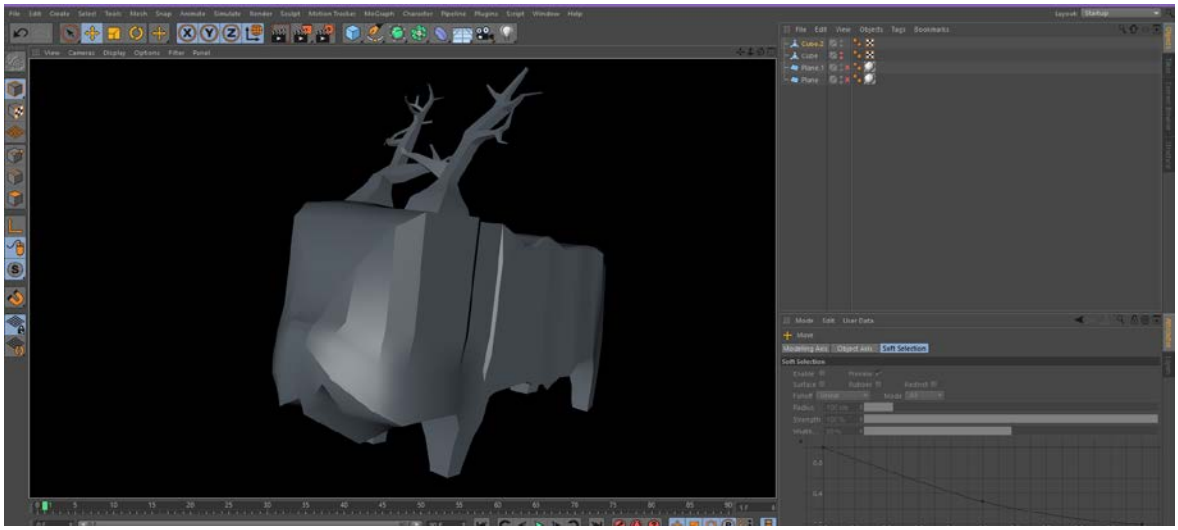


*Image 21 Screenshot of 3D-model of a reindeer in development on Cinema 4D-software. Jukka Aittakumpu 2017.*

The geometric shape of the ‘Colourwheel’ enables people to recognize it without having to think what is it, due to the symmetrical form of the product and the colours laid on top of it. Geometric shapes are usually symmetric, reducing the complexity, therefore making it visually easier to be understood (Kettunen, I. 2000. p 22). The shell of the product is entirely white, making the coloured wheel stand out. Bright, attractive colours on top of the product give visual hints for the users to touch the wheel, eventually drawing them to try out different combinations. However, the product itself does not refer to a possibility to use the product as a bridge between a mobile app and mobile augmented reality, but this will be told as either a verbal or written statement during the observation.

*Image 22 Colourwheel's unfinished top view showing the process. Jukka Aittakumpu 2017.*

*Image 23 A close-up of the Colourhweel before finishing the design. Jukka Aittakumpu 2017.*

The product's symmetrical shape is inspired by consumer electronics, mobile devices and voice-activated speakers (Amazon Echo and Google Home) and home appliances. Creating a mental relation to smart devices categorizes the product to the same field as smartphones, which it is used with and links it to the similar environment, homes and organizations (schools, colleges). Its pocket-sized shape lets users carry it around, just like mobile devices and everyday objects are.

Being able to share visual stories forms a core part of the interaction provided by the app and the product. It supports the use of mobile devices as content sharing platforms. Mobile phones were developed for text messaging and calling wirelessly (Anjarwalla, T. 2010.). This trend has since continued and evolved towards even a more social platform connected to other devices which have an internet connection, as well as other wireless connection solutions, too.

The app will overlay following content and/or information on the device's camera view:

- 3D-character
- Location based 3D-content
- A graphical effect
- Possible more graphical effects

The content will be static instead of animated.

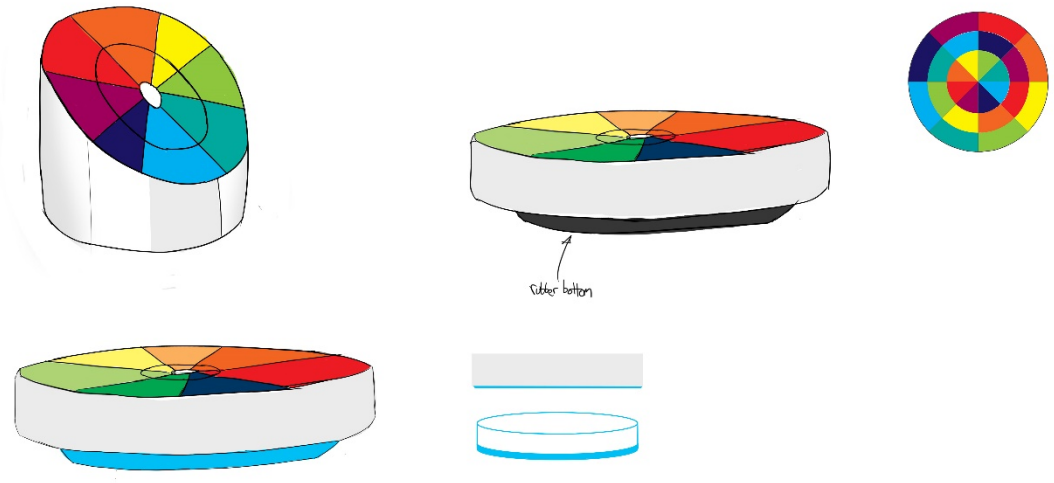



*Image 24 Illustrated variations of the Colourwheel's appearance. Jukka Aittakumpu 2017.*

The product itself has 5 possible colour combinations (scannable markers). Each marker has one virtual object which is augmented in mobile device's camera view once user scans the colour combination with the app.

*Image 26 One version of the colourwheel design. Jukka Aittakumpu 2017.*


*Image 25 Vuforia Image Target features for the same colour design. Jukka Aittakumpu 2017.*

Vuforia, the plug-in for Unity software offers useful tools for examining the image target, the markers which trigger the virtual content. Having more variance and contrast provides better results for the readability of the marker (Image 29 and Image 31). Several iterations were required to provide a good amount of features, making the app work more accurately. Because the users may want to use the app from different angles, it is important to take this into consideration aiming to provide them a successful user experience.

The next version of the colourwheel design had an added amount of contrast. The pictograms representing the virtual content were added on the outer part of the wheel. Now there are visual cues as what kind of virtual content to expect when using the product and mobile app.

*Image 27 The colourwheel design with added features. Jukka Aittakumpu 2017.*


*Image 28 Vuforia Image Target features for the same colour design. Jukka Aittakumpu 2017.*

The finalized design is presented below, where the printed colourwheel is added to the surface of the round plywood-circles. Chapter 5.1 provides an overall look to the product and functionalities, which are already partly covered in this chapter.

*Image 29 The final Colourwheel product. Jukka Aittakumpu 2017.*

## 5.5 Observing the use of the product in a real environment

The activity for the observation consisted of people using the product and the app on an Android-tablet, which has the app developed to work with the product. The observation took place at the University of Lapland, Rovaniemi, Finland. To make people interested, coming over and testing the product, a poster was set at the scene inviting them over and breaking ice between the observer and the possible participants. The product was set on a desk accompanied by the tablet-PC. The poster was laid on the table, visibly in the field of sight of passers-by. The observation was carried out as a *direct observation in the field*, where researcher was *actively* present focusing on how participants use, or do they manage to use the product as it was designed. The sampling of the observation included people from different faculties within the university including Faculty of Arts and Faculty of Law, both international and Finnish students, the age range being between 22 and 29 years.

Content of the observation:

Observing the interaction between the product and app

- How natural is it for the users?
- What new does it bring?
- 'Does the Colouwheel's design support the use of mobile AR for self-expression'

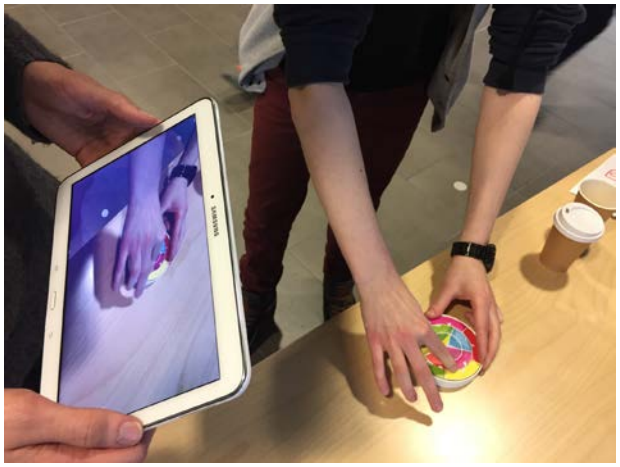


*Image 30 Participants using the product during observation. Jukka Aittakumpu 2017.*

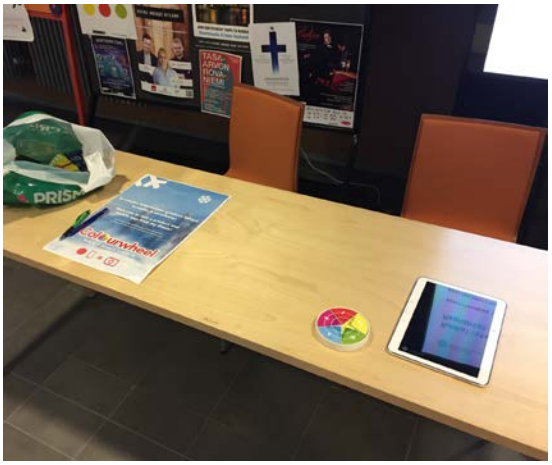


*Image 31 The set-up of the observation at University of Lapland. Jukka Aittakumpu 2017.*

Participants were given a task to try out different markers by changing the colour combination of the Colourwheel then using the mobile app to scan the marker. When the virtual content was seen as appealing, the participants were given an opportunity to take a screenshot as if to share the photo with content.

12 persons took part for the observation and filled a brief survey about the experience. Some people were in groups and if only one of them participated, others were observing from afar or by the participant's side therefore indirectly taking part to the study. The use of the product and app were seemingly successful. There were no major issues related to the use. Sometimes, circling the Colourwheel in order to change the marker caused mild distress, however, the participants managed to operate both app and product successfully in the end.

*Image 35 Participant during the observation. Jukka Aittakumpu 2017.*

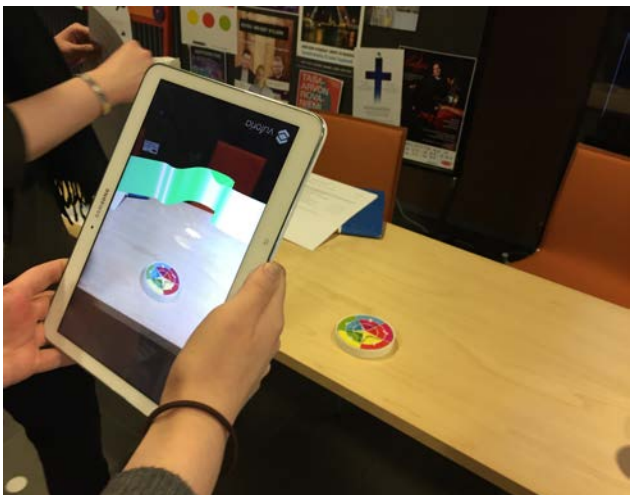


*Image 36 Participant during the observation. Jukka Aittakumpu 2017.*

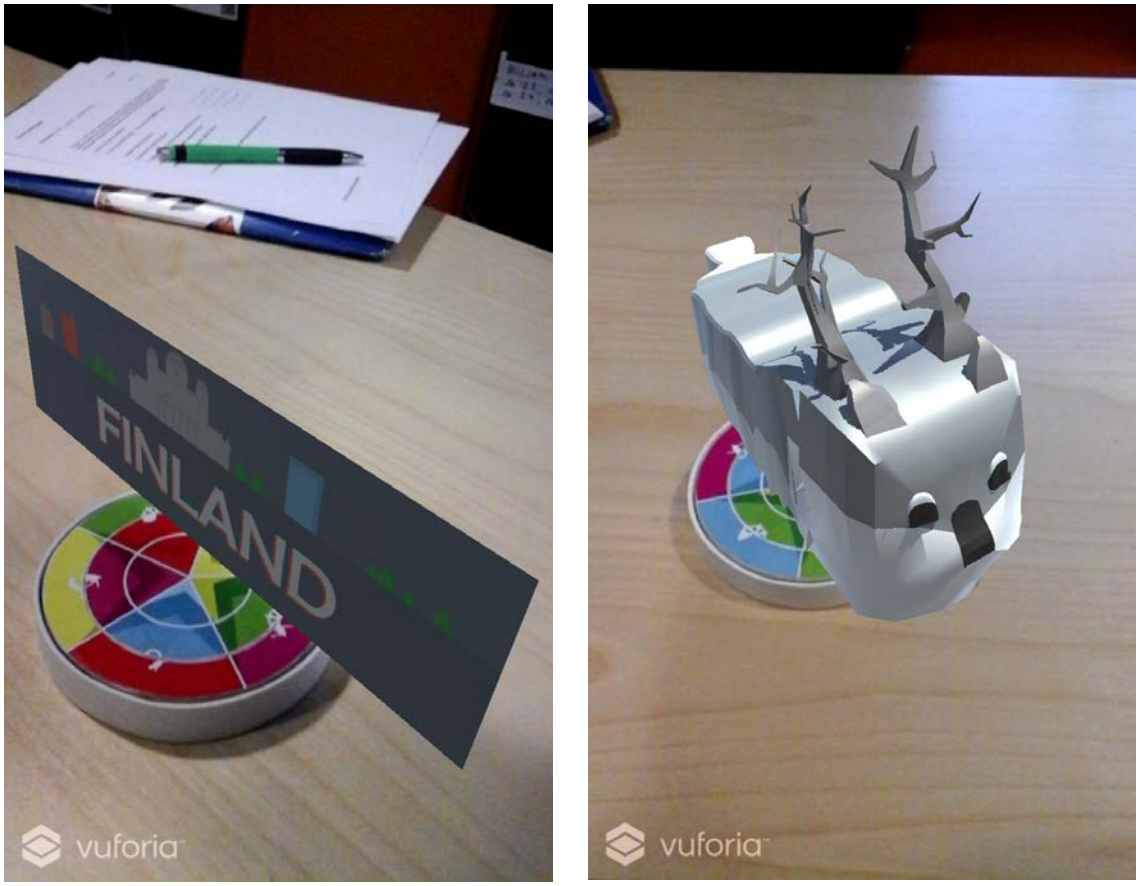



*Image 32 Two of the screenshots participants took using the Samsung tablet-PC where the app was installed and used on. Jukka Aittakumpu 2017.*

## 5.6 Analysing and interpreting the observation data

There were five questions set beforehand for the observation. They were meant to be easy to remember, regarding the usability and the digital content so that when observing, no notes would be needed and the focus could fully be in the participant. In order to get written feedback, too, these questions were also covered in the short survey participants filled after the use. The questions were categorized to cover the ***product***, ***content*** and the ***mobile app***, producing results regarding use and interactivity for creating content to express oneself. This approach is one way to prepare the data for the content analysis, providing themes to work on.

**Were there difficulties in the use of the product?**

Most of the participants agreed almost/completely that it was easy to use. There was mild distress regarding the wheel and circling it in order to change the content, but judging from the after use-survey, almost all of the participants agreed that it was easy-to-use.

**Was the content suitable/relevant?**

Participants were seemingly interested trying out the combinations, which was the given task, too. The reindeer (Image 37) got most screenshots, which says about its popularity among the sampling of the observation.

**Would the participant want to share such content?**

There was some variation among the sampling considering how likely they would share photos with such content, most of them agreeing to some extent.

**Were there difficulties in the use of the app?**

Almost all of the participants agreed the application was easy to use. Most of the difficulties regarded having to keep the product in the device's camera view, or the content would disappear and a re-scan would be required. One participant described that changing this might ensure a better interaction between the user and the app, expanding the use-cases too as it would add freedom.

**Did the design and features of the product fit for the app?**

Two of the participants disagreed to some extent (however not completely) about the suitability of the product's design for this kind of use.

Many participants found the Colourwheel-product and the wheel-part particularly good, it was described as "pleasant and fresh" and "entertaining and creative", whereas the virtual content, as one described, could be "fine-tuned"

*"The app was, after finding the right scanning technique, easy-to-use and captivating. The graphics of the product were nice and fresh-looking. 3D-models could use a bit of a fine-tuning."*

Participant's comment translated from Finnish to English.

The product and app worked well together, giving users the ability to choose content for self-expression using the product and app. Based on the observation, participants enjoyed even playing with the product, which was not a particularly designed aspect, although the design invites people to try different colour combinations. There were some new suggestions for different use cases as the product was used. It is a sign of some sort of success if a design allows new ways to use a product, creating a more engaging experience and leading to new solutions, new findings. Additionally, some participants suggested new use cases they saw potential using products and augmented reality apps in education and learning, as letting people change and play with the product reminded them of games and playful applications which could be used in many different cases, in addition of self-expression.

Yanghee Nam (2014) studied interactive narravites for mobile augmented reality, suggesting more engaging approach letting users participate to AR narrative generation and real-time discovery of storified virtual content. The Colourwheel designed in this work approaches this paradigm by letting users change the marker which is scanned using the mobile app, therefore contributing to an engaging and playful experience differentiating from entirely pre-defined experiences where users would merely act as an audience.

# 6. Results

In this chapter the design process is summarized as a whole, consisting of the physical product and the mobile application and the interpretation of the whole research. The product and the app are examined separately, because they are different in terms of how they are being interacted with and benefited of.

## 6.1 Colourwheel product and its features

The product developed in this thesis is a cylindrical, wooden Colourwheel painted glossy white (Image 38). It has two movable wheels created of plywood with printed textures on top of it. As the wheels were made of plywood, in a certain thickness so they could be fit together, it may have caused some issues during the observation. Once people figured out how to circle the colourwheel smoothly, there were no issues regarding the use.

The outer circle can be circled as such, and the two inner circles can be circled together, providing five (5) different colour combinations (Image 39). It was designed to fit well in different types of environments, as the users could use it whenever they want to. It has to look good in the mobile device's camera view, too, as it will be visible on the screen when it is used with the mobile app. The colourwheel-texture has five icons representing the digital content (location, country, snowflakes, reindeer and northern lights).

*"Toys are not really as innocent as they look. Toys and games are the prelude to serious ideas."*

Charles and Ray Eames

**Research question 1**

How to enable self-expression with a mobile augmented reality app connected to a product?

**Research question 2**

Does the Colourwheel's design support the use of mobile AR for self-expression?

The work presented here (design process, interview and observation) covers the research questions providing a solution for creating a product which is connected to a mobile app allowing users to express themselves. This answers to the research question 1 (*How to enable self-expression with a mobile augmented reality app connected to a product?)*. Nevertheless, self-expression as a framework covers a wide range of different elements, even as it is here narrowed down to a specific context. This work covers young adults and teenagers as the user group, focusing on how they could use technology with a product which they can control.

*Image 38 The Colourwheel product and the default colour combination (marker). Jukka Aittakumpu 2017.*

*Image 39 All the five colour combinations stacked vertically. Jukka Aittakumpu 2017.*

The research question 2 (*Does the Colourwheel's design support the use of mobile AR for self-expression?)* was examined using observation as a data gathering method. The product offers a new solution for augmented reality with a marker that users can change to get different content when they use the mobile app with it. It has a playful aspect too, since users can try out different colour combinations to get different virtual content on the app when they scan the product. It emphazises the fact that design can be used to create engagingin experiences.

When the design itself is simple, users focus more on the interaction exploring different possibilities as the observation showed. In overall, the research question is answered, but there is room for more iterations as always. The observation can be seen as a part of the design process which could continue refining the product to smoothen the interaction and fine-tuning the virtual content of the mobile app.

The Cone of Experience (Chapter 3.2) suggests that people also remember things they have said and done longer than those they read only. Letting them change the products appearance (circling the colourwheel) it is expected to make the experience greater rather than providing a ready-made solution which would include no control of the user. Image 39 partly shows the different colour combinations.

The amount of the combinations could be bigger with a wider range of virtual content for each combination but it was enough for this work to get general, even if restricted feedback. It would be, however, more difficult for users to remember dozens of combinations and the virtual content they would trigger in the mobile app. In some cases that could be ideal, but here it could have caused more errors in the use and therefore affecting the feedback, too.

## 6.2 Mobile AR app and its functionality

In the context of the thesis, augmented reality is used in the form of mobile augmented reality, which limits its use to mobile devices only. This decision is made purely on the perks of mobility and wireless interaction, which limits its use to neither time nor space but merely user's imagination. Being able to take part in such a free-formed way of communication represents the side of self-expression which the work is focused on. The app has five different (5) virtual content, which appear when a specific colour combination, marker, is scanned using the app. The default colour combination, where all colours were in the normal order, a location-based content appeared to the app (Rovaniemi, 3D-model). Some of the 3D-content lacked some details in the app, like the glowy effect of the snowflakes, and the gradiant-colour of the northern lights due to problems importing certain materials from 3D-software to Unity.

The virtual content was static reducing the amount of lag and letting users concentrate on the possibility of sharing photos that have virtual content, as well as the interactivity the product offers.

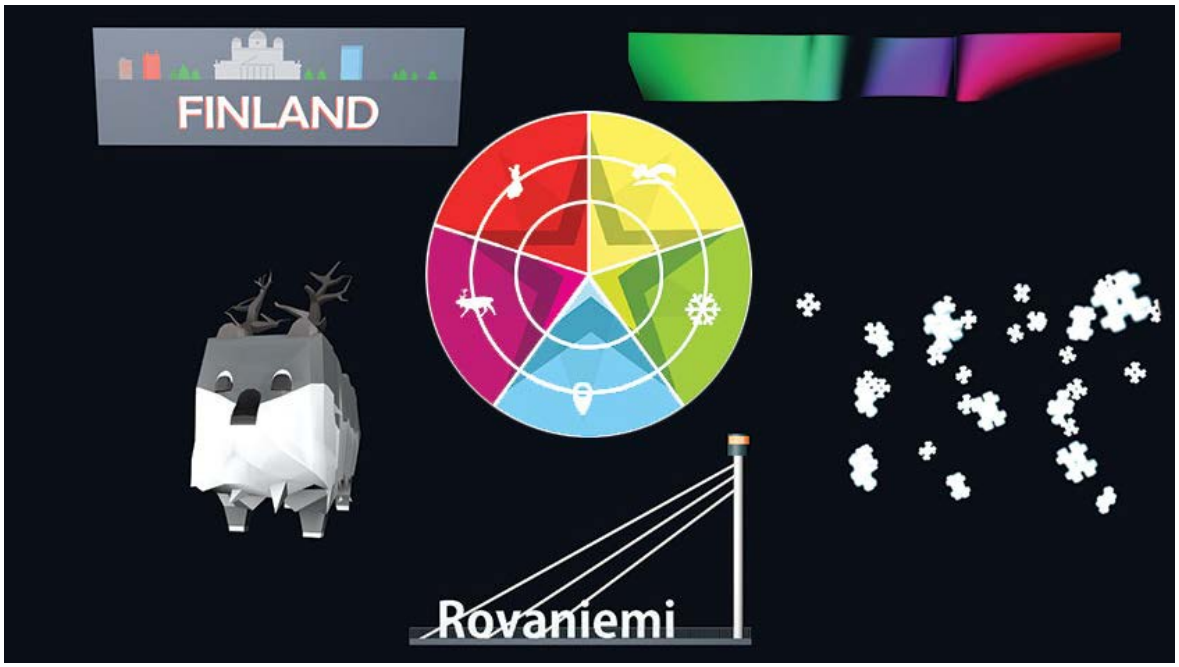



*Image 40 All five of the virtual object used in the app. Jukka Aittakumpu 2017.*

The virtual content was also designed to fit in different kind of use cases.

**Reindeer-character**

Can be used in many kind of photos from casual situations to ones where the Arctic area is wanted to be highlighted. The character appears right on top of the Colourwheel, standing on its feet.

**Finland, country based sign**

There could be situations when users want to express their whereabouts in a more abstract manner than exact locations. Since users could stay in touch with people from all over the world, it is good to take this in consideration in the virtual content, too. The Finland-sign appears on top of the Colourwheel, floating in the air.

**Northern Lights**

This 3D-model represents the northern lights (aurora borealis), which are a local tourist attraction in Lapland, Finland. The 3D-model appears in the air above the Colourwheel, as if it is placed in the sky.

**Snowfall**

This master's thesis was done mainly during the winter season, which is why content related to the time of the year was added to connect it to the time of the year. The 3D Snowfall appears around the Colourwheel, floating in the air.

**Rovaniemi, location-based 3D-model**

A representation of location-based content was added in a form of a 3D-model for Rovaniemi, Finland, where the research was mainly done and where the observation was held, too. This lets users share almost their exact location to friends who are in the country or elsewhere.

## 6.3 Does the design fulfill the needs for self-expression?

The combination of the product and mobile app provides users with ways to capture moments with virtual content they choose to be saved and perhaps shared, too, as photos. The universal design attracted those who participated to its use during the observation. The virtual content designed for the mobile app was generally good and satisfactory. There were some notes like fine-tuning the 3D-models, which could lead to a better experience. Perhaps animated 3D-content such as characters or animals would be worth considering. Then the focus would shift from self-expression to a more playful experience, which could engage users for longer lasting use and make them return to use the app.

The design does fulfill some aspects users have for self-expression. It lets users be in charge of what kind of virtual content to get to the mobile app and how to use it in their own kind of way. It also lets them create and share the content The results from the observation were mainly positive. There is interest to use such product and application. The target group seems to have been correctly limited, as younger genereations are used to sharing massive amounts of visual content among their social circles.

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Letting people stay in touch with their social circles in any form of communication can help them build and maintain their personality too. Altough it is limited in this context, it can still represent ways of using mobile augmented reality and products to support such interactions for self-expression. (Markus, H., Schwartz, B. 2010)

Even though we have almost endless amount of ways to share content nowadays, our surroundings may not always be worthy of sharing as such. With virtual content, such as the ones you get using Colourwheel and the mobile app, you can make your surroundings look funnier, more relatable to people you are likely to share such photos to. This study covered a little part of these interactions that could be available, but it seemingly attracted the participants and, were they to use it in different places and times, there could be

much more this kind of positive experiences. Even during the observation participants discussed (Chapter 5.6) about different areas to use this kind of products.

An optimal solution would be creating content that would change by regular updates or that would let users contribute, too. Because we all tend to prefer different kind of things and we have different preferences, it would attract a wider audience and gain more engagement in a longer run, making people return to the use.

# 7. Discussion

This work has examined the possibilities to support ones needs for self-expression using mobile augmented reality in a product design case. When a product is connected to this experience, it provides a wider range of options allowing users to choose how and when to use it. The app alone creates no content but when it is used to scan the product it makes the virtual content visible in the device's camera view. This is taken even further in a form of markers on the product which users can modify to change the virtual content at the same time.

During the design process, an interview was held to gather data about the target group's expectations for the augmented reality technology, presenting them different products with one kind of mobile app. The mobile app was designed to let users share photos with virtual content layered on it, which is a commonly used use case for AR applications. After the interview, one of the ideas was selected taking the interview data in consideration. The design process proceeded to paper prototypes of the product. The mobile app was developed at the same time, testing its usability on different kind of markers which would later trigger the virtual content to appear on the app's camera view.

After the right kind of design for the markers were found, creating a smooth and working experience, the product was finished using recycled wood. As a closure for the design process in this context, an observation was held in order to get feedback on the use from people withing the targeted user group.

As a design process is iterative by its nature (Kettunen, I. 2000) it would be logical to continue the work refining the user experience especially related to the interaction- how to ensure an engaging experience in overall. Industrial design is a surprising field, as you will never guess the outcome when you start working on a topic. Each turn, path and way you choose will end

up in a different destination, a different design. This makes the work even more fun. It would be dull knowing what you will make, limiting the possibilities, too.

The product and app were designed for ages ranging from 13- to 30-years, people who most likely use photos as means for self-expression. People who do not necessarily care about pixel-perfect photos, but more about staying connected to the ones they want to. It is increasingly more popular to share even silly and reckless photo-content, content which is not meant to be saved forever. Snapchat -mobile app is a fine example in this category. It has its share of competitors, like Snow-app in Asia and Facebook's Messenger, WhatsApp and Instagram, all of which have introduced similar ways to share photos which only last for 24 hours. The idea behind the photo-sharing function of the app in this work is meant to belong in the same genre, staying connected and expressing oneself in a visual way. Since there are already so many applications to message one another, the app in this work focuses on making photos to share in those networks.

The overall deduction is that there are possibilities in developing especially playful experiences for the intersection of self-expression and mobile augmented reality. There are also increasingly more such products as manufacturers and developers are adapting the technology to different kind of contexts. The demand for mobile augmented reality solutions for self-expression was also covered in a keynote by Mark Zuckerberg, founder of Facebook, Inc during his presentation at F8-conference in April of 2017. Since people already share photos of certain situations in their lives, augmented reality can overlay more information or simply decorate photos in a funnier way to make even the most boring photos a bit more informative and fun to look at (Zuckerberg, M. 2017).

## 7.1 Reliability of the results

To design optimal products that fulfill target users' needs and desires it is important to approach them during the design process letting them participate and have their voices heard (Norman, D. 2013: 224). Focus group interview and an observation of the use of the product and mobile app were arranged in order to better understand, firstly, is there interests towards such products and secondly is the designed product addressing their interests. The focus group interview generated certainly a limited amount of information (4 participants), which can have affected the outcome. There could easily be demand for more of them which could help to better get into the subject. However, it is not meaningful to continue asking for too long. At a certain point, there will be no more valuable information as the saturation point is reached.

The observation was a more concrete step, where participants had an opportunity to try the real product out themselves. It sparked conversation and future applications which speaks of the interest in the intersection of a product and technology, especially if the product is created for a certain audience. The product designed for this research worked generally well during the observation, resulting in a positive experience which also generated information for the work.

The research was made between 9/2016 and 3/2017, in a relatively fast pace. As mentioned, there could be room refining the virtual content and iterating the product's design for even a better user experience. Still, it was enough in this context as they were mainly created for data gathering purposes.

There is also always possibility that participants do not take part to researchs in an entirely honest manner. They could answer and do things they think the researches wants them to do, affecting negatively to the research.

The participants were informed about the interview and observation beforehand and afterwards. They were treated anonymously to get as neutral feedback as possible, in addition, a form for permission was sent for the interview participants' parents who might be underaged.

## 7.2 Proposals for a follow-up research and work

There are possibilities to study the relation of products with augmented reality apps in learning and teaching contexts as well as tourisms, which has already been widely covered in prior research. Also, there could be areas where modifiable markers could be studied, if it makes more sense than using for example more advanced solutions such as markerless tracking. Additionally, there could also be interest in studies regarding more advanced interactions, such as games, animations and short films in a similar context, where a product would be a central part of experience. Different types of products for self-expression could be studied using methods from user-centered design. This work studied one product out of five ideas with the same mobile app for each of the idea. As well as studying different kind of products, different kind of mobile apps could be in researchers' interests.

As a spin-off from this thesis, I have been developing a viable business idea regarding a physical marker, a little similar, yet different from the product presented in this work. It is an interesting area and it is strongly related to my interests and skills as a product designer, involving everything from social design to sketching, 3D-modelling, design research and harnessing cutting-edge technology for meaningful, fresh and innovative user experiences.

# 8. Conclusions

Mobile devices play a major role in people's lives, forming ways to communicate and stay in touch with our social circles. At first, it was by making calls and sending text messages. As the technology evolved towards a diverser communication, mobile phone owners could include more emotions and personality in their communication.

This work belongs to the field of industrial design, focusing on interaction design and mobile augmented reality technology in context of self-expression. These three areas are linked together in the presented design process, aiming to answer to two research questions. Firstly; "*How to enable self-expression with a mobile augmented reality app connected to a product*". This questions was studied using focus group interview within the targeted user group. Second research question; "*Does the Colourwheel's design support the use of mobile augmented reality for self-expression?*" was studied by observing the use of the Colourwheel-product which was developed after the focus group interview, in the design process.

During the focus group interview, the participants discussed about five different product ideas. Each of the produt ideas were different, but they all had the same kind of augmented reality app. The app would let them scan the product and a marker on top of the product, making virtual content appear on the device's screen, in the device's camera view. They would then be able to share this view with virtual content.

At the observation, the usability of the Colourwheel was studied reflecting it to the second research question. Because the Colourwheel lets users change the colour combinations, it made the experience engaging, letting participants try different combinations and scanning them with the mobile app to find out what kind of content would appear on the screen. It lets the users be in charge of the whole experience. This aims to support their personality and their preferences.

In other words, this master's thesis studies a way of creating digital content in a form of photos which include virtual content. To be able to create this content, users had to set the related product, the Colourwheel, in the scene and scan it with a mobile app to make the virtual content appear in the app. Colourwheel includes a set of markers, which in this case were different kind of colour combinations. Each colour combination is its own marker, meaning that they all have their own virtual content, too.

Users have the freedom to choose when and where to use Colourwheel and the developed application. Because we all are ultimately different, the time and space of using the product and app can vary on our personality. Our personal preferences. In this work, that is exactly the self-expression aspect which

provides the users an ability to create their kind of content and, additionally, decide where they share the content they create. Although the virtual content is pre-defined, the environment they use the product-app combination is up to them.

The results from the observation were mainly positive. Meaning most of the participants thought the product was creative and they could use it if such a product was available in the markets. As noted, there are still room for improvements and maybe adding more freedom to express oneself. Also, another focus group interview or observation in a different environment could be appropriate, giving people a chance to use the product for a longer period of time, which could let them find new ways of using it in a way they prefer.

As a result, this work presents the design process of a product and a mobile AR app. Both of them were studied among the target group and their usability was tested, too. The outcome, a product with a modifiable marker provides a new kind of way of creating markers to be used for mobile augmented reality. It differs from the traditional markers that can not be changed, making the experience more comprehensive and engaging.

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# Figure and image references

# Appendix 1.

Taustakysely 19.12.2016

Sukupuoli: mies __ nainen __ en halua sanoa __ Ikä: __

Tietoja: Tämä kysely kartoittaa aiempia kokemuksia mobiililaitteiden ja sovellusten osalta haastattelun teemaan liittyen. Sen tarkoituksena on pohjustaa haastattelua sekä luoda kuvaa sen sisällöstä. Kyselyn tuloksia käytetään ainoastaan kyseessä olevassa tutkimuksessa. Vastaukset käsitellään anonyymisti.

Vastaa seuraaviin väittämiin

1: Olen täysin ERI mieltä … 5: Olen täysin SAMAA mieltä

| | |
|---|---|
| Mielestäni teknologia antaa minulle vapauksia ilmaista itseäni | 1 __ 2 __ 3 __ 4 __ 5 __ |
| Olen kuullut/ tiedän mitä virtuaalinen todellisuus on | 1 __ 2 __ 3 __ 4 __ 5 __ |
| Olen kuullut/ tiedän mitä lisätty todellisuus on | 1 __ 2 __ 3 __ 4 __ 5 __ |
| Pidän sovelluksista joissa voi muokata kuvia | 1 __ 2 __ 3 __ 4 __ 5 __ |
| Jaan visuaalista sisältöä eri sovelluksissa | 1 __ 2 __ 3 __ 4 __ 5 __ |
| Pidän mahdollisuudesta lisätä kuviin filtereitä/visuaalista sisältöä | 1 __ 2 __ 3 __ 4 __ 5 __ |

1. En käytä … 5. Käytän päivittäin

| | |
|---|---|
| Käytän mobiililaitteita päivittäin | 1 __ 2 __ 3 __ 4 __ 5 __ |
| Olen pelannut Pokémon Go-peliä | 1 __ 2 __ 3 __ 4 __ 5 __ |
| Käytän Snapchat-sovellusta | 1 __ 2 __ 3 __ 4 __ 5 __ |

Eniten käyttämäni sovellus on (arvio) _____

# Appendix 2.

**Focus group content (in Finnish)**

Alustus aiheeseen

. Käytätkö mobiilisovelluksia joiden avulla voit ilmaista itseäsi, ajatuksia ja visuaalista sisältöä?

. Millaista sisältöä haluaisit ilmestyvän mobiililaitteesi näyttöön kun otat ja jaat kuvia?

Pitäisikö sisällön olla vaihtuvaa tai kausittaisten teemojen mukaista?

. Kerro jokin mieleenpainuva tapa/sovellus juuri sinua kuvastavan sisällön jakamisesta.

Miksi ja kenen kanssa käytät sitä?

Case-kohtaiset kysymykset ja keskusteluaiheet:

Ranneke:

*Ranneke, jossa on kuva/merkki jonka voi skannata mobiililaitteen kameralla saadaksesi kuvaan/merkkiin liittyvää sisältöä laitteen näytölle (kamera-kuvaan).*

Tuntuisiko sinusta luontevalta pitää ranneketta, jonka kautta saisit virtuaalista sisältöä puhelimeen?

Millaista sisältöä haluaisit rannekkeen tuovan?

Olisko rannekkeen sekä mobiilisovelluksen yhdistäminen mielestäsi luontevaa?

Millaisia ajatuksia tuote itsessään herättää? Mahtuuko ranteeseesi yksi uusi tuote?

kolme hyvää kolme huonoa asiaa

Kuutio:

*Pienehkö kuution muotoinen esine, jonka joka sivulla on skannattavia merkkejä. Merkkien kautta saat niihin liittyvää sisältöä mobiililaitteesi näytölle (kamera-kuvaan).*

Miten voisit mielestäsi käyttää mukanasi kulkevaa kuutiota, jossa on erilaisia skannattavia merkkejä?

Voisiko sitä käyttää yhdessä kavereiden kanssa? Jos, niin miksi? Jos ei, miksi?

Mitä mieltä olet itse tuotteesta? Kuvaile sitä muutamin adjektiivein. Innovatiivinen, hankalasti mukana kulkeva, kätevä jne

Kuutio on pehmeä ja kestävä, voit heittää sen vaikka kaverille, joka tarvitsee ainoastaan sovelluksen käyttääkseen kuutiota sisällön tuomiseen mobiililaitteeseen. Voisitko kuvitella tämän toimivan?

kolme hyvää kolme huonoa asiaa

AR-rasia:

*Taskukokoinen rasia joka sisältää vaihdettavia merkkejä joita voit skannata mobiililaitteella saadaksesi merkkeihin liittyvää sisältöä laitteen näytölle (kamera-kuvaan).*

Voisitko kuvitella käyttäväsi rasiaa, jonka pinnalle voi kiinnittää erilaisia merkkejä tuodaksesi niihin liittyvää 3D-sisältöä (esim. hahmo) mobiililaitteesi kamera-kuvaan?

Miten hyödylliseltä tuote sinusta tuntuu?

Millaisia merkkejä haluaisit tuotteen sisältävän ja tuovan laitteeseesi?

Ajatuksia tuotteen ulkonäöstä, koosta ja toimivuudesta.

kolme hyvää kolme huonoa asiaa

Väriympyrä:

*Pyöreä esine, jonka pinnassa on väreistä koostettu ympyrä, jossa jokainen väri-rivi on pyöritettävissä ja siten kuvio vaihdettavissa. Voit skannata väriympyrän mobiilisovelluksella tuodaksesi sisältöä laitteen näytölle (kamera-kuvaan).*

Miten käytännölliseltä ajatus siitä, että voisit itse päättää skannattavan merkin ulkoasun tuntuu?

Vaatiiko kyseinen tapa liikaa aikaa ja vaivaa ollakseen usein käytössä?

Millaista sisältöä haluaisit tuotteen tuovan? Hahmoja, tekstiä, videoita?

Millaisia muita tapoja kuvion vaihtamiseen voisi olla?

kolme hyvää kolme huonoa asiaa

Tulevaisuus-idea

kolme hyvää kolme huonoa asiaa

# Appendix 3.

**Kysely osallistujille** **20.03.2017**

Sukupuoli: mies __ nainen __ en halua sanoa __ Ikä: ___

Tietoja: Tämä kysely kartoittaa kokemuksia suunnitellun mobiilisovelluksen sekä tuotteen käytöstä sekä aiemmista kokemuksista samaan teemaan liittyen. Kyselyn tuloksia käytetään ainoastaan kyseessä olevassa tutkimuksessa. Vastaukset käsitellään anonyymisti.

Vastaa seuraaviin väittämiin

1. Olen täysin **ERI** mieltä … 5: Olen täysin **SAMAA** mieltä

| | |
|---|---|
| Tuotteen käyttö oli helppoa | 1 __ 2 __ 3 __ 4 __ 5 __ |
| Sovelluksen käyttö oli helppoa | 1 __ 2 __ 3 __ 4 __ 5 __ |
| Tuote sopi mielestäni hyvin yhteen sovelluksen kanssa | 1 __ 2 __ 3 __ 4 __ 5 __ |
| Voisin kuvitella käyttäväni vastaavaa tuotetta | 1 __ 2 __ 3 __ 4 __ 5 __ |
| Voisin jakaa kuvia samankaltaisen sisällön kanssa | 1 __ 2 __ 3 __ 4 __ 5 __ |

2. Millaisia ajatuksia sovelluksen sekä tuotteen käyttäminen herätti?

Kiitos osallistumisesta!

# Appendix 4.

**Questionnaire for participants** **20.03.2017**

Gender: male__ female__ do not want to state __ Age: ___

Information: This questionnaire asks about the use of the designed product and mobile application and prior experience of the related theme. The results are only used in the research related and they will be treated anonymously.

Please answer the following statements

1. I completely **DISAGREE**… 5: I completely **AGREE**

| | |
|---|---|
| The product was easy to use | 1 __ 2 __ 3 __ 4 __ 5 __ |
| The mobile app was easy to use | 1 __ 2 __ 3 __ 4 __ 5 __ |
| I think the product and mobile app fit well together | 1 __ 2 __ 3 __ 4 __ 5 __ |
| I could imagine using a similar product | 1 __ 2 __ 3 __ 4 __ 5 __ |
| I could imagine sharing this kind of content in photos | 1 __ 2 __ 3 __ 4 __ 5 __ |

2. What kind of thoughts did using the product and mobile app arise?

Thank you for your participation!