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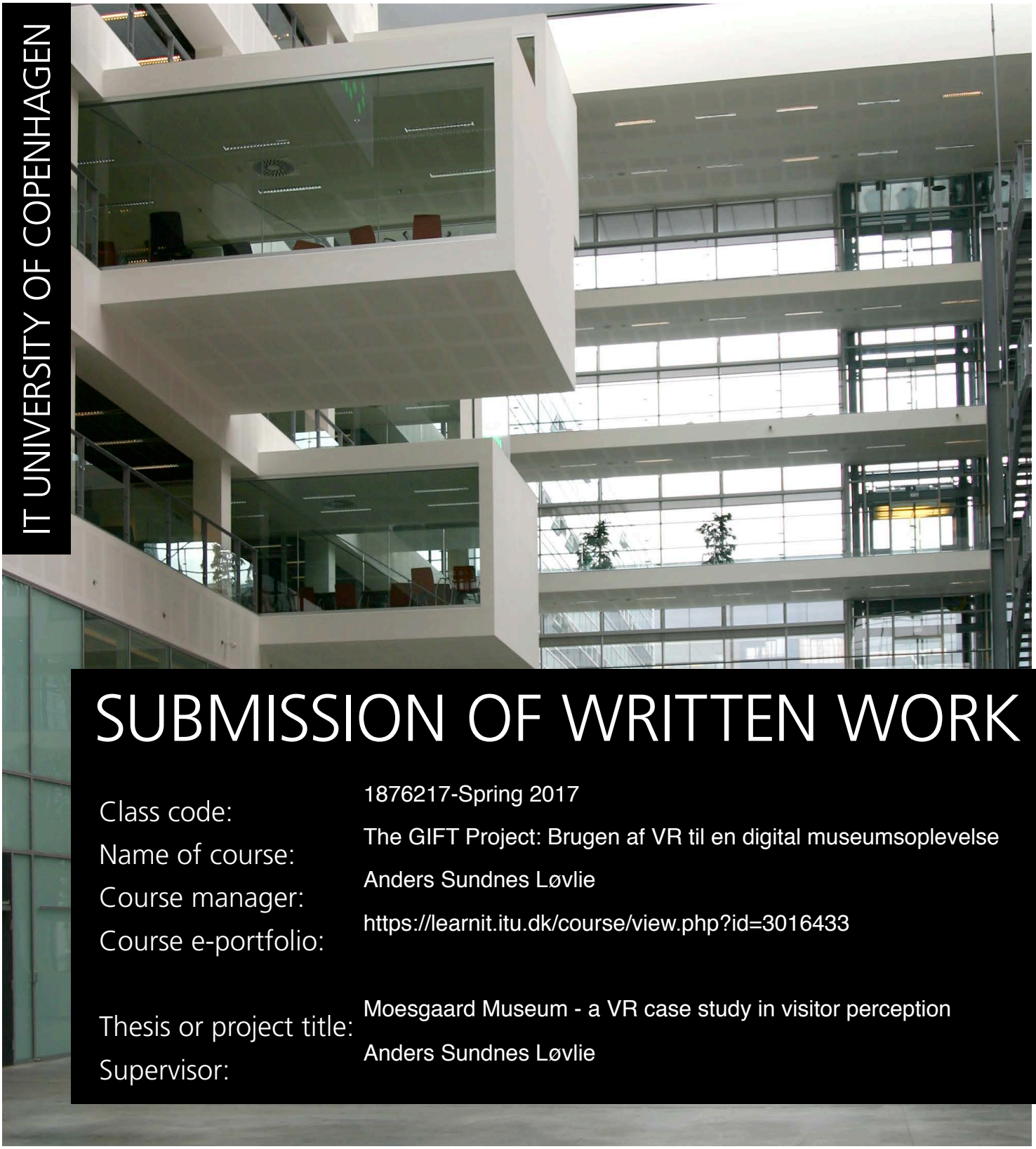

SUBMISSION OF WRITTEN WORK

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Abstract

The scope of the project is rooted in *GIFT*, a Horizon2020-funded project exploring how hybrid virtual museum experiences can lead to new ways of exploring and experience the museum. The paper seeks to uncover how virtual reality is being used to engage visitors at Moesgaard Museum and how the visitors perceive this virtual reality experience. To answer the research question, I have made use of a triangulation of a quantitative AttrakDiff survey and eight qualitative semi-structured interviews. The analysis of the qualitative data suggests that the informants perceive the VR experience at Moesgaard to be an overwhelmingly positive addition to the museum exhibition with a few negatives and potential additions. The findings are not to be generalized about *all* museum visitors, but merely reflect the eight informants' perceptions. The findings can give an indication of how *some* visitors *might* perceive this VR experience. The qualitative findings are backed up by the AttrakDiff results of the experience being perceived as innovative, bold, novel, premium, captivating and creative and technical - however, more research is required due to the questionable validity of the quantitative data, based on the small sample size.

Character count: 57409

Introduction

Come the 21st century and technology is booming more than ever. Every industry, conservative or progressive, is dealing with digitalization. Cultural educational institutions such as museums are no exception to the digitalization that the world is facing. Customarily, museums have allocated their resources to create compelling exhibitions within the physical space. With technologies such as Virtual Reality becoming increasingly common, museums are starting to experiment with moving their exhibitions past the walls of the institution and into the virtual space.

The motivation for this project is a personal interest in new technologies, whether it be for gaming, entertainment, education or something else entirely. Especially virtual reality is something that I've always wanted to explore. The scope of the project is rooted in *GIFT*, a Horizon2020-funded project exploring how hybrid virtual museum experiences can lead to new ways of exploring and experience the museum. To contribute to this, I have chosen Moesgaard Museum as a case study in uncovering how the museum visitors perceive the museum's virtual reality exhibition. Thus, the problem statement which the paper seeks to answer is:

> *How is virtual reality being used to engage visitors at Moesgaard Museum and how do the visitors perceive this virtual reality experience?*

The paper will seek to answer this research question through an analysis based on data from a triangulation of qualitative and quantitative methods, more specifically an AttrakDiff survey and eight semi-structured interviews. The research design is based on desk research in the shape of a literature review on what characterizes the VR technology, the VR experience and how it can be used in a museum exhibition. Furthermore, the findings as well as the methodology will be discussed. The findings are not to be generalized about *all* museum visitors, but merely reflect the eight informants' perceptions. The findings can give an indication of how *some* visitors *might* perceive this VR experience.

Literature review

The purpose of this literature review is to gain a deeper understanding of virtual reality (VR), museums and the museum experience in general. Furthermore it will explore how these have been used in conjunction through specific use cases. This will be done through examinations of academic papers, books, articles and websites.

Virtual reality

Definition and terminology

How can you describe the virtual reality experience and what is it characterized by?
Gigante (1993) argues that VR is characterized by the illusion of participation *within* an environment, rather than external observation known from e.g. TV. It usually relies on 3D, stereoscopic, head-tracked displays that the users wear. Furthermore it can involve body tracking and sound. Muhanna (2015) expands this definition and introduces five key elements that a good virtual reality experience should contain. *Key element one: A virtual world*. It must take place in a virtual world - it is not a part of real life. *Key element two*: *Immersion*. The participants must be involved in the VR experience to the extent that their minds are separated from their physical spaces and drawn into the virtual world. In combination with VR, this particular kind of immersion is known as mental immersion (Muhanna, 2015). This mental immersion can be either partial or complete. Nakatsu & Tosam (as cited in Muhanna, 2015) suggests that this immersion can be either passive or active, distinguished by whether the participant actively interacts with the world or if they are merely a spectator - much like a movie. *Key element three: Feedback.* When interacting with the virtual world, participants must receive feedback in the shape of results. This feedback should be sensory, e.g. the imagery reacting and changing when the participant turns her head to the right, or when the participant 'touches' something in the virtual world. This feedback can be haptic, aural or even related to smell and taste. *Key element four: Interactivity.* The virtual reality experience must give the participants the ability to interact with the virtual world e.g. through motion control. *Key element five: Participants.* It is essential for the VR experience that there are participants. VR systems can

relate to participants in different ways, for instance one-to-one or one-to-many, however there must be minimum one participant.

Taxonomy of current hardware

When seeking to understand how VR can contribute to a museum experience it is advantageous to examine the possibilities with the current hardware that's available to the public. Anthes et al. (2016) has conducted a state of the art of current virtual reality technology. The state of the art was conducted in early 2016, but the technology is still relevant in 2017.

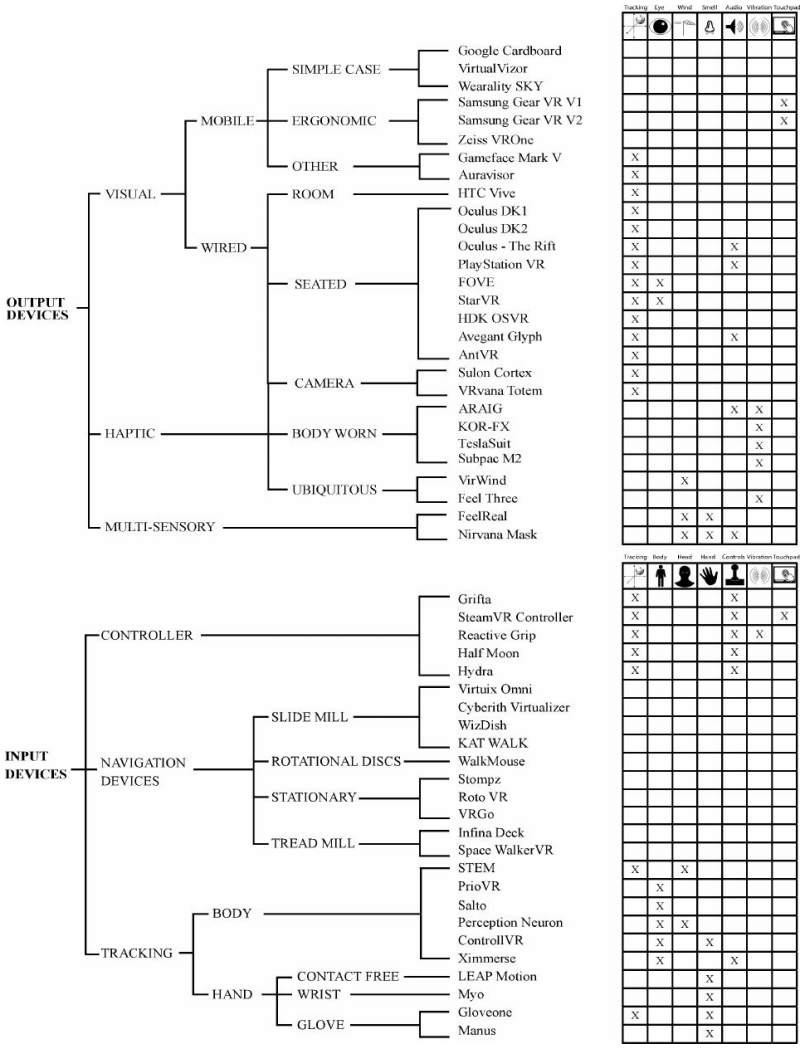


Figure 1 - taxonomy of current VR hardware (Anthes et al., 2016)

The taxonomy distinguishes between output devices - the device that the participant experiences the VR experience on - and input devices - the device that the participant can use to interact and manipulate the virtual world. The paper highlights that the main category within output devices currently represents visual displays, more specifically head mounted displays (HMDs). These can be either mobile or wired. The mobile HMDs can be used without a PC and are typically connected to a smartphone. The wired HMDs provide high resolution, six degree of freedom tracking and typically need to be connected to a powerful PC to function. Another categorization are the haptic devices. These devices give haptic feedback, e.g. blowing wind in your face if it's stormy within the virtual world. Haptic devices can be used in combination with HMDs and can increase the level of mental immersion. The input devices mainly consist of *controllers* that the participants can use to manipulate the experience. There are also *navigation devices* such as an omnidirectional treadmill or *bodytracking* that can track the participant's posture or hand-gestures.

The museum experience

Before we can examine the virtual reality museum experience, we must firstly establish the essence of the traditional museum experience. What do we consider a museum and what kind of experiences do these institutions offer? According to Falk & Dierking (2016), the term 'museum' refers to a wide range of educational institutions:

> *"*[On what constitutes as a museum] *... including art, history, children's and natural history museums; zoos, arboretums, botanical gardens, science center, archives, and a variety of other exhibitions and collections."*

The broad definition and multiplicity of museum-themes makes it challenging to condensate exactly what the museum visitors want out of the visits. Falk & Dierking (2016) suggest that the individual visitor's experience can be understood by researching and combining three contexts:

1) The Personal Context
   Each visitor's personal context is unique. Their experience with museums in general varies as well as the specific museum being visited. Furthermore, every visitor has a

predefined set of beliefs, interests, needs, preferences and other individual personality traits that can affect the experience. This context and the connected variables can help us understand why certain individuals enjoy certain museums and why others don't.

2) The Sociocultural Context
   Museums are created by people with a set of sociocultural values and beliefs, thus shaping what they deem valuable as museum content. This also applies to visitors. Congruence or similarly incongruence between the visitor's and the museum's values can affect how the visitor experiences the museum. The social setting in which you encounter the museum also affects your experience. For instance, it will not be the same experience if you visit it by yourself as it would if you were to visit with your girlfriend, a group of people or a child.

3) The Physical Context
   The Physical Context encompasses the 'feel' of the building that is the museum. The architecture, color of the walls, amount of stairs, amount of benches, walking distance between art work, heat and any element that influences the visitor physically - also before the museum visit itself - is a part of the physical context and influences the experience.

Although the individual visitors museum experience is based on all these factors, Sheng & Chen (2012) elaborate on what kinds of experiences visitors *expect* when going to the museum. They argue that the visitors' expectations can be broken down into five primary categories: *easiness & fun, cultural entertainment, personal identification, historical reminiscences* and *escapism*.

Virtual museum

Now that we know what a museum experience entails, we can dive into the subject of virtual museums and how you can transfer the traditional museum experience into the virtual world. Bandelli (1999) argues that communication technologies are changing the way we use and experience museums. The 'virtual' part usually consists of a website, an electronic network or 3D graphics. He expands on this and adds that an important area and use of the virtual museums is when the virtual context overlaps the physical one - i.e when the virtual experience

is connected to the physical space. The distinction between the “real” and the virtual should be very clear to the visitor. He proclaims that the social space, one of the commonly accepted main characteristics of museums, is disrupted through the virtual museum. An example of this could be audio-guiding-system or one-on-one VR experiences that limit the visitor’s means of social interaction. However, he elaborates that a virtual museum also can provide the visitor with an experience that is not possible in the physical context. Styliani et al. (2009) complements the notion that virtual museums can offer an enhanced display of the museum artifacts and adds that virtual museums exhibit the same traits and serve the same purpose as traditional ‘brick and stone’ museums.

Virtual reality and museums

Now that we have established what a virtual reality experience entails, what hardware is commercially available, what a museum is, what the museum experience entails to the visitor, and how you can make this experience virtual, we can look into how Virtual Reality is being used in museums and how it contributes to the museum experience. Wojciechowski et al. (2004) proclaims that VR can help museums showcase artifacts that they do not have the space or resources required to exhibit. In addition, the technology can help out when an artifact is too fragile or in other ways incapable of being shown to the public. The paper expands on this and addresses that traditional museum experiences are restricted when it comes to user interaction. In most cases the user can only experience the artifact from a set angle, distance and the physical context of the museum. VR can offer a solution to this and allow the visitor to interact with the artifact in a variety of ways. Additionally, the technology enables different audiences to access the objects in ways that are not physically possible, i.e disabled people, children or even remotely through the Internet. Roussou (2001) argues that VR is a strong tool to let visitors experience heritage sites in a unique and engaging way. However, the paper highlights some issues with the technology. When creating VR exhibitions, it is important that museums take into account the physical context of the space and make sure that it supports the standards of the learning purpose of said artifact or exhibition. Moreover, the physical limitations of the VR output devices must considered: does it fit all head-sizes - can it be trusted to children - does it cause motion sickness?

Examples of VR in museums

After establishing how VR can be used in museums, we will explore real life use cases of VR in museums in this section.

British Museum

At the Samsung Digital Discovery Centre's virtual reality weekend, British Museum recreated a scenario from the bronze age in VR ("Virtual reality: how the Samsung Digital Discovery Centre created a virtual Bronze Age roundhouse", 2015). Visitors were to try the new Samsung Gear VR. Within the virtual world, the user was able to walk about, using a touch pad on the side of the headset. The museum had 3D scanned three of their artifacts from the bronze age and placed them in the virtual world, for the viewers to explore. The museum's purpose of the exhibition was to explore the potential of virtual reality with the hypothesis, that virtual environments can help address misconceptions about prehistory due to the close up, 3D experience.

Picture 1 - The bronze age virtual world

The Dali Museum

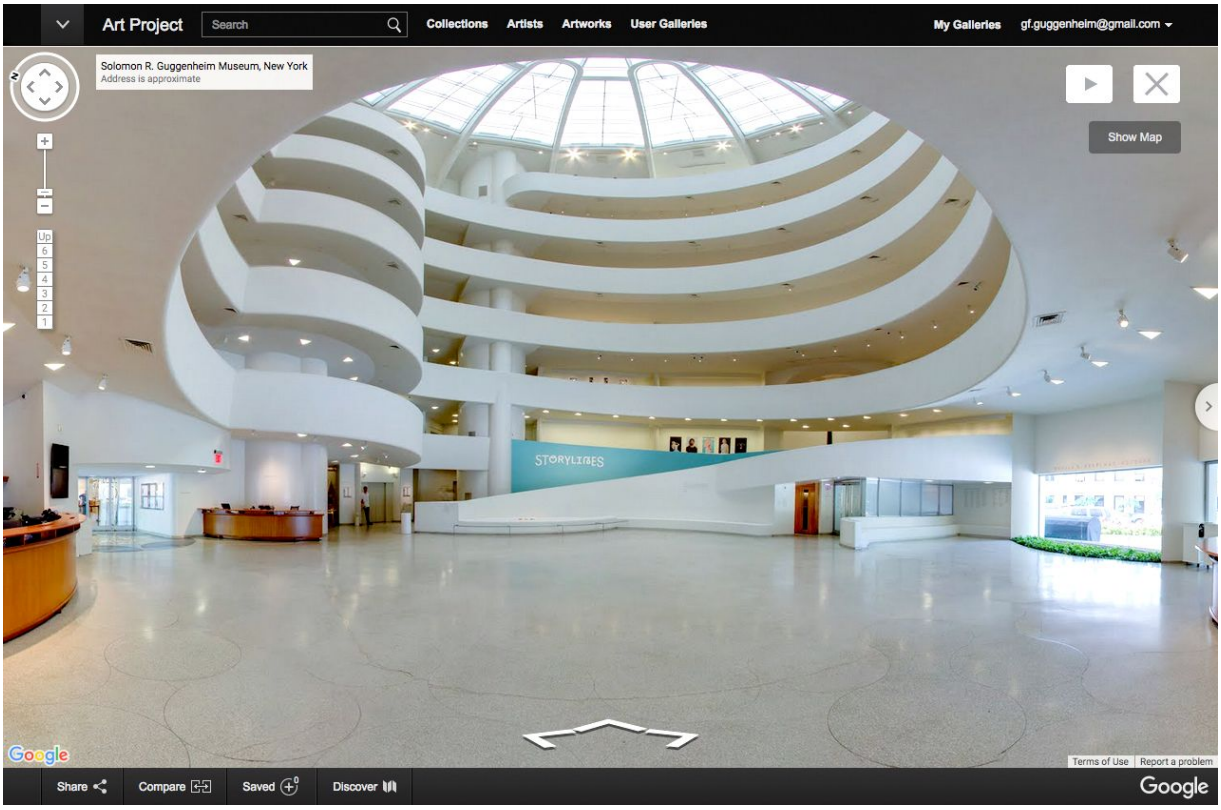
The Dali Museum features the VR exhibition *Dreams of Dali*. Through an Oculus Rift, the visitor can ”*Travel inside and beyond Dali’s 1935 painting Archaeological Reminiscence of Millet’s “Angelus”* ("Dreams of Dali - Unparalleled collection of Salvador Dali art works", 2017). It is a 360° video. This is used in conjunction with the physical space, being exhibited after the visitor has already seen the 2D painting in the real world. The video can be accessed from home through YouTube (https://www.youtube.com/watch?v=F1eLeIocAcU) and can be displayed on most VR devices as well as phones, tablets and computers.

Picture 2 - Dreams of dali

Guggenheim Museum

In collaboration with Google, Guggenheim Museum has created a Street-View-esque virtual representation of Guggenheim Museum, allowing visitors to visit the museum remotely through VR and move about within the virtual version of the museum (Stinson, 2016). This allows people from all over the world to visit the museum remotely at no cost. The experience is a part of

Google's *Expeditions Pioneer Program*, a virtual reality platform where teachers and students can go on expeditions to educational institutions together.



Picture 3 - The navigable virtual world of Guggenheim Museum

VR in Danish museums

Roskilde Museum

Roskilde museum has set up a pair of VR goggles in the top of the Saint Laurentius church tower in Roskilde, overlooking Stændertorvet (Paulsen, 2016). In this sense, the goggles appear to be traditional sightseeing binoculars. The virtual world consists of the same view from the Saint Laurentius church tower but from three different periods in time - the years 1150, 1500 and 1931. These three years are particularly important for the church, but the museum plans to add more time periods to the exhibition in the future.

Picture 4 - Saint Laurentius VR

Greve Museum / Mosede Fort

Mosede Fort has a permanent exhibition that tells the story about Denmark during the first world war. During special events, they open their VR add-on to the WW1 exhibition, where the virtual world takes the user back to the fort during WW1 using VR goggles (Müller, 2017).

Moesgaard Museum

Moesgaard Museum has a permanent exhibition about the stone age and the way of life in that era. They incorporate VR goggles and audio to tell a story that visualizes the living conditions at the time (Fejerskov, 2016).

Method

This section will highlight the methodology used to answer the research question. Virtual Reality is a complex technology that has evolved a lot in recent years. Thus, to understand and gain insight in this field, desk research has been conducted. The desk research resulted in a literature review highlighting what the technology entails in general as well as in conjunction with a museum exhibition. Furthermore, it has been explored how VR has been used in museum exhibitions around the world and more specifically Denmark. This was done to gain an overview of the current exhibitions using VR in close proximity, that could be used in a case study. The desk research revealed that VR in conjunction with a museum exhibition isn't widespread in Denmark. Three museums are currently using the technology as highlighted in the previous section. Afterwards I sought to figure out which one of these three museums would be the best fit for the research. The scope of the project is that it has to be used in combination with a physical visit to the museum. Thus, Roskilde Museum could be excluded, as their VR device is placed in the top of a church tower, and not inside an actual museum. Greve Museum/Mosede Fort's VR exhibition cannot be accessed at all times and is only open for special occasions. The research was conducted in week 9, and the exhibition wasn't open after week 8 (http://www.danmark1914-18.dk/Om%20os/Nyheder/1%20billet%20-%202%20verdener.aspx). In this fashion, Moesgaard Museum became the case study for this report. This decision was backed up by an e-mail from Louise Thisgaard Andersen from "Museernes Videncenter for Digital Formidling" (MMEx - http://mmex.dk/), responding to my inquiry as to what Museum might be a fitting choice for the scope of my project.

Research design

Given the scope of the project, the VR experience that I set out to evaluate was very clearly defined, as well as the setting it takes place in. Thus, I was not able to manipulate the physical setting or the VR experience in any way, but merely seek to understand how the visitors perceived it. Fagerjord (2015) highlights and discusses common humanist evaluation methods for locative media. Granted, the virtual reality exhibition isn't locative, but the paper serves as inspiration into how you might be able to test these kinds of experiences. It empathizes that a large scale quantitative study is the only way to capture the variations in taste in regards to the

experience, however, quantitative studies do not give any information as to *how* and *why* it's being perceived this way. Considering the scope of the project, qualitative interviews with the users is a more fitting approach to probe into how the users have understood and perceived the experience. Fagerjord (2015) argues that quantitative studies and qualitative interviews can be used favorably in conjunction. Thus, to gather data for analysis I chose to make use of a triangulation of user interviews and a small scale quantitative survey using the AttrakDiff tool (http://www.attrakdiff.de/index-en.html). The AttrakDiff tool is an online tool that serves to asses *what* the user's feeling about a system through a questionnaire (Schrepp et al., 2006). It measures both hedonic as well as the pragmatic dimensions of the user experience. These are studied with semantic differentials (Schrepp et al., 2006). The main focus will be the qualitative interviews, and the AttrakDiff survey data will be used as an extra means of insight in understanding how people perceive the experience. Both the qualitative as well as quantitative data was gathered in one day during a visit at Moesgaard Museum, thus they do not serve as a basis for one another.

> "*Interviews provide in-depth information pertaining to participants' experiences and viewpoints of a particular topic. Oftentimes, interviews are coupled with other forms of data collection in order to provide the researcher with a well-rounded collection of information for analyses.*" (Turner, 2010)

More specifically I have chosen to make use of a semi-structured interview due to the fact that it has a system to it but at the same time is left open to spontaneous changes of sequence driven by the flow of the conversation (Kvale, 1996). For many museum visitors, the novelty of a virtual reality exhibition could prove to be problematic in an interview context, when trying to articulate their experiences about a newly discovered technology. To solve this problem I draw inspiration from Sutcliffe & Gault (2004), who provide a list of heuristics for evaluating virtual reality applications with the purpose of improving usability. Considering the scope of the project, the heuristics will not be used for evaluating the usability, but merely serve as inspiration for more precise questions in the interview. To assess how the VR experience worked in conjunction with the museum visit, the physical, sociocultural and personal context of the interviewees was also probed into (Falk & Dierking, 2016). Eight interviews were conducted in total, with eight informants.

Themes & interview guide

To help myself uncover the participants' experiences I conducted an interview guide (Appendix 1). Based on the literature review on museum experiences and VR as well as the research question, the interview questions were shaped with the following themes in mind:

1) Age and profession.
2) Experience with museums.
    a) Follow-up questions probing into why the interviewee visits museums, what kind of museums they prefer and what they expect from the visit.
3) The VR experience.
    a) Follow-up questions probing into heuristics such as sense of presence, realistic feedback, faithful viewpoints, level of immersion, inspired by Sutcliffe & Gault (2004).
    b) VR as medium of storytelling.
    c) Hardware - how does this affect the experience?
    d) What could be done to improve the experience?
4) Does this contribute to the museum experience as whole? Does it fit?
    a) What makes it a good/bad thing?
    b) Does it blend in seamlessly with the exhibition?
    c) Does it maintain its educational value?

Due to the nature of the semi-structured interview, the interviews did not always feature the exact same questions, but adapted to the conversation and merely sought to uncover the overall themes. I tried to keep the formulation of the questions as open-ended and neutral as possible, avoiding to influence the interviewee and allowing them to choose their own terms when answering the questions (Turner, 2010). Furthermore I ensured that the participants understood who I was, what the purpose of the interview was and what it was being used for. Audio from the interviews was recorded with consent from the participants. The names of the informants have been altered for them to maintain their anonymity.

AttrakDiff

AttrakDiff is a tool for measuring the attractiveness, pragmatic and hedonic quality of an interactive product. The user can indicate their perception of the product through opposite pairs of adjectives. The specific adjective-pairs seek to evaluate (Novak & Schmidt, 2009):

1) Pragmatic quality (PQ): The perceived quality of manipulation - how effective and easy to use is it?
2) Hedonic quality stimulation (HQ-S): How well does the system stimulate development through e.g new skills or knowledge.
3) Hedonic quality identity (HQ-I): Does the product allow the user to express their identity?
4) Attractiveness (ATT): Overall attractiveness - is it good, bad, pleasant, repelling etc.

Picture 5 - example of an adjective pair

Due to the fact that I had to get respondents that I had confirmed as having gone through the VR experience at Moesgaard, I gathered the surveys at the museum. For this purpose I had printed out the survey and handed it to museum visitors that were leaving the VR area, asking them to fill it out anonymously. I took these printed out versions and plotted them into the online tool at a later stage.The online tool accepts 20 respondents in the free version, so I made sure that I had 20 responses before leaving the museum. The adjective-pairs in the survey were displayed in English and I made sure that the respondents understood that they could ask me, if they did not understand a specific word.

Selecting informants

Due to the setup being a permanent part of the museum exhibition, I chose to recruit informants in the at the museum immediately after they were done with the VR experience. My problem

statement defines my target group as being visitors at Moesgaard museum that have experienced their VR exhibition. Thus, I tried picking a variety of different informants, i.e young men, young women, older women and so forth. I purposely chose informants that I had observed as having finished the experience. This was done to make sure that the informant would have spent sufficient amount of time on the experience to be able to answer the questions of the interview. Considering the fact that there were museum visitors that walked away from the VR experience before having finished it, it would have been beneficial to interview these as well, to understand *why* they chose not to finish the experience, but I did not consider this at the time. The lack of insight from this group of museum visitors will be discussed later in the paper.

Interpreting data

The structure of my analysis will roughly follow the structure of my interview guide. This is due to the fact that my interview guide was constructed with the purpose of answering the research question, supported by the literature study on museum experiences and virtual reality. In this I will condense and identify recurring themes and interpret the findings from the interviews by highlighting specific quotes that shed light upon different facets of the experience. Furthermore I will compare the qualitative data to the quantitative data from the AttrakDiff survey. To support this I have completed a partial transcription of the interviews. Considering the fact that the transcription was only partial and translated from Danish to English, the quotes are considered paraphrases.

Findings

To give the reader a better frame for understanding the findings, I will particularize the VR experience as well as the physical setup of the exhibition as a whole. Secondly I will go through the AttrakDiff survey results.

The VR experience

The VR experience is a part of the permanent Stone Age exhibition at Moesgaard Museum. The output device is a visual, wired, seated pair of VR goggles (unknown what type) in combination with a headset for audio. The term VR goggles is used instead of HMD, due to the fact that they

are not mounted on the head. There are no input devices that affect the experience. The experience itself is a story told through 3D-visuals as well as audio. The 3D virtual world in combination with the VR goggles allows the user to receive visual feedback when looking in any direction. The user is in the virtual world alone, hence there is no interaction with other users. It is the story about how the people of the prehistoric Stone Age (3500-3000 BC) built dolmens, the first stone monuments, as well as passage graves and cult houses. In the virtual world you can look around in 360 degrees while the dolmens, passage graves and cult houses are being built around you. When you look down, you can see that the story is being told from the point of view of a person from The Stone Age, as you can see your avatar's body and judge the size of the constructions based on this. Thus, Moesgaard's VR experience showcases a heritage site that would be otherwise unavailable, one of the strengths of VR museum exhibitions (Roussou 2001). The sequence of actions of the visuals matches the narrator's story, and you cannot affect the sequence of actions in any way, thus the immersion is passive (Nakatsu & Tosam, as cited in Muhanna, 2015). In this sense, Moesgaards VR experience incorporates Muhanna's (2015) five key elements for the good virtual reality experience except for the interactivity.

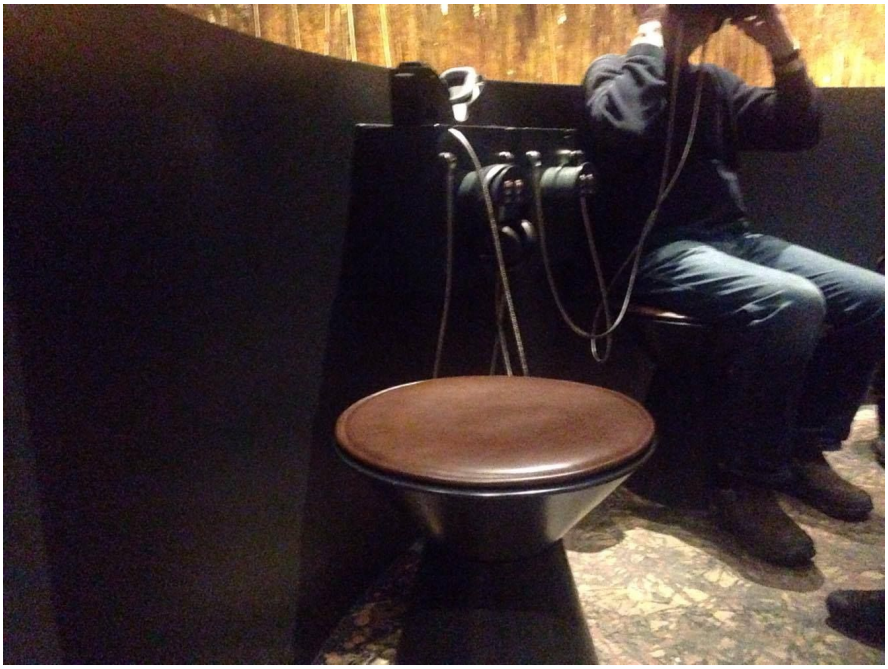
The physical setup

The physical setup of the VR exhibition is a part of the larger Stone Age exhibition. It consists of several rooms with a variety of museum artifacts such as tools from the era, sculptures, weapons, living conditions etc. These are showcased through physical artifacts, video, reconstructions, pictures, audio and text, VR and other interactive experiences. The VR exhibition takes place in a little enclosure (See picture 6). The enclosure is decorated in the same style as the rest of the exhibition and has 7 pairs of VR goggles. There was no mention of what technology it was, nor a guide on how to use it.

Picture 6 - the VR exhibition enclosure

Picture 7 - the VR goggles

There was a chair next to each of the VR goggles. Visitors would typically sit on this chair while going through the experience. The chair was able to spin, to support the user in looking around in 360 degrees.



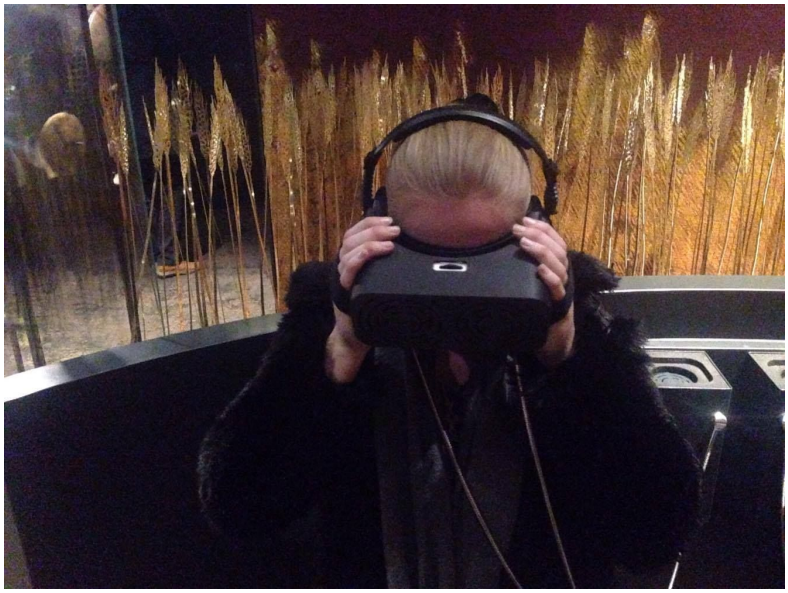
Picture 8 - The chair

The audio was delivered through a pair of full ear headphones. The headphones mostly blocked out the sound of the surroundings and were adjustable in size. They were not attached to the VR goggles, so the user wasn't specifically forced to wear them.

Picture 9 - the headphones

The user did not equip the VR goggles by attaching them to the head, but instead held them to their face using the two straps located on both sides of the goggles, thus disqualifying the term HMD.

Picture 10 - the straps



Picture 11 - how the user typically handled the hardware

To activate the experience, the user would press a button indicating whether they wanted the story told in Danish or English. This was the only action that the user had any influence over, other than what direction to look in, inside of the virtual world.

Picture 12 - choosing language

AttrakDiff results

The AttrakDiff survey was conducted during one day at the museum. Respondents filled it in on paper and I plotted in the results in the online tool at a later time.

Testing duration:	4th of march 2017 - 4th of march 2017.
Testing method:	infield survey - online tool
Tester group:	Museum visitors that had gone through the VR exhibition.
Respondents:	20
Age:	Ranging between 18-70

Portfolio-presentation results

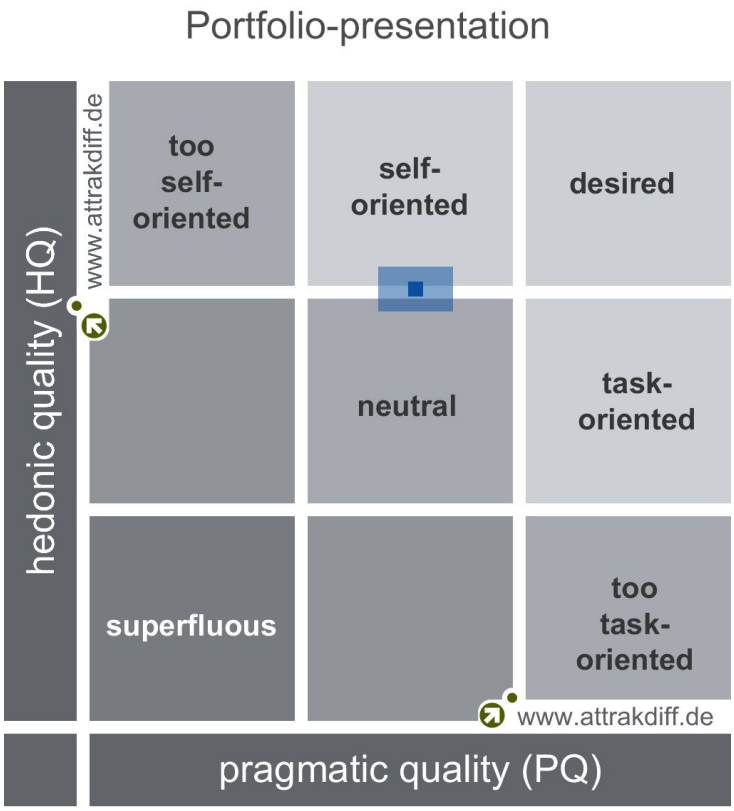


Figure 2 - Portfolio-presentation

The y-axis in the portfolio-presentation displays the perceived hedonic quality (HQ) of the VR exhibition, and the x-axis displays the perceived pragmatic quality (PQ). The inner square shows which region the VR experience lies within. The outer square is the confidence rectangle. The size of this rectangle visualizes whether there's congruency and validity within the results - are the answers widespread or reliably gathered within the same region. The results indicate that the hedonic quality of the VR exhibition is slightly above average. Thus, the respondents are stimulated by the exhibition to some degree. However, the pragmatic quality is average and indicates, that the experience is too self-oriented. The confidence rectangle is small which indicates that there is congruence within the responses, signalling reliability within the dataset.

Average values

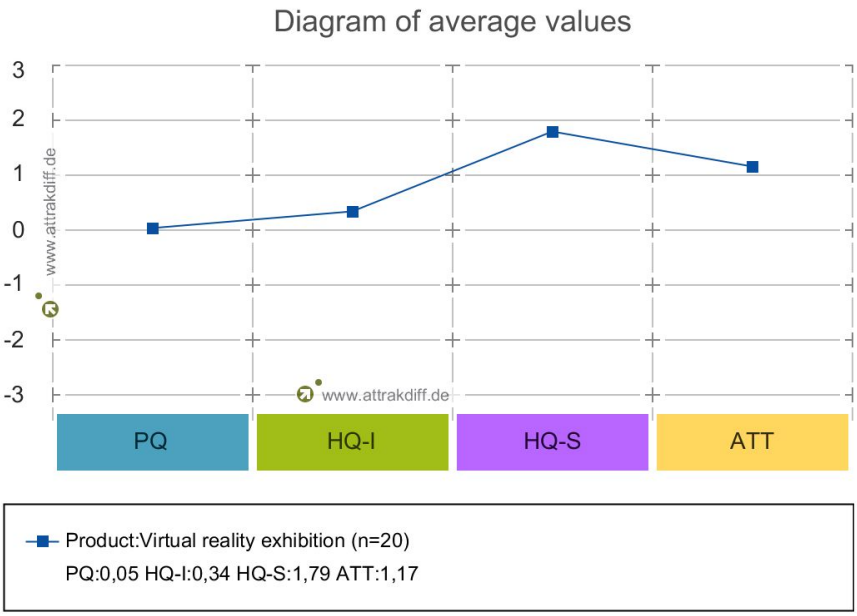


Figure 3 - evaluation results

This diagram distinguishes between the perceived PQ, HQ-I, HQ-S and ATT of the experience. The survey indicates that the pragmatic quality as well as hedonic quality in regards to identity is perceived as being average or very slightly above average. The respondents perceive the attractiveness of the experience as being above average and the hedonic quality in regards to stimulation as being more than above average. These values will be elaborated upon in the next section, that will look into the specific adjectives.

Description of word-pairs

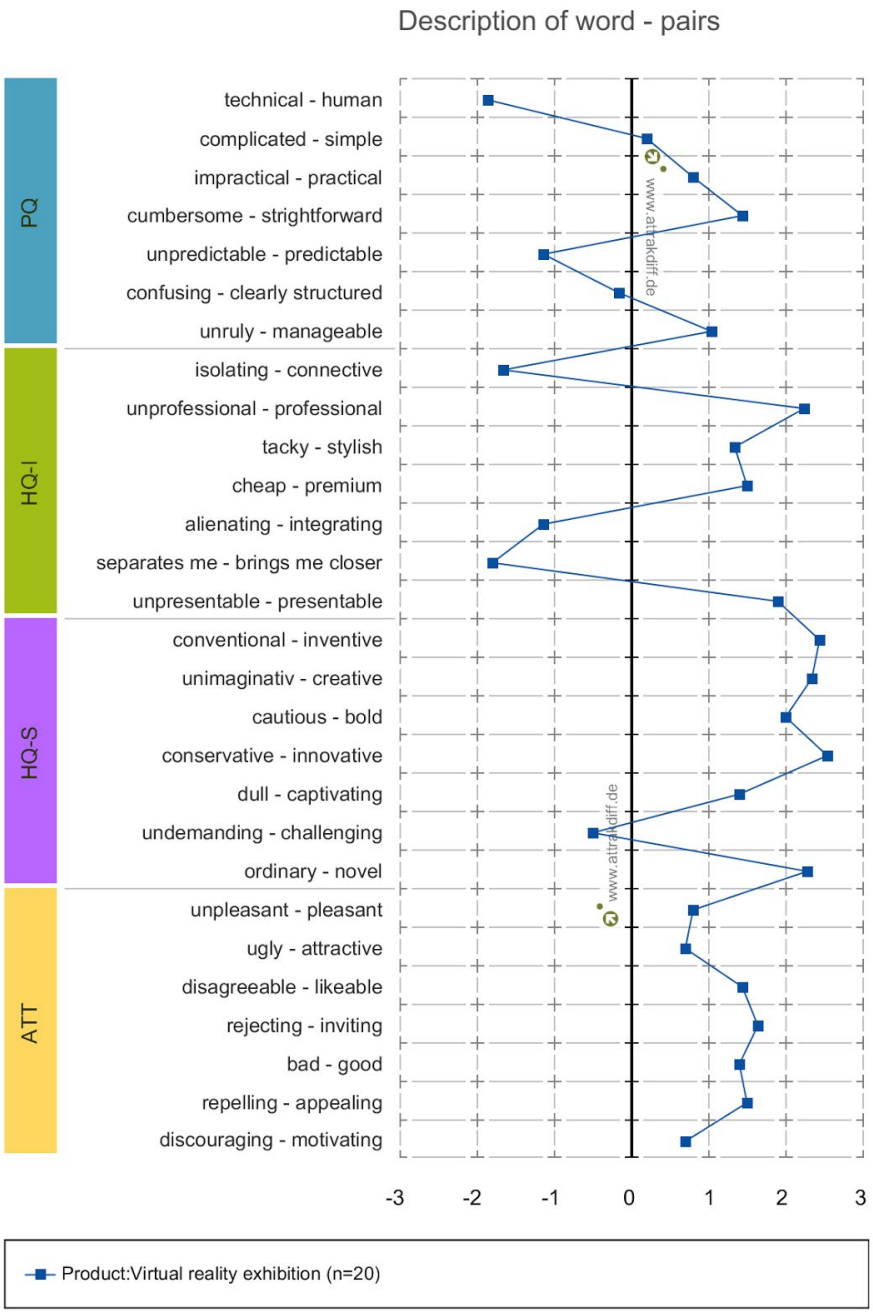


Figure 4 - word pair mean values

Figure 4 displays the mean values of the word pairs in the survey. The rating of -3 to 3 indicates the users' perception of whether the tested subject is doing something extremely bad, extremely

good or somewhere in between. Later in the paper it will be discussed, whether these adjectives are fitting for evaluating whether something is “extremely bad” or “extremely good” in regards to a virtual reality experience. The survey indicates that the respondents perceive the experience as being very technical, isolating, alienating and separating from other people, as well as being slightly confusing, undemanding and unpredictable. Furthermore it’s being perceived as very inventive, creative, bold, innovative, professional and novel in addition to being slightly attractive, pleasant, captivating, premium, stylish, manageable and simple.

Analysis

In this section I will present the findings from the eight interviews with the eight informants and compare them with the AttrakDiff data with the purpose of answering the research question. In this I will try to involve the informants’ personal and sociocultural context in my interpretation of their statements.

The interviews

Expectations to the museum visit

Before commenting on the specifics of the VR experience, it is relevant to shed light upon the informants’ expectations of a museum experience and background with museum visits, as this can indicate why this sort of experience might contribute to their perception of the museum exhibition. Katherine, a 23 year old multimedia designer expressed that when going to the museum, she expects to see something new. To get inspired. She is fascinated by the physical space, the architecture and the atmosphere. More so she wants to learn something new, and she likes to learn about historical subjects.

> *"I like the atmosphere, the beautiful architecture and the interesting exhibitions."*
>
> *“I would like to feel inspired and experience something new, that I haven't seen before”*
>
> *"I like museums with historical artifacts, where I can learn about the cultures of the past, for instance the Stone Age."*

This attitude towards experiencing something new and exciting as well as well as learning something about cultures and history, but in a different way was a recurring theme within the interviews. Michael, a 25 year old IT student elaborates that the information that is being communicated at the museum might be readily available from other sources, but that it's the presentation and delivery of the information, that makes the museum experience exciting:

> *"Is is different from when you sit at home and browse online. You might be able to find the same information, but it's a different experience when you're there in the physical space that a lot of work has been put into"*

Diving more into the subject of the delivery of information, a recurring theme was the interactivity. Several informants with different backgrounds and experiences with museums explicitly expressed interactivity as being an important reason for visiting the museum. Jacob, a 27 year old carpenter expressed:

> *"I like going to the museum when you can experience something new. You know, something interactive instead of just reading some boring text."*

Backed up by Anne, a 42 year old economy manager as well as Linda, a 54 year old physician. Linda, explicitly describing it as being lifelike.

> *"I like to learn something about history and past cultures. They make it very interactive here. The interaction is exciting."*

> *"Especially interactive museums are exciting. It's amazingly impressive with these kinds of "lifelike" museums."*

These expectations match the research of Sheng & Chen (2011), stating that the primary expectations when going to the museum are *easiness & fun, cultural entertainment, personal identification, historical reminiscences* and *escapism.*

The VR experience

Comparing the expectations to statements about the VR experience and the AttrakDiff results, might give an indication to whether the VR experience contributes positively to the museum exhibition or not. When asked about the VR experience, especially the novelty of the technology was a recurring theme. Jane, a 54 year old elementary school teacher underlines that the more traditional museum exhibitions are anticlimactic compared to the VR:

> *".. It would be nice with more of these new and different kinds of experiences! It can be a little anticlimactic to go back to the rest of the exhibition after this."*

And explicitly states that the VR feels like the epitome of the exhibition:

> *"The way you walk down the stairway and into the exhibition with the ice age landscape works really well, and when you come in here it's like "the epitome" of the exhibition where everything is beautiful and interactive."*

Here she also highlights how the physical space is important - underlining that the staircase leading to VR room itself sets the tone and mood for the exhibition. Katherine elaborates on this and adds that it’s important that the VR technology isn’t in focus, but merely complements the theme of the exhibition and blends in, in a seamless way:

> *"I think it's important that they don't focus on the technology, but instead uses it as a part of the exhibition to communicate something about the Stone Age. It shouldn't remove focus from the exhibition."*

Michael agrees with the notion of the novelty contributing positively to the experience, in spite of having tried VR before visiting the museum. He describes it as being a fresh breath of air:

> *“I think it is a fresh breath of air in a museum exhibition like this. It's very different when you try these VR goggles and you become a part of this virtual world. It's a different way of telling a story."*

When asked about what added the novelty and what it was, that made it exciting, Barbara, 64 years old and retired, underlined that the feeling of immersion was *amazing*. She explicitly stated that she felt like she was a part of this stoneage virtual world, in spite of never having tried VR before:

> *"It was completely amazing! You feel like you're* [emphasis added] *THERE! You suddenly notice "your own legs" - not your* [emphasis added] *OWN, but you know - and then you're in the dolmen - crazy! I felt like a part of the virtual world."*

Anne complemented this notion and added that it engages the senses in a new way when you are in the virtual world and can look around. She described it as an immense sensation:

> *"It is an immense sensation when you can look around and feel like you're a part of it. It was a positive experience."*

Lisa, 72 years old and retired, mentioned the sensory input as well in regards to storytelling. She highlights how the visuals and audio in combination with the ability to look around makes for a more memorable story, and that it's more engaging and less boring than a book:

> *"It is easier and not as boring as reading in a book. It's more alive when you use all your senses and can look around while listening."*

Katherine and Michael did however not find the way of storytelling appealing. Katherine highlights how the novelty of the feedback distracting and takes away focus from what is being told. Furthermore she highlights how the graphics weren't good enough for her to feel completely immersed. She was the only informant that mentioned this, thus drawing on experience from her profession as a multimedia designer:

> *"I think this way of storytelling was a bit troublesome, mainly because of all the many impressions and the ability to look in all directions - so I think more about what I see than what I hear. The graphics weren't all too good either, so in this sense I didn't feel disconnected from the real world and immersed in the virtual world."*

Michael thought about how the technology worked, when experiencing it, instead of focusing on the story. This might be because he is an IT student and interested in technology and elaborates that this would surely change, once he gets used to the technology, comparing it to the way that we consume TV nowadays:

> *"If we used VR as much as we use TV in our everyday, I see great potential in the technology! However, because the technology is so new, it's easy to ponder the technicalities instead of focusing on the actual content."*

Jacob, Lisa and Katherine expressed that hardware issues affected the experience as a whole. Jacob requested a guide on how to go through the experience. He went through three VR goggles before figuring out how it worked. Lisa requested adjustable headsets in different sizes. The headsets are in fact adjustable, but the fact that Lisa underlined that it partly ruined her experience suggests that the physical hardware of the VR experience needs to be trouble-free to not affect the experience negatively. Katherine argued that the weight of the goggles was straining, and that this might be a problem for children. In this sense, the physical setup needs to complement the VR experience. Roussou (2001) complements this notion of having to consider the physical limitations of the hardware, when facilitating an exhibition like this.

> *"It was interesting... but the headphones kept falling off my head because they were too big. It ruined the experience a bit. They should have some headphones that fit more sizes, or they should be adjustable in size.. I didn't know how to do this. You can't hold both the headphones and the goggles in your hands at the same time - it simply needs to work."*

> *"Technically it worked fine, but I could've used a guide on how to get started. I went through three of the goggles before figuring it out."*

> *"I didn't get as immersed in the virtual world as I could've because I had to hold up the goggles to my eyes, and it strained my arm - that was unfortunate.. I thought that they were quite heavy, and that would probably be problematic for kids as well."*

Michael adds to the notion that the physical space needs to complement the VR experience. He expressed that the feeling of immersion broke when he was spinning the chair, trying to look behind himself, thus hitting the wall with his legs in the real world.

> *".. At one point I was spinning around and hit the wall with my knee, which reminded me that "alright, you actually exist in the real world" - so it's very important that the physical space is arranged to facilitate virtual reality properly."*

These statements are backed up by the AttrakDiff results of the experience being perceived as innovative, bold, novel, premium, captivating and creative and technical. Thus, in comparison with the informants' expectations to the museum experience, the data suggests that the VR experience contributes positively to the exhibition, for them, in adding "something new", that the visitors are not used to experiencing in their everyday. For the informants, the novelty is found in the immersion in the virtual world and the sensory impression in the combination of visual, audio and feedback/interactivity. However, the novelty of the technology can also be perceived as distracting. The graphics of the experience can affect the experience negatively for some users if it's not up to speed with modern graphics. Furthermore, it is indicated that the physical space and hardware enabling the VR experience needs to be seamless for the experience to not be affected negatively.

Educational value

As stated in the literature review, a museum is in it's essence an educational institution. This, combined with the fact that the informants all expressed the need to *learn* something new when visiting a museum, it is relevant to establish whether the VR experience nurtures or disrupts this educational value. Jane is a teacher and had some insight in this area. She accentuates that the aversions that young students might have when going to the museum could potentially vanish if they were to try VR. The excitement and the novelty of the technology alone could make them interested - even drawn in - in a subject they would otherwise not care about, i.e. the stone age.

> *"I think you can maintain the educational value. The way everything is arranged makes you.. and the kids... interested - it draws you in. I am sure that it would remove the*

aversion that children otherwise might have when going to a historical museum. They too would be drawn by the atmosphere."

Linda shares the opinion that the educational value lies with the memorability of the experience. She asserts that the educational value of an exhibition is moot if you do not remember any of it. She argues that interactive technologies such as VR makes you remember what you learned, and helps you visualize it better. The memorability of the exhibition was a recurring theme among the informants, and something they all tied to nurturing learning.

".. It is no use to have a museum full of educational stuff that you don't remember. If you experience something like [emphasis added] *THIS, then you remember it and you can connect it to the historical knowledge. You can visualize it better."*

Barbara elaborates that it is the combination of the visual + audio + being able to read about the things you experienced in the virtual world, in the rest of the exhibition that makes it truly memorable. Thus, if the VR experience fits the theme of the physical space it enables the visitor to remember it better and learn from it.

"You can learn a lot! It's a mix of the visuals, the audio + walking about the museum and reading about the stuff you just experienced [in the virtual world]*."*

Michael underlines the 3D visuals as being the main learning point. He says that they allowed him to get a sense of scope and to understand the size and looks of the Stone Age buildings being erected in the VR experience.

".. At one point the narrator tells something about how the buildings are being constructed while rocks fall down around you. You could really sense the size of these rocks and what the buildings looked like up close."

Katherine did not share this view, and emphasized the technology distracting her from learning from the experience. She said that when being able to look around in all directions, she spent more energy thinking about this, than to listen to the narrator.

> *"I didn't really learn anything. When looking around all the time, I didn't really think about listening."*

In summary, the informants perceived the VR experience as having educational value nurtured through the memorability, sensory input and combination of visuals, audio and the connection to the physical space. Beside this, one informant perceived the novelty of the visual feedback to distract her from learning something.

Potential additions

After gathering insights about the VR experience and the educational value, it is relevant to look into what Moesgaard could've done better or what could make the VR experience better. The three youngest informants, Katherine, Michael and Jacob were the only ones who had insights in this area, without having to be told what kind of possibilities there are with various input/output devices. This might be because of their knowledge of current technologies and knowing what the possibilities are within VR. They all emphasized the interaction/feedback and immersion as being the interesting part of the experience. Katherine requested better graphics and that this would help the immersion greatly.

> *"Better graphics would make a big difference. If it looked like the real world, I'd definitely feel more like "a part of it"."*

Both Katherine, Michael and Jacob requested interaction, thus making the immersion active. They all argue that walking about in the virtual world would enhance the experience. They suggest that this could be combined with some kind of consequence or choice, that would alter the experience.

> *"If something was to be added, it should definitely be the ability to move about and affect what happens in the "video". If you could see your hands and touch the stuff you see and affect the story this way.. that would be cool."*

In this, Jacob also requests to be able to touch the things in the virtual world, thus requesting an input device enabling this. Michael builds upon the notion of interaction, and describes it as

going on an adventure in the virtual world by incorporating touch, movement or even haptic feedback.

> *"It would be exciting if you could touch the things you see or move about. Definitely. Maybe lift some of the stuff or even smell or feel it. Maybe affect the story? Then it would be less like listening to a story and more like going on an adventure."*

The other informants, due to their lack of experience and knowledge of current technologies did not explicitly express what could've been done better. I chose to enlighten them on the area of the possibilities within haptic feedback and movement in the virtual world. Some informants expressed confusion regarding this, highlighting that they had trouble imagining how this would work, but overwhelmingly agreeing that it would add to the experience with another layer of interaction. Jane mentions how more sensory inputs in the shape of haptic feedback would be interesting.

> *"Obviously it would add another dimension if you could make use of all your senses or if you could move about. But it's hard to imagine."*

Conclusively, the informants highlighted active immersion through interaction, better graphics and increased sensory input as being the main improvement points of the experience. These improvements match Muhanna's (2015) key elements of the good VR experience, thus adding the last key element that it was missing - interaction. This analysis only provides insights into the eight informants' experiences with the museum exhibition and the VR experience and thus cannot be foisted upon *all* museum visitors with certainty.

Discussion

In this section I will discuss the methodology used in the process, the validity of the data as well as the findings and parts of the analysis.

Socio cultural and personal background of the informants

Falk & Dierking (2016) argue that the personal and sociocultural context has to be taken into account when trying to interpret an individual's museum experience. This was apparent when researching a (to the public) new technology such as virtual reality. The youngest informants who were well informed and used to technology were more critical and less impressed by the VR. They requested a higher level of graphics and interaction due to them being aware of the possibilities of the technology, whereas the older informants didn't have sufficient knowledge to articulate or expect this. Thus museums should take into account the target group's sociocultural background and knowledge about the technology when integrating VR to make sure that it's as contributive as possible to the exhibition.

Visual feedback masked as interactivity

Following Muhanna's (2015) definition on what constitutes as interactivity in a VR experience, Moesgaard's VR experience was not interactive. The user was not able to interact or manipulate with the virtual world in any way. Even so, the informants congruently underlined the interactivity of the VR experience as being captivating. When probing into what the informants constituted as interactivity, the informants highlighted the ability to look around in the virtual world, which Muhanna describes as *Feedback*. Thus, when the informants talk about interactivity, there is a possibility that they are in fact talking about feedback. To avoid invalid findings, researchers must be aware of this incongruence between the theoretical definition of interactivity and the discourse of the word in the general population when evaluating VR experiences.

Lack of negative feedback

When picking informants for the interview, I strictly picked people that I had observed as having finished the experience. However, when seeking to evaluate how visitors at Moesgaard museum perceive the VR exhibition it is crucial to get insight from both people that enjoy the experience as well as people who do not like it. Due to the fact that the visitors were not forced to try the VR experience I hypothesize that those who went through the entire experience primarily liked it and those that put on the VR goggles, tried it for a couple of seconds, took off the goggles and walked away, deemed it uninteresting. Thus, to answer the research question

thoroughly, it would have been beneficial to cover the negatives of the experience as well. However, I speculate that the feedback from this group of visitors would have been more superficial, due to the limited amount of time spent on the VR experience.

Methodology

Process

When using a triangulation of methods, it is common practice to conduct either a preliminary qualitative investigation or quantitative investigation, and use this as the basis for the other. However, given the clearly defined terms of the AttrakDiff survey, doing a preliminary qualitative investigation would not have altered the structure of this method in any way. Conducting the AttrakDiff survey and analysing the data before conducting the interviews would have given valuable insight into the hedonic as well as pragmatic quality of the VR experience, that could've lead to different clarifying questions, probing into the specifics of the adjective pairs or the portfolio-presentation results. Aside from this, the literature review on museum experiences and virtual reality served as a good basis for conducting an interview guide on the subject.

Validity of the data

Given the nature of the qualitative investigation, the findings cannot be generalized to every visitor at Moesgaard, but merely constitutes for the eight informants' points of view. The findings give an indication as to what, why and how *some* visitors perceive the VR experience, and can be used as basis for further research. The AttrakDiff data is not representative of the population that is visitors at Moesgaard Museum. The sample consisted of 20 respondents that were not carefully selected. The size of the sample alone disqualifies the data as being valid. However, the congruence within the results indicates how the hedonic and pragmatic quality of the VR experience *might* be, but it cannot be concluded with certainty from this sample. Doing this type of survey on a larger scale with a bigger and more representative sample would give more valid results. Nonetheless, the aim of the AttrakDiff survey, in this specific investigation, was never to gather enough responses to generalize about the population, but as stated in the method section, the data was primarily to be used as an extra means of insight that *could potentially* help in the analysis of the qualitative data.

AttrakDiff adjective pairs

In the AttrakDiff survey, the adjectives on the left side of the word pairs are considered negative, and the adjectives on the right side are considered positive. When evaluating the user experience, including the usability, of an interactive product, this assessment of the quality would usually be correct. However, when evaluating a VR experience that takes you away from the “real world” and into the virtual world, it is not necessarily a bad thing, that the product is described as “technical”, “isolating” or “separates me from people”, but merely a premise of the technology. Due to the fact that these type of adjectives are related to the interactivity, and that the Moesgaard’s VR experience was inherently non-interactive, it can be discussed whether AttrakDiff was the right evaluation method. However, as most of the adjective-pairs are not related to interactivity, but describe other facets of the product, the method still grants valuable insight into the respondents’ perceptions of the quality of the product.

Conclusion

The research question of the paper was to uncover how Moesgaard Museum uses Virtual Reality to engage visitors, and how the visitors perceive this VR experience. Through desk research in the shape of a literature review it has been highlighted what characterizes the VR technology, the VR experience and how it can be used in a museum exhibition. Furthermore it has been clarified what a digital as well as traditional museum is, what visitors expect from a museum experience and how museums have used VR in their exhibitions. The knowledge gained from the literature review has been used as a basis for identifying a museum in Denmark for a case study, as well as a basis for the themes and questions in the interview guide. In this case study, I have sought to answer the research question through a triangulation of quantitative as well as qualitative research methods, more specifically an AttrakDiff survey and semi structured interviews with museum visitors. The research was conducted in one day during a visit to Moesgaard Museum. The qualitative data has been the main data source, whereas the AttrakDiff findings have been used mainly as comparison to the interviews. The analysis of the qualitative data suggests that the informants perceive the VR experience at Moesgaard to be an overwhelmingly positive addition to the museum exhibition with a few negatives and potential additions. There is congruence between the informants’ expectations to the museum visit and

and how they perceive the VR experience's contributions to the exhibition. According to the informants, the VR experience provides novelty in the shape of interactivity, immersion, visual feedback and sensory input. They consider the VR experience to nurture learning through the novelty of the technology, the memorability and the combination of the visuals and audio. They consider potential additions to include more sensory input, haptic feedback and interactivity affecting choice and movement in the virtual world. Negatives include the graphics being too bad for the informant to be fully immersed in the world, as well as the novelty of technology distracting the informant from the story and theme of the exhibition. Furthermore it is indicated that the physical space of the museum should complement the VR experience, and that the physical limitations of the hardware must be handled, for the experience to not be affected negatively. These findings reflect the eight informants' perceptions and cannot be applied to all museum visitors with certainty. The findings can give an indication of how *some* visitors *might* perceive this VR experience and serve as a basis for further research. These statements are backed up by the AttrakDiff results of the experience being perceived as innovative, bold, novel, premium, captivating and creative and technical - however, more research is required due to the questionable validity of the quantitative data, based on the small sample size.

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Appendix 1

Interview guide

Interview guide used in the semi-structured interviews. Not all questions were formulated exactly like this or used exactly in this sequence during the interviews, but were used as overall guidelines.

Expectations

Hvad hedder du?

Hvor gammel er du?

Hvor er du fra?

Hvor ofte går du på museum?
Stil uddybende spørgsmål ud fra svaret.

- Hvorfor / hvorfor ikke?
- Hvad er det du finder spændende ved museer?

Hvad vil du gerne have ud af et museumsbesøg?

Hvilken type museer foretrækker du at besøge?

- Kunstmuseer/lærerige?

VR experience

[Refering to the VR experience] Prøv at sætte nogle ord på hvad du lige har oplevet, da du sad der med brillerne og høretelefonerne på.

Hvad synes du om det?

Stil uddybende spørgsmål ud fra svaret.

- Hvad var godt?
- Hvad var skidt?

Tilføjer det noget til oplevelsen af udstillingen?

- Passer det ind?
- Hvorfor/hvorfor ikke?

Hvad synes du om den måde at få fortalt en historie på?

Var du en del af historien?

- Observatør eller aktiv del?

Følte du dig som en del af denne virtuelle verden?
Stil uddybende spørgsmål

- Hvorfor/hvorfor ikke?

Kan du sætte nogle ord på hvordan denne oplevelse er sammenlignet med de andre ting i udstillingen?

Lærte du noget af det?
Stil uddybende spørgsmål ud fra svaret

- Hvad var det lærerige?
- Hvorfor/Hvorfor ikke?

Hvad kunne have gjort oplevelsen bedre?

- Stil uddybende spørgsmål
- Hvis informanten ikke kan svare, så oplys dem omkring mulighederne og stil spørgsmål ud fra dette