

Sense of Place in Virtual Reality

15 April 2016

Master thesis Cultural Geography

University of Groningen
Faculty of spatial sciences

Student: J. W. Bolks
Student number: s2675269

Mentor and first assessor: Ph.D. G. Weitkamp
Second assessor: Ph.D. B. Van Hoven



**university of
groningen**

faculty of spatial sciences

Summary

Virtual reality is a technology that is rapidly developing and the technology is getting available for the general public currently. This indicates that the technology can have a significant impact in the future. One factor that will determine the impact of the technology is the possibility to develop an emotional connection with a virtual environment. This research is conducted to study if it is possible to develop a sense of place within virtual reality.

The main research question is: *To what extent is it possible to have a sense of place in virtual reality?*

This study focuses on virtual reality through a head mounted display, which creates an immersive experience. Different experts on virtual reality were interviewed to collect the necessary data.

Getting to know if it is possible to develop a sense of place in virtual reality requires a thorough understanding of the concept sense of place. A sense of place is an emotional connection that people have with a place. The development of a sense of place differs between people. There are several important elements that can contribute to the development of a sense of place.

The essential elements consist of the senses and cognition. All the information that is provided by an environment is perceived through the senses and processed by the brain. These cognitive processes can result in a sense of place.

The other elements that facilitate the cognitive processes and which can contribute to a sense of place are interchangeable. One single element, in combination with the senses and cognition, can result in a sense of place as well as a combination of different interchangeable elements. These elements are: the activities that a place facilitates, the possibility for social interactions, the social and symbolic meaning that a place possesses, an identity derived from a place, othering, possibilities for private experiences, the possibility to shape an environment, continuity, the aesthetic qualities of a place and the possibilities that an environment provides to satisfy the needs of people.

These elements can all be facilitated by virtual reality to some extent currently. There are some aspects that differ from a sense of place in a physical environment. These differences relate to how virtual reality is experienced. The aspects that are important in the development of a sense of place in virtual reality are: content, the senses, cognition, interaction and realism.

The aspect of content is related to the interchangeable elements. Different content is currently developed that facilitates activities that can contribute to the development of a sense of place. These activities range from personal activities to social activities. Personal activities are linked to the element of privacy. Social activities are linked to the elements of social interactions, othering and social and symbolic meaning. Both types of activities can contribute to a place identity. The different activities can lead to satisfaction of the needs of people. The quality of these experiences can be further improved, such as the use of avatars for social interactions.

The senses are essential in the collection of the information provided by an environment. The visual stimuli provide the main information to perceive an environment. The visual and the audial can be fully incorporated in a virtual reality experience. The possibilities regarding the other senses are currently limited. The biggest limitation is that it requires inconvenient devices which do not create enough added value to compensate the discomfort. The experts do expect that some of the limitations will be overcome and that the devices will continue to improve. The importance of the stimulation of the different senses differs between people. It depends on a person if the different senses are stimulated sufficiently to create a meaningful experience.

It is currently possible, through the use of devices, to move through and interact with a virtual environment. There are however currently also some limitations regarding the possibility to interact with a virtual environment. The devices mentioned above are available currently but these devices have to be further improved. This will attribute to a more realistic virtual reality experience. The experts do expect that these improvements will be made.

Another limitation is related to the computational capacity and the framerate. Moving through an environment and interacting with an environment requires a large amount of computational power. The computational capacities have to increase to make it possible to develop a virtual environment with a high realism and the possibility to move through and interact with an environment. The computational capacities will continue to improve. Interaction is highly linked to the element

possibility to shape the environment. It is currently difficult to shape a virtual environment because it requires specified knowledge but this will change in the future, as indicated by the experts.

One of the most important elements that needs improvement is continuity. The computational capacity has to increase to make it possible to create a high framerate with a high aesthetic quality to make a virtual experience as real as possible. When this is accomplished this will provide the possibility to experience virtual reality for a longer period of time. The experts expect that the computational power will continue to improve.

It is already possible that people process a virtual environment the same as a physical environment, due to the fact that the brain processes a limited amount of stimuli. These environments can be a depiction of a physical environment as well as an imaginary virtual environment. The results, however, also show that improvements can be made regarding all the different elements.

The answer to the main research question is that it is already possible to develop a sense of place and that the possibilities will increase in the future. This could result in the fact that the technology of virtual reality will have a big impact on the lives of people. This means that the technology has to be taken serious and that the possible future impacts have to be further considered, especially in the field of cultural geography.

Index

- Chapter 1. Introduction 5**
 - 1.1. Relevance 6
 - 1.2. Research questions 6
 - 1.3. Reading guide 7
- Chapter 2. Theoretical framework 8**
 - 2.1. Connection between people and place..... 8
 - 2.2. Essential elements..... 8
 - 2.3. Interchangeable elements..... 10
 - Case study one: ‘Second Life’ 14
- Chapter 3. Research methodology 15**
 - 3.1. Information collection 15
 - 3.2. Data analysis..... 17
- Chapter 4. Results 18**
 - 4.1. Senses 19
 - 4.2. Cognition 21
 - 4.3. Activities 23
 - 4.4. Social Interactions 25
 - 4.5. Othering..... 27
 - 4.6. Social and symbolic meaning 28
 - 4.7. Place identity 29
 - 4.8. Privacy 30
 - 4.9. Possibility to shape environment 31
 - 4.10. Continuity 32
 - 4.11. Aesthetics and realism 34
 - 4.12. Possibility to satisfy needs..... 36
 - Case study two: ‘A breathtaking journey’ 37
- Chapter 5. Discussion and conclusion..... 39**
 - 5.1. Discussion 39
 - 5.2. Conclusion 41
 - 5.3. Limitations 42
 - 5.4. Future research 43
- References 44**
- Appendix A 48**
- Appendix B 49**
- Appendix C..... 50**

Chapter 1. Introduction

Virtual reality seems to be on the verge of a breakthrough. The technology is getting ever more sophisticated and the prices for virtual reality devices are decreasing. This makes the technology accessible for many people. The increase of technology in general has already had a great impact on the way people use and perceive places (Malpas, 2006). It is already possible to watch or communicate with other parts of the world using the internet, telephone or television. Immersive virtual reality was also developed decades ago, but the computational capacities have only recently increased to a level that makes it possible to create smooth virtual reality experiences with a high quality. That is why the technology starts to get adopted by people currently.

Virtual reality might make it possible to 'step' into other parts of the world, or even to entirely new worlds, without having to travel. Will virtual reality be a technology that is fun to use for a couple of minutes or will it be a technology that can open up new worlds for people? This can for example impact how people will work or how people are educated in the future. There has to be a certain 'feel' to make a virtual reality experience appealing and meaningful. Therefore this research will be conducted to find out to what extent it is possible to have a sense of place in a virtual environment. The concept of sense of place is therefore chosen, a sense of place is the emotional connection that people have with a place. This concept is chosen because the possibility to develop an emotional connection with a virtual environment will be important in the possible success of virtual reality. When a sense of place is developed within virtual reality and when virtual environments can represent meaning to people, it is likely that people will use virtual reality often in their daily lives. If this is not the case the technology might only be a hype that will pass.

The definition of place that is used in this research is: *space imbued with meaning* (Tuan, 1977). Spaces become places when people attach value to a certain space. Some people say that virtual environments cannot be places (Vanclay et al., 2008), while other state that a virtual environment can be a place because of the fact that virtual environments can have meaning just as real places (Mennecke et al., 2011). Place making is something personal and it differs between people. Therefore you cannot formulate specific criteria that have to be met before something can become a place.

Virtual environment can be replications of the real world as well as imaginary environments. Both types of environments will be mentioned. This study focuses on the use of a head mounted display (HMD), because it creates an immersive experience within a virtual environment and because these devices are becoming available for many people.



(OpticsGamer, 2016)

This study will be an exploratory study because virtual reality is not widely used currently and because the concept of sense of place is hard to deconstruct into measurable components. People experience

places in a different ways resulting in a unique sense of place for every individual (Holloway & Hubbard, 2001; Koppen, 2012; Massey, 1994; Relph, 2009; Turner & Turner, 2006; Vanclay, 2008). This means that general claims about the possibility to create a sense of place in virtual reality cannot be made without nuance. Another factor is the difficulty to ask many people about their personal experiences with virtual reality because the technology is not used frequently by many people currently.

There are several definitions used for virtual reality in the literature. Siltanen (2012) defines virtual reality as 'an immersive environment simulated by a computer'. This is a very basic definition. Muñoz et al. (2014) use a similar definitions but they added physical presence; 'virtual reality is defined as a computer-simulated environment that can simulate physical presence in real or imaginary worlds'. Gooskens (2010) uses another definitions that ads interaction; 'a virtual environment is an artificial space in which we can interact with objects that are not real but simulated by the computer. The definition that will be used in this research is similar to the definition of Siltanen. Siltanen however uses the world simulated which could suggest that a virtual environment has to be imaginary. A virtual representation of a physical environment can also be an immersive virtual environment, therefore a small change is made to the definition of Siltanen. Resulting in the following definition: *virtual reality is a computer processed immersive environment.*

Augmented reality is a technology similar to virtual reality. Augmented reality enhances the real world environment through computer generated images while virtual reality is an entirely computer generated world (Carmigniani et al., 2011). So although similar, the two technologies are essentially different. Virtual reality has been chosen because it provides an immersive virtual environment probably having a bigger impact on the possibility to create a sense of place (Diemer et al., 2015).

1.1. Relevance

A sense of place in virtual reality is a subject that has not been thoroughly studied in the past. Some studies have been conducted but they often miss a thorough description of the concept of sense of place and what this concept entails. Virtual reality can, however, have a big impact in the field of cultural geography especially when it is possible to develop a sense of place in virtual reality. This study will focus on getting to know if this is likely. This thesis can contribute to the discussion about the impact virtual reality will have in the future and can indicate if virtual reality should be better considered in the field of cultural geography. Also because of the fact that virtual reality applications can have a big impact on matters such as healthy ageing or heritage preservation. Virtual reality applications might offer opportunities regarding these topics, such as the possibilities for the treatment of illnesses or the fact that heritage sites can be 'preserved' through digitization (Turner & Turner, 2006).

Some studies related to a sense of place in virtual reality have been conducted such as the study of Plunkett (2011). He did study the possibilities of place attachment in virtual worlds. He used the game Second Life as a case study. Second Life provides a virtual environment that is used through a desktop. Plunkett concludes that it is possible to be attached to and have a sense of place in a virtual world, but he did not give an excessive description about the concept of sense of place and which elements play a role in the development of a sense of place in a virtual environment. Similar studies will be discussed in the theoretical framework.

1.2. Research questions

Aim

The aim of this research is to find out to what extent it is possible to have a sense of place in virtual reality. Virtual reality can possibly further increase the role of technology in the lives of people. Finding out if it is possible to have a sense of place in virtual reality will help to get to know if this is likely. The results have to contribute to the discussion on the use of virtual reality.

Main research question:

To what extent is it possible to have a sense of place in virtual reality?

The eventual impact of virtual reality depends on the ability of virtual reality to create an experience that can match or replace a physical-world-experience. An important aspect of physical-world-

experiences is the feeling that people have with specific physical places. Getting to know if it is possible to have these feelings within virtual environments will be the main focus of this research.

Sub-questions:

To what extents is it currently possible to have a sense of place in virtual reality?

Virtual reality is a rapidly evolving technology. This sub-question will however be used to examine the current possibilities when it comes to a sense of place in virtual reality.

What are the likely future possibilities of virtual reality for the development of a sense of place?

This question will help to get to know what the future potential of virtual reality is when it comes to the development of a sense of place. There might be important elements that are currently impossible to facilitate in virtual reality but which are likely to be facilitated in the (near) future.

Some current practical limitations of virtual reality will not be mentioned. Such as the fact that the technology needs to become socially accepted and affordable or the fact that the technology requires certain hardware which most people do not have at the moment. The technical requirements for the technology will also not be discussed in detail, such as the software that has to be used or the exact requirements regarding the computational capacities. These factors can also influence the impact that the technology will have in the future (Carmigniani et al., 2011; Gooskens, 2010). This study will focus on the cultural geographic aspects of virtual reality, meaning that the influences above lay outside the scope of this study.

1.3. Reading guide

The theoretical framework will be first hereafter. The concept of sense of place and the literature about virtual reality in relation to the concept of sense of place will be discussed in the theoretical framework. The research methods will be mentioned thereafter in chapter three. Followed by the results of the interviews that were conducted. The research questions are answered and discussed in chapter five.

Chapter 2. Theoretical framework

Introduction

Sense of place is an often-used concept in cultural geography. Places can be of great importance to people. The process of attaching meaning to a place, resulting in emotional connection to a place, will be discussed using a conceptual model. This model will be used to test if virtual reality can facilitate the elements that are important in the development of a sense of place in a physical environment.

There is a wide range of definitions of the concept sense of place. This can range from: a sense of place can develop where people just simply can be (Dymnickaa, 2010) to complex models with many, often abstract and vague, elements and connections between these elements. Besides that there are many different definitions used. Jorgensen and Stedman (2001), for example, use place attachment, place dependency and place identity in their description of the concept of sense of place. The aspects that contribute to these three elements will be incorporated in this theoretical framework without using the same definition. The different views of other authors and the different definitions that are used are included in this chapter. A new model is made to deconstruct the concept of sense of place into specific different elements. This provides the opportunity to discuss the elements separately to gather data on the possibilities of virtual reality regarding these different elements.

The elements that are discussed are chosen because of the reoccurrence throughout the literature. The link of these elements to literature on virtual reality will also be discussed. The goal of this chapter is to mention the views of different authors and how this relates to current literature on virtual reality and to create a comprehensive conceptual model of the concept of sense of place.

The theoretical framework will end with a case study discussing the game *Second Life*. This is a game that provides the possibility to control an avatar in a virtual environment, through the use of a computer. The current possibilities of the platform, regarding the elements of the conceptual model, will be discussed.

2.1. Connection between people and place

A sense of place is an emotional connection with a place that people can develop, as mentioned before. There are different elements that can contribute to the development of a sense of place. These elements can be divided in essential elements and interchangeable elements.

The essential elements comprise of the senses and cognition. These elements are essential in perceiving an environment and in the development of an emotional connection with a place. The interchangeable elements are linked to characteristics of an environment. These interchangeable elements can together contribute to the development of a sense of place, but a single interchangeable element could also result in the development of a sense of place.

2.2. Essential elements

Senses

The senses are essential in collecting information and perceiving the world around us. The different characteristics of an environment are firstly perceived through the senses before meaning can be attached to a place (Benyon et al., 2006).

Relph (2009) and Holloway and Hubbard (2001) mention the importance of the different senses in the process of developing a sense of place. Relph (2009) states that a sense of place is formed through a combination of sight, hearing, smell, movement, touch, imagination, purpose and anticipation. Holloway and Hubbard (2001) also state that places are not just seen but they are also sensed through sounds, smells, tastes and feelings on the skin. Sight plays the most important role in perceiving an environment (Holloway & Hubbard, 2001).

Cognition

A sense of place develops through cognitive processes. The information, provided by an environment, is collected through the senses and this information has to be processed by the brain. The information that is processed can result in association, knowledge, memory, judgement, etc. of a place. Memories of a place and activities that happened at that place seem to be one of the most important factors in

the creation of an emotional connection with a place, and therefore in the development of a sense of place (Arora & Khazanchi, 2010; Gustafson, 2001; Holloway & Hubbard, 2001; Kudryavtsev, 2012; Stewart et al. 2013; Turner & Turner, 2006). These memories can be the result of the facilitation of the interchangeable elements that will be discussed in the following section. Memories can be formed through unique experiences as well as through experiences that have happened often and are familiar (Gustafson, 2001; Kudryavtsev, 2012).

The cognitive processes are also linked to how people experience a place when they observe or interact with that place (Takatalo et al., 2008). Different authors agree that everybody experiences a place in its own way, resulting in a unique sense of place (Gustafson, 2001; Holloway & Hubbard, 2001; Koppen, 2012; Massey, 1994; Relph, 2009; Turner & Turner, 2006; Vanclay, 2008). The interchangeable elements facilitate the conditions to have experiences that can contribute to an emotional connection with a place. The extent in which a place can become important to someone differs between people (Gustafson, 2001; Massey, 1994; Relph, 2009).

Cognition also plays an important role in the creation of a sense of presence. A sense of presence is the feeling of being present in a place (Cumming & Bailenson, 2015). This can have an impact on the development of a sense of place. Many studies regarding virtual reality focus on getting to know what contributes to the cognitive processes that can result in a sense of presence within a virtual environment.

Villani et al. (2012) studied if virtual reality can result in an increase in the experience of presence. This was tested by a job interview in the physical world and a similar job interview in a virtual environment. Their findings suggest that the experience of presence was higher in the virtual environment compared to the physical world. This could be the result of the extra information that is provided through virtual reality (Villani et al., 2012).

Cummings and Bailenson (2015) did a similar research studying the spatial sense of presence. They found that the level of immersion has an effect on the sense of presence that is experienced. The greater the immersion the greater the sense of presence. There were some particular features that had a large effect on spatial presence. These features were: stereoscopy, field of view and tracking level. The tracking level being the amount of interaction a person can have with his surroundings. Kwon et al. (2013) also concluded that a higher immersion evokes a higher sense of presence.

Balakrishnan and Sundar (2011) studied the impact of the possibility to navigate to a virtual environment on a sense of presence. They found that a small difference in the possibility to navigate through a virtual environment can have a significant effect on the spatial sense of presence. The importance of interaction is also stressed by Chen and Kalay (2008) in their study they conclude that content developers should focus on the interactive opportunities of a virtual environment. Virtual reality might also provide the chance to create a greater interactivity, than a physical world can provide, because virtual reality provides the possibility to react actively on the actions of a user.

Slater et al. (2010) also studied the possibilities of virtual reality to impact the cognitive processes. They found that it is possible for people to experience a virtual body as if it is their own. In this research people reacted similar to threats to the virtual body as to threats to their own body.

Jarmon et al. (2008) concluded that virtual reality can improve learning processes. The virtual world provided additional options for learning experiences. The most interesting reason for this was an enhanced tangible and personal experience in the virtual world. Besides that the costs to create virtual environments specifically designed for the learning tasks, such as sustainable housing models, are significantly lower compared to the creation of a physical world environment (Jarmon et al., 2008).

The studies, discussed above, indicate that virtual reality can have a significant impact on the cognitive processes. This suggests that virtual reality can also impact the cognitive processes that result in a sense of place.

The interchangeable elements will be discussed hereafter. The interchangeable elements can be impacted by the outcomes of the cognitive processes, because association, knowledge and memories impact how people perceive places through their senses. This also illustrates that the concept sense of place is a circular process meaning that a sense of place changes over time.

2.3. Interchangeable elements

Activities

The possibilities a place offers for activities seems to be one of the most important aspects in the development of a sense of place (Gustafson, 2001; Relph, 1976; Turner & Turner, 2006). The kind of activities differ from the activities of the daily live (Arora & Khazanchi, 2010; Malpas, 2006; Stewart et al. 2013), to special events that have a bigger impact on the lives of people. These activities have the biggest impact when they have symbolic meaning (Chen & Kalay, 2008) and when they contribute to the process of self-identification (Gustafson, 2001). The impact of the activities on the development of a sense of place is highly linked to the way that a virtual environment is experienced discussed above and on how these activities facilitate the other interchangeable elements.

Social interactions

Social interactions play an important role in the development of a sense of place. This can be through the quality of the social interactions that happen or have happened at a particular place as well as because of the repetitiveness of social interactions, which results in familiarity. These social interactions can result in experiences and the creation of meaning, this can contribute to creation of important places to people (Arora & Khazanchi, 2010; Kudryavtsev, 2012; Turner & Turner, 2006). This element is strongly linked to the following elements of othering and social and symbolic meaning.

Another important role that social interactions play is in ascribing meaning to a place (Jorgensen & Stedman, 2001; Sampson & Goodrich, 2009; Williams, 2014). Places become important when people attach meaning to it, as discussed before. Social interactions are an important factor in this process. The ascription of meaning can also lead to othering which will be discussed in the following paragraph followed by an explanation of the social and symbolic meaning that is created and attached to certain places through social interactions.

The possibilities for social interactions can also impact the sense of presence. Mennecke et al. (2011) mention that interactions within a virtual environment can contribute to a sense of presence. These can be interactions with human like appearances but also with objects that have no close resemblance to humans. These appearances or objects do not have to be controlled by another human.

Important to social interactions are the emotions that are shown by a respondent. Qu et al. (2014) studied the possibilities regarding the synthetic emotions of virtual humans. They found that positive synthetic emotions can have a positive impact on the emotion of the participant as well as negative synthetic emotions which can have a negative impact. They also found that the emotions have to match the conversation. When the emotions do not match the conversation the conversation is less satisfying for the participant. This closely relates to the uncanny valley. The uncanny valley describes the fact that people can feel disgust towards something that closely resembles a human being, such as an avatar or a robot. The closer the resemblance with a human being the bigger the disgust towards that certain something (Wang et al., 2015).

Othering

People want to belong to groups to be able to have social interactions and create meaning to life and to places. These groups can also be formed using digital media (Leung, 2011). Places can be associated with a person's own group as well as with 'others', this can result in a value judgement and in feeling comfortable or uncomfortable in a place. This feeling can contribute to a development of a sense of place. (Gustafson, 2001, Sampson & Goodrich, 2009). Having the possibility to exclude others from a place and making the place your own can also contribute to a sense of place (Holloway & Hubbard, 2001). This is linked to power relations and the desire of people to control places. These power relations can be the result of experiences and social interactions.

Social and symbolic meaning

Ascribing meaning to a place is an important aspect in the development of a sense of place. This meaning is mainly ascribed through social interactions as mentioned above (Jorgensen & Stedman, 2001; Sampson & Goodrich, 2009; Williams, 2014). But places can also become important through personal experiences (Gieryn, 2000). The value that a place possesses can be a result of one of the

other elements in the conceptual model. The meanings of a place is socially or symbolically constructed in the context of the day-to-day lives of people (Williams, 2014).

Chang et al. (2015) studied the possibilities of augmented reality to contribute to a development of a sense of place. They used an augmented reality application to guide people through an environment. They compared it to audio guidance and to no guidance. The results showed that the people who used augmented reality to guide them, developed a stronger sense of place. The results of this study could be explained by the fact that the participants received more information. This information could help in the process of attaching meaning to a place. Virtual reality also offers the possibility to provide additional information. A heritage site can, for example, be recreated as a virtual environment to show how the site would have looked in the past.

Place Identity

Place identity is a well-known concept in the field of cultural geography (Cuba & Hummon, 1993; Krupat, 1983; Proshansky et al., 1983; Jorgensen & Stedman, 2001). Places can become self-identifying for people through the different elements in the conceptual model, through the social and symbolic meaning of places and the experiences with- and memories of that place, such as the place where someone was raised (Cuba & Hummon, 1993; Krupat, 1983; Proshansky et al., 1983; Jorgensen & Stedman, 2001; Sampson & Goodrich, 2009; Williams, 2014). People, for example, use places to describe themselves and people can have the feeling that they represent a place (Gustafson, 2001). A place identity can underpin the behaviour of someone at a particular place and can contribute to the development of an emotional connection with a place (Jorgensen & Stedman, 2001; Krupat, 1983; Kudryavtsev, 2012).

Privacy

A sense of place is personal as mentioned in the previous element and in chapter one. Privacy can therefore be an element that is as important as social interactions. Places can become important to people because of the solitude and privacy a place can provide (Jorgensen, 2010). Privacy is also linked to security. People need places where they feel secure, these are often personal places with the possibility to exclude others (Holloway & Hubbard, 2001; Gustafson, 2001). The possibility to exclude others is linked to the element of othering as mentioned before.

Possibility to shape environment

Linked to the elements of privacy and othering is the element possibility to shape the environment. People often personalise their surroundings to make a place their own. Making a place your own or having the possibility to shape your surroundings can contribute to the development of a sense of place (Gustafson, 2001).

Continuity

As mentioned before places can become important when people are often at a particular place or for a longer period of time (Beidler & Morrison, 2015). Linked to this is the fact that places have to provide a certain extent of continuity. The memory of places is important but knowing that a place will be around in the future makes it also more likely that a place will become valuable (Gustafson, 2001).

Aesthetics and realism

There is an ongoing discussion in the field of cultural geography if environments can have intrinsic value or if values are also ascribed through social interactions. The fact is that environments can have positive as well as negative qualities. These qualities, such as beauty, can play an important role in the development of a sense of place (Arora & Khazanchi, 2010; Jorgensen & Stedman, 2001; Malpas, 2006; Stedman, 2003; Williams, 2014). Related to this is the fact that a lack of graphic qualities of a virtual environment can lead to a less convincing virtual experience and a lack of realism that is perceived (Benyon et al., 2006).

Realism is an important factor in how people perceive an environment and in having a sense of presence (Go, 2012). One of the possibilities virtual reality offers is to replicate the physical world in a

virtual environment. In this sense you can strive to create a virtual environment that matches the aesthetics of the real world as close as possible. But a virtual environment can also be an imaginary environment that is entirely rendered by a computer. This can result in the fact that virtual reality can become a reality of its own (Gemeinboeck, 2004). These imaginary places can also have realistic aspects such as how someone can move through and interact with an environment. Kwon et al. (2013) studied the impact of detailed graphics of a virtual environment, they concluded that an increase in detailed graphics leads to an increase in a sense of presence. A similar study was conducted by Bouchard et al. (2012) who state that photorealism and immersion strongly impact the feeling of presence. Besides that they mention that the expectations of people, regarding an experience, also plays an important role in feeling present. They misled people into believing that they would be in a real environment, while they were in a virtual environment, this resulted in a higher sense of presence. This indicates that realism and an increase in detail are important in how a virtual environment is experienced and therefore important in the development of a sense of place.

Another aspect that plays a role and which is linked to the qualities of a physical place are the natural conditions of a place (Gustafson, 2001). Many people visit places because of nice temperatures and the sunny conditions of that particular place for example.

Possibility to satisfy needs

One of the most abstract elements that is included in the model is the element possibility to satisfy needs. Tuan (1977) states that people have to pause from movement, which is needed to get ahead in life. This happens at certain spaces that provide the possibility to satisfy certain needs. When a certain place can satisfy the needs of people it can result in the development of a connection with that place. Tuan speaks of the possibility that people, objects or ideas can become important 'places' for people. These needs can vary from the need for self-identification to particular activities such as work.

Williams (2014) has a more concrete view on the satisfaction of certain needs. Williams states that places can have specific material qualities that can help to satisfy behavioural or economic goals that an individual desires to achieve.

Gustafson (2001) also mentions that places have to provide possibilities, such as the possibility to perform activities or chances for personal development. Satisfaction of needs can therefore be the result of the facilitation of the other interchangeable elements. Possibilities of virtual reality to satisfy needs will also be discussed in the case study discussed below.

Conceptual model

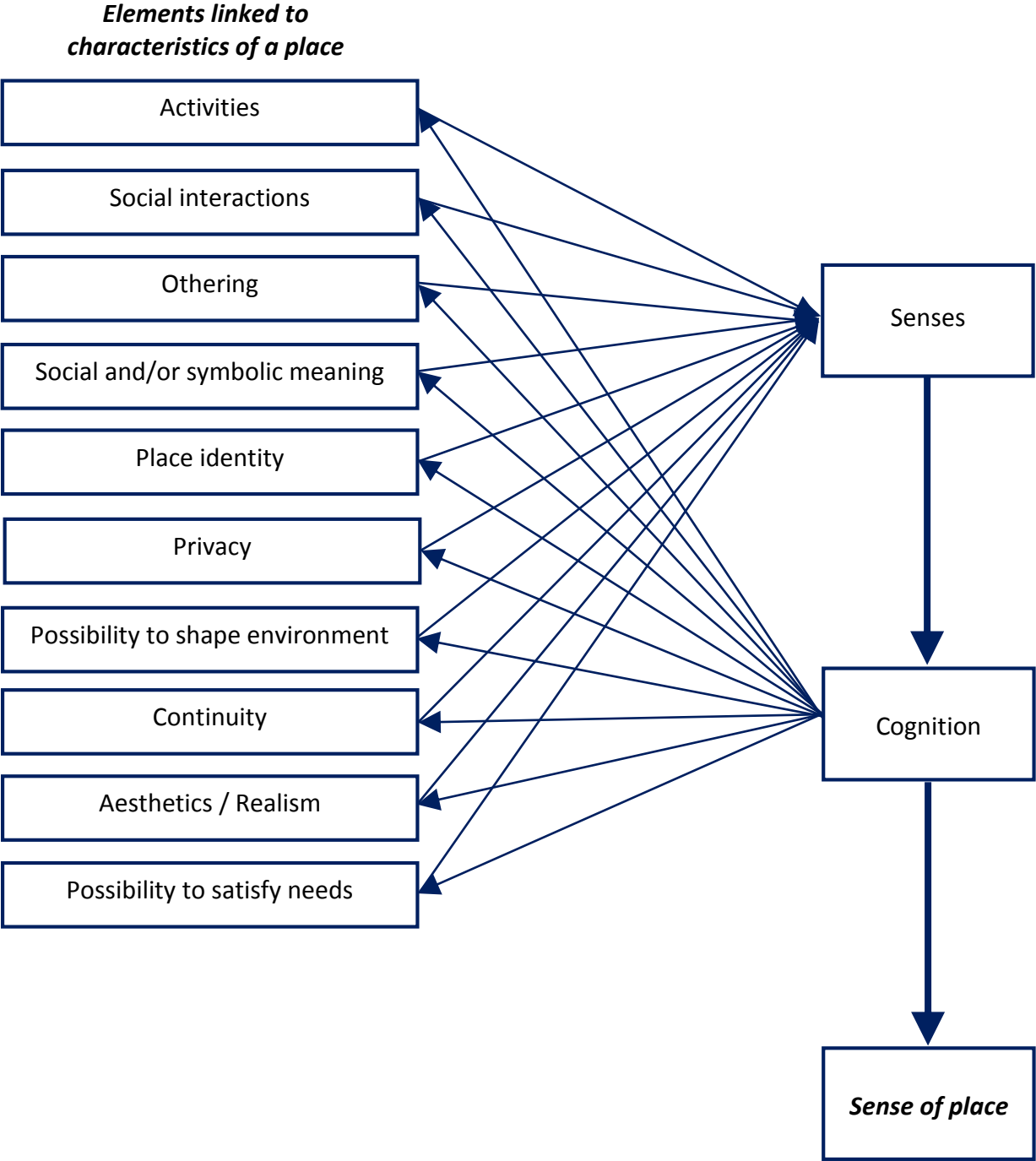


Figure 1: conceptual model of the concept sense of place

Case study one: 'Second Life'

The platform Second Life has been referred to before. In this case study the platform of Second Life will be discussed. The aim of this case study is to see which possibilities the current platform of Second Life provides for the development of a sense of place compared to the possibilities of an immersive experience, using a head mounted display (HMD), of the same platform. This is strongly connected to the previous elements linked to social interactions. Some aspects of the elements that will follow will also be discussed.

Second Life provides the opportunity for people to create and personalise an avatar that can be controlled in the virtual world. Second Life started in 2003 and is currently used by 900.000 people monthly (Weinberger, 2015). The primary objective of Second Life is to provide a platform for socialisation. Second Life facilitates a wide range of activities, such as education and leisure activities (MacCallum-Stewart, 2007). Different researchers studied elements that are linked to the conceptual model of this study. These studies will be discussed hereafter followed by the expected future possibilities of these elements in a platform that can be used through a HMD.

The platform provides possibilities for aural social interaction, with limited possibilities for facial expressions of the avatars, and through text messages. There are many different communities within Second Life. Some communities are linked to specific virtual environments. These virtual environments are also getting marked with symbols to claim these environments, similar to the marking of a virtual environment mentioned before. There have even been virtual wars between rivaling communities (MacCallum-Stewart, 2007). This indicates that these virtual environments can have social and symbolic meaning and that othering is present within Second Life.

Corder and U-Mackey (2015) studied the possibilities of Second Life to create critical awareness for people about their identity, their worldview and their attitude towards other cultures. In their study a small group of students had to perform certain tasks with the goal to create awareness of their own identity and awareness of the differences between people and cultures. The study showed that Second Life can be a tool to create a heightened awareness of someone's own identity and can help in the ability to deal with differences with other people. It even had a bigger impact than course material provided in real life. This indicates that Second Life can have an impact on the self-identification of people. This is also mentioned by Boon and Sinclair (2009) who state that Second Life can be a way to escape the real world and its problems, which can be fulfilling for some people.

Mennecke et al. (2011) also studied the possibilities of the game of second life for educational purposes. They also used the game of second life during a course to collect the necessary data. Their results corresponds with the results of Corder and U-Mackey, stating that Second Life can be useful for organizational purposes, such as meetings, training and socialization.

Barnes and Pressey (2012) compared how the needs of people can be fulfilled within a virtual world to how needs can be fulfilled in the physical world. The possibility to satisfy needs will be discussed in chapter 4.12. They found that real-life fulfilment of needs is significantly better than virtual world fulfilment of needs. They however also conclude that the virtual worlds can satisfy needs in a significant way, such as self-actualization (Barnes and Pressey, 2012). This supports the main conclusions of the three studies discussed above.

The studies mentioned above indicate that Second Life already provides the conditions for some of the elements in the conceptual model. It also indicates that Second Life is used by a limited amount of people. The possibilities of virtual reality to provide all the different elements will be discussed in this thesis. The developers of Second Life are currently working on an immersive experience in virtual reality (Weinberger, 2015). The question is if an immersive virtual environment will provide the conditions that will result in the fact that more people will use these virtual worlds. When this virtual reality version of Second Life facilitates more elements of the conceptual model it could result in the fact that more people will use the platform.

Chapter 3. Research methodology

Introduction

The research methodology that was used, to collect the necessary information will be discussed in this chapter. Starting with the information collection followed by the experts that participated and finishing with how the data was analysed.

3.1. Information collection

For the collection of the necessary information qualitative research methods are used. In the previous chapter the literature regarding the concept of sense of place and how it relates to literature on virtual reality is discussed. This provided the theoretical framework and the input for the rest of the study.

The literature review was followed by information collection about the possibilities of virtual reality regarding the development of a sense of place. This was researched using semi-structured interviews with ten experts. The possibilities of virtual reality, regarding the elements of the conceptual model, were discussed during the interviews using a semi-structured interview guide. The interview guide is attached in appendix A. A deliberate choice was made to divide the concept of sense of place into different elements. This offered the opportunity to discuss the different elements separately, which was important because of the fact that most experts were not familiar with the concept of sense of place. The division between the different elements made it possible to discuss the concept of sense of place in a comprehensible manner.

The virtual reality experts have extensive experience with the use of virtual reality environments and devices to know the current possibilities of the technology and to be able to say something about the expected future developments of the technology. Interviews with experts is the research method that is chosen because of the exploratory nature of this study and because the technology is not commonly used by- or easily accessible for the general public. This makes it hard to use participants to test if they can have a sense of place in a virtual environment, but also because continuity is an important element in the development of a sense of place. A sense of place often develops over a longer period of time or because of repetitive visits to a place. Creating the test settings for the element of continuity is difficult, because of this and the exploratory nature of the study, interviewing experts was chosen as the main research method. Besides this restriction there are other limitations to create a test setting for participants, such as the fact that privacy is hard to facilitate in a test setting and it takes a lot of resources to facilitate a range of activities that are possible in virtual reality for example.

The experts were asked to sign an informed consent form, attached in appendix B. This form states that the experts participated voluntarily and that they could stop their participation without reason. The form also stated that the data collected will only be used for this research. The interviews were conducted at the working places of the experts and at the virtual revolution event, held in Veldhoven on March 1st, 2nd and 3th. The interviews were recorded and transcribed afterwards. The transcripts were sent to the different experts giving them the opportunity to make remarks. The data analysis is discussed in the next section.

The virtual reality experts were selected to form a comprehensive group of experts on virtual reality. The experts had to have extensive experience with the technology of virtual reality, this could range from the development of virtual reality environments to research on the applications of virtual reality. People that met this criteria were found through a search on the internet and by asking the different experts. The search on the internet focused on the accomplishments regarding virtual reality and on the working functions of the targeted participants.

More than ten experts were approached, but some replied that they did not have time. The number of ten was chosen assuming that there would be homogeneity between the opinions of the experts and because of the exploratory nature of this research. The assumption of homogeneity was made because of the technical nature of the technology, which also reduced the risk of differing personal opinions of the experts ensuring qualitative data. The group of experts provided an overview of the possibilities of virtual reality regarding the different elements of the conceptual model. The following experts participated in this research.

Participants

Ph.D. R. Belleman

Belleman is a lecturer and researcher at the University of Amsterdam. He lectures a course called scientific visualisation and virtual reality. This course is part of the master computational science. In this course the focus is on the visualisation of large amounts of data making it possible to recognize structures and patterns.

As a researcher Belleman studies applications of virtual reality in interactive virtual environments. He has expertise on virtual reality in general and on the application of virtual reality in education in particular.

T. Van der Grinten

Van der Grinten is an architect who started with an interest in how spatial designs are conveyed and how virtual reality can facilitate this process. He started with a company called Moodbuilders, which developed, with other start-ups, into a company called Enversed. Enversed focuses on high-end applications for the creation of experiences in virtual reality.

Van der Grinten has expertise on the spatial component of virtual reality and what this means for users of virtual reality in particular. Besides that he has expertise on the technology in general and on what it takes to create virtual environments.

F. Van Hoesel

Van Hoesel works for the Donald Smits Center for Information Technology of the University of Groningen. His work consists of every aspect related to virtual reality ranging such as the development of virtual environments and software programming. He facilitates the needs of different faculties when it comes to virtual reality, such as the faculties of psychology, archaeology, chemistry and pharmacy. Van Hoesel has expertise on the different possibilities of the technology when it comes to technological capacities as well as the wide range of practical applications of virtual reality.

PhD Stud. M. Kors

Kors is a researcher at Eindhoven University of Technology. He studies the possibilities of virtual reality to create empathy and the possibility of virtual reality to persuade people to change their point of view and possibly their behaviour.

He created a virtual environment of a moving truck simulating an experience that refugees have when they flee their country. This experience also included scent incentives and the need to control your breathing to see if this enriched the experience.

Therefore Kors has expertise on the use of incentives for the senses next to the possibilities to create a virtual environment.

D. La Grand

La Grand developed a web platform, called VRmaster, providing the opportunities to publish and share virtual reality content for users of the platform. He develops virtual reality content and he collaborates with different developers of virtual reality content.

La Grand has expertise on the possibilities of virtual reality regarding the content of virtual reality applications and on the possibilities to create this content. Besides expertise of the technology in general.

R. Overweg

Overweg works for TripleIT and took part in the development of Beyond Sports. Beyond Sports provides virtual reality experiences for professional athletes. Besides that Overweg explores the possibilities of virtual reality for treatment purposes.

Overweg has expertise on the possibilities of virtual reality to enhance the lives of people. Besides that he has expertise on what it takes to create these virtual environments and the important aspects that contribute to the success of such virtual environments.

J. Seubers

Seubers is a lecturer in archaeological history and theory at the University of Groningen and he is an ICT and GIS-specialist. He has done a PhD studying the settlement of Crustumium (Rome). He works with 3D data and develops 3D models of archaeological artefacts.

He has expertise on the possibilities of virtual reality in the field of heritage and on the application of virtual reality for educational purposes. Besides that he has expertise on the possibilities to create virtual environments.

S. Soolsma

Soolsma works for NORISK IT Groep. This company creates, among other things, virtual reality environments and they are exploring the possibilities of virtual reality. Soolsma has worked on diagnostic tools to create easier ways to diagnose certain disorders.

Soolsma has expertise on what it takes to create a virtual environment and what is needed to let these virtual environments help people.

M. Venema & B. Hooimeijer

Venema and Hooimeijer work for Happyship. Happyship is a computer animation studio. They created a virtual reality experience that made it possible to swing in the Aa-kerk in Groningen. They also research the possibilities regarding the representation of objects in virtual reality and how people react to these different representations. People can for example react differently to a 360 degrees recording compared to a computer rendered environment.

Venema and Hooimeijer have expertise on the process of creating a virtual environment. Besides that they have expertise on how people experience virtual environments.

3.2. Data analysis

The different interviews were transcribed and coded using the different elements of the conceptual framework as codes, see appendix C. The interviews provided comprehensible codes, this made it possible to manually process the codes without the use of specific coding software. The codes were the tool to find similarities between the different experts as well as important differences. These similarities are used to answer the two sub-questions: *to what extents is it currently possible to have a sense of place in virtual reality?* And *what are the likely future possibilities of virtual reality for the development of a sense of place?* The similarities and the important differences between the experts will be discussed in the following chapters. The data provides an extensive overview of the current and expected future possibilities of virtual reality to facilitate the elements in the conceptual model. The quality of the data will be discussed in section 5.3 *limitations*.

Chapter 4. Results

Introduction

In this part of the report the results of the interviews, regarding the different elements of the conceptual model, are presented. This is the input for the discussion in the next part of the report. The elements will be presented in the same order as in the second chapter, beginning with the senses and ending with the element possibility to satisfy needs. So the elements will be discussed separately although the elements can strongly influence each other. An activity in virtual reality in itself might be possible but if the social interactions are not correct or the aesthetic qualities of a place are low this can result in the fact that people will not participate in such an activity, for example. It differs between people, which of the interchangeable elements have to be facilitated and what qualities these elements must have to develop a sense of place. How the different elements relate to each other and influence each other in virtual reality will be discussed in chapter five.

The second case study will be discussed at the end of this chapter to show how the different elements can be incorporated in a virtual reality application. The case study discusses the application: 'A breathtaking journey'. This is a virtual reality application that is developed to create an experience that simulates an experience that refugees go through.

4.1. Senses

Sight is the most important sense in perceiving an environment, as mentioned in the previous chapter. The other senses however do also play a role in perceiving an environment. The possibilities of virtual reality regarding the senses will be discussed in this chapter, except for the sense of taste because of the limited relevance to how an environment is perceived (Holloway & Hubbard, 2001; Relph, 2009). The senses are highly related with all the following elements because all information is perceived through the senses.

Sight

All the experts indicate that it is already possible to fully incorporate the sense of sight into a virtual reality experience. The quality of the visual stimuli provided by the virtual environment will be discussed in chapter 4.11, *Aesthetics and realism*.

Hearing

Audial stimuli can and are already incorporated in virtual reality experiences. Belleman does mention that there is still room for improvement however. The sounds that are used do not always behave in a similar way with how sounds behave in the real world. The other experts such as Soolsma mention that sound is something that is fully available to incorporate in a virtual reality experience.

Touch

Being able to touch a virtual environment or virtual objects is something that is worked on by many people currently. Hardware is developed that provides simulates the feeling of touching a virtual object. This hardware takes different forms, from a complete exoskeleton, to gloves, to simpler controllers. These devices already provide opportunities to touch things in virtual reality. Overweg mentioned gloves that work with different sensors to make you feel the things that you see in a virtual experience. Van der Grinten mentioned that static fields have been developed to make it possible to feel different textures on a surface. La Grand for example did add temperature changes and vibration to an experience to create extra immersion. Kors mentioned the fact that there are devices developed that produce air pressure to create a certain wind effect to improve immersion.

The ten experts do however point to the fact that the devices have to be further developed to improve the experience and make it accessible to the general public regarding price and comfort. But the experts do also agree that these steps will be taken in the future making it possible to experience the sense of touch in a virtual environment. They also agree that touch can contribute to a more impressive experience. Seven experts however mention that the devices might remain too complicated or too uncomfortable to get generally accepted.

Scent

Devices making it possible to experience smell are also currently developed and people are working on the improvement of such devices to make it possible to experience the sense of scent. The experts share the opinion that these devices will continue to improve in the future. However there is some controversy between the different experts about the importance of scent in a virtual experience. Six experts say that it has limited added value in experience a virtual environment and mention the downside of the devices that are needed and that negative smells are also possible. Kors mentioned that it will be hard to create the right composition and the right timeframe for such smells. But Venema mentioned that he experienced a virtual scent experiment which was very convincing. He envisions that these possibilities will be incorporated in future devices to create the possibility to experience pleasant scents. This difference in opinions seems to be linked to how smell contribute to the personal experience in virtual reality of the experts. The results show that the sense of scent can be stimulated to some extent currently.

Vestibular system

Another important sense is the vestibular system. This relates to the fact that some people get nauseous when they use virtual reality devices. The eyes can perceive stimuli that differ from the

stimuli that are recorded by the vestibular system. This is due to the fact that there can be a small delay because it takes a small amount of time when a new point of view has to be calculated when someone turns his head for example. This is something that is not applicable to all people and happens mainly when people have to interact heavily with a virtual environment. The capabilities to match the visual stimuli with the movement that someone makes will continue to improve in the future. This will be discussed in more detail in chapter 4.10, *Continuity*. Kors did also mention that researchers are working on devices to influence the vestibular system. This might provide the possibility to add G-forces to an experience for example.

The vestibular system can currently form limitations when it comes to experiencing virtual reality. The experts agree that these limitations will be reduced in the future.

Proprioception

The last sense that will be discussed is proprioception. This is related to a sense of presence discussed in chapter two. People can already experience a virtual body as if it is their own (Slater et al., 2010). Besides that, Belleman mentioned that there are already exoskeletons that provide the possibility to exert a counter pressure to muscle movement to create the illusion that a virtual object has mass. Seubers also mentioned that a virtual body in a virtual experience adds to the credibility of such an experience. This indicates that it is already possible to create credible stimuli for the sense of proprioception.

Conclusion

As discussed above there is a wide range of developments regarding the possibilities to stimulate all the senses within virtual reality. The experts expect that these possibilities will continue to be improved in the future. They however differ in their opinion on the importance of the senses of touch and scent and if devices regarding the experience of these senses will get widely accepted. This will also be something that depends on personal preference. These personal preferences also seem to be the reason for the opinions of the experts. The conditions will most likely be created to facilitate the senses discussed above in a virtual reality experience. This can provide the conditions for the development of a sense of place.

4.2. Cognition

The element of cognition is of course highly related to all the other elements in the conceptual model. All the information that is present in an environment is collected through the senses and is processed by the brain. The possibilities of virtual reality regarding the production of this information will be discussed in the following chapters. In this chapter the focus will lie on the way that this information is experienced and processed by the brain and if it is possible to have memories of virtual experiences similar or equal to memories of real life experiences, for example.

Experience

Belleman, Kors and La Grand mention that, with the current limited possibilities, it is already possible to create credible impressive experiences that can be perceived as real events by the brain. La Grand stated:

“Your brain thinks that you are in that virtual environment, they did study that. A VR environment is a real environment for your brain. Experiences in a VR environment are experienced as real.”

He mentioned that this is related to the fact that the brain can process a limited amount of stimuli. When you provide the right stimuli a virtual experience can feel real and you can perceive a sense of presence within a virtual environment. For example through adding the possibility to navigate through an environment or by creating immersion or higher aesthetic qualities (Balakrishnan and Sundar, 2011; Bouchard et al., 2012; Chen and Kalay, 2008; Cummings and Bailenson, 2015; Kwon et al. 2013). Besides that it is already possible to perceive a virtual body as if it is your own (Slater et al. 2010). Adding a virtual body to a virtual experience can therefore have a big impact on the cognitive processes and make an experience more credible, because someone reacts similar to treats to a virtual body, as mentioned in the theoretical framework.

So it is already possible to create a real experience for the brain and the possibilities of the technology will continue to improve in the future. Even up to the fact that it will be hard to see the difference with a physical world experience. Seven experts say that this will always be possible and the other experts say that it will become impossible to see the difference. Kors mentioned that it will be possible to know the difference because of the fact that people know that they have a head mounted display on their head or gloves on their hands.

Memories

Virtual reality is currently used to reduce the impact of traumatising events that happened in the past. Belleman said that it is possible to relive a traumatising experience through a virtual reality experience. This provides the possibility to go through these experiences and give these people psychological help to make these negative memories less of a burden. This is also something that Overweg did experiments with. He did an experiment in which he tested if it is possible to adjust a memory through a virtual experience. People had to do a task in real life which was followed with a virtual experience with results that differed from the real life results. When the people were asked how they performed they answered the results that were presented in the virtual experience. So virtual reality can be an important tool to influence memories or to create new ones.

Kors is studying the possibilities of virtual reality when it comes to empathy and change of behaviour. The first results show that a virtual experience can result in the change of empathy towards a certain matter. He also studies the possibilities of virtual reality to change the behaviour of people but he did not yet have results.

Familiarization

There are several possibilities to create virtual environments, as mentioned above. When people experience such an environment for the first time they are often impressed. But this could change over time and people might get used to such experiences of such environments, because of the fact that the experts have experienced these environments many times they can provide information about how the experience changes over time. Hooimeijer mentioned that there is a certain amount of getting

used to the experience making it less impressive after a while, but he also mentioned that it maintains a pleasant experience in itself. Venema made the comparison with television, virtual reality will always be more impressive than watching television because of the fact that it is all around you and because it is possible to see depth.

Interaction

The importance of interaction with the environment around you is mentioned in the theoretical framework (Balakrishnan & Sundar, 2011; Chen & Kalay, 2008). Interaction with the environment is linked to the element possibility to shape your environment. Regarding interaction a division can be made between recordings of physical places, such as 360 degrees recordings and computer rendered environments. Computer rendered environments can be imaginary but can also be based on reality. Computer rendered environments provide more possibilities to interact with an environment.

Linking 360 degree video with the interactive possibilities of computer rendered environments could result in an even better experience. As Kors stated:

"If we can figure out how we can combine the interactive component of games with the realism of a recording it can get close to the goal and create an experience in which you think: I am actually somewhere else."

Games are entirely rendered by a computer providing the possibility to control an object and interact with an environment.

Currently there are a lot of virtual reality experiences that are created with 360 degree video. These are recordings of particular parts of the world or of certain events that have happened. Although these videos can create an intense immersive experience these experiences often miss an interactive component. There is a world created around you can move through the environment but you often cannot interact with it. This is an important shortcoming for the development of a sense of place.

The computer-rendered environments are mentioned by all the ten experts. Some of these rendered environments do already offer the possibility to interact with the virtual environment around you. This is achieved by using tracking devices to track your movement, which in turn can be processed and incorporated in the virtual environment. This is making it possible to move through an environment and interact with it. These tracking devices are currently getting on the market but there is still a lot of room for improvement to make it easier to navigate through and interact with a virtual environment. These devices can range from tracking devices that make it possible to move through an environment to tracking devices that make it possible to see and use (your) hands in a virtual environment. All the experts do expect that these improvements, to the hardware, will be made in the (near) future. This indicates that interaction with a virtual environment will continue to improve, this will improve a sense of presence and will help in the development of a sense of place.

Conclusion

It is currently already possible to trick the brain into thinking that you are going through a real experience in a virtual environment. This makes it possible to have a sense of presence and create memories of virtual experiences as if these events have happened in real life. This provides an important condition for the development of a sense of place. An increase in interaction could further improve a virtual reality experience and help in having a sense of presence. The experts expect that the possibilities regarding interaction with a virtual environment will continue to improve in the future.

4.3. Activities

There is a wide range of activities that are currently facilitated within virtual reality. Besides that there are other activities that are expected to be facilitated by virtual reality in the future. These activities will be discussed hereafter and range from practical applications, to entertainment to whole new virtual worlds. These activities are strongly linked to the other elements. Activities can contribute to the elements of othering, social and symbolic meaning, place identity, privacy and possibility to shape the environment. Social interactions are also activities but social interactions will only be discussed in the following chapter.

Practical applications

Virtual reality is currently often used for practical applications. These applications are mostly used to treat or to train people. Treating people happens for people with particular disorders that can be influenced by an environment such as fear of heights, as mentioned by Seubers. Another example that Overweg is working on is a virtual environment to help people push through the pain that they have, in this case someone with clogged arteries. They use a virtual environment to create a distraction from the pain that someone has, trying to make someone walk further by influencing the distance of an objective in the distance. Similar applications have been developed and more will most likely be developed in the future. Soolsma is for example working on a virtual environment to create a diagnostic tool for certain disorders.

The possibility of repetitiveness of such treatment makes it possible that a sense of place develops. Especially when such an environment results in pain relief. This is related to the element of continuity. When people do not visit the virtual environment repetitively it will provide limited possibilities to develop a sense of place because of the specificity of the environment.

Training people is another practical purpose for virtual reality applications. Training in virtual environment already happens for some jobs, such as in healthcare. This is however applicable for a limited amount of people currently.

Another form of training that could be facilitated in virtual environments is education. Currently the technology seems to become accessible to use for educational purposes. Seubers for example uses virtual 3D models of archaeological artefacts. But he mentioned that, at the moment, it is difficult to create an immersive virtual environment that provides the necessary tools for specific learning goals, because of specific computing skills that are required and because of the costs of creating such an environment.

Belleman is also studying how virtual reality can be applied in an educational setting. He focuses on abstract subjects that require certain models that are hard to or cannot be created physically. Providing the possibility to 'walk through' such a model in virtual reality could help people to comprehend the matter.

Virtual environments that can be applied in education are also specific environments. Because of changing learning goals and therefore changing content it will most likely have limited possibilities to create a sense of place over time.

Leisure applications

Besides practical applications virtual reality also offers entertainment possibilities. This can range from watching a movie to playing a game to visiting a virtual environment. These possibilities are mentioned by all the ten experts. All these activities are currently to some extent possible in virtual environments. It is possible to watch a movie in virtual reality. This however has a limited spatial component, because people often do not interact with the virtual environment making it less likely that it contributes to the development of a sense of place, as mentioned by five experts. This could change when movies are specifically created for virtual reality.

This is not the case for games or the possibility to visit virtual environments. These two activities are linked because games are often situated in virtual environments. Currently some of these possibilities are already facilitated in virtual reality, such as visiting a virtual environment of a particular building. These are however often experiences that last for a short period of time. This is linked to the comfort of virtual reality devices and the current computational capacity. If the comfort and the computational

capacity increases, content can be developed that provides an experience for a longer period of time. This will be discussed in chapter 4.10, *continuity*.

Visiting virtual environments can range from a virtual representation of a specific place to planned future environments to imaginary virtual environments. These environments can be interactive environments for leisure purposes such as visiting an historical building or visiting a concert. Another possibility is the development of an environment that tells a particular story, such as the virtual environment creating an experience of a refugee. Kors developed an application called: 'A breathtaking journey, this application will be discussed at the end of this chapter. These environments can be created to help understand and explore different environments and different situations.

Content

All the ten experts agree that large amounts of content, regarding these virtual environments, will be developed in the future. Belleman states:

"I think that in the coming period a lot of content will be developed that will give people the feeling that they want to join in and which they do not want to miss. Resulting in the fact that people will buy a head mounted display and start experimenting with it"

In the future it may also be possible to create an entire parallel virtual world. Attempts have been made in the past to make this succeed, such as Second Life. This was adopted by a limited amount of people, as mentioned before. Virtual reality could provide the opportunity in the future to make this appealing to a larger group of people. Van der Grinten mentioned that this can be a world that coexists with the real world. This virtual world can also change when you are not present giving the sensation of missing out on something.

Conclusion

The activities that are currently possible within virtual reality can provide the conditions to develop a sense of place. This activities range from activities that are undertaken a single time, such as applications for treatment to activities that can be undertaken repetitively, such as leisure activities. The current range of activities that are possible is however limited. It mostly focuses on practical and leisure activities. Besides that a limited amount of content is currently developed. The experts indicate that this will change resulting in more content and a wider range of activities that can be undertaken within virtual reality. This will lead to an increase in possibilities to develop a sense of place.

4.4. Social Interactions

There are different possibilities when it comes to social interactions. This can range from text messages to the use of avatars to physical contact. Avatars are virtual representations that can be chosen by someone to represent themselves in a virtual environment. As mentioned in chapter two, someone can experience a virtual body as if it is their own (Slater et al., 2010). The focus will be on the use of avatars and the possibility of emotional expressions from these avatars, because this gets the closest to real life communication. Besides that, aural communication and communication through the use of text messages is something that is already possible with many modern technologies and that is something that is also possible in virtual reality.

Avatars

Currently the use of avatars in virtual reality is an underdeveloped possibility. Most current applications focus on virtual environments itself to create an experience and not on social interactions, as mentioned by six experts. This is partly because of the difficulties regarding interaction, but also because of the fact that an impressive experience can be created without interaction. Avatars are however already used in several other digital media.

There are two possibilities using avatars, the first is to use an avatar that does not resemble a person's own body and the second is an avatar with a close resemblance to someone's body. As mentioned above there are already a lot of media where it is possible to use avatars, such as in games as Second Life. These avatars can be personalized and can, but not necessarily, have a humanlike appearance. A character that someone controls in a regular game can also be seen as an avatar.

There are currently some virtual reality applications that provide the possibility to use an imaginary avatar for social interactions. One application, called Social Alpha, for example offers the possibility to sit in a cinema and watch a movie simultaneously with others who are also represented by an imaginary avatar. Two different experts that were interviewed used this application. Overweg said that he had a really nice experience having an interesting conversation with someone who was likeminded. Hooimeijer however did not like the experience and spoke of a kind of invasion of his personal space, because the avatar got close and he felt that there was another person behind the avatar. This difference is explained by the personal preferences of the experts. Hooimeijer mentioned that he especially liked the solitude that virtual reality can provide.

Hooimeijer also mentioned that, in other virtual reality application, certain head movements processed by tracking devices makes you unconsciously realise that you are dealing with a human being behind the avatar. This can contribute to having a sense of presence, as mentioned in the theoretical framework (Mennecke et al., 2011).

The success of the use of an imaginary avatar might depend on the person but it does offer possibilities for social interactions. Especially when these avatars can be personalized. The emotions displayed by the avatar however do have to match the message that is conveyed as mentioned in the theoretical framework (Qu et al., 2014). Kors and Van der Grinten also mentioned that it is easy for people to get emotionally attached to computer-generated content even if it is an imaginary appearance. This could take shape in the form of a computer-generated animal with which someone can interact for example. This corresponds with the study of Mennecke et al. (2010) who mention that a sense of presence can develop through communication with objects that do not have a humanlike appearance, as mentioned in the theoretical framework.

Another aspect that might be possible in the future is the use of avatars that are representations of an actual physical body. Hardware measuring and recording emotional expressions are already under development and all the 10 experts do expect that this will improve massively in the (near) future.

There is however a limitation that has to be overcome to make such social interactions widely possible. This problem is referred to as the uncanny valley, it describes the responses of humans to humanlike appearances. When something closely resembles a human but when it is still possible to see that it is not a human being, people tend to feel disgust towards that something (Wang et al., 2015). The uncanny valley is currently a gap that still needs to be bridged to have social interactions close to real world interactions. The expectations of the experts are that this will happen in the future. Making it possible to have social interactions with emotional expressions as good as in real life.

Conclusion

It is currently already possible to have social interactions in virtual reality. These interactions could for some people offer the possibility to have experiences that can contribute to the development of a sense of place. But others may need the expected future developments to create the conditions for a development of a sense of place. The next three chapters are related to this chapter and discuss the possibilities that social interactions provide.

4.5. Othering

The possibility to have social interactions within virtual reality might also afford the possibility to form groups and the social and symbolic characteristics that are linked to these groups. In this chapter these possibilities will be discussed. The element othering is also strongly connected to the next two elements being social and symbolic meaning and self-identification.

Currently there are limited virtual reality applications for the head mounted display that facilitate the possibility to form groups. The applications that do have this possibility are regular games that have an equivalent for the HMD. This is probably the result of the fact that the technology is not widely accepted currently. So in this case relating digital media, such as games, and the applicability of these cases to virtual reality applications will be discussed. Resulting in the future possibilities of virtual reality regarding the formation of groups and therefor othering.

The most striking example of the formation of groups, using digital media, is in gaming. Currently almost all games provide the possibility to play that game online with others. This provides the opportunity to form groups. There are nowadays already large rivalling online communities for particular games such as League of Legends. In this game there are clans that form territories that are marked using symbols that are linked to that particular community, as mentioned by Overweg.

Another possibility that is already provided by current widely used digital media is the fact that it is easier to find people that are likeminded. Virtual reality will also provide this possibility with an addition of more in depth communication as mentioned in the previous chapter. This can result in the fact that it will be even easier for people to find likeminded people and build stronger connections with these people and form communities.

All the ten experts agree that this will become possible in virtual reality environments. Belleman mentioned that current digital media will get an equivalent in virtual reality, such as the possibility to play games in virtual reality and visit certain events linked to particular communities. This will be followed by the fact that environments will be specifically designed for certain communities. This is also mentioned by Venema who envisions that he will be creating such environments in the future. Possibilities regarding the creation of such environments will be explained in detail in chapter 4.9, *Possibility to shape the environment*.

Conclusion

The results shows that the conditions for othering can be provided within digital media and currently partly within virtual reality. This possibility will be provided in the future when more content is developed and more people start to use the technology. This can result in the creation of groups and the creation of specific virtual environments for these groups. This can contribute to the development of a sense of place.

4.6. Social and symbolic meaning

Social and symbolic meaning has a large overlap with the previous two elements and the following element of place identity. There are already some relevant subjects discussed in the previous two chapters, such as the fact that it is possible to have social interactions which can lead to the formation of groups. This can result in the creation of social and symbolic meaning. It also mentioned the possibility to create virtual environments specific for particular communities and the fact that it is already possible in games to have symbols to mark territories. In this chapter this will be discussed in more detail.

Soolsma mentioned that it will be possible to have different virtual environments and that it is possible to choose the environment that is closest to your liking. This is also something that is mentioned by Hooimeijer:

"I think that people will be looking for experiences that suit them. Experiences that express their symbolism so to say, to experience something that has a particular story behind it and which therefor has meaning. This is already something that happens with other media. (...) VR will only increase and widen these possibilities."

This is also mentioned by Van der Grinten who made the comparison with games. In some games it is already possible to store certain objects, such as a sword that has been used in the game and which therefor have symbolic meaning to someone. There are rooms that can be filled with these kind of objects. This is something that can happen in virtual reality environments as well. He also mentioned that content developers should create a framework that can be personalized by the users. For example by creating galleries that can be filled with photos of certain events that took place, or with pictures from a holiday. This will be discussed in further detail in chapter 4.9, *Possibility to shape the environment*.

Conclusion

The information above indicates that it is possible to attach social and symbolic meaning to certain virtual objects and virtual environments. This can therefor provide conditions for the development of a sense of place.

4.7. Place identity

The element of place identity can be the result of the other elements in the conceptual model (Cuba & Hummon, 1993; Proshansky et al., 1983; Jorgensen & Stedman, 2001). The possibilities regarding the other elements are discussed in the other chapters. The focus of this chapter will be on self-identification through the use of (imaginary) avatars in a virtual environment and on the possibility that virtual reality provides for people to express themselves.

To mention the possibilities regarding self-identification in virtual reality, the experts often refer to other digital media such as Facebook and Instagram. Personalizing a profile with data that represent a person will also be possible within virtual reality. There are however two sides to this: people can represent who they are in real life but they can also make fictional representations, as is possible with other current digital platforms. Both will be discussed hereafter.

Digital media already offer the possibility to present yourself. This has become an important way for many people to express themselves and therefor has become a part of their identity. Digital media also often make it easier to express yourself. This advantage will also be provided by virtual reality. Seubers and Kors mentioned that it is easier for people to 'speak up' in a virtual world. Kors also mentioned that you have a certain amount of freedom in who you are and what you do in virtual reality. This can for example make it easier to feel appreciated. This is also discussed in the case study on Second Life (Barnes and Pressey, 2012).

Someone can also have more freedom regarding how a virtual environment is shaped compared to a physical environment. The possibilities to personalize an environment will be discussed in chapter 4.9. A personalized virtual environment or a virtual environment linked to a specific group can also underpin the behaviour of someone. This is important as discussed in the theoretical framework (Jorgensen & Stedman, 2001; Krupat, 1983; Kudryavtsev, 2012).

Another aspect of virtual reality is the fact that people are not limited to their real life persona. People can be someone that differs from their real life persona on digital platforms. This possibility is something that is often criticised in the use of social media by some people. People tend to represent themselves in a more positive way for example. This is also something that is mentioned by six experts. They mention that the persona created in games or on social media can become more important than the real life persona for some people. Making them believe in the image that they have created online resulting in a digital identity. This is also something that is linked to the possibility to use and personalize an avatar. This avatar can also become something that people identify themselves with when someone has put a lot of effort in personalizing an avatar.

Conclusion

The freedom that virtual reality will provide regarding the way that people behave and the way that a virtual environment is shaped can result in a place identity. This can result in an emotional connection with a digital identity as well as with a virtual environment where someone feels appreciated. This can offer a possibility for the development of a sense of place.

4.8. Privacy

Privacy differs from the previous four elements and has a private character. A private environment can also contribute to a place identity. Privacy, as mentioned in the theoretical framework, has to do with the possibility to have a place for your own and having the control over the environment with the power to exclude others (Holloway & Hubbard, 2001; Gustafson, 2001). This element is strongly linked with the next element being the possibility to shape the environment.

A head mounted display is in itself a device that shuts someone off from the physical around someone. This suggests that it should be possible to create personal experiences. But this depends also on the content that is available. As discussed in the previous chapters various content has been and will be developed in the future. A lot of content that has been created has focussed on the creation of a personal experience often with the purpose to reduce stress. Hooimeijer stated:

"I think that it, for some people, will become a nice world to flee to so they can close themselves off from the physical world around them. But for some people it will definitely be something that they especially want to share with others."

Other experts also agree on this. La Grand mentioned that these environments are already created, mentioning an example of a zen garden created by Enversed, the company that Van der Grinten works for as mentioned before. Van Hoesel mentioned studies that proved that virtual environments can reduce stress as good as physical environments. La Grand also mentioned that virtual environments are always experienced differently by different people. These environments provide the freedom to interact with an environment as you wish. This will always result in a personal experience specific to that person.

Overweg also mentioned that these virtual environments, with the goal to create relaxing personal experiences, have already been created and that he tried such an experience himself and he spoke of a really pleasant relaxing experience.

Conclusion

These virtual environments for personal experiences are already created and more will be created in the future. This could, for some people, provide the conditions for the development of a sense of place with such particular virtual environments. The possibility to create such an environment yourself will be discussed in the next chapter discussing the element of the possibility to shape the environment.

4.9. Possibility to shape environment

An important aspect in the development of a sense of place is how someone can control the environment around him. This is also mentioned in the previous two chapters discussing the ability to personalize an environment and the possibility to exclude others from an environment. In this chapter the possibilities to shape an environment will be discussed.

Computer rendered environments

There are currently limited opportunities for ordinary people to shape a virtual environment using applications for a head mounted display. As mentioned before Van der Grinten stated that content developers have to create a framework that can be personalized by the users. This can be compared with personalizing a house or creating a gallery as discussed in chapter 4.6, *Social and symbolic meaning*. The ten experts agree that such possibilities will be available in the (near) future. This will give people control over a virtual environment.

This possibility can be facilitated by software on a computer that provides the opportunity to create a personalized environment, which can then be uploaded into a virtual environment. There are already different platforms that provide databases with different objects that can be uploaded in an environment such as Google SketchUp. But the ten experts also think that it will become possible to affect an environment when someone is in a virtual environment through the use of specifically created devices.

The experts however differ in their opinion how much interest there will be in such applications. Kors and Overweg for example expect that the interest in such possibilities will be limited. Overweg mentioned that most people have limited creativity when it comes to creating their own world. Van der Grinten expects that a small segment of the people will have the desire to make their own environments and that such possibilities therefor will not become commonly used. But Hooimeijer expects that this will be one of the most important features of virtual reality, partly because of the fact that such applications will become easily accessible. This difference is based on the personal assessment of the desire of people to create their own virtual environment of the experts. These opinions seem to be based on personal preferences regarding the use of virtual reality.

The previous possibilities are linked to personalization of an existing virtual environment. But the different experts do also expect that virtual reality can be used to create houses, virtual environments or even entire parallel worlds for example in cooperation with other people from a community, which will facilitate the elements of social and symbolic meaning and othering. Minecraft is an example of a game that is widely used which makes this already possible. These houses or worlds can be based on the physical world as we know it, but it also provides the opportunity to create imaginary fictional environments.

Representations of physical environments

The previous discussion referred to computer rendered virtual environments. But another option is to record physical world environments as mentioned by La Grand and Seubers. Devices to record real world environments are available currently. These devices are getting within the price range of a lot of people. These prices will continue to decrease in the future. This will provide the possibility to create a recording of a physical world environment that can be transferred into a virtual environment.

Conclusion

Currently the options to shape a computer rendered environment are limited, but the different experts agree that this will change in the future. The possibilities regarding the recording of physical world environments are getting within the price range of a lot of people. These recordings of a physical place can be transformed into virtual environments making it already possible, for regular people, to create their own virtual environment. This suggests that there are already opportunities to develop some conditions for the development of a sense of place. The possibility to shape computer rendered environments will be provided in the future. This will improve the conditions regarding the possibility to shape an environment. This indicates that conditions for the development of a sense of place regarding this element can be provided.

4.10. Continuity

Continuity can be divided into the length of a single experience and to the possibility to have several experiences over a longer period of time. The first aspect is highly linked to the comfort of the hardware devices and the frame rate of the devices. Framerate is the frequency of the pictures that are depicted by a device. The aspect of comfort is not discussed in the theoretical framework but this can have a big impact on the continuity of an experience that is why it will be discussed in this chapter. This will be discussed first followed by the possibilities to visit a virtual environment repetitively.

Comfort

Currently most of the head mounted displays are big and heavy. This results in the fact that such a device will become uncomfortable after a short period of time. The latest devices do provide more comfort making it possible to have an experience for a longer period of time. But the experts mention that it still remains an important limitation currently.

All the ten experts do agree that the devices will get considerably smaller. Some expect that it will get as small as regular glasses others expect that it will get even smaller resulting in the use of small projectors that project the images directly on a person's lens for example. This therefor seems a limitation that will be overcome when the technology advances making it possible to experience VR without noteworthy discomfort.

Framerate

Another important current limitation is the fact that some people develop nausea when they have a head mounted display on their head. This is something that is also mentioned by Overweg who stated:

"In the tests that we did with players 30% got nauseous because of the experience. That is unacceptable. I cannot go and sit in VR with my friends when some of them will get nauseous."

Nausea can develop because of the fact that there is a small delay in the movements that a body makes and the depiction of these movements in the virtual environment. The other experts do agree that this is currently one of the most important limitations of the technology.

They however also agree that this will improve in the future. The frame rate will increase with the increase of the computational capacities, making it less likely that people develop nausea. Seven experts expect that this problem will be overcome in the future and three other experts expect that some people will continue to develop nausea when they intensely interact, for a longer period of time, with a virtual environment. An expected increase in computing capacities is also supported by Moore's Law which describes the exponential increase of computing capacities over the years (Mack, 2011). Passive use of a head mounted display, such as watching a movie, does not result in nausea.

The difference in opinions is the result of a different estimation on how much the computing capacities will increase. Most experts expect that a changing point of view can be processed faster by a computer in the future while the other three experts expect that the brain will continue to be able to detect a small delay. This will be discussed in more detail in the next chapter.

Future visits

As mentioned in the theoretical framework knowing that a place will be around in the future is also important (Gustafson, 2001). Virtual reality does provide important advances in this regard. The only thing that is needed to maintain a virtual environment is the software, storing capacity and small devices to visit a virtual environment. This makes that virtual places are not subjected to decay and cannot stand in the way of other spatial developments for example. This can be an important advantage providing opportunities to digitalise a physical place that has to be destroyed or becomes too expensive to be maintained. This is relevant to the discussion within the field of cultural geography on heritage and how it should be preserved.

The experts expect that the technology will be used frequently by people in the future. This can contribute to the element continuity and therefor to the development of a sense of place within virtual reality.

Conclusion

There are currently some important limitations related to continuity being uncomfortable devices and a limited frame rate. Most experts do however expect that these limitations will be mostly overcome in the future. Although it is possible that a few people will continue to develop nausea. The current limitations seem to be an important factor that makes it hard to develop a sense of place. But these problems will most likely be resolved in the future, for the majority of the people, providing the conditions for the development of a sense of place.

4.11. Aesthetics and realism

In this chapter the comparison will be made between the aesthetic qualities of a virtual environment and the aesthetic qualities of physical environments. But the possibilities to create imaginary virtual environments with aesthetic qualities will also be discussed. This element has a strong link with the frame rate and with the computational capacity of devices discussed in the previous chapters. A division between recordings and computer rendered virtual environments will also be made.

Realism

The importance of realism on how people experience virtual reality is already discussed in the theoretical framework (Bouchard et al., 2012; Go, 2012; Kwon et al. 2013). Realism is linked to the aesthetics and interaction which both impact the sense of presence. The possibilities regarding interaction are already discussed in chapter 4.2, *Cognition*.

When it comes to a recording of a physical world environment the main factor regarding the aesthetic qualities of a virtual environment is the resolution of the displays that are used. The experts mention that devices are getting on the market currently that cover the gap between an experience in which you can single out a pixel to an experience where this is not possible anymore. There are already mobile phones available with a 4K display and 8K displays are expected. So limitations of the displays of the devices seem to be resolved providing the possibility for realistic aesthetics.

When it comes to computer rendered environments there are currently some limitations. The current computational capacities result in limitations regarding the framerate of an application that offers interaction, as mentioned before. The computational capacity of most devices is currently not high enough to create a high framerate with the highest quality of computer rendered frames. Belleman and Van der Grinten mentioned that the frame rate should not get below 90 frames per second. If it does get below this point it will decrease the experience itself. This means that the frames that are used in current experiences are not of the maximum quality that is currently possible. This however does not mean that an experience has a low aesthetic quality. The aesthetic qualities of an experience can still be impressive.

The ten experts do expect that the computational capacities of the devices will continue to improve in the future making it possible to use a higher frame rate. This is supported by Moore's Law, as mentioned before (Mack, 2011). Five experts even say that it will become hard to, or even impossible to see the difference with a physical environment. Van Hoesel mentions that it is already possible to create a virtual environment that cannot be distinguished from a physical environment but this requires a large amount of computational power. La Grand for example used computer rendered environments and got responses from different customers that they did not want a photo of a real environment, but a computer rendered image.

The other experts expect that the technology will not advance far enough, resulting in the fact that the computational capacity limits the aesthetic quality or the possibilities regarding interaction.

Imaginary environments

In the previous section a comparison is made between virtual environments and physical environments. Virtual reality however also offers the possibility to create imaginary environments. Van der Grinten mentioned that the spatial component, of a fictional virtual environment, in itself can provide an experience that is similar to the experience of a physical environment. Belleman also mentioned that a fictional virtual experience can have a profound impact on people. What people consider beautiful is also something that differs between people, as mentioned by Venema. This means that fictional environments can also be perceived as something beautiful by people. These environments do not necessarily have to have realistic aesthetics. In this case the realism of the interaction with the environment plays an important role.

Conclusion

The current possibilities of virtual reality, when it comes to aesthetics and realism are bound to certain limitations. The computational capacity of most devices is currently not high enough to create an experience of a virtual environment with an optimal aesthetic quality and a high frame rate. But the

aesthetic qualities can nevertheless be high also in fictional environments. This will however change in the future. When the computational capacities improve the aesthetics and therefor the realism will improve as well. This improvement is something that all the ten experts expect. If these aesthetic qualities are high enough will depend on a person's own preferences. But the necessary conditions will be provided for some people to be able to develop a sense of place.

4.12. Possibility to satisfy needs

In this chapter the possibility to satisfy needs through virtual reality will be discussed. This is the most abstract element in the conceptual framework. In the interviews the experts were asked what they think that the impact of virtual reality will be in the future. Will people, for example, begin to work or educate themselves in virtual environments in the future?

The experts differ in their opinions about the future and the impact of virtual reality. All experts agree that the technology will continue to improve and that the impact of the technology will increase. But some think that it will be mostly used for entertainment purposes while others think that parallel worlds can be created and that it will become an important technology in the lives of people. This difference seems to be the result of personal preferences, because all experts expect large developments and improvements to the technology itself.

One of the needs of people is to share their story with others as mentioned by La Grand. He mentioned that people have felt the need to tell stories and share their experiences since the beginning of time. Sharing your stories with the world has become easier in the last years. It started in the early days with drawings, followed by script, followed by computers such as mobile phones and the latest medium is virtual reality. This technology will again make it easier to share your experiences and share it with other people in more detail. This will meet the need of people to share their stories.

A similar point was made by Van der Grinten who mentioned that people always envisioned imaginary worlds. This happened first through reading a book and someone's imagination but every medium has made it easier to create your own imaginary world. Virtual reality will provide the opportunity to create such an imaginary world in more detail compared to other media. Virtual reality also offers the opportunity to 'visit' other places that can be out of reach for some people to visit physically.

The experts also mentioned the possibilities of the technology regarding education and work. This can help in the satisfaction of the economic goals of people (Williams, 2014). The technology provides opportunities in education to make it easier to explain matter with a spatial component. This can range from a 3D model of a molecule, to the anatomy of animals, to geological processes, to visualization of the entire universe. The technology will provide the opportunity to explain difficult matter in a way that is easy to comprehend.

The same is applicable to jobs that deal with a strong spatial component, such as the creation of new products or the design of buildings or the design of entire new neighbourhoods. 3D models of these planned future developments can be made in virtual reality to have a first look at these planned projects. Making it possible to see a close simulation of the future product which will make it possible to see possible defaults in a plan for example.

Conclusion

Most experts (six out of ten) do think that virtual reality will be used for short periods of time in the daily lives of most people. They think that some limitations will remain or that people will be looking for true experiences. But these experts often mention that this is their personal opinion and that they could be wrong. Four of these experts also mention that a minority of the people will use the technology excessively in the future.

The other four experts, such as Van der Grinten, think that the technology will have a bigger impact on the day-to-day lives of people, stating:

"I think that virtual reality will meet needs such as the need for connection, the need to explore, the need to travel and the need to be accompanied. I think that it can become a medium which makes it possible to have deep connections with other people. I believe that it will make the world very small."

A small world refers to globalization and the fact that people can contact each other and share their stories all over the world. This for example makes it easier to find likeminded people to find fulfilment in life, as mentioned before.

The possible future impact of the technology will be further discussed in chapter five, which discusses the results and answers the research questions. The next section will exist of an example of a virtual reality application to show the elements that are facilitated by this application.

Case study two: 'A breathtaking journey'

'A breathtaking journey' is a virtual reality application that is developed by M. Kors in cooperation with C. Ketel. Kors is one of the experts that is interviewed for this study. The goal of the application is to influence the empathy that is felt by people towards the refugee crisis and see if this change in empathy can result in a change in behaviour.

Kors mentioned that they detected an increase in empathy towards the refugee crisis. The possibilities of virtual reality regarding behavioural change is something that they are still working on. The change in empathy indicates that virtual reality influences cognitive processes. The influence on the cognitive processes is achieved through the provision of the conditions for several elements of the conceptual model. The story of the application and the elements that are facilitated within the application will be discussed hereafter.

The application starts with a flashback showing how 'you' tried to flee across the sea to escape a warzone and how this attempt failed. This failed attempt resulted in the fact that you have spent your last money. When the flashback is finished you feel that you are sitting in a moving truck. This is accomplished through visual and audial stimuli as well as by vibrations and the smell of tangerines, which are depicted as the cargo inside the truck.

The different stimuli are provided through different devices. You are placed inside a booth mimicking the virtual hiding place, the visual stimuli are provided through a head mounted display, the audial stimuli are provided through headphones and a mask detects your breathing which influences the course of the experience. Real tangerines are used to create the smell of tangerines.



(Ketel & Kors, 2016)

When you are inside the truck you can look around you and look through a small hole in the side of the truck. Then the truck is stopped and you can hear and see the doors of the trailer open and you can hear that a man is searching the cabine. This is when you have to hold your breath to make sure that you are not detected. The man leaves and the doors of the trailer close again when you have successfully held your breath.

This application facilitates the possibility to experience an activity that makes it possible to go through an experience that simulates the distressing situation of many refugees. This experience is perceived as impressive by many people and gives you the opportunity to get to know what refugees might go through when they flee their country.

An important element in the creation of an impressive experience and a sense of presence is the possibility to influence the environment, as mentioned before. In this application it is possible to impact the experience because your breathing is monitored. The application reacts to your breathing which makes it possible that you will be detected.

This application can also influence other elements in the conceptual model such as othering and social and symbolic meaning. The experience can make it possible to get to know what it means to people when they have to go through such an experience. When you hear a story of refugees, after you have used the application, it could make you rethink the experience and feel more empathy towards refugees. Social and symbolic meaning can be attached to the virtual environment of the application. This can, for example, lead to the fact that you remember this experience when you see a picture of a hiding space in a truck.

Knowing what people have to go through can also influence how you look at other people. This means that it can impact the element of othering. The experience might make you realise the severity of the things that refugees have to go through. This can result in an increase in empathy.

Most of the senses are stimulated through the application, as mentioned above. The audial and the visual play an important role in the experience. Besides that the sense of touch is also stimulated through vibrations and the sense of smell is stimulated through the scent of tangerines. Kors mentioned that the results regarding the impact of the incorporation of the different senses are not yet available

The application shows that many elements of the conceptual model can currently be facilitated within a virtual environment and that it can impact cognitive processes. Some of the elements are not facilitated within the application, such as continuity and privacy. This is because of the fact that the application was specially developed to create a unique experience with the aim to influence empathy.

Chapter 5. Discussion and conclusion

5.1. Discussion

In the previous chapters short conclusions are given regarding the possibilities of virtual reality to facilitate the elements in the conceptual model. These conclusions will not be repeated in the same detail in this chapter.

The conceptual model in the theoretical framework focused on the concept of sense of place and how it relates to the literature on virtual reality. The results and the literature on virtual reality show that there are some aspects that are of great importance when it comes to the development of a sense of place within virtual reality. These aspects are depicted in the figure below and will be discussed thereafter. This figure is made to show how the elements of the conceptual model relate to each other in virtual reality and to show which aspects are essential in the development of a sense of place in virtual reality.

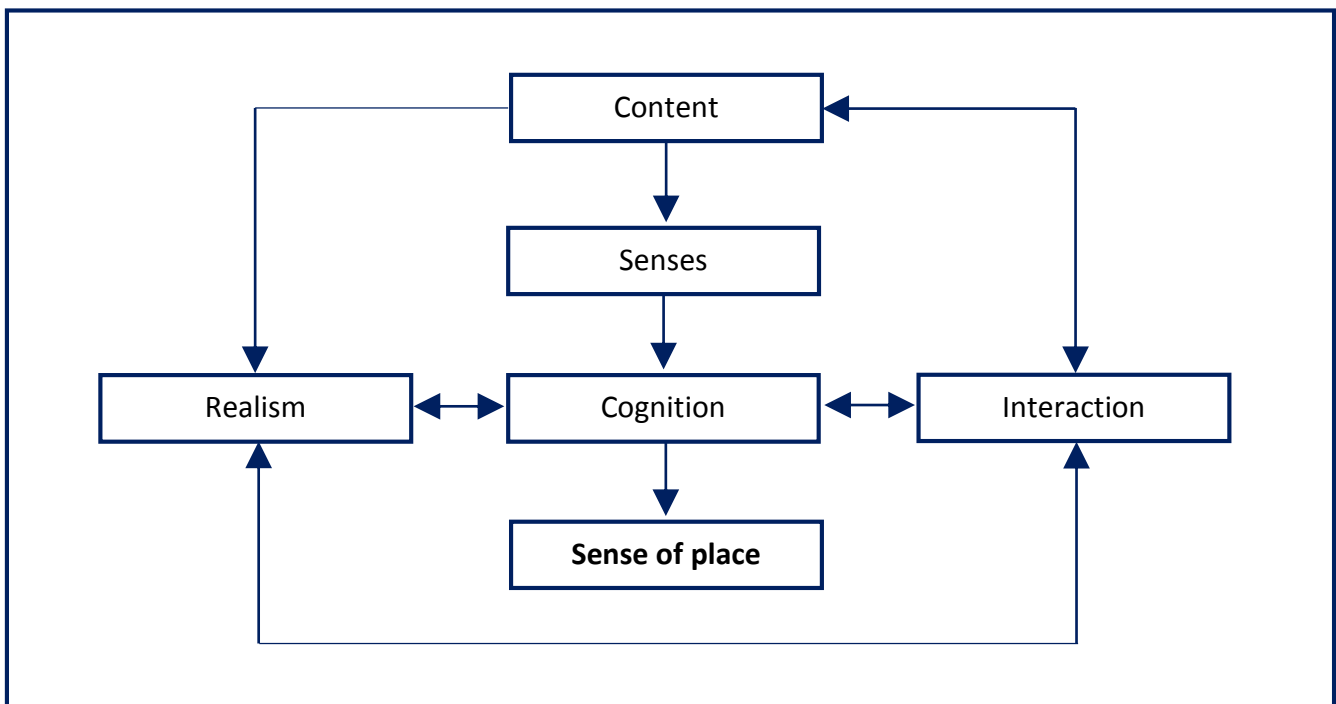


Figure 2: Important aspects in the development of a sense of place in virtual reality

Content

The content of a virtual environment consists of the interchangeable elements of the conceptual model. The results show that it is possible to have impressive experiences in virtual reality and that it is possible to facilitate all the interchangeable elements to some extent within a virtual environment, but the results also show that the quality of these virtual environments can be further improved. It depends on a person if the quality of the virtual environment is high enough currently. The experts agree that the quality of the virtual reality experiences will increase in the future. The content also facilitates interaction and the amount of realism that is perceived. These aspects will be discussed below.

It depends on the purpose of the virtual reality application which interchangeable elements are facilitated. Virtual environments provide the possibility to undertake certain activities, which is one of the most important elements, as mentioned in the theoretical framework (Arora & Khazanchi, 2010; Chen & Kalay, 2008; Gustafson, 2001; Malpas, 2006; Stewart et al. 2013). These activities range from personal activities to social activities. Personal activities can contribute to the element of privacy and social activities can contribute to the elements of social interactions, othering and social and symbolic

meaning. Both types of activities can contribute to the element of place identity. These different activities can lead to the satisfaction of the needs of people.

Senses

The senses are essential in the collection of the information provided by an environment (Benyon et al., 2006; Holloway & Hubbard, 2001; Relph, 2009). In the case of virtual reality the information is provided by the content of a virtual reality application. Sight can be fully incorporated in a virtual reality experience currently. The audial stimuli can also be fully incorporated in a virtual reality experience.

The biggest limitation regarding the senses is the possible mismatch between the visual stimuli and the stimuli for the vestibular system, because of a small delay between movement and the depiction of this movement. This results in the fact that some people get nauseas when they interact with a virtual environment. The experts indicate that this mismatch will be reduced, resulting in the fact that fewer people will get nauseas. This will provide the opportunity to use virtual reality for a longer period of time, assuming that the comfort of the devices improves, as expected by the experts. This can facilitate the element of continuity.

The possibilities regarding the other senses are currently limited. Devices that provide stimuli for the other senses have been developed, but a significant limitation is the need for inconvenient devices, which do not create enough added value to compensate the discomfort of these devices currently. These devices will however be improved in the future, as mentioned by the experts.

The importance of stimulating the different senses differs between people. The visual provide the main and most important stimuli for perceiving an environment as discussed in the theoretical framework (Holloway & Hubbard, 2001; Relph, 2009). It depends on the person if the other senses are stimulated sufficiently to create a meaningful experience. The experts do expect that some of the limitations will be overcome and that the devices will continue to improve. This could improve virtual reality experiences and it can contribute to the fact that a larger amount of people will be able to develop a sense of place in virtual reality.

Interaction

The importance of interaction is mentioned in the theoretical framework and in the results (Balakrishnan and Sundar, 2011; Kalay, 2008). The possibility for interaction can contribute to a sense of presence within virtual reality. This means that interaction can have a big impact on the cognitive processes.

The possibility for interaction is provided by the content of a virtual reality application. The results show that recordings often provide limited possibilities for interaction while computer rendered environments provide greater possibilities for interaction. It is currently possible, through the use of devices, to move through and interact with some virtual environments. These devices can be further improved to enhance the experience of this interaction. The experts agree that the devices will be improved, as mentioned before.

The interaction can also lead to a changing content in a virtual environment. This is highly linked to the element possibility to shape the environment. The different experts indicate that it is currently difficult to shape a virtual environment because it requires specified virtual reality applications and specific computing knowledge, but the experts also indicate that applications that provide the possibility to easily shape an environment will be facilitated in the future.

A limitation regarding interaction are the current possibilities regarding the computational capacity and the framerate. Moving through an environment and interacting with an environment requires a large amount of computational power. The computational capacities have to increase to make it possible to develop a virtual environment with high aesthetic qualities in combination with the possibility to move through and interact with the environment. All the experts agree that the computational capacities of virtual reality devices will continue to increase, which is also supported by Moore's law (Mack, 2011).

The data indicates that it is possible to interact with a virtual environment, but it still has some limitations. These limitations can also reduce the possibility for some people to develop a sense of place. The experts agree that these limitations will be reduced in the future, which will result in an

improvement in possibilities to interact with an environment as well as in an improvement in how this interaction is experienced. For some people the limitations might remain too big which prevents them from developing a sense of place.

Realism

Realism can have a significant influence on a sense of presence, which is related to a sense of place (Bouchard et al., 2012; Go, 2012; Kwon et al. 2013). This means that the amount of realism that is perceived can have a big impact on how a virtual environment is experienced.

Realism is facilitated by the content and perceived through the cognitive processes. Realism is also linked to the possibilities regarding interaction. Correct interaction can lead to realism and a realistic environment can stimulate interaction. An experience has to be realistic to influence the cognitive processes and make the brain react to it similar to a real experience. This can contribute to the development of a sense of place.

The results show that it is already possible that people process a virtual environment the same as a physical environment, due to the fact that the brain only processes a limited amount of stimuli, as mentioned before. These environments can be a depiction of a physical environment as well as an imaginary virtual environment. Recordings of a physical environment are realistic. It is also possible to create computer rendered environment with realistic aesthetics. The current computational capacities however form limitations regarding the creation of high aesthetics in combination with the possibility for interaction. These limitations will be reduced the computational capacities increase, as expected. The results also show that improvements can be made to all the different elements in the conceptual model, which can lead to an increase in realism.

Cognition

The reoccurrence of cognition in the discussions about the previous aspects shows the importance of the cognitive processes in the development of a sense of place. The previous aspects form the input for the cognitive processes. Cognition influences interaction and realism too, former experiences with virtual reality can lead to a change in interaction, because of the familiarity of an environment for example. The same is the case for perceiving realism, experiences that happened in the past influences what the brain perceives as real.

How virtual reality is experienced is the result of the other aspects in figure 2 in combination with the cognitive processes. The data shows that the aspects in figure 2 can be facilitated within virtual reality, but also that there are improvements that can be made. The importance of the cognitive processes also indicates that the development of a sense of place is a personal process (Holloway & Hubbard, 2001; Koppen, 2012; Massey, 1994; Relph, 2009; Turner & Turner, 2006; Vanclay, 2008). This can result in the fact that some people can have meaningful experiences in virtual reality while other people cannot.

5.2. Conclusion

Conditions for the aspects above have to be provided to make it possible to develop a sense of place in virtual reality. The different aspects are highly connected, limitations regarding one aspect can result in limitations for another aspects. Limited possibilities for interactions can result in the fact that an application is experienced less realistic for example.

The discussion above indicates that conditions to develop a sense of place can already be provided. There are currently, however, considerable limitations, such as the limitations regarding interaction. It depends on the application and on an individual if the right conditions are currently provided. This means that it is possible for some people to develop a sense of place in virtual reality currently, but that there are also a lot of people who will not be able to develop an emotional connection with a virtual environment. This answers the first research question: *To what extent is it currently possible to develop a sense of place in virtual reality?*

The experts do expect that the limitations, discussed above, will be reduced in the future. An expected increase in computational capacities of devices will lead to an increase of content available, an increase in continuity, an increase in the interaction that is possible, an increase to the stimuli for the senses

and therefore an increase in the realism of a virtual reality experience. This means that the possibilities for the development of a sense of place will continue to improve. This will increase the number of people that are able to develop a sense of place with a virtual environment. The experts differ on their opinion on how important virtual reality will become in the lives of people. This seems to be linked to the personal preferences of the experts. All the experts agree that the technology will increase in importance in the future. Six experts, however think that people will use it for short periods at a time while the other experts think that the technology will be used for longer periods of time. These personal preferences can also be compared to the fact that some people will not be able to develop a sense of place in virtual reality, while other people will develop a sense of place in virtual reality.

Concluding, the possibilities for the development of a sense of place in virtual reality will continue to improve. This will most likely result in the fact that an increasing number of people will be able to develop a sense of place in virtual reality. This answers the second research question: *What are the likely future possibilities of virtual reality for the development of a sense of place?*

The answers to the research questions indicate that it is already possible to develop a sense of place in an immersive virtual environment and that these possibilities will continue to increase in the future when the computational capacities will continue to improve. This answers the main research question: *To what extent is it possible to have a sense of place in virtual reality?* It will, however, always depend on the person if someone can develop a sense of place in a virtual environment.

There are currently already people that are emotionally connected to digital media, as mentioned throughout the report. This number of people will most likely increase when the technology of virtual reality improves. This indicates that virtual reality can have a big impact, firstly on the people that are able to develop a sense of place in virtual reality but also on the field of cultural geography. The technology can eventually have a big impact on the world. It could, for example, become possible to work in a virtual environment meaning that some people do not have to travel to their work anymore. Or it might become possible to create a virtual environment of a heritage site that can match a physical heritage site. Resulting in the fact that the physical site does not have to be preserved. The technology has to be taken seriously and the possible future impacts have to be further studied and considered. This will be further discussed in section 5.4.

5.3. Limitations

Throughout the research it was difficult to critically discuss the data. The goal of the conceptual framework was to provide a comprehensive framework. This meant that all the different elements found in the literature were incorporated into the conceptual model and that the biggest differences were related to how the different elements were named. This meant that it was not needed to choose one element over another which would have needed a critical line of reasoning. This resulted in general and sometimes abstract information. This was partly because of the fact that sense of place is such a personal concept. It is possible to mention the conditions that have to be provided for the development of a sense of place, but these conditions are used differently by every individual to develop a personal sense of place.

The wide range of elements also limited the possibilities to discuss each element in depth. Reasons for some of the possibilities regarding an element or the reasons behind the opinions of the experts could have been discussed in further detail. The exploratory nature of this study prevented this due to a lack of time and information. This would be done differently in hindsight, focusing on more detailed qualitative information.

Another aspect that made it hard to analyse and discuss the results of the study critically was the consensus between the experts. There are differences but these differences seem to be linked to how the experts experience the technology themselves. The exploratory nature of the interview guide and of this research resulted in the fact that the exact reasons behind the opinions of the experts were not determined. It would have been useful if there was more emphasis on the qualitative reasons behind the data gathered.

The participation of experts on virtual reality, to study the possibilities of the technology, results in the risk of biased opinions. The technical and practical nature of the technology and the consensus between the different experts resulted in valid results regarding the technical possibilities of the

technology. This differed regarding how virtual reality is experienced and the expected future impact of the technology. The personal preferences of the experts seemed to play a part in their opinions on these matters. This also resulted in differing opinions between the experts. These differences have been mentioned and discussed. This also shows that people react to the technology differently. Where one expert likes to be in an imaginary environment for a longer period of time, another expert does not necessarily like such an experience.

5.4. Future research

When virtual reality gets used by more people it is possible to study the possibility to create a sense of place within virtual reality by asking people, who have used the technology for a longer period of time, to participate in a study. This could also help to study the different aspects, in figure 2, separately to get to know how these aspects work in more detail and what the most important conditions are to provide these aspects.

The comparison of virtual reality with games is often made throughout this report. Nowadays a limited amount of people play games. When virtual reality exceeds the quality of games and creates a more credible experiences it could result in the fact that more people will use virtual reality. The results suggest that this could be the case. This however also depends on if the technology will get socially accepted. The social acceptance of virtual reality can be studied in future researches. The impact of the technology will be highly depended on the social acceptance of the technology.

Another aspect highly related to technology in general and the social acceptance in particular are the ethical aspects of the technology, such as privacy. Virtual reality can result in a reduction of the privacy of people, as mentioned by La Grand and Overweg. The ethical aspect of virtual reality is already studied to some extent by Gooskens (2010). Future research can study this aspect focussing on immersive virtual reality including the latest developments of the technology.

Virtual reality is highly related to augmented reality. Augmented reality is also discussed in the theoretical framework. Augmented reality, adding computer generated content to an existing environment, can also impact the way that people experience a place and therefor impact a sense of place. This impact can be studied in future researches.

References

- Arora, V. & Khazanchi, D., (2010). Sense of Place in Virtual World learning environments: a conceptual exploration, *Information Systems and Quantitative Analysis Faculty Proceedings & Presentation*, 8
- Balakrishnan, B. & Sundar, S., (2011). Where Am I? How Can I Get There? Impact of Navigability and Narrative Transportation on Spatial Presence, *Human-Computer Interaction*, 26(3), 161-204.
- Barnes, S. J. & Pressey, A. D., (2012). Who needs Real-Life? Examining needs in Virtual Worlds, *Journal of Computer Information Systems*, 52(4), 40-48.
- Beidler, K. J. & Morrison, J. M., (2015). Sense of place: inquiry and application, *Journal of Urbanism: International Research on Placemaking and Urban Sustainability*.
- Benyon, D., Smyth, M., O'Neill, S., McCall, R. & Carroll, F., (2006). The Place Probe: Exploring a Sense of Place in Real and Virtual Environments, *Presence*, 15(6), 668-687
- Boon, S. & Sinclair, C., (2009). A world I don't inhabit: disquiet and identity in Second Life and Facebook, *Educational Media International*, 46(2), 99-110.
- Bouchard, S., Dumoulin, S., Talbot, J., Ledoux, A., Phillips, J., Monthuy-Blanc, J., Labonté-Chartrand, G., Robillard, G., Cantamesse, M. & Renaud, P., (2012), Manipulating subjective realism and its impact on presence: Preliminary results on feasibility and neuroanatomical correlates, *Interacting with Computers*, 24, 227-236
- Carmigniani, J., Furht, B., Anisetti, M., Ceravolo, P., Damiani, E., Ivkovic, M. (2011). Augmented reality technologies, systems and applications, *Multimedia Tools Application*, 51, 341-377.
- Chang, Y.-L., Hou, H.-T., Pan, C.-Y., Sung, Y.-T., Chang, K.-E. (2015). Apply an Augmented Reality in a Mobile Guidance to Increase Sense of Place for Heritage Places. *Educational Technology & Society*, 18 (2), 166-178.
- Chen, X. & Kalay, Y., (2008). Making a Liveable 'Place': content design in Virtual Environments, *International Journal of Heritage Studies*, 14(3), 229-246.
- Corder, D., & U-Mackey, A., (2015). Encountering and dealing with difference: Second Life and intercultural competence, *Intercultural Education*, 26(5), 409-424.
- Cuba, L., & Hummon, D. M., (1993). A Place to Call Home: Identification with Dwelling, Community, and Region, *The Sociological Quarterly*, 34(1), 111-131.
- Cummings, J. J. & Bailenson, J. N., (2015) How Immersive is Enough? A Meta-Analysis of the Effect of Immersive Technology on User Presence, *Media Psychology*, 1-38.
- Diemer, J., Alpers, G. W., Peperkorn, H. M., Shiban, Y. & Mühlberger, A. (2015). The impact of perception and presence on emotional reactions: a review of research in virtual reality, *Frontiers in Psychology*, 6.
- Dymnickaa, M., (2010). The end of place as we know it? *Human Geographies*, 4(1), 53-65
- Gemeinboeck, P., (2004). Virtual Reality: space of negotiation, *Visual Studies*, 19(1), 52-59.
- Gieryn, T. F., (2000). A space for place in Sociology, *Annual Review of Sociology*, 26, 463-496

- Go, H., (2012). *Sense of place evoked by interactive maps*, Texas A&M University
- Gooskens, G. (2010). The Ethical Status of Virtual Actions, *Ethical Perspectives*, 17(1), 69-78.
- Gustafson, P., (2001). Meanings of place: everyday experience and theoretical conceptualizations, *Journal of Environmental Psychology*, 21(1), 5-16.
- Holloway, L. & Hubbard, P., (2001). *People and place*, Dorchester: Pearson Education Limited.
- Jarmon, L., Traphagan, T., Mayrath, M. & Trivedi, A., (2008). Virtual world teaching, experiential learning, and assessment: An interdisciplinary communication course in Second Life, *Computers & Education*, 53, 169-182
- Jorgensen, B. S., (2010). Subjective mapping methodologies for incorporating spatial variation in research on social capital and sense of place, *Tijdschrift voor Economische en Sociale Geografie*, 101(5), 554-567.
- Jorgensen, B. S. & Stedman, R. C., (2001). Sense of place as an attitude: Lakeshore owners attitudes toward their properties, *Journal of Environmental Psychology*, 21, 233-248
- Ketel, C. & Kors, M., (2016). A Breathtaking Journey, visited on 07-04-2016 via <http://abreathtakingjourney.com/>
- Koppen, H., (2012). *Het fenomeen van de geografische ervaring, Een fenomenologisch onderzoek naar opvattingen van filosofen en geografen over het ervaren van plaats en ruimte*, Enschede: Ipskamp Drukkers BV
- Kudryavtsev, A., Stedman, R. C., Krasny, M. E., (2012). Sense of place in environmental education, *Environmental Education Research*, 18(2), 229-225.
- Krupat, E., (1983). A Place for Place Identity, *Journal of Environmental Psychology*, 3(4), 343-344
- Kwon, J. H., Powell, J. & Chalmers, A., (2013). How level of realism influences anxiety in virtual reality environments for a job interview, *International Journal of Human-Computer Studies*, 71, 978-987.
- Leung, L., (2011). Loneliness, social support, and preference for online social interaction: the mediating effects of identity experimentation online among children and adolescents, *Chinese Journal of Communication*, 4(4), 381-399.
- MacCallum-Stewart, E., (2007). The warfare of the imagined – building identities in Second Life, *International Journal of Performance Arts and Digital Media*, 3(2-3), 197-208.
- Mack, C. A., (2011). Fifty Years of Moore's Law, *IEEE Transactions on Semiconductor Manufacturing*, 24(2), 202-207.
- Malpas, J. E., (2006). *Heidegger's Topology, Being, Place, World*, London: The MIT Press Cambridge
- Massey, D., (1994). *Space, Place and Gender*. Cambridge: Polity.
- Mennecke, B. E., Triplett, J. L., Hassall, M., Conde, Z. J. & Heer, R., (2011). An Examination of a Theory of Embodied Social Presence in Virtual Worlds, *Decision Sciences*, 42(2), 413-450.

Muñoz, F., Peña, F., Meza, M. (2014). Virtual Reality Models for the Structural Assessment of Architectural Heritage Buildings, *International Journal of Architectural Heritage: Conservation, Analysis, and Restoration*, 8(6), 783-794.

OpticsGamer, (2016). *Archos VR headset review & comparison with other VR devices*, visited on 05-02-2016 via <http://opticsgamer.com/archos-vr-headset-review-comparison/>

Plunkett, D., (2011). On place attachments in virtual worlds, *World Leisure Journal*, 53(3), 168-178.

Proshansky, H. M., Fabian, A. K., & Kaminoff, R., (1983). Place-Identity: Physical World Socialization of the Self, *Journal of Environmental Psychology*, 3, 57-83.

Qu, C., Brinkman, W. P., Ling, Y., Wiggers, P., Heynderickx, I. (2014). Conversations with a virtual human: Synthetic emotions and human responses, *Computers in Human Behavior*, 34, 58-68.

Relph, E., (2009). A pragmatic sense of place, *Environmental & Architectural Phenomenology*, 20(3), 24-31

Relph, E. (1976). *Place and placelessness*. London: Pion.

Sampson, K. A. & Goodrich, C. G., (2009). Making place: identity construction and community formation through "Sense of Place" in Westland, New Zealand, *Society & Natural Resources*, 22(10), 901-915.

Schroeder, H. W., (2007). Place experience, gestalt, and the human-nature relationship, *Journal of Environmental Psychology*, 27, 293-309

Siltanen, S. (2012). *Theory and applications of marker-based augmented reality*, VTT Technical Research Centre of Finland.

Slater, M., Spanlang, B., Sanchez-Vives, M. V. & Blanke, O., (2010). First person experience of body transfer in Virtual Reality, *PLoS ONE*, 5(5)

Stedman, R. C., (2003). Is it really just a social construction?: The contribution of the physical environment to sense of place, *Society & Natural Resources*, 16(8), 671-685

Stewart, W. P., Williams, D. R., & Kruger, L. E., (2013). *Place-based conservation: Perspectives from the social sciences*. Dordrecht: Springer.

Takatalo, J., Nyman, G. & Laaksonen, L., (2008). Components of human experience in virtual environments, *Computers in Human Behaviour*, 24(1), 1-15

Tuan, Y., (1977). *Space and place, The perspective of experience*, London: University of Minnesota Press

Turner, P. & Turner, S., (2006). Place, Sense of Place, and Presence, *Presence*, 15(2), 204-217.

Vanclay, F., Higgins, M. & Blackshaw, A., (2008). *Making Sense of Place, Exploring concepts and expressions of place through different senses and lenses*, Canberra: National Museum of Australia Press.

Villani, D., Repetto, C., Cipresso, P., Riva, G. (2012). May I experience more presence in doing the same thing in virtual reality than in reality? An answer from a simulated job interview, *Interacting with Computers*, 24, 265-272.

Wang, S., Lilienfeld, S. O. & Rochat, P., (2015). The Uncanny Valley: Existence and Explanations, *Review of General Psychology*, 19(4), 393-407

Weinberger, M., (2015). This company was 13 years early to virtual reality – and it's getting ready to try again, *Business Insider*, 29-03-2016, visited on 23-0-2016 via <http://uk.businessinsider.com/second-life-is-still-around-and-getting-ready-to-conquer-virtual-reality-2015-3?r=US&IR=T>

Williams, D. R., (2014). Making sense of 'place': Reflections on pluralism and positionality in place research, *Landscape and Urban Planning*, 131, 74-82.

Appendix A

Interview guide

The experts will be interviewed using the different elements of the conceptual model. Every element will be discussed to find out to what extent virtual reality can facilitate that element currently and what the expected future possibilities are. The different steps of the interview and the order in which the elements will be discussed will be mentioned below.

1. Ask if the participant agrees that the interview will be recorded
2. Explanation about the study and the objective of the interview
3. Question what the participant has to do with virtual reality
4. Discuss the different elements in the following order:
 - Activities
 - Experiences
 - Social interactions
 - Social/symbolic meaning
 - Self-identification
 - Othering
 - Privacy
 - Possibility to shape the environment
 - Continuity
 - Aesthetic qualities of a place
 - Senses
 - Cognition
 - Possibility to satisfy needs
5. Remaining questions depending on the way the interview went
6. Ask the participant if he would like to add something that he thinks is important
7. Ask if the participant has any remaining questions

Appendix B

Informed consent form

Titel onderzoek: Is it possible to have a sense of place in virtual reality?

Verantwoordelijke onderzoeker: Jan Willem Bolks

Bij deze verklaar ik op duidelijke wijze te zijn geïnformeerd over het onderzoek en het doel van het interview. Ik heb de gelegenheid gehad om vragen te stellen over het onderzoek, het interview en de verwerking van de gegevens voortkomend uit het interview. Ik accepteer dat de gegevens voortkomend uit het interview verwerkt kunnen worden in het uiteindelijke rapport dat het resultaat vormt van dit onderzoek. De verzamelde gegevens worden uitsluitend voor dit onderzoek gebruikt.

Mijn deelname aan dit onderzoek is geheel vrijwillig. Ik heb het recht om te allen tijde mijn deelname te beëindigen zonder opgaaf van redenen.

Datum:

Naam deelnemer:

Handtekening deelnemer:

Appendix C

Codes:

- Senses
- Cognition
 - Sense of presence
 - Interaction
- Activities
- Social interactions
- Social/symbolic meaning
- Place identity
- Othering
- Privacy
- Possibility to shape the environment
 - Interaction
- Continuity
- Aesthetics / realism
- Possibility to satisfy needs