Why interactive, digital museum exhibitions fail

A critical evaluation of interaction design in Danish museums

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Abstract: Interactive, digital exhibitions have become prevalent at Danish museums who brand themselves as to offering you and your family intimate and memorable experiences. However, through observations I have found that many of the digital initiatives do not deliver as promised. These installations are plagued not only by lose connections, start-up issues, stability issues and wear but also by flaws in usability and pure design, resulting in unnecessary breakdowns for the visitors and harming their user experiences.

In this thesis I investigate which design-, usability- and interaction design principles are conformed and violated respectively and I account for how such violations can affect the users psychologically. Conclusively, I provide my suggestions to how to utilize interaction design principles in a museum context.

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Preface

The title for this thesis was originally planned to be "Rethinking experience centres' interactive, digital communication". The problems I wanted to address were these:

- How can current, digital, interactive technologies be rethought to support and extend the communication to visitors of Danish experience centres?
- How does the inclusion of visitors as active participants contribute to the communication, contra visitors remaining as passive consumers?
- Which current design solutions have the highest rate of success and why?

During my early research, I realised that this approach was inaccurate. Rather than *rethinking* possibilities for interactives and visitor participation, the actual problem turned out to concern *violations in essential principles of interaction design*, where visitors were unable to understand, to use or even to turn on certain interactive exhibitions.

Because of this finding, the title became "Why interactive, digital museum exhibitions fail: A critical evaluation of interaction design in Danish museums".

Concept clarification

Human-Computer Interaction (HCI) practitioner: The term for "designer" as defined by Zimmerman, Forlizzi and Evenson. (2007, pp. 1-2)

Interaction design: I use this as an umbrella term referring to academic disciplines and/or design practices, as illustrated in Figure 8, page 15. (Preece, Sharp, & Rogers, 2015)

Interactive, digital exhibitions: Digital installations at museums that the museum visitors can interact with. Synonyms that I use throughout the thesis include: interactives, interactive installations, etc., which all refer to the same.

Interactives: Refers to interactive, digital exhibitions or interactive technologies.

Selected exhibitions: Museum exhibitions that I have selected myself as cases for exemplification.

Experience centre: In this thesis I do not distinguish between experience centres and museums. A museum is by definition *"a non-profit, permanent institution in the service of society and its development, open to the public, which acquires, conserves, researches, communicates and exhibits the tangible and intangible heritage of humanity and its environment for the purposes of education, study and enjoyment."* (ICOM, 2007)

1 Introduction

The foci of this report are to discern weaknesses in interactive, digital exhibitions at selected Danish museums and then mapping out possible pitfalls to why some of these interactive designs fail in the museum environment.

1.1 Literature review

Initially, the foundation for this project began with me visiting museums in Jutland, Denmark and being frustrated over poor interaction design choices of current, interactive installations, which is described further in the next section on page 3.

Following the concept of "new museology" (Ross, 2004) where visitors have turned from passive observers to active participants (Simon, 2010), museums have been implementing a wide range of interactive technologies, also encouraged by the Danish Ministry of Culture (Kulturministeriet, 2006, pp. 26,114-120).

Despite the museums' efforts and a promise of world class experiences (Moesgaard Museum, 2015), not all interactives seem to deliver as successful outcomes as intended; I have observed cases of interaction where the visitor's mental model seemingly discord with the design of the exhibition being interacted with (Norman, 2013), leading to present-at-hand breakdowns (Winograd & Flores, 1986), shifting focus from the experience onto the design itself, disrupting flow (Csikszentmihalyi, 1997) and ultimately causing frustration and bad user experiences.

I argue that these breakdowns and disruption of flow is due to violations of design-, usability- and interaction design principles.

In chapter 2, I begin specifying the problem in concern followed by a description of my methodology through my position as the interaction designer in accordance with a revised model originally by Zimmerman, Forlizzi and Evenson (2007), discussed and illustrated in Figure 3, chapter 2.2, page 8.

Throughout chapter 3, I account for my understanding of the terms of and theories on i.a. design (Norman, 2013), interactivity (Jensen, 2008), interaction design and human-computer interaction (Preece, Sharp, & Rogers, 2015) including which principles to be aware of when working with these subjects. Further material on interactivity (Witcomb, 2006) and HCI (Guo, 2014) are also part of the included literature for a wider angle on both subjects.

For projecting this knowledge into a museum context, I cover material regarding target groups in said context (Falk & Dierking, 2013) and participation (Simon, 2010).

Searching for a reason behind the issues referred to, I review and criticise recent, Danish research in chapter 5 for not providing a sufficient insight on interaction design technologies in museums. For collecting enough evidence for this criticism, I include the following literature:

- a case study, "THE WALL" in Copenhagen (Rudloff, Det medialiserede museum: digitale teknologiers transformation af museernes formidling, 2013)
- an anthology focusing on interactivity in museums (Drotner, Løssing, Larsen, & Weber, 2011)
- current research on museum- and media usage of young Danes (Kobbernagel, Schrøder, & Drotner, 2015).

For a broader view on Danish museum research, I also examine a recent report of overall statuses and tendencies (Gransgaard, Jensen, & Larsen, 2014).

Furthermore, I try to be cautious when including theories from e.g. Bartle (2004) as his work has been criticised and revised multiple times, which is why I accompany his work with a supplying article (Dixon, 2011).

I say not that my research on interaction design improvements in this thesis are definite solutions for achieving success. I will, however, attempt to explain the possibilities for what can be generalised and what not (Gaver, 2012) in chapter 8: *My suggestions to good museum interaction design*.

> *"[...] there is always an implicit sometimes in statements about how to design successfully, to reflect the myriad of factors that remain untheorised yet crucial to a project's success."* (Gaver, 2012, p. 940)

The complete bibliography can be found on page 76.

1.2 Thesis motivation

I enjoy being an active part in creating user experiences, where it is possible to immerse into play and games with today's computer technologies. The majority of my projects at Aalborg University have included user interaction in coherence with miscellaneous devices such as smartphones, tablets, dance pads and other game controllers including the modalities within.

1.2.1 Minecraft

My motivation for this thesis can be tracked back to a Minecraft project by the Danish Geo Data Agency in April 2014, where they released their ground-breaking model of Denmark in Minecraft in scale 1:1 to the public (Geodatastyrelsen, 2014) (Mojang Synergies AB, 2015). It became world famous (BBC, 2014). The Danish Geo Data Agency did, however, not have much experience in actually administrating a Minecraft server, thus they were lacking proper scaffolding. They had no safety software for preventing mass-destruction of the land (CNN, 2014), no automatic profanity filter for user chat messaging, no rollback feature in case of griefers (Bartle, 2004) or any equivalent preventive systems.

I therefore created and administrated an extensive Minecraft server myself, hosting an identical copy of the entire Danish country. During its eight months life span my server had around 3.000 unique

visitors; some whom actively participated in the growth and expansion of the Minecraft world and community. In this period I studied how to scaffold and design digital, interactive user experiences; what to do and what not to do.

In Appendix F, page x-17, I will utilize this knowledge to drawing parallels between a Minecraft server and a physical museum installation, explaining how some design principles can be generalised across media platforms.

Figure 1: Promotional image for my Minecraft server

1.2.2 My frustration with experience centres

It pleases me to see and to use good interaction design, just as must as it frustrates for me, seeing when written and unwritten principles of design alike are being violated in cohesion with a lack of, to me, basic technical sense. I describe this in my autoethnography in Appendix A on page x-2, in regards to my visit at Moesgaard Museum.

When such violations of design principles concerns only smaller products to be operated by few people, I can turn a blind eye, but when obviously fallible, interactive installations are being presented with fanfare to the public space for display and usage by numerous people, it leaves a bad taste in my mouth.

How can it be that I must see Danish experience centres falling short time after time when trying to utilize a – to them – new technology in their experience offers?

Some concrete examples include:

- **North Sea Science Park**: Acquires countless touchscreens, equipping them with already-outdated Flash-animations and long text phrases. (Møller, Jeppesen, Sahl, & Kiel, 2014)
- **Kattegatcentret**: Introduces a whole interactive zone loaded with modalities but where certain installations fails to couple user actions with intuitive feedback. (Møller, Jeppesen, Sahl, & Kiel, 2014) (Dourish, 2004)
- **The Blue Planet**: Implements an extensive touchscreen system throughout their centre, which breaks down one year later due to wear, costing millions of Danish Kroner to replace. (Kjær, 2014)
- **Moesgaard Museum**: Mouse cursors on monitors, error messages from crashed systems, loose connections between devices and similar novice mistakes mark one of the recent attempts on a modern, interactive museum. Explained further in chapter 4.

These findings are discussed throughout chapter 4, starting from page 18, where I also present results from my two observations at Moesgaard Museum carried out in December 2014 and March 2015 respectively.

From becoming aware about aforementioned implications in design and interactions at museums, I postulate that these have a negative impact on the users hereof. This leads to the following hypothesis:

> **Hypothesis #1**
> Museum visitors' user experiences are affected negatively by violations of design-, usability- and interaction design principles.

In the next chapter I specify and delimit this problem.

2 Problem specification

On behalf of my introductory experiences with bad interaction design in museum, as mentioned in chapter 1.2 and in my autoethnography in Appendix A on page x-2, I specify the initial problem as so:

> How do certain interactive, digital museum exhibitions violate principles of design and how do these design violations affect the users?
>
> Within interaction design, what is important to be aware of when designing interactive, digital installations for museums?

2.1 Problem delimitation

To illustrate different angles for approaching and delimiting the specified problem I utilize the 3D model by Vistisen and Jensen (2012) in Figure 2:

- Focusing on the museum; the business
- Focusing on the user; the guests
- Focusing on the technology; current installations in the museum and technological possibilities elsewhere

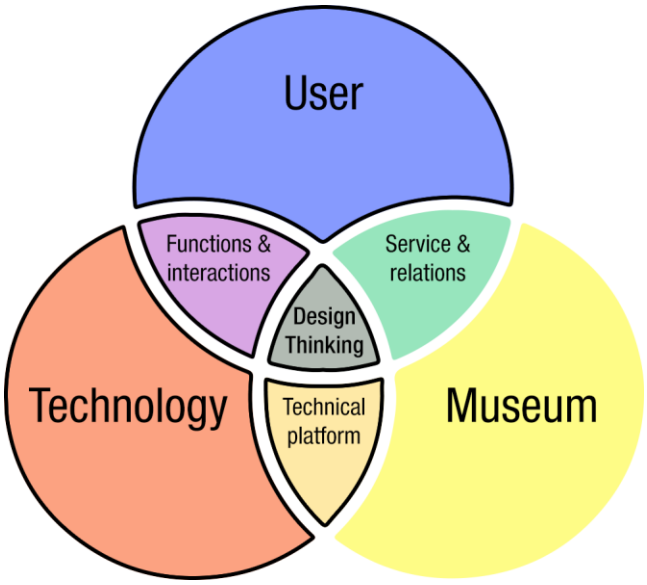

Figure 2: My revision of the 3D model (Vistisen & Jensen, 2012)

I mainly focus my research on the technology itself, the user and the two overlaps between technology-and-user and technology-and-museum respectively, as illustrated in the figure with black strokes around my foci. This omits the examination of the museum as an organisation and their social

relations with their users. I delimit this on the basis of the specified problem at hand and my thesis motivation in chapter 1.2, which concerns the role of interaction design in museums rather than the museums' function as organisations. It could be argued that certain "human errors" within the museum would more likely be avoided if the staff received proper training. However, I believe in optimising the design itself rather than the people using it.

> "*The technology should conform to the people, not people to the technology. […] redesign the system to fit the people who must use it. This means avoiding the incompatibilities between human and machine that generate error, making it so that errors can be rapidly detected and corrected, and being tolerant of error. To blame and train does not solve the problem."* (Norman, 1998)

Groups of people affiliated with the museums' technical platforms are, however, to be included in my research. This involves museum researchers and developers whose work affects the complete exhibitions, which makes them jointly responsibly of ensuring decent user experiences.

Within the field of technology research I cover material on both prevalent and state-of-the-art literature. In the overlap between technology-and-museum I strive to explain technological possibilities relevant in a museum context in accordance with my methodology described in the next section. With this said, my technology research is delimited to concern mainly human-computer interactions rather than technical functionalities of modalities.

Finally, the overlap between technology-and-user – function and interaction – concerns examining usability, user experience and interface design of selected exhibitions.

2.2 Methodology

This section constitutes the mindset I act through.

To describe my methodology, I utilize the model of interaction design research within HCI research by Zimmerman, Forlizzi and Evenson (2007, p. 6) in Figure 3. I have revised the model to suit my needs for this thesis.

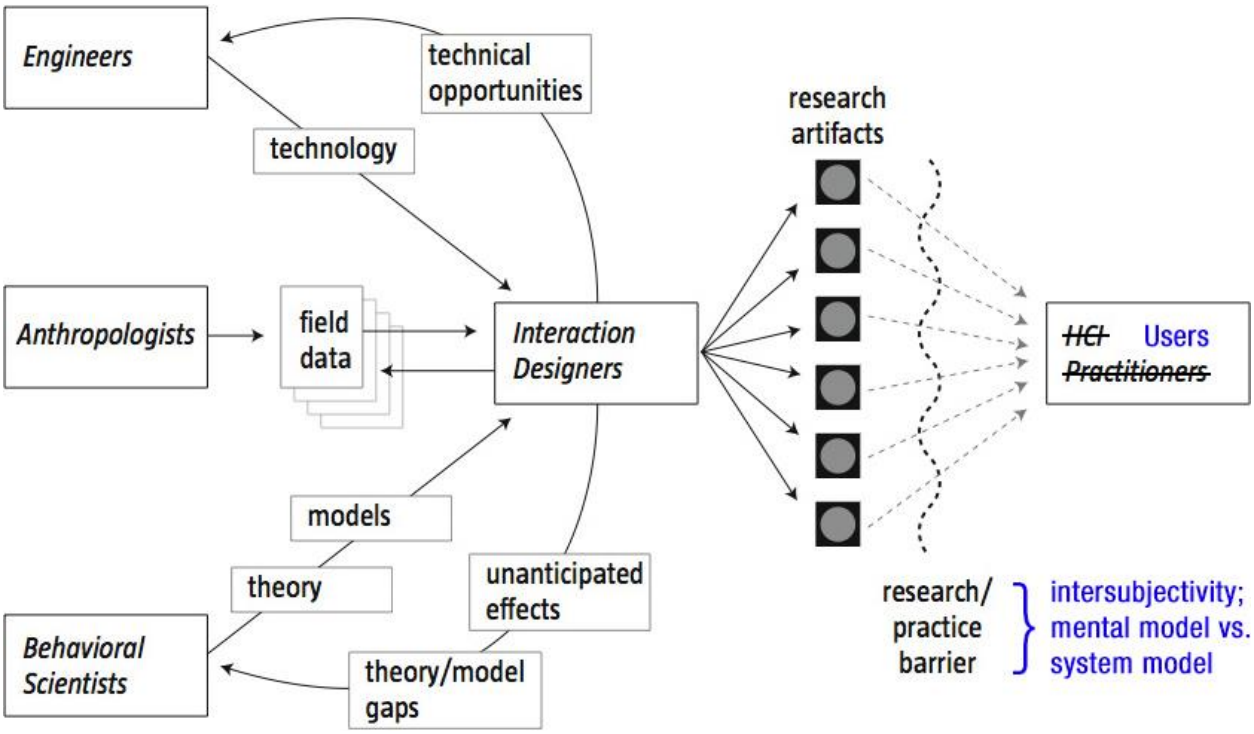

Figure 3: Revised model of interaction design research within HCI research. (Zimmerman, Forlizzi, & Evenson, 2007)

My role in this project is as a critical intermediary in-between the work by stakeholders and their final productive outcome; where digital, interactive museum installations (research artefacts) are created in a cooperation between developers (engineers), museum inspectors (anthropologists) and researchers (behavioural scientists), I shall function as the interaction designer mapping technical opportunities, unanticipated effects and gaps in theories.

I have revised the model to fit my own understanding, where I place the psychological barrier not between the research artefacts and HCI practitioners, but rather between the research artefacts and their end-users, in other words: between the museum installations and the museum visitors.

Through this lens the barrier illustrates intersubjectivity; that there is a difference in how the HCI practitioner intends for his design to be used versus how it is perceived and used in practice by the user. The barrier can be overcome through coupling; when the user's mental models cohere with the system image and meaning emerges for the user. (Dourish, 2004) (Norman, 2013)

This coupling is crucial for the user's perception and understanding of a design. Therefore I find it problematic in situations where communication is unidirectional from stakeholders to design, where the position of an interaction designer for critical evaluation of theories, methods and technical opportunities is omitted.

I aim to follow a research through design practice (Dourish, 2004) (Gaver, 2012) (Zimmerman, Forlizzi, & Evenson, 2007):

- I identify user needs through observations
- My long-term goal is to change how interaction design is utilized in museums – rather than simply describing it
- I document my findings by camera and by writing notes – this is explained further in chapter 4.1 on page 18
- I use the socially constructed knowledge I accumulate to provide suggestions for good interaction design in chapter 8 on page 64

I will, however, not be designing any prototypes. Nor have I joined partners with any HCI practitioners (Huang, 2010).

2.3 Summary

My role in this thesis is to critically assess selected, interactive, digital exhibitions pointing out design flaws and seeking solutions within interaction design for ways to improve on these, providing visitors an overall better experience ultimately.

Next, I define aspects of interaction design to account for my own understanding of the individual terms.

3 My understanding of interaction design

In this chapter I account for my understanding of the many aspects of interaction design; the umbrella term that happens when interaction and design comes together (Preece, Sharp, & Rogers, 2015). The following information is relevant to being aware of when creating or evaluating interactive experiences for avoiding pitfalls accidentally causing design principle violations.

3.1 Aspects of design

One way of defining "design" is this:

> "*a* specification *of an* object*, manifested by some* agent*, intended to accomplish* goals*, in a particular* environment*, using a set of* primitive components*, satisfying a set of* requirements*, subject to some* constraints" (Ralph & Wand, 2009, p. 108)

For instance this could be an interactive exhibition (object), created by programmers and designers (agents), intended to communicate a message or to entertain visitors (goals) in the museum (environment) performing in a specific way (requirements). The exhibition might consist of several modalities and electronical hardware inside of a plastic casing (primitive components), from which the exhibition's behaviour and feeling emerges (specification). The exhibition cannot exceed e.g. the laws of physics or assigned computational power (constraints).

What I am interested in, however, is what differentiates *good* designs from *bad* designs.

As mentioned in chapter 2.2, users make mental models of designs, which may or may not cohere with the designer's own thoughts when interpreted by the user through the system image of the design. (Norman, 2013)

It is worth mentioning that other, more up-to-date theories like Norman's (2013) mental models exist. For instance, Preece, Sharp and Rogers (2015) has another way of describing the perception of designs, through what they call *conceptual* models:

> *"[…] a conceptual model provides a working strategy and a framework of general concepts and their interrelations"*.

Even though the term used by Norman (2013) is aged, I am familiar with this theory, and it covers my needs for use in this thesis sufficiently.

Another design principle I would like to cover in this chapter is the affordances in a design:

> *"Affordances represent the possibilities in the world for how an agent (a person, animal, or machine) can interact with something. Some affordances are perceivable, others are invisible."* (Norman, 2013, p. 18)

If a door has a visibly perceivable handle, it affords pulling. When a door with a handle must instead be pushed, as shown in Figure 4, it is a violence of affordance; handles are for pulling. To my understanding, when a design must rely largely on its signifiers – such as written labels – due to violations of affordance, I consider that design as *bad*.

Figure 4: Doors with mixed messages. (Mittal, 2012)

As defined by Ralph and Wand (2009), designs are meant to accomplish goals and satisfying a set of requirements amongst other things. In a museum context one of the main goals of the exhibitions is to satisfy the users' needs. One method to approach these needs can be by utilizing the hierarchy of needs illustrated in Figure 5. (Lidwell, Holden, & Butler, 2010)

At the very least a design must be functional before being able to address higher-level user needs. In an example where the design to be analysed is an interactive museum installation, these questions could be asked:

- Can the design be turned on, started or in other ways executed?
- Is the design reliable or does it have loose connections causing instabilities?
- Is the design easy to use?
- Does the design empower the user to do something better than they previously could?

When these needs are conformed, the user has a better foundation for expressing himself or herself creatively with the design in innovative ways. (Lidwell, Holden, & Butler, 2010)

The aforementioned theories and principles regarding mental models, affordances and hierarchy of needs are some of the initial principles of design that I have in mind during my observations of interactives and users in chapter 4. I introduce more design principals throughout the thesis as I progress.

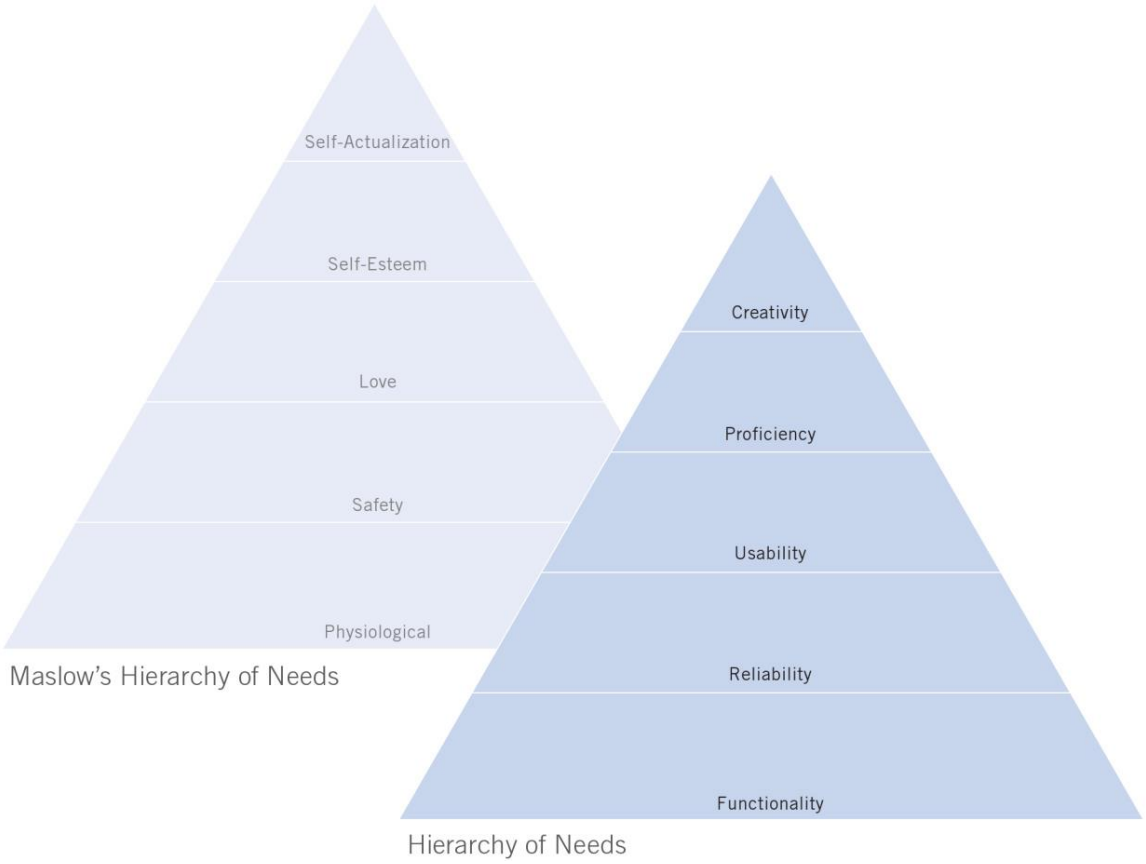

Figure 5: Hierarchy of needs (Lidwell, Holden, & Butler, 2010, pp. 124-125)

3.2 Defining interactivity

The sort of design that is targeted in this thesis is *interactive* designs; those which provides feedback when for instance touched.

I refer to the following suggestion for a definition of interactivity by Jens F. Jensen (1998). Interactivity is:

> *"a measure of a media's potential ability to let the user exert an influence on the content and/or form of the mediated communication."* (Jensen, 1998, p. 201)

Jensen (2008) divides the concept of interactivity into four dimensions, illustrated in Figure 6.

	Information produced by center	**Information produced by consumer**
Distribution controlled by center	1) Transmissional interactivity	4) Registrational interactivity
Distribution controlled by consumer	3) Consultational interactivity	2) Conversational interactivity

Figure 6: The Matrix of Interactivity (Jensen, 2008, p. 130)

Transmissional interactivity concerns one-way media such as TV, without the possibility for users to make requests besides to e.g. switching channels.

Conversational interactivity involves a framework where two-way information sharing is possible, such as e-mailing.

Consultational interactivity includes e.g. online information services such as websites where users can choose amongst pre-produced information.

Registrational interactivity is able to adapt and respond to specific user needs or actions both from direct user input but also automatically, such as the interface in a smartphone; automatic brightness adjustment or facial recognition for Snapchat selfie filters displayed in Figure 7 (Snapchat, Inc., 2015). (Jensen, 2008, p. 129)

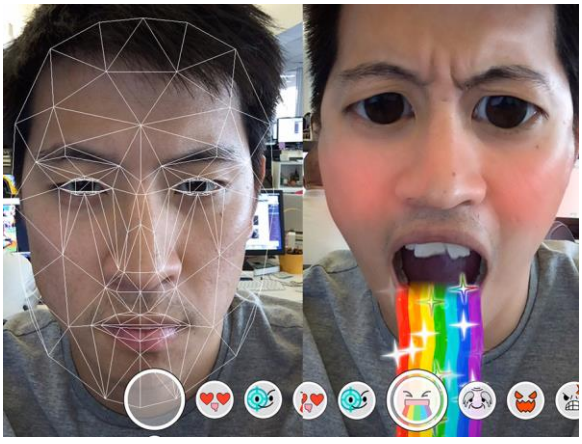

Figure 7: Snapchat's use of facial recognition (Business Insider Inc., 2015)

Preece, Sharp and Rogers (2015) have another way of dividing interaction into different classes. They propose that there are four main types:

1. *Instructing – where users issue instructions to a system.*
2. *Conversing – where users have a dialog with a system.*
3. *Manipulating – where users interact with objects in a virtual or physical space by manipulating them.*
4. *Exploring – where users move through a virtual environment or a physical space.*

(Preece, Sharp, & Rogers, 2015, pp. 47-48)

This information can be used for classification of the museum exhibitions to be observed in chapter 4 to determine their different types of interactions.

As this thesis revolves interactivity in a museum context I include this final way of describing how interactives is generally understood in a museological view:

"The development of interactives in a context of ideas about scientific methodology, particularly the idea of the experiment, has shaped the wider museological community's understanding of the nature and purpose of interactives. This understanding almost invariably involves:

1. *The presence of some technological medium.*
2. *A physical exhibit which is added to the main display.*
3. *A device which the visitor can operate, involving physical activity."*

(Witcomb, 2006, p. 354)

3.3 Aspects of interaction design

Having proposed aspects and definitions for design and interactivity respectively, I now attempt to uncover the aspects of interaction design. Norman (2013) define interaction design as:

"The focus is upon how people interact with technology. The goal is to enhance people's understanding of what can be done, what is happening, and what has just occurred. Interaction design draws upon principles of psychology, design, art, and emotion to ensure a positive, enjoyable experience." (Norman, 2013, p. 5)

Preece, Sharp and Rogers (2015) present interaction design as an umbrella term of i.a. academic disciplines and design practices as illustrated in Figure 8. They state that interaction design concerns:

> *"designing interactive products to support the way people communicate and interact in their every day and working lives."* (Preece, Sharp, & Rogers, 2015, p. 8)

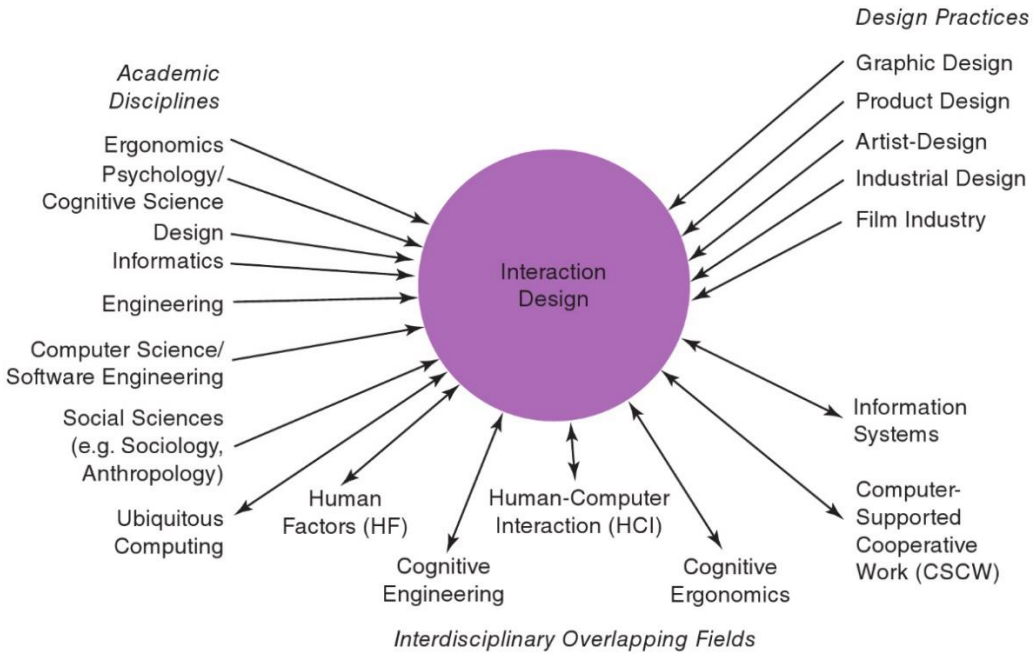

*Figure 8: "*Relationship among contributing academic disciplines, design practices, and interdisciplinary fields concerned with interaction design*" (Preece, Sharp, & Rogers, 2015, p. 9)*

Amongst other things Figure 8 illustrates how interaction design also overlaps HCI. Roughly described, HCI involves *"Understanding how humans interact with computers"* and *"Creating new and effective ways for humans to interact with computers."* (Guo, 2014, p. 10). As HCI is essentially a subset of interaction design, I will not be distinguishing between the two further.

Since my intention is to undertake the mindset of an interaction designer as described in my methodology, Figure 3 on page 8, I must know about what makes a good interaction design.

According to Preece, Sharp and Rogers (2015), good interaction design involves *"[investing] the time and effort to follow a user-centred design process"* and "*getting the right balance between aesthetic appeal and the optimal amount and kind of information per page.*" (Preece, Sharp, & Rogers, 2015, pp. 5,31)

The interaction designs I observe and evaluate at Moesgaard Museum – and have previously evaluated at The North Sea Science Center and Kattegatcentret (Møller, Jeppesen, Sahl, & Kiel, 2014) – are all meant to be operated by end-users, which is why I find it relevant to consider a user-centred approach. Some guidelines to bear in mind when designing interactions for users involves:

- *Taking into account what people are good and bad at.*
- *Considering what might help people with the way they currently do things.*
- *Thinking through what might provide quality user experiences.*
- *Listening to what people want and getting them involved in the design.*
- *Using tried and tested user-based techniques during the design process.*

(Preece, Sharp, & Rogers, 2015, p. 7)

3.4 Flow and breakdowns

Two additional theories I utilize through my observations in the following chapter, is the theory of flow and the theory of breakdowns.

Flow is a state of mind that *"tends to occur when a person's skills are fully involved in overcoming a challenge that is just about manageable"* (Csikszentmihalyi, 1997, p. 30). Being in flow is favoured as it leads to overall better user experiences. The theory is illustrated in Figure 9.

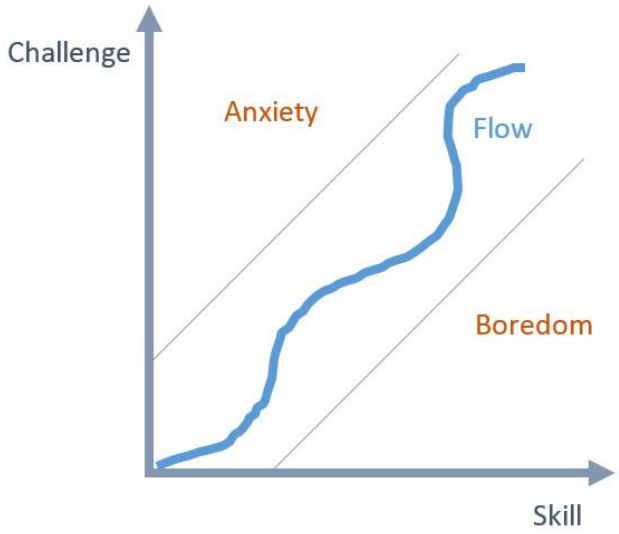

Figure 9: Illustration of flow. (Csikszentmihalyi, 1997)

One thing that can immediately disrupt flow is a breakdown. I occurs when something goes wrong during the use of a design. An example could be when a user interacts with a system that suddenly crashes. Such a breakdown can potentially ruin the user experience by throwing the user's state of flow out of balance. In other words: the user becomes aware of the design again, which is then pre-sent-at-hand. (Winograd & Flores, 1986)

"Whenever information disrupts consciousness by threatening its goals we have a condition of inner disorder, or psychic entropy*, a disorganization of the self that impairs its effectiveness.*

> *Prolonged experiences of this kind can weaken the self to the point that it is no longer able to invest attention and pursue its goals."* (Csikszentmihalyi, 1990, p. 37)

In any decent, interactive design the interaction should be ready-to-hand. It is crucial for the user experience that the flow in using the design is problem-free with as few breakdowns as possible. (Winograd & Flores, 1986)

3.5 Summary

In this chapter I have outlined aspects of interaction design and my preunderstandings hereof.

With this I have a base of knowledge when conducting my observation, presented in the next chapter.

4 Observing visitor-exhibition interactions

The empirical data presented in this chapter is gathered on basis of my problem specification; "How do certain interactive, digital museum exhibitions violate principles of design and how do these design violations affect the users?"

In accordance with the 3D-model in Figure 2 on page 6, my observations concerns the overlap between technology-and-user; functions and interactions.

4.1 Background and preparation

I conducted two individual observations at Moesgaard Museum:

- **Observation #1**, 29 December 2014
  - Visiting with my family
  - Casual; no preparations made
  - Duration of observation was approximately three hours; from 13:30 to 16:30
- **Observation #2,** 21 March 2015
  - Visiting alone
  - Semistructured; preparations made as described below (Martin & Hanington, 2012, pp. 120-121)
  - Duration of observation was five hours; from 11:00 to 16:00

The difference between the two observations revolves my mindset and preparations made amongst other things. Observation #1 started as a family tour and ended up with me scouting and trying out flawed interactive exhibitions, making it more of a hands-on approach than an observation as Martin and Hanington defines it (2012, pp. 120-121).

Before conducting observation #2, I made preparations based on my understandings of aspects of interaction design from chapter 3 on page 10-14 and on results from utilizing the KJ-method (Scupin, 1997) (Spool, 2004) on data from my first observation. These results are included in Appendix D, Figure 54 on page x-15.

With these preparations made, the data I am looking for involves:

- Live user interactions with different types of digital, interactive exhibitions
- User reactions – including spoken comments and body language – when interacting with said exhibitions
- Violations or affordances of interaction design principles
- Frequency and severity of breakdowns

In my second observation, I utilize the Fly-on-the-Wall method without my direct participation or interference with the users being observed. This observation type is supposed to minimize potential biases on the users from my presence. The downside with this method in not engaging the users

I observe is, that I can only gather explicit data such as speech, body language, facial expressions etc. (Martin & Hanington, 2012, pp. 90-91)

When not observing museum visitors, I utilize action research as my research method. This means that I get a closer relationship to the exhibitions through first hand, direct interaction, testing for aforementioned violations of interaction design in practice. (Wynekoop & Conger, 1990, pp. 133,135) It would have been advantageous to also engage with one of more museum practitioners (Huang, 2010). However, I conduct my research without any partners.

My observation findings of exhibitions are documented through recording video footage and pictures, which can be found in the media folder on the included DVD. The media adhere to the ethics described in the next section. My documentation on visitor behaviour is mainly done through handwritten notes.

A detailed description covering the process of observation #2 – including all findings – can be found in Appendix B on page x-5.

4.1.1 Ethics

In being a Fly-on-the-Wall, it implies that my data gathering happens without the knowing of the people being observed. Ethically, participants in such research should be asked for their consent. My ethical approach involves making the people in my observations anonymous, mentioning no names or other information to identify any person. Furthermore, in any photograph featured in this thesis, taken by me, people's faces have been blurred out – as in Figure 10 on page 20.

4.2 Case: Viking sailing game

The first – and most prominent – interactive, digital exhibition at Moesgaard Museum I observe resides in the museum's Viking section. The exhibitions in this section is described by the manager of Moesgaard Museum's tegnestue, Ole Birch Nielsen (2014), in an interview by Jyllands-Posten (2014):

> *"Et gennemgående tema i vores udstillinger er, at de skal kunne opleves af tre generationer på samme tid. […] Ideen med vikingeudstillingen er, at man følger en person på nært hold og sammen rejser ud i verden og møder andre kulturer. Man kan enten vælge en personhistorie eller et arkæologisk spor. Det arkæologiske spor er en ren faktuel fortælling, og her er det arkæologen, der er guiden."* (Nielsen O. B., 2014)

The exhibition I observe is called the Viking game. It features a three dimensional, virtual environment and is made up of two parts; a spherical globe with an image of Europe projected onto it, and a video game consisting of two game stations, each with a set of monitors – touchscreens – displaying the game and physical rudders serving as a controller. See Figure 10.

> "*[…] i stedet for at læse om, hvordan vikingerne fandt til England alene på fornemmelser, kan de [besøgende] få lov at prøve det eller se andre forsøge på det. Så ikke nok med, at de interagerer med udstillingen, de interagerer også i høj grad med hinanden denne søndag formiddag på Moesgaard Museum, mens de kigger på den digitale jordklode.*" (Jyllands-posten, 2014)

The exhibition's type of interactivity is *registrational interactivity* if utilizing Jensen's (2008) theory – or *instructing*, *manipulating* and *exploring* in accordance to Preece, Sharp and Rogers (2015). By moving the rudder, the user instructs the game to steer their virtual ship, manipulating its rotation and movement as they explore the virtual environment.

In this section I attempt to systematically describe my experience with and observation of usability forces and weaknesses within this exhibition by utilizing Nielsen's (1995) ten heuristics for user interface design. Then I look into the game aspects of the exhibition including Salen and Zimmerman's (2004) definition of games. And finally I utilize the heuristics of user needs mentioned in chapter 3.1.

I must stress that the heuristics by Nielsen (1995) are targeted usability for *websites* in particular. Therefore, I use his work as guidelines rather than facts, when projecting the web-oriented heuristics onto exhibitions in a physical space.

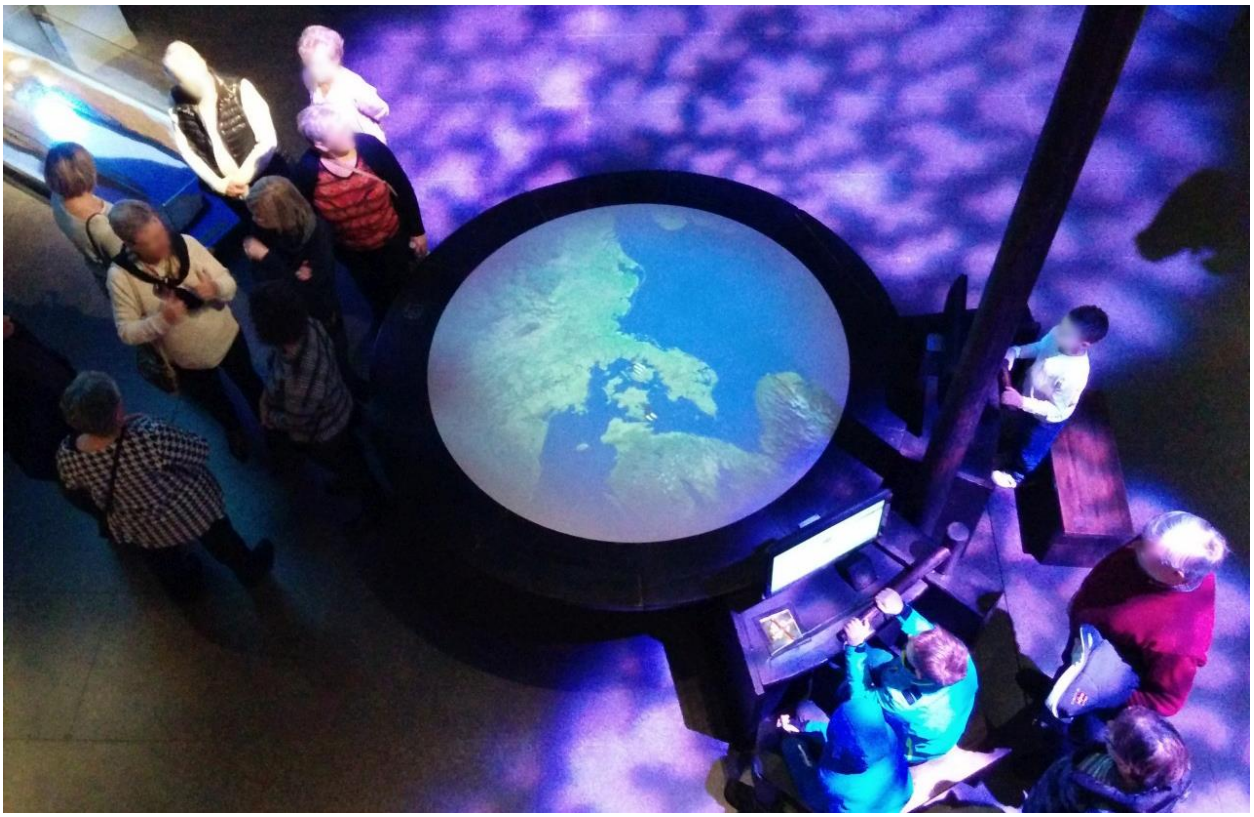

Figure 10: Viking sailing game from above

4.2.1 Ten usability heuristics for user interface design

Visibility of system status

At first look, the game monitor displays a helpful guide with text describing how to begin: "*Please place your token on the reader to start the game*" as shown in Figure 12. 3D-models of each player token is shown on the screen. The story being told and the route to sail in is matched to the visitor's token to start the game.

Figure 11: Tokens for visitors in Moesgaard Museum's Viking section.

The tokens referred to are physical objects hanging at the entrance to the Viking section for visitors to bring with them (Figure 11). The tokens have a chip inside of them and are used throughout the interactive exhibitions in this section of the museum by being placed on receivers as in Figure 13. My first impression of these tokens and their use can be found in my autoethnography in Appendix A, on page x-2.

Figure 12: The Viking game start screen displaying six tokens encouraging players to place theirs on a receiver.

When a token is placed on the receiver, as in Figure 13, the display on the monitor changes. A male voice speaks in Danish, instructing to touch the ship on the monitor to start the game. There are, however, no clear visual signifiers (Norman, 2013) supporting this auditory information besides a small text in the bottom right corner of the screen.

The voice instructs the player to steer their ship with the rudder, following a white guideline, hovering on the ocean (see Figure 14). After approximately five seconds of gameplay, the white line disappears and the player is on his own. There is now no visual feedback to whether the player sails in the right or wrong direction. An audial response from the male speaker occasionally nags on the player when accidentally or deliberately sailing off course.

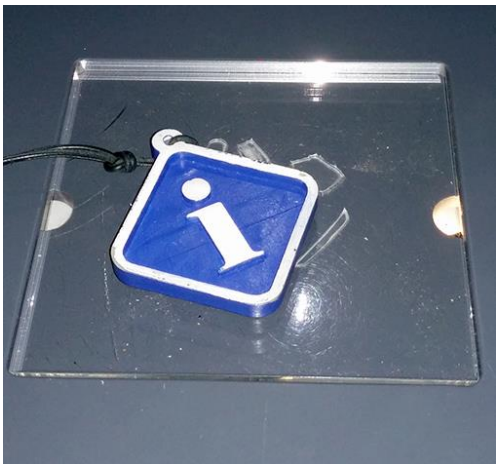

Figure 13: Close-up of token receiver.

Help and documentation

At game start, the speaker explains the setting and mission of the game, according to the token of choice. Most of the Danish documentation in the game therefore relies on auditory communication. I did not observe whether the English version had subtitles or not.

The white guideline that disappeared, can be summoned by pressing map-like graphics in the lower right corner of the screen, making it reappear. Few players realise this however, as there is no visual cue explaining this. The only cue for this was auditory, informed by the speaker at the beginning.

Because of an instable connection between the token and receiver, a pop-up message keeps flashing on my screen "*Your token was removed from the reader. Please place your token on the reader to continue to play*". When connectivity if broken for more than a few seconds, the game resets. This documentation and feature is useful if the token is removed either deliberately or by accident, but in my case it rendered the game unplayable.

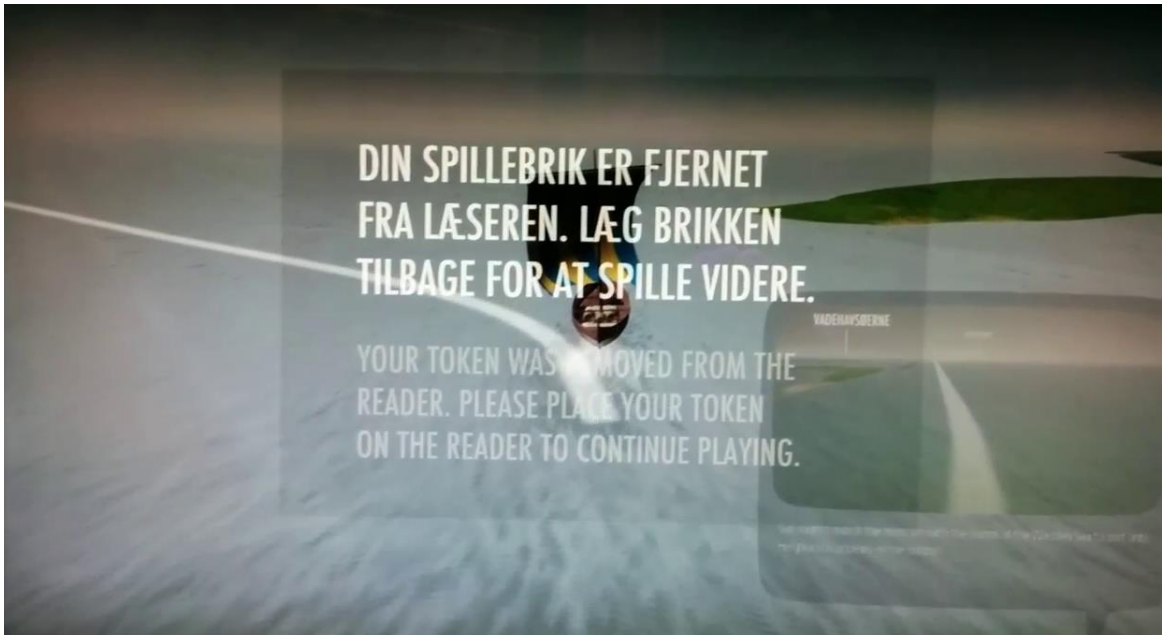

Figure 14: The view on my monitor during gameplay with an error pop-up displaying.

Match between system and the real world

Pushing the rudder slightly, makes the ship turn left, pulling turns the ship right. The connection between the virtual ship and the physical rudder is easily understood by the majority of players, but difficult to master for younger players without a preunderstanding of how rudders steer in water. As mentioned in my autoethnography (Appendix A, page x-2) one girl thinks that she is supposed to "pump" the rudder for making the ship move forward. Even though this is not how rudders work, her mental model is not wrong and the ship actually sails forward.

The consistency between the design of the game on the monitor and what is projected onto the globe in the room, however, is difficult to perceive. People not playing the game walk up to the globe, observe it briefly and then they move on. Here, more work should be put into optimizing the coupling between what is displayed on the monitors and how the players' actions are reflected on the globe for the spectating audience to easier articulate a meaning (Dourish, 2004). Without this coupling, the spectating audience are prone to moving on, unreceptive of what the museum is trying to communicate with the exhibition.

Contrary to both ships being displayed on the globe, I found that the two players are in fact not connected. Even though they might be sitting right next to each other, seemingly sailing in same, virtual world, the two players are separated into individual single player games.

User control and freedom

When the game is running, the main part of it concerns pushing or pulling the rudder. If you steer the ship out of its course, the system is not very forgiving:

- The white guideline does not automatically reappear and the storyteller's voice does not do much besides reminding you of how bad you are at steering.
- If the ship is eventually too far off of the course, the game takes over, depriving the player's control of the ship and skips to the end story.

I find two issues in this design. Firstly, it violates the design principle of forgiveness, which concerns how "*Designs should help people avoid errors and minimize the negative consequences of errors when they do occur"* (Preece, Sharp, & Rogers, 2015, pp. 104-105); if you cannot follow the rules and steer the ship in the direction as the game wants you to, you are not allowed to play. Csikszentmihaly (1997) defines this as alienation:

> *"Alienation […] is a condition in which people are constrained by the social system to act in ways that go against their goals."* (Csikszentmihalyi, 1997, p. 86)

Secondly, within game theory there do exist more player types than only those who enjoy linier story lines. For instance opportunists, who might rather want to explore possibilities in the virtual environment instead of striving to complete their forced mission (Bartle, 2004).

Both the strength and weakness in this choice of design, lies in the fact that regardless of the player's performance, he or she is always rewarded the same; with a voice telling the end of the story. Everybody wins.

This issue is described further in section 4.2.3: Stimuli and rewards.

Consistency and standards

The visual design and textual explanations are straightforward with no overly complex systems to learn. The graphics in the game follows the same Viking theme as the physical exhibition and its surroundings, which conforms the principal of consistency (Preece, Sharp, & Rogers, 2015, pp. 56-57).

Error prevention

One major flaw in the exhibition's design is the connectivity issue regarding the token and reader. On one of the two game devices, the error message in Figure 14 flashed almost constantly during most playthroughs. This makes the player focus on the malfunctioning system instead of enjoying the experience as originally intended (Winograd & Flores, 1986).

If the connection continually fails for a few seconds continually, which it often did, the game ends and the player must start completely over, listening to the introduction story again.

Help users recognize, diagnose, and recover from errors

The error message concerning the poor connectivity was written in both Danish and English, clearly stating what the error was and how to fix it. In reality, however, there was no possible, immediate solution for the visitor to attempt. A father walked approximately 20-30 metres from the exhibition centre, all the way back to the entrance of the Viking section, through a crowd of people to collect a new token for his son, thinking that the one they got was broken, just to experience the same issue once again with the new token. During my 45-minutes observation of the Viking game, I saw multiple people walking back and forth for changing tokens.

In my case, the spoken language in the game is in Danish. The method of choosing language is decided by your choice of token. If your token has a sphere with the Union Jack on it, as highlighted in Figure 15, the spoken information throughout the Viking section will be in English, otherwise it is in Danish. This presents two issues:

1. The user must realise this at the entrance where the tokens are hanging. If he or she chooses a token with the wrong language by accident, there is no way of changing language in the Viking game or at the other interactive exhibitions.
2. Tourists, whom prefer communication in their own language, must satisfice with either English or Danish.

Figure 15: Worn comb tokens. A sphere with the Union Jack is highlighted in red.

Recognition rather than recall

This part of Jakob Nielsen's (1995) heuristics does not apply directly to the Viking game.

Examining aspects of recognition and memory through a different lens, though, players are indeed forced to making guesses for which direction to sail in on the open sea as soon as the white guideline showing the path to follow disappears, immediately increasing the difficulty of the game significantly.

Flexibility and efficiency of use

Whether the player is a young child or an experienced sailor, there is only one control unit (the rudder) with its limited features for an easy-to-learn approach; push forward or pull backwards. As mentioned previously, the youngest players seem to have more difficulties with understanding the relationship between the rudder and the ship's movement, but that is part of the experience in learning how to steer a Viking ship.

Aesthetic and minimalist design

Jakob Nielsen (1995) states that "*Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility*" (Nielsen J. , 1995). At the beginning of the game, as the narrating voice is trying to both provide a good story and simultaneously giving playing instructions and game objectives, part of the information risks being lost to the player. I observed examples of this information loss in multiple cases when children unknowingly steered off their track or not understanding which way to sail in, undermining their objective.

Instead of presenting every information at the beginning of the game, progressively displaying information to the player might resolve in the player being more receptive towards it.

4.2.2 The exhibition as a game

In its essence the Viking game *is* a game. To get a better understanding of what that means, game theory should be included in analysis of the exhibition.

First I would like to clarify what type of game the Viking game is. Caillois (1961) has categorised games into four major types: agôn, alea, illinx and mimicry – competition, chance, vertigo, and role-play respectively.

In the Viking sailing game you are unable to compete with other players, there are no enemies and no urgency such as time. There are no random encounters and you will not accidentally find any hidden treasures by luck. The game is also no rollercoaster by definition. You do, however, undertake the role of controlling the ship, hearing the story of the person affiliated with the token you chose at the main entrance to the Viking section. I therefore argue that this game focuses on the storytelling and role-playing elements; there are no elements of agôn, alea or illinx. This is a game of mimicry.

I use Salen and Zimmerman's (2004) definition of games:

> *"A* game *is a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome"* (Salen & Zimmerman, 2004, p. 80)

Hold up against the Viking sailing game; its system includes the virtual, 3D-world itself, the monitor, the rudder and the projected globe of Europe. The visitors act as individual, non-cooperating and non-combating players in each of their own, empty, virtual world. The rules are made out of mainly the in-game physics; how the virtual boat moves on the water as the rudder is pushed, how the virtual wind affects the boats movement and how collision with land works. The artificial conflict resides in the storytelling; the character you follow by the token you have selected must reach his target – be that either sailing along a coastline or towards the nearest island to find freshwater etc.

But in my optic the game does not present a quantifiable outcome. When the player successfully reaches the goal with his ship, focus is forced towards the storytelling. The display freeze and you lose control of your ship while the narrator speaks until the story ends the story. This is all you get. Game over.

It can be argued that this advance in the storyline can be understood as the reward for playing, but for children, is this truly a valued reward compared to a medal or a new highscore? Furthermore, even if you do not reach your goal, e.g. if you steer the ship far out of course and the narrator automatically skips to the same ending and the exact same storyline still plays out, which I mentioned in the previous section. This is illustrated in Figure 16.

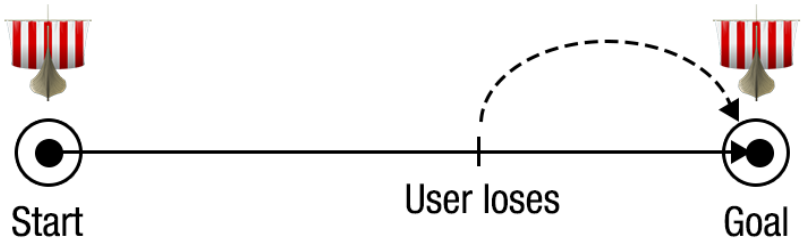

Figure 16: Illustrated storyline of the Viking game in a scenario where the player loses the game halfway (www.openclipart.org, 2015)

Even though the player can choose between different storylines to play through by picking another token, the true potential of digital narratology is not embraced; all tokens still only provide linier stories (Ryan M.-L. , 2001). Moreover, with the exact same, linear outcome for both losing and winning the game, why should the player bother showing an effort? I expect this to affect the game's replay-value negatively.

Ryan (2001) explains that plenty scenarios can unfold when in a digital world. For a more divergent storyline, more endings and objectives could be introduced in the narrative. For instance, when the player is lost out at sea contra when he or she reaches the correct destination.

With a linear storyline as illustrated in Figure 16, the game story is limited similar to that of a book, instead of utilizing the possibilities of a digital narrative.

For instance, the narrative could change in response to the actions of the player; introducing happenings on the way based on player-choices, ultimately providing a good or a bad ending as illustrated in

Figure 17.

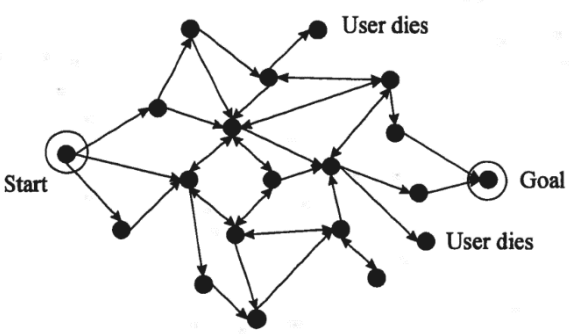

Figure 17: The maze – example structure of an adventure game (Ryan M.-L. , 2001, p. 251)

In retrospect, it all boils down to the museum wanting to communicate a message to its visitors and satisfying the needs of these. Seen through the eyes of the museum staff, it makes sense would they want the story of the Vikings to reach a visitor regardless whether he or she understands the premise of the *game* or not. The game itself is merely a medium to for carrying the message. Therefore, it also makes sense to generalise that no medium should ever hold back information, preventing a visitor from reaching the message to be communicated.

In regards to games, however, rewarding a player regardless of his effort lies in direct contrast to how games work.

4.2.3 Stimuli and rewards

One motivational factor within games are stimuli and rewards – also known as reinforcements within behavioural game theory. (Salen & Zimmerman, 2004)

> *"Behavior theory distinguishes between positive reinforcements (a positive reward, such as a rat getting a food pellet), negative reinforcements (the removal of something unpleasant, like silencing a loud, high-pitched noise), and punishments (the addition of something unpleasant, such as a sudden electric shock)."* (Salen & Zimmerman, 2004, p. 345)

Optimally, the visitors' actions should be reflected in stimuli from the Viking game; bad and good actions reflecting in punishment and positive reinforcement respectively.

When sailing in the wrong direction, the punishment includes auditory warnings from the narrator, ultimately skipping to the ending, whereas the only positive reinforcements during gameplay resides in *not* having the narrator nagging at you.

I have covered more game theory, seeking a definition of games by Crawford (2003) and discussing free-to-play games, but I chose to move this to Appendix E, page x-16, since I deem my current game theory sufficient.

4.2.4 Utilizing the hierarchy of needs

As a final method in analysing the Viking game exhibition, I hold it up against the hierarchy of needs, mentioned previously in chapter 3.1 on page 12.

Is it functional?
The monitors are turned on and the rudders reacts upon being interacted with. However, many users are having issues starting the one of the devices with the loose connection.

Is it reliable?
If considering the one game station with a loose connection, then: no, not at all. Users are unable to

play a full game or even to start the game because of this instability. The second game station does hold a stable connection though.

Is it usable?
The interactivity concerns pulling or pushing the rudder and touching the monitor. Controlling a rudder deemed a challenge for younger players, but agency seemed to occur in most cases, meaning that the game controls corresponded to – or quickly evolved to correspond with – their mental models. Adults who had a preunderstanding of rudders and experience herewith could assimilate how a real rudder works and use this information to predict how the ship would move in-game in correspond to their actions (Kolb, 2005, pp. 196-198).

Observing how users had to lean over the rudder to touch the screen seemed as an awkward method of interacting with the installation, in comparison to having a physical rudder in their hand. Besides when forced to touch the monitor for starting the game – or when attempting to skip the story – most users did not interact further the monitor.

Is it proficient?
Younger users, who had never operated a rudder before, is possible to learn the basics of how steering a ship works. The core purpose of the Viking game, though, is to communicate how sailing once relied on recognizing land, rather than detailed maps and GPS coordinates, and dependency on wind direction. With the simplified game graphics of landmasses and occasional bugs where the user ended up sailing through these, I deem that those being able to suspense their disbelief (Coleridge, Engell, & Bate, 1984, p. 216), allowing them to accept the virtual world and being immersed, had the best potential for enjoyment and learning.

Does it allow for creative expression?
Cases were observed (see Appendix B, page 5) where users tried exploring the environment by sailing in other directions than the game suggested. This action was punished by the game either by preventing players from sailing against the wind – which makes sense in relation to the laws of physics – or by simply skipping to the end of the story when players strayed too far off course. This limits the game to following the linear storyline decided by choice of token – e.g. the axe token or comb token.

4.2.5 Summary of the Viking game

Judging from my observations it is my belief that the core message in the Viking game does come through; it was once very difficult to navigate the seas.

I can see how the game positively make use of "scaffolding", displaying information in steps to the user. Scaffolding is a "*process that enables a child or novice to solve a problem, carry out a task or achieve a goal which would be beyond his unassisted efforts. This scaffolding consists essentially of the adult 'controlling' those elements of the task that are initially beyond the learner's capacity, thus permitting him to concentrate upon and complete only those elements that are within his range of competence"* (Wood, Bruner, & Ross, 1976, p. 90). In this case the user is the "novice", trying to navigate the ship, and the narrator and white guideline acts as the "adult".

As a game, the exhibition fails on delivering a quantifiable outcome and proper reinforcements; rewards and punishments based on performance.

One action I noticed with every second or third user is that they deliberately try to skip the storyline. Especially younger children are impatient when starting the game over and they are forced to wait until the game allows them to play. I call this *forced content*; or *interaction powerlessness*.

Considering the Viking game from the view of the spectating audience, the exhibition does not perform very well. The coupling between the playing users' actions and what is displayed on the globe in the centre seems to confuse the audience. The only visible cue is the display of two boats on the globe, representing the players' locations in real-time with no cue representing which boat belongs to which player. This issue can easily be overcome by adding different colours to each player's boat and painting each monitor and rudder in the same colour.

Likewise, the meaning of the boats' placement in accordance to what the exhibition tries to communicate is neither explained. Figure 18 features a close-up of the Viking game's projected globe with player locations highlighted in red, which at times can be difficult to spot.

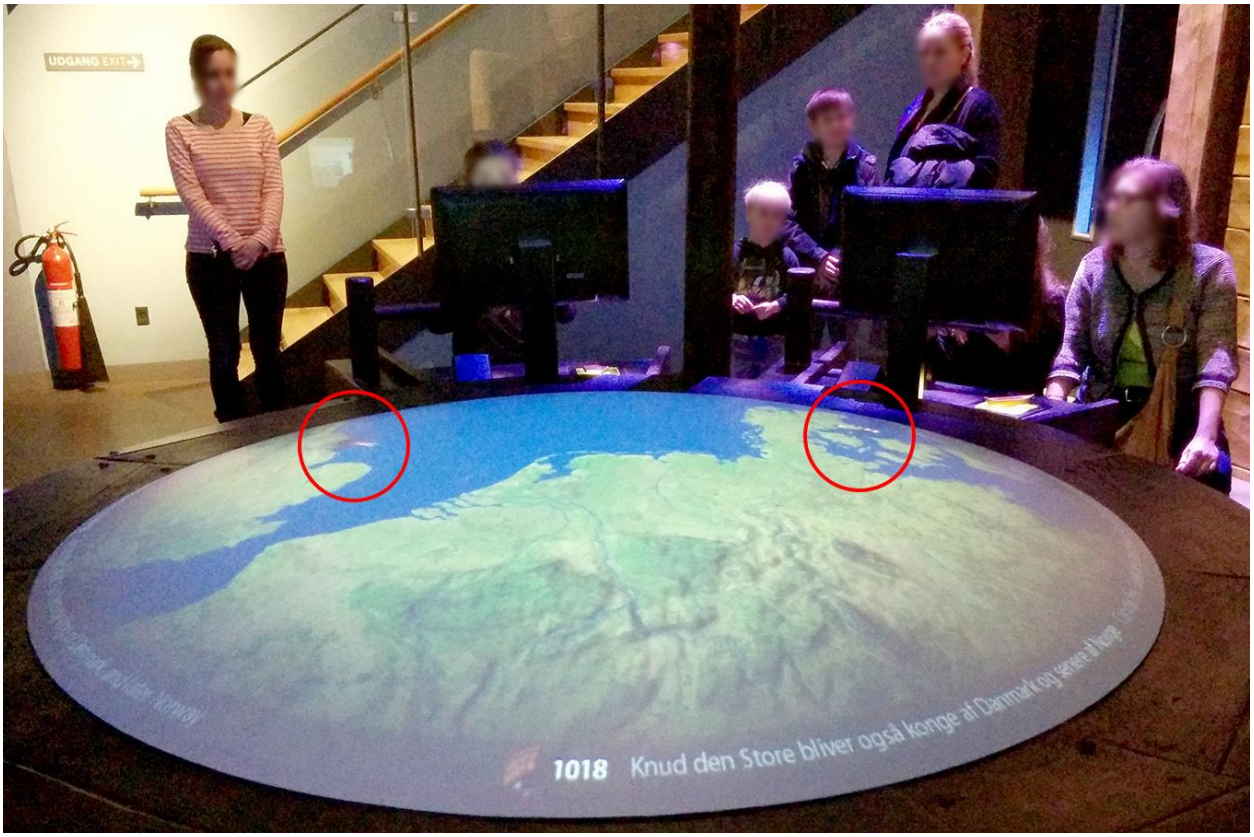

Figure 18: Close-up of the Viking game's projected globe with player locations highlighted

The primitive components of the design is dependent of a constant connection between a physical player token and reader for being able to run continuously or entirely. (Ralph & Wand, 2009)

In a relatively complex design as the Viking game is, many factors are in play and there many can go wrong. When the system errors because of a loose connection in this case, that system is no longer invisible to the user (Norman, 1998). This leads to a breakdown for the user, resulting in a disruption of flow and likely a loss of interest (Winograd & Flores, 1986) (Csikszentmihalyi, 1997).

I did observe cases of users perfectly understanding the concept and easily mastering the controls, but I also noticed recurring episodes where users leave without ever figuring out how to either complete the game or even manage to start it up. They experience failure when trying to having fun.

4.3 Case: Dance with the dead

The exhibition "Dancing with the Dead" provided some of the most positive user experiences that I observed.

Figure 19: Interactive, digital exhibition at Moesgaard Museum: "Dance with the dead" (Due, 2015)

The design consists of physical, static skeleton models in a festive environment, a projected image with three-dimensional, virtual, skeleton ragdolls, and a Microsoft Kinect (Microsoft, 2015). The exhibition is displayed in Figure 19.

The message to be conveyed regards how death is thought of differently across the world; in some cultures the dead are celebrated with dancing and parties.

The most prominent types of interaction is again *registrational interactivity* and *manipulation*, as the users manipulate the virtual skeletons through their own body movement. When the Kinect senses no people in the room, the exhibition is silent, and the virtual skeletons stand still. But as soon as someone enters the room, joyful music starts playing and the Kinect begins tracking the users' movements. As one or two users walk in front of the exhibition their limbs are recognized by the Kinect and their movement becomes mirrored by the skeleton ragdolls.

This interaction is immediate and seamless – provided the users stand a certain distance from the Kinect and at a maximum of two users simultaneously. Coupling seems to happen for users at an instant as they shake their arms and legs in front of the skeletons who then shakes back.

I observe joy and laughter from the majority of the users of this exhibition – mostly children, families or visitors in pairs.

Dance with the dead draws upon the kinaesthetic learning style *movement*, embracing visitors who favours learning through body movement, which especially the children seem to enjoy (Dunn, Griggs, Olson, Beasley, & Gorman, 1995).

I see two main issues with this exhibition, however:

1. Some users walk up too close to the Kinect, making it difficult for the technology to recognize the limbs of the users correctly, which shows as artefacts in the virtual skeletons
2. Non-users passing by the exhibition while it is being used by others can interrupt the Kinect, making it switch target, locking on to the wrong person.

The first issue can be addressed by introducing a signifier for correct positioning in distance from the Kinect. This is not something that is difficult to implement. For instance, IKEA make use of simple lighting to project arrows onto the floor for helping its visitors in navigating their shopping centre. See Figure 20. Following IKEA's example, projecting two discrete symbols onto the floor as signifiers is an easy way to enhance Dance with the dead.

Figure 20: Arrow projected onto the floor in IKEA. (Russell, 2014)

The second issue is concerned with hardware. The Kinect featured in this exhibition might be an older model. In that case a *technological opportunity* could be to upgrade to the latest Kinect model. Another restriction, which is more difficult to alter, is the environment; the size and placement of the room. I observed cases of two users having fun with the exhibition, which attracted a progressively larger audience, which at one point resulted in the Kinect creating artefacts, failing to distinguish users from audience. When this breakdown occurs, the users and most of the audience usually end up leaving the room, which evidently "fixes" the issue.

4.4 Other notable findings at Moesgaard Museum

To be able to present a wide range of findings without diving into too much details, the following exhibitions and their interaction design issues are only briefly mentioned in this chapter. Appendix B includes the complete data from my observation including actions and spoken comments from the museum visitors.

The next five exhibitions all have one thing in common: They are subject to immediate breakdowns, caused by either bad design, hardware errors or wear.

A frequent thing I observed was how users blamed either themselves or each other when having trouble operating the interactive exhibition. This phenomenon is named *taught helplessness* by Norman (2013, p. 63). This lead to negative remarks, discouragement and frustration.

Figure 21 displays an interactive, digital installation, which is intended to communicate the preservation procedure of archaeological material through gamification. The user chooses a material token placed on the table next to the preservation box. Its lid opens with a dramatic sound effect. This was especially liked by the children, I observed. When a token is placed inside the preservation box, the user must press *start* on the transparent screen. As illustrated in Figure 22 the start button

changes colour when touched. Nothing happens besides the change in colour, though. The start button must be pressed a total of *three times* for the game to start – and the final two presses provide *no feedback*.

This violates the first step in the hierarchy of needs from the device not even being functional. It is such a crucial design mistake that I observed multiple cases of friends and families never figuring out how to start the installation, simply walking away from it.

Concerning the users who did manage to pass the persistent start button, they were presented with what I define as a clunky interface and dull looking graphics more appropriate for a free-to-play smartphone app. See Figure 23.

When the game is completed, the user is rewarded with a closing message. The message I received from preserving a piece of gold can be seen in Figure 24. I was not amused.

The preservation installation does not adhere to the hierarchy of needs by being unfairly difficult to start; it include simplified graphics and an unforgiving interface; the reward at the end does not seem worthwhile.

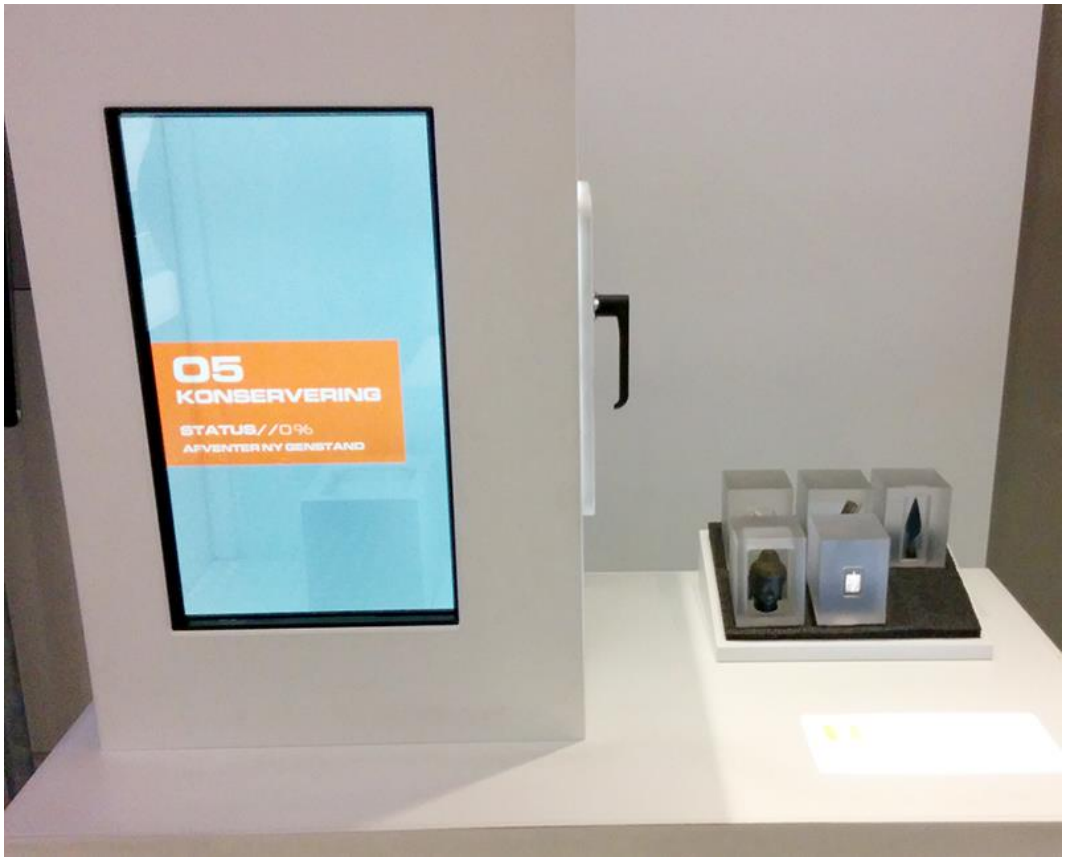

Figure 21: Preservation installation with tokens.

Figure 22: A start button must be pressed trice to start the preservation installation.

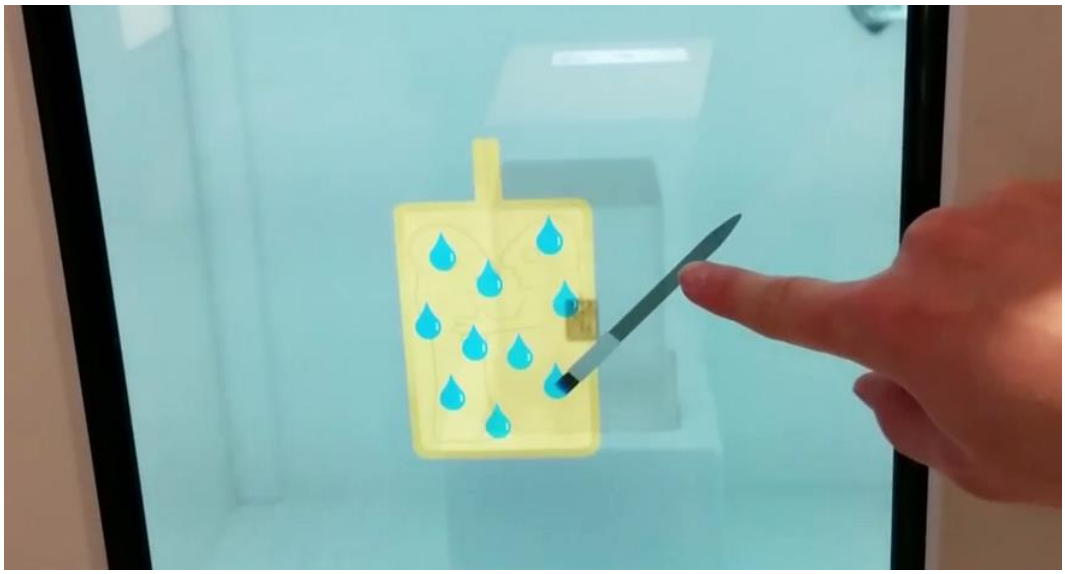

Figure 23: Dull graphics in the preservation installation.

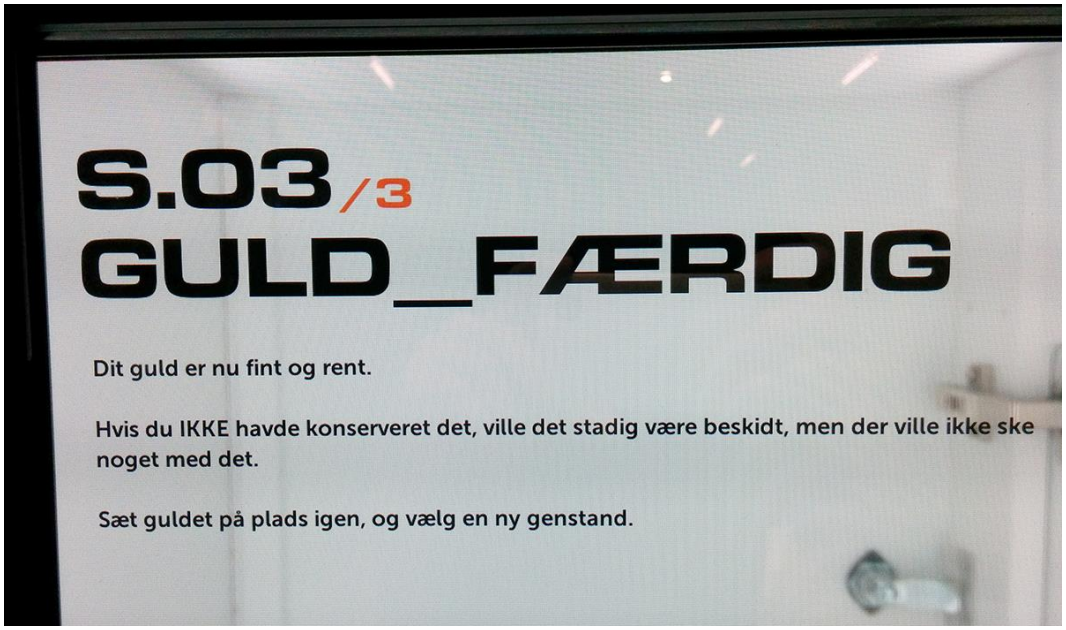

Figure 24: Message displayed when completing the game.

An exhibition which communicates how to determine the age of logs is shown in Figure 25. The user places a log piece of choice in the installation and uses a physical wheel and a physical button for interaction. Upon placing a log, the instructional text in Figure 26 is displayed, whereupon the user may begin marking log ores.

However, not all users do read instructions. I noticed cases where eager users skipped the instructions and began to spin the wheel. The installation made a beeping sound and restarted the user's progression every time he or she spun the wheel past a point where the button was supposed to be pressed. With no visual reminders in the game for making the user aware of the *white* button in the *white* table, this ended up in confusion and frustration.

With its poor usability, this installation does not adhere to the third step in the hierarchy of need, and the design of button violates the principle of visibility.

> *"Fact of life #3: We don't figure out how things work. We muddle through."* (Krug, 2005, p. 26)
>
> *"Make it obvious what's clickable"* (Krug, 2005, p. 37)

Figure 25: Learn to determine the age of (fictive) logs. A button for interaction is highlighted in red.

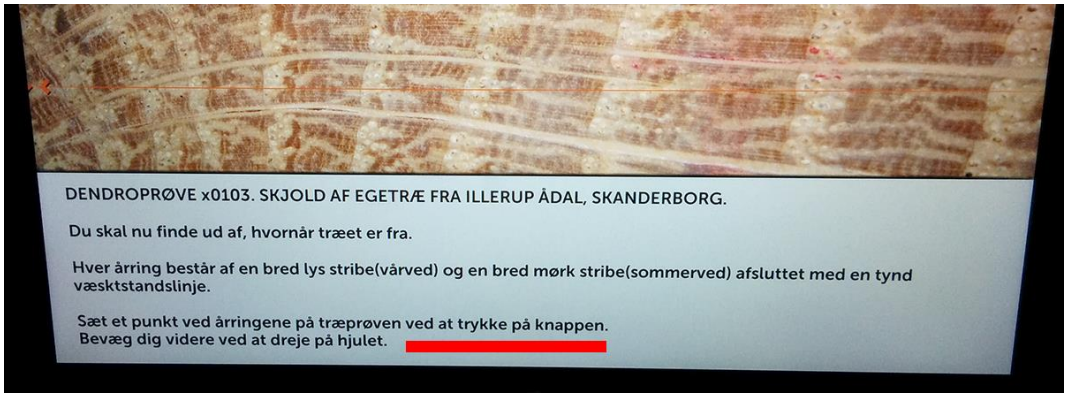

Figure 26: A description of how to use the installation. Text mentioning the interactive button is highlighted by me.

An example of an unreliable installation is shown in Figure 27. It features two screens and a small camera. The camera is supposed to track the user's head and mirror head movement to the skull displayed on the larger of the two screens. In approximately 50% of the cases I observed users trying to interact with this installation, the tracking failed to work. A user would simply sit down in

front of the camera, turn his head, reposition himself and repeat the process until he or she felt uncomfortable with the situation and then leave.

In other cases the installation immediately started tracking users, working fine.

Even though the installation is functioning and usable – when it works – this kind of instability deems it unreliable, violating the second step in the hierarchy of needs.

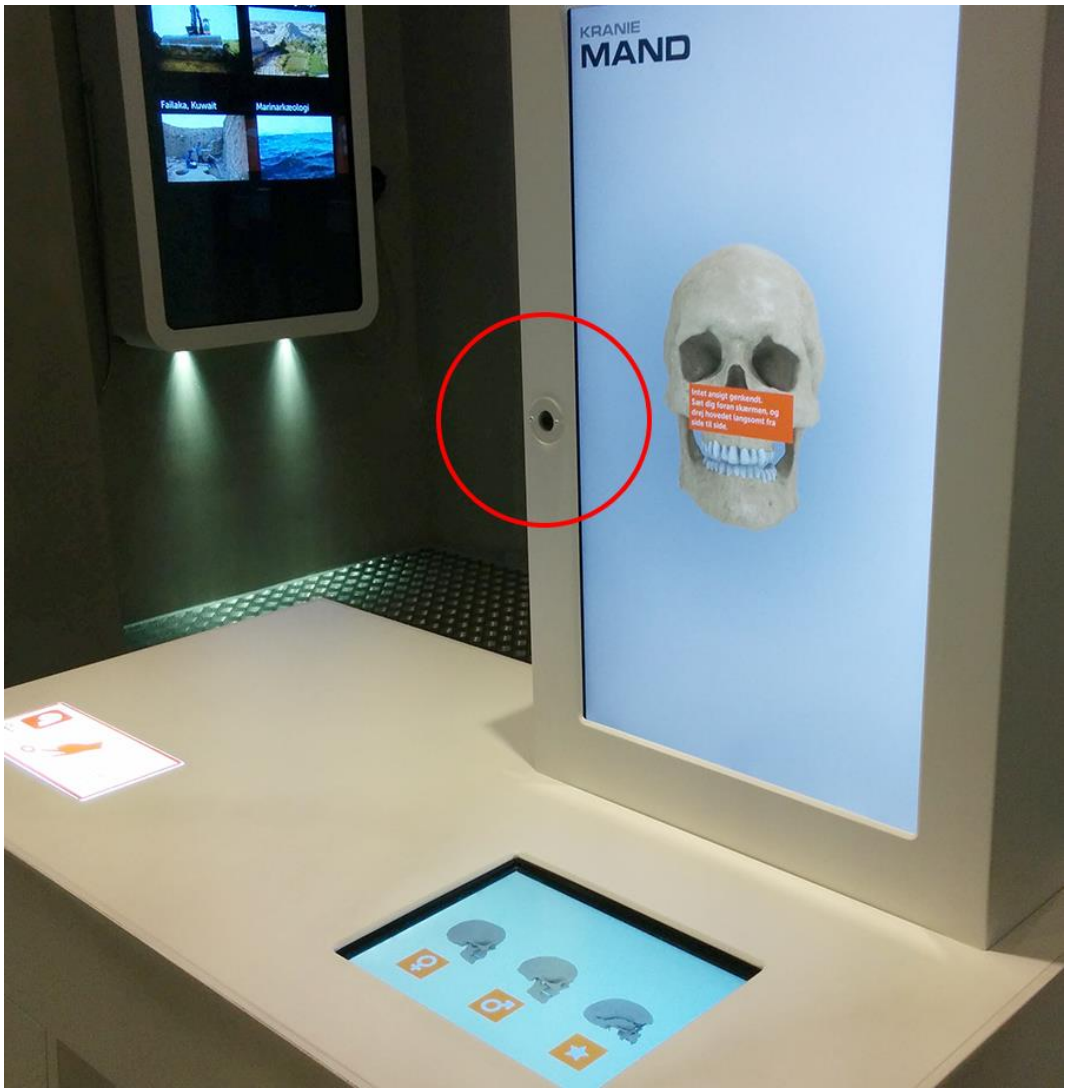

Figure 27: An installation, which tracks the user's skull. Webcam highlighted in red.

When I visited Moesgaard Museum in December 2014 I tried on a hat device as the one displayed in Figure 28. It features earphones, a shade to cover the wearer's eyes and possibly a modality for locating the user's position. The hat belongs to an exhibition called the Gundestrup installation and it is supposed to be worn inside a dark, cylinder-shaped room with embossed markings to feel with

your hands as you walk through. Only one or two of the hats worked, and those were in use as I was standing at the exhibition – the rest were broken.

Figure 28: Hat with earphones and a shade to cover the wearer's eyes.

This is a quote by Nielsen O. B. describing the exhibition:

> *"I Gundestrupinstallationen skal museumsgæsten i stedet for at se kedelen føle sig frem. Når vi fjerner synssansen, skærpes føle- og høresansen, hvilket giver gæsterne muligheder for at skabe deres egne visuelle billeder af de mytiske fortællinger. Når de så efterfølgende ser den udstillede kedel, fordyber de sig mere i kedelens udsmykning."* (Nielsen O. B., 2014)

In March 2015, when I conducted this second observation, the hats were still broken, and the only working one was in use.

As a final observation at Moesgaard Museum, I present an example of a crashed system with an error message displayed in Figure 29. This was on display as I passed a series of wall-projected images. Why has staff not acted immediately by simply closing the error message and rebooting the system – or at the very least shut it down?

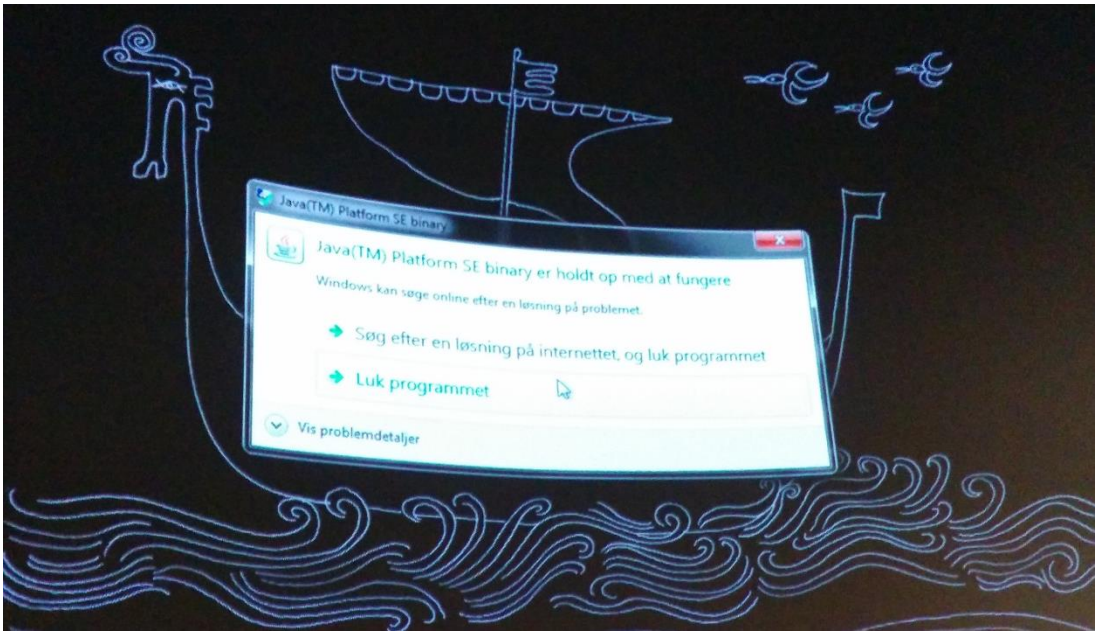

Figure 29: Projected image with a Java error message from a crashed system

4.5 Closing comments on observation at Moesgaard Museum

On their website Moesgaard Museum has stated their vision:

> *"Vi vil udforske og fortælle om menneskelivets mangfoldighed og skabe tankevækkende og vedkommende museumsoplevelser, der er blandt de bedste i verden."* (Moesgaard Museum, 2015)

I find that a bold expression in regards to the quantity of dysfunctional exhibitions I have observed. Please take another look at Figure 29.

In the brochure I received at the entrance to the museum – also displayed in Figure 30 – this was written:

> *"Glæd dig til en museumsoplevelse, hvor scenograferede og dramatiserende fortællinger baseret på den nyeste forskning og teknologi bringer dig helt tæt på menneskene bag de udstillede genstande."* Source: See Figure 30. The brochure was collected at Moesgaard Museum 2014.

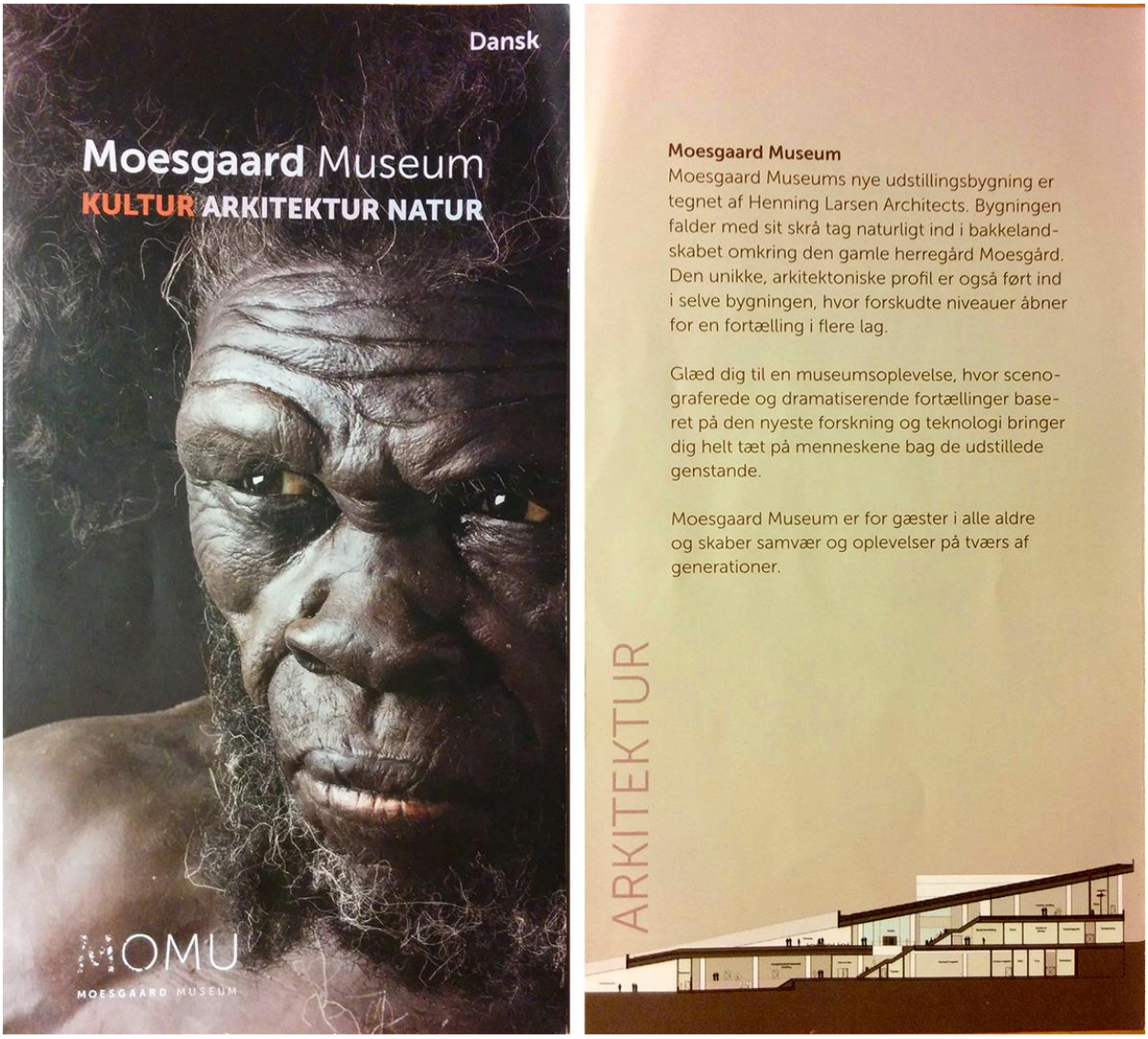

Figure 30: Scanned image of two pages in a brochure collected at Moesgaard Museum 2014

In this commercial material, as Moesgaard Museum are branding themselves, they are not writing about their digital, interactive exhibitions, which concerns a significant amount of their total exhibitions.

The following quotes include all the information I could find on their website about any kind of interactivity. They concern the Viking museum section and the laboratory museum section, which I discussed earlier in chapter 4 from page 18:

> *"**Bliv opdagelsesrejsende i Vikingetiden***
>
> *800 e.Kr. – 1066 e. Kr. Med vikingernes personlige fortællinger i øret, følger du i hælene på dem gennem de røgfyldte, snævre gyder i Aros, vikingernes Aarhus. Styr dit eget skib gennem åbent vand og bælter til Norges fjelde eller rejs via floder til det eksotiske Konstantinopel.*
>
> ***Forsøg dig som superforsker i MOMU-lab***
>
> *I museet laboratorium kan du blive superforsker for en dag og hjælpe med at opklare mysterier fra fortiden. Brug naturvidenskaben og din nysgerrighed til at blive klogere på de mennesker, der levede før os."*
>
> (Moesgaard Museum, 2015)

4.6 Findings from elsewhere

Before closing this chapter, I present some findings from other experience centres. I do this to stress that what I observed at Moesgaard Museum is not unusual or unique.

Further insight on findings from The Blue Planet, the North Sea Science Centre and Kattegatcentret are available in my 7th semester report. (Møller, Jeppesen, Sahl, & Kiel, 2014, pp. 39-52)

4.6.1 The Blue Planet

After one year of running with new touch devices for their exhibitions across the whole museum, the staff concludes that most things have broken down, since its durability in regards to wear was underestimated. They did not have a service agreement and apparently thought that the magic touch devices would last forever. (Møller, Jeppesen, Sahl, & Kiel, 2014)

The touchscreens are controlled via TYPO3, an Open Source content management system. One is shown in Figure 31. This is how the creators describe the system made for The Blue Planet:

> *"Systemets fleksibilitet gør det muligt løbende at ændre på sammensætningen af akvarier og dyr, og det gør systemet til en økonomisk fordel for Den Blå planet. I forhold til statiske videostandere eller touchpaneler, som er besværlige og dyre at flytte rundt på og ændre indhold på, giver TYPO3 mulighed for hurtig og billig tilpasning af udstillingerne."* (T3CMS, 2014)

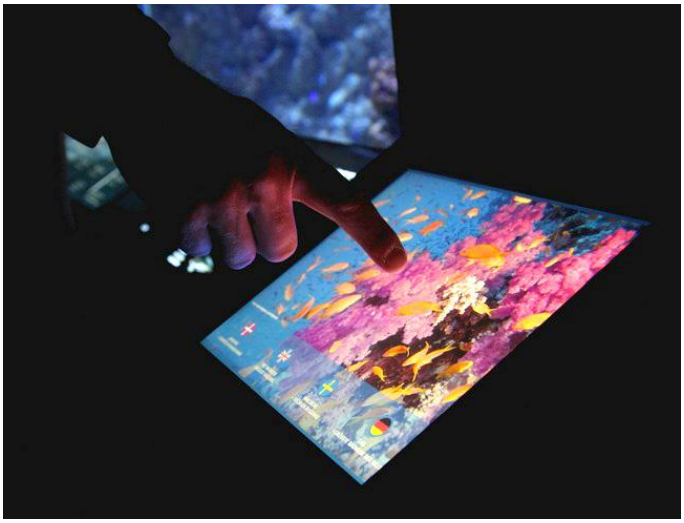

Figure 31: A touchscreen in The Blue Planet (T3CMS, 2014)

12.5 million DKK was devoted in 2014 for replacing the entire system (Kjær, 2014). I quote Mette Broksø Thygesen, The Blue Planet's commercial director at the time:

> *"Fagligheden fejler ikke noget, men formen og metoderne, mekanikken og elektronikken har ikke fungeret godt nok."* (Kjær, 2014)

4.6.2 The North Sea Science Centre

Impressed by touch technology likewise, the North Sea Science Centre installed touchscreens throughout their museum. The content featured, however, were Flash animations looking like something made in the 90s. See Figure 32. The content included mainly clipart images of fish, leading to a textbox with information when touched. The touch technology itself was awkward to interact with compared to e.g. the responsiveness of a tablet. In certain cases the touch input was uncalibrated making it difficult to hit your intended target. (Møller, Jeppesen, Sahl, & Kiel, 2014)

I discovered an artefact by chance, as I was clicking through the drawings of fish: When rapidly pressing the same fish it grew indefinitely in size. See Figure 33. (Møller, Jeppesen, Sahl, & Kiel, 2014)

These touchscreens with Flash content do not conform proficiency, as the user could just as well look up this information of fish on the internet from his or her home computer.

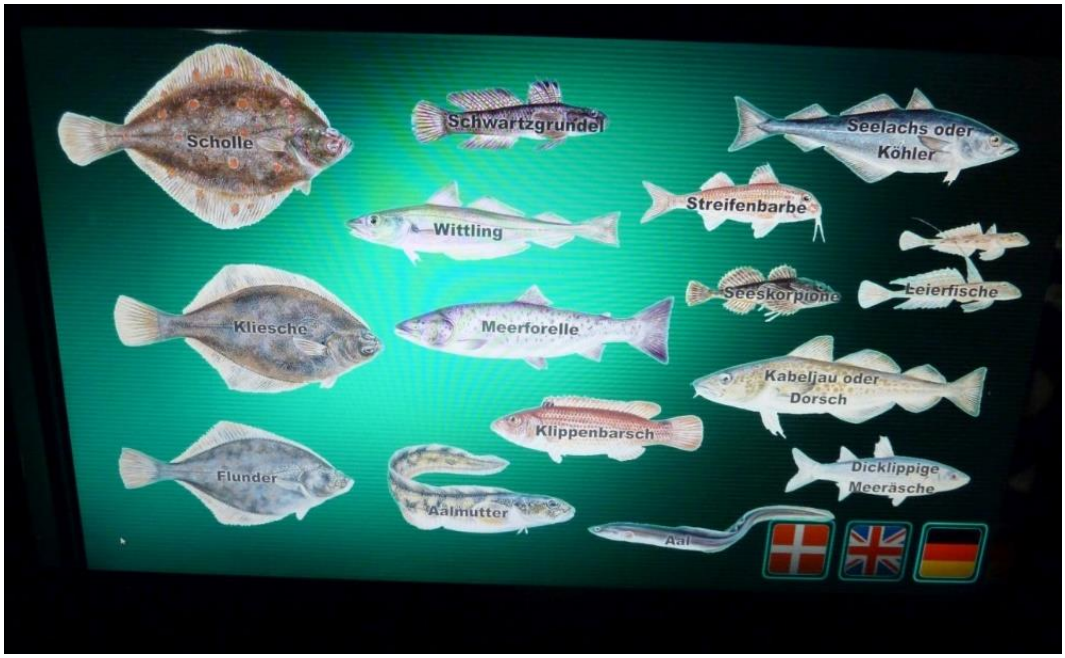

Figure 32: A touch screen on the North Sea Science Centre. (Møller, Jeppesen, Sahl, & Kiel, 2014)

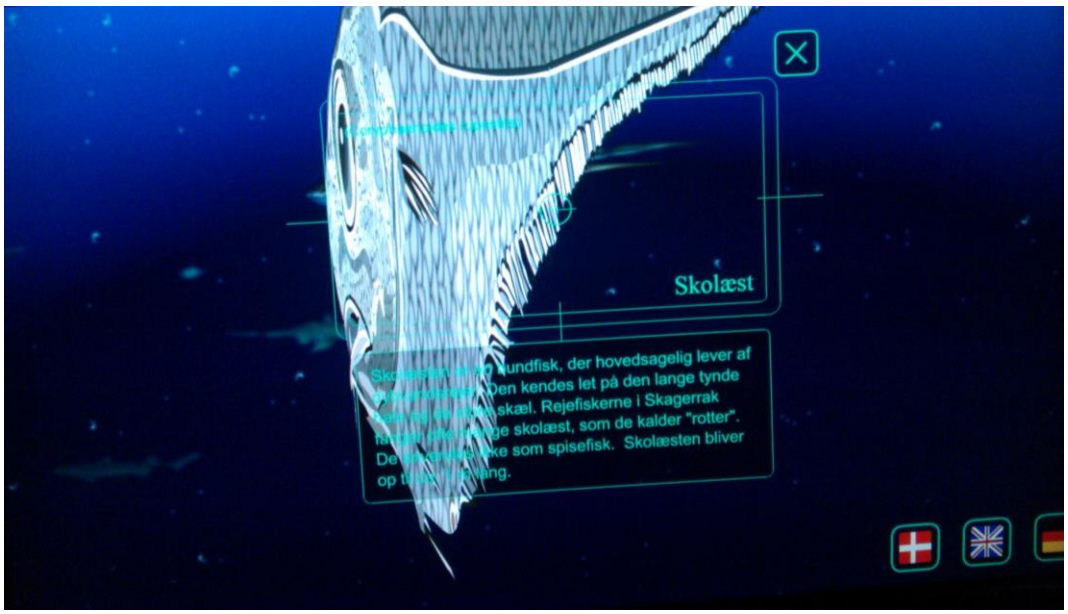

Figure 33: An artefact where the drawing of a fish has been stretched. (Møller, Jeppesen, Sahl, & Kiel, 2014)

The most impressive-*looking*, interactive installation I found at the North Sea Science Centre was a fish auction game where players each had a single, physical button as the only mean of interaction. The game window is displayed in Figure 34. Through pressing the button it was both possible to select language, start the game, and to bid on fish at a virtual auction. My study group at the time and I tested the game and agreed in consensus about its most noticeable flaws: the game was unfair and its usability low. (Møller, Jeppesen, Sahl, & Kiel, 2014)

Every player started with a different amount of money to use for bidding. It made sense if the reason behind this choice was to resemble reality, but this was at the cost of gameplay. This game was largely competitive, so introducing different starting money by random chance was equivalent with giving random players a head-start in a racing game.

Figure 34: Fish auctioning game at the North Sea Science Centre (Møller, Jeppesen, Sahl, & Kiel, 2014)

But most importantly, having a single button for controlling a complex auctioning game was not very usable in this case. My 7th semester study group and I accidentally started the game in German, and was unable to go back to change language. The game had to be completed for restarting it. After playing for several minutes, in German, we gave up and left. (Møller, Jeppesen, Sahl, & Kiel, 2014)

Observing other visitors using the auctioning game involved cases of them becoming either frustrated with the restricted interaction or engaging in button-mashing competitions. (Møller, Jeppesen, Sahl, & Kiel, 2014)

This installation violates both the need for usability and Nielsen's (1995) heuristic for recovering from errors.

As a final example from the North Sea Science Centre, Figure 35 is an example of transmissional interactivity, as mentioned in chapter 3.2, where the interactivity in this case is limited to the user switching channels on a TV. When one of the buttons are pressed, a pre-recorded five to twenty minutes long video stream with audio starts playing. One noticeable, frustrating issue with this installation is that once a video plays, it cannot be paused, changed, stopped or seeked through.

Transmissional interactivity is not necessarily *bad*. In this case, however, the physical button interface for controlling lengthy video streams does not afford interactive video playback. The transmissional interactivity becomes forced content as mentioned on page 31. At the very least the user should be allowed to either stop or change the video.

Figure 35: "Interactive" television at the North Sea Science Centre (Møller, Jeppesen, Sahl, & Kiel, 2014)

4.6.3 Kattegatcentret

"Havet in Action" is the name of an interactive zone without real aqua life that Kattegatcentret added to their centre in 2013. By adhering to different learning styles, the visitor learns about the life underwater mainly through kinaesthetic learning (Dunn, Griggs, Olson, Beasley, & Gorman, 1995). In the exhibition "Can you run faster than a shark?" visitors must run from one end of a room to the other as fast as possible while an animation of light shines on a wall next to them, which is the virtual

shark they are racing against. After running they receive feedback in form of a score; “you ran as fast as a sea turtle!” This is a proper reward; the user is rewarded based on performance.

Figure 36: Kattegatcentret's interactive zone "Havet in Action" (Kattegatcentret, 2015)

4.6.4 The bench that costed one million DKK

In recent news, an interactive bench costing approximately one million DKK has been developed for a playground in Copenhagen. The static bench itself costed 3.000 DKK. The projector – which broke soon after the project launched – costed 110.000 DKK and is too expensive to repair. Most of the budget, however, was spent on consultants; 850.000 DKK in total. (DR, 2015)

Figure 37: Interactive bench in Copenhagen (DR, 2015)

The stakeholders associated with this project omitted the target user from the design process and ended up with an expensive, unwanted product.

4.7 Summary

To explicate core findings from my second observation, I yet again utilize the KJ-method. This manifests into these categories:

- Motivation
- Availability and accessibility
- Immersion and flow
- Social aspects
- Crowd-pleasing for the indirectly participating audience
- To influence; not only creating
- Family quality time
- Fun

Negative findings:

- Unforgiving designs
- Dysfunctional design or -hardware
- Frustration; resulting in blaming oneself or others
- Alienation
- Interaction powerlessness in regards to forced content
- Mental model discordance
- Lack of visibility concerning interaction design

Figure 38 lists all the categories from both KJs combined, unfiltered.

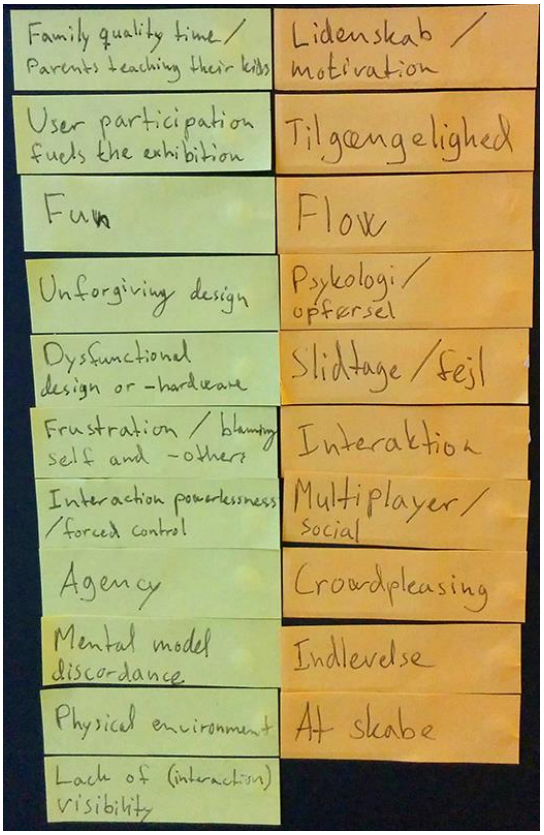

Figure 38: List of all categories from both KJs

In regards to these findings, I confirm hypothesis #1: *"Museum visitors' user experiences are affected negatively by violations of design-, usability- and interaction design principles."*

In chapter 5 I review Danish research regarding interaction design in museums.

5 Critique of current, Danish research

From concept to production an interactive, digital museum installation can involve many different departments and professions. I classify the most fundamental professions in these three categories – also mentioned in my methodology on page 7:

- Museum inspectors
- Researchers
- Developers

This chapter concerns the researchers, as I include material from DREAM (Kobbernagel, Schrøder, & Drotner, 2015) – an organisation of researchers associated with Moesgaard Museum amongst others – and a PhD thesis THE WALL (Rudloff, 2013) as cases for reflecting on the mentality of Danish museum researchers in regards to their understanding of interaction design.

5.1.1 Case: THE WALL

THE WALL is a multimedia installation consisting of four multi-touch plasma screens with a combined length of twelve metres. See Figure 39. (Københavns Museum, 2015)

Figure 39: THE WALL in Copenhagen. (Politiken, 2011)

Ideally, users of THE WALL are able to access and interact with historical texts and images of past Copenhagen. The concept of THE WALL works to such a degree that people do walk up to and interacted with THE WALL. On a qualitative note, however, just as many users being positive towards THE WALL, expresses an equal amount of negative response in the sense of frustration towards the interface and towards the interaction herewith. (Rudloff, 2013)

An example of negative feedback by a user of THE WALL followed by the worrying statement that almost all users shared similar negative comments towards the installation when asked:

> *"'Jeg havde lidt svært ved at finde ud af, når man var inde, hvordan man gik tilbage.' Hun uddyber: 'Hvis jeg for eksempel går ind i Landbohøjskolen, hvordan jeg så kommer tilbage til noget af det andet, til Vesterbro… eller… jeg kan ikke finde ud af, om man kan komme tilbage!?' De problemer med navigationen, som kvinden udtrykker, gentager sig med meget få undtagelser hos alle øvrige observerede og adspurgte brugere."* (Rudloff, 2011, p. 85)

Other examples of negative feedback were words like "complicated", "unclear", "messy" and "illogical" despite the fact that accessibility and an intuitive navigation was prioritised highly by the museum and developers themselves. (Rudloff, 2011, p. 88)

What strikes me the most, is how this feedback is perceived by the researchers:

> "[…] [*vi ved] i virkeligheden endnu relativt lidt om, hvordan de nye digitale formidlingsformer lever op til målsætningerne om øget og mere engagerende brugerinvolvering"* (Rudloff, 2011, pp. 79-80)
>
> *"Set i lyset af, at VÆGGEN repræsenterer helt ny teknologi, der eksperimenterer med nye former for museal brugerinddragelse, er det forventeligt, at man oplever en række uforudsete problemer i mødet mellem medie og bruger."* (Rudloff, 2011, p. 98)

I distance myself from this mentality. This new technology Rudloff (2011) speaks of might be new to her or her colleagues, but it is not as unknown as she makes it to. Interaction with THE WALL concerns touch. Touch is not a new technology. From how I understand it, what users become frustrated about with THE WALL largely concerns bad interface design:

> *"I VÆGGENs tilfælde førte brugernes manglende forståelse af navigationsveje og søgefunktioner til, at mange brugere hurtigt udtrykte irritation eller gav op, inden de reelt kom ned i de dybere lag af VÆGGEN."* (Rudloff, 2011, p. 97)

Rudloff (2013) argues, that the possibilities for interaction and participation can vary from project to project:

> *"Hvert enkelt digitalt museumsprojekt er typisk konstrueret til et bestemt museum og/eller til en nærmere defineret formidlingssituation, som har rod i det enkelte museums unikke samling, og som kan være målrettet bestemte målgrupper og/eller til en bestemte type interaktion og/eller formidlingsoplevelse […] Det betyder, at ethvert museumsprojekts design, indhold,*

> *placering, den eller de anvendte mediegenrer [...] og dermed mulighederne for interaktion og deltagelse kan variere voldsomt fra projekt til projekt.* (Rudloff, Formidling i forandring: Et casestudie af VÆGGEN - et dansk eksempel på digital, interaktiv museumsformidling i overgangen fra genstandsrepræsentation til brugergenereret kultur, 2013)

Even though this is true, fundamental design-, usability- and interaction principles still apply. For instance, the design should still be forgiving if users make mistakes and help them recover from errors – in regards to Nielsen's (1995) heuristics. The navigational problems mentioned earlier is in contrast to this, where users were unable to go backwards in the system.

5.1.2 DREAM report

DREAM is an organisation of researchers cooperating with museums in Denmark – Moesgaard Museum amongst others. DREAM recently released a report covering young Danes' museum- and media usage (Kobbernagel, Schrøder, & Drotner, 2015):

> *"Undersøgelsen afdækker 13-23-årige danskeres brug af museer og medier i en tid, hvor både museumsaktiviteter og medier er under stærk udvikling. Hensigten med undersøgelsen er at få dokumenteret centrale udviklingstræk i udviklingen af unges museumsbrug set i lyset af unges hverdagskultur, hvor medier spiller en hovedrolle."* (Kobbernagel, Schrøder, & Drotner, 2015, p. 5):

The report also accounts for how many young Danes play video games, uses social media, shares content online etc. This research could be used in determining the relevance of implementing game related content in museum experiences as a mean of reaching out to that particular target group; 13-23 year old Danes whom are underrepresented in Danish museums. (Kobbernagel, Schrøder, & Drotner, 2015)

The report relies on documenting youngsters' use of social media, websites and apps rather than on how this data can be used in practice.

The wording seems to favour the importance of optimising a museums' presence on the internet in regards to social media and own websites. All in all, the report mostly concerns the part of the experience before and after a user choses to visit the museum:

> *"Der er mange forskellige formål med museernes formidling og kommunikation via hjemmesider og sociale medier, og et af dem handler om at påvirke brugernes opfattelse af organisationen i en positive retning."* (Kobbernagel, Schrøder, & Drotner, 2015, p. 27)

I do not intend to devalue this statement, but the report does not definitely express how the knowledge gained from the collected data on young Danes' media usage can be utilized in museum exhibitions for affecting users *during* a museum visit.

All touch points – before, during and after a visit – are of importance to the total experience, including experiences on social media, which DREAMs report relies much on. However, if the exhibitions in the museum do not live up to a user's expectations during his visit – for instance when experiencing the breakdowns observed in chapter 4 – why should he then share anything positive on the social media afterwards?

Based on findings from my observations at Moesgaard Museum I deem that it is more important to regard current issues with the dysfunctional, interactive installations in the museum rather than optimising their website or Facebook page further.

To support this argument, the DREAM group's own research states that visitors judge the physical exhibition to be one of the most important aspects of a museum visit, illustrated in Figure 40:

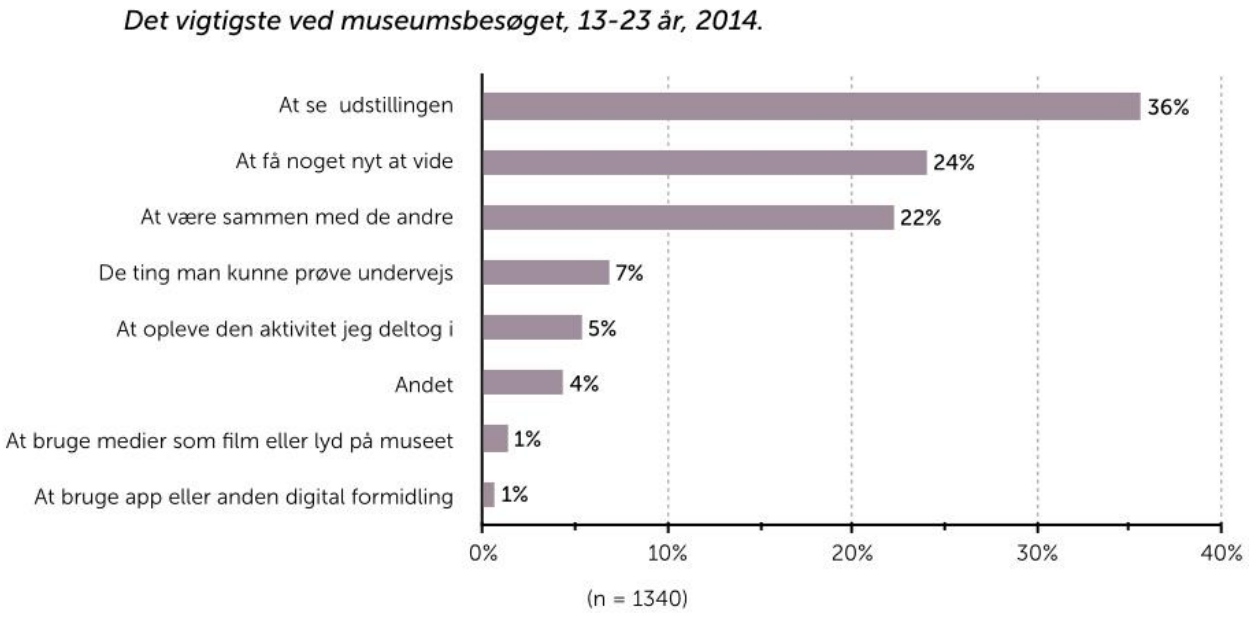

Figure 40: Diagram showing what museum users thought of as most important when visiting museums (Kobbernagel, Schrøder, & Drotner, 2015, p. 36)

> *"36% svarer, at det vigtigste ved museumsbesøget er udstillingen, 24% at det vigtigste er at lære noget nyt, og 22% at det er at være sammen med de andre."* (Kobbernagel, Schrøder, & Drotner, 2015, p. 9)

The importance of the exhibitions has also been noticed by Falk (2013):

> *"Although people visit museums for many reasons, seeing exhibitions and 'stuff' still represents the main goal of most* current *visitors."* (Falk & Dierking, 2013, p. 128)

Another thing I would like to note, is how the report also concerns usage of Museum apps for smartphones. The approach is quantitative. Focus relies on app-downloads and site-visits instead of whether the applications or websites live up to their users' expectations or whether they provide good experiences. E.g.: "How many times has this museum app been downloaded?" instead of "How do users use the app, and which parts are used most often?"

The questionnaires used in gathering the data on young Danes' museum- and media usage are included in the reports' appendix (Kobbernagel, Schrøder, & Drotner, 2015, p. bilag). Figure 41 shows part of one of these questionnaires – the red dots mark that I have cropped out part of it:

Medieaktiviteter til kommunikation og handling

Tænk på sidste uge, og prøv at huske, hvor mange gange du i din fritid har brugt følgende medieaktiviteter. Det er ikke vigtigt, hvilket udstyr du brugte, så det kan enten være via pc, tablet, iPad eller mobiltelefon/smartphone, og det kan være med en eller flere slags software:

	Har ikke brugt den sidste uge	1 gang om ugen	2-3 gange om ugen	4-6 gange om ugen	En gang om dagen	Flere gange om dagen	Ved ikke
Tale i telefon	○	○	○	○	○	○	○
[...]							
Spille spil (fx Boom Beach, Dragons, SMASH, Pac Man Dash, WordFeud)	○	○	○	○	○	○	○

Figure 41: Part of a questionnaire where the user had to fill in his or her media activity (Kobbernagel, Schrøder, & Drotner, 2015, p. bilag).

The game titles chosen for the questionnaire looks as if picked by random from a list of popular smartphone apps. Boom Beach? SMASH? What happened to Minecraft (Mojang Synergies AB, 2015) and World of Warcraft (Blizzard Entertainment, Inc., 2015)?

This suggests that the DREAM organisation's experience with video games in general are either dated or otherwise insufficient. If they wish to collect useful information through questionnaires for youngsters and to extract useful statistics from this, they should possess a minimum of knowledge in game theory.

5.2 Summary

The research by DREAM does state that young people use social media and games in their everyday lives; alas, any practical mean or guidance of how to utilize this knowledge in a museum setting is omitted.

I find the literature included in this chapter inadequate and ignorant in terms of designing digital user interactions. There seem to be a tendency where digital interactivity in a museum context is thought of as unexplored territory, a hitherto untested, unique and incomparable technology, where common interaction design principles do not apply.

6 The responsibility of museum stakeholders

Developers, researchers and museum inspectors alike have a shared responsibility in the experiences they provide for their users. This responsibility is manifested in the Danish museum law:

> *§ 2. Gennem de indbyrdes forbundne opgaver indsamling, registrering, bevaring, forskning og formidling skal museerne i et lokalt, nationalt og globalt perspektiv*
>
> *1) aktualisere viden om kultur- og naturarv og gøre denne tilgængelig og vedkommende,*
> *2) udvikle anvendelse og betydning af kultur- og naturarv for borgere og samfund og*
> *3) sikre kultur- og naturarv for fremtidens anvendelse.*
>
> (Kulturstyrelsen, 2014)

In this chapter I discuss how museums are encouraged to target a user-centred approach in their communication, how there is a difference in technical competences in museums.

6.1 Encouraged by the Ministry of Culture

From 2006 onwards initiatives has been made by the Danish Ministry of Culture (Kulturministeriet, 2006) by i.a.:

- Encouraging a more comprehensive documentation of experiences with user participation
- Economically supporting museums to incorporate user participation
- Distributing international research amongst nationally recognised museums
- Economically supporting new and experimental exhibition projects involving an integration of digital and physical communication forms
- Introducing further training of staff
- Reinforcing research to enhance museum-to-user communication

Brugerinddragelse: *Der bør – i et samarbejde mellem Kulturarvsstyrelsen og museerne – ske en højere grad af dokumentation af museernes forskellige forsøg eller initiativer med brugerinddragelse, så der kan sikres udveksling af erfaringer om brugerinddragelse mellem museerne. Internationale erfaringer og udviklinger af perspektiverne ved brugerinddragelse bør inddrages.*

Dialog med brugerne: *Der ydes tilskud til museernes udvikling af udstillingsmediet i dialog med brugerne. Her kan redskaber til brugerfeedback og forsøg med brugere som medproducenter give ny viden og inspiration til museernes formidlingsvirksomhed. Der bør ske en systematisk dokumentation og vidensdeling af de iværksatte projekter. […]*

Centralt udvilkingsinitiativ: *Der etableres et centralt udviklingsinitiativ i Kulturarvsstyrelsen for museernes formidling, der virker for udvikling af moderne museumsformidling og sikrer, at internationale erfaringer udbredes til de statslige og statsanerkendte museer i Danmark. […]*

Eksperimenterende formidlingsprojekter: *Der ydes tilskud til nye og eksperimenterende udstillingsformer og formidlingsprojekter. Tilskuddene forudsætter, at der sker en sammentænkning af forskellige digitale og fysiske formidlingsformer, samt at der sker en dokumentation af såvel det støttede formidlingsprojekt som projektets virkning og modtagelse hos museumspublikummet. […]*

Uddannelsesinitiativer: *Der sikres et udbud af kurser, som kan kvalificere museumsformidlingen og give øgede formidlingskompetencer til museernes formidlingspersonale. Dette kan ske ved at yde støtte til særlige uddannelsesinitiativer, gerne etableret i samarbejde mellem universiteter, Museumshøjskolen og øvrige relevante uddannelsesinstitutioner, fx de kunstneriske uddannelser på Kulturministeriets område.*

Forskning: *Forskning i museumsformidling styrkes blandt andet ved etablering af ph.d.-forløb i samarbejde mellem museer og universiteter, som kan øge den forskningsbaserede viden om museumsformidling til nytte for udviklingen af den konkrete museumsformidling.*

(Kulturministeriet, 2006)

This means that the Ministry of Culture is encouraging and paying museums to target user-centred approaches and to introduce new, experimental forms of exhibitions where both digital and physical communications forms should be involved. Interactive, digital media is an ideal option:

> *"Med de digitale medier kan museet arbejde med en højere grad af differentieret og lagdelt formidling, hvor brugerne selv kan vælge mængden og dybden af information til og fra grundet mediernes interaktive potentiale. […] Men de digitale medier kan naturligvis ikke i sig selv initiere en dialog, det er derimod museets opgave at realisere det dialogiske potentiale og opstille en meningsfuld ramme for denne dialog."* (Larsen & Løssing, 2013, p. 178)

The initiative from the Ministry of Culture is called "Formidlingsplanen" and was conducted from 2007 to 2013. 41.2 million DKK were delegated yearly to projects in national museums. A range of museums are still working on projects being supported financially through Formidlingsplanen. (Kulturstyrelsen, 2015)

6.2 Scepticism and digital divides

Not all affiliates are equally thrilled about being forced to introduce digital, interactivity in their museum, however:

> *Erfaringerne […] viser, at der er en række forhold, som kan være medvirkende til at afholde museer fra at benytte digitale medier til formidling:*
>
> - *Museernes eget materiale er ikke tilstrækkeligt digitaliseret, og mange museer bruger derfor ressourcerne på at digitalisere samlinger*
> - *Ressourcer og medarbejdere er generelt knappe på de mindre museer*

- *Det kræver vedligeholdelse, når den digitale formidling er udviklet*
- *Det kan være komplekst at udvikle webformidling, fordi det involverer mange fagområder*
- *Der kan være skeptiske holdninger til internetmediet.*

(Kulturministeriet, 2006, p. 117)

This suggests that there exist a variation between museums in their utilization of interactive technology. This is not only because of the fact that digital, interactive exhibitions can be expensive. The reason also resides in digital divides; a difference in competences (Samfundslitteratur, 2013):

> *"Når det gælder* digital envejskommunikation*, er danske museer langt fremme. De fleste har i dag en hjemmeside, som kan tilgås fra en pc eller smartphone […] Når det gælder* digital tovejskommunikation*, er der stor forskel på udnyttelsen og udviklingen I danske museer.* (Drotner, Løssing, Larsen, & Weber, 2011, pp. 14-15)

But this scepticism towards interactivity is a sad point of view to have. Utilizing interaction design in a museum does not mean that the mission of the museum is being downgraded:

> *"Entertaining museum experiences actively engage visitors intellectually, emotionally, and physically by inviting them to participate and become intellectually involved, touching objects, posing questions, manipulating machines, smelling an environment, and hearing sounds. Here, properly applied, multi-media and multi-sensory approaches are often beneficial. The combination of intellectual, emotional, and physical involvement is the essence of an interactive (and enjoyable) museum."* (Falk & Dierking, 2013, p. 114)

Until now I have conducted observations at Moesgaard, presented my findings, criticised current Danish research and briefly covered the underlying motivational factors for museum stakeholders' responsibilities in accordance with the creation of exhibitions.

Based upon this research I propose the following problem statement.

7 Problem statement

The main problem discussed in this thesis concerns how the interactive, digital exhibitions presented do not live up to the intended quality of user experiences.

This is an issue because visitors then do not receive the learning or communication that the museums promises them to.

Hypothesis #1 was confirmed in chapter 4.7, to the degree that I have observed how museum visitors have expressed themselves negatively – either via spoken words or body language – when interacting with aforementioned museum installations.

On this basis of assessment, I articulate the following problem statement:

- Where and why do errors occur?
- Why are Danish museums failing to comply with the use of interactive, digital technology?
- Why does the technology and user experiences not meet the design requirements?
- What makes a successful, interactive installation that provides good user experiences?

In design and HCI practice, success can never be guaranteed (Gaver, 2012), hence I only strive to provide *as best as possible* suggestions to making good interaction design in museums.

8 My suggestions to good museum interaction design

Based on the accumulated knowledge from the previous chapters, I now attempt to constitute what *possibly* makes successful interaction design that provides good user experiences.

8.1 What makes a good experience?

To clarify what I mean by a "good experience", I utilize Jantzen, Vetner and Bouchet's (2011) ten criteria for good experiences. These are depicted in Figure 42.

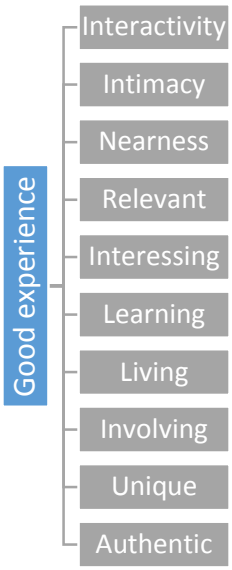

Figure 42: The ten elements that good experiences are made of. (Jantzen, Vetner, & Bouchet, 2011, pp. 98-99)

Good experiences can appeal to the individual user's values and issues and recognizes the user as a co-creator of the experience. (Jantzen, Vetner, & Bouchet, 2011)

Csikszentmihaly (1990) describes good experiences like dance, chess, etc. as the following: *"They have rules that require the learning of skills, they set up goals, they provide feedback, they make control possible."* (Csikszentmihalyi, 1990, p. 72)

Addressing his theory of flow, which is also a core part of good experiences, he states the following:

> *"Flow tends to occur when a person faces a clear set of goals that require appropriate responses. It is easy to enter flow in games such as chess, tennis, or poker, because they have goals and rules for action that make it possible for the player to act without questioning what should be done, and how."* (Csikszentmihalyi, 1997, p. 29)

What I deduce from this is that if the main goal of a design is for its users to reach a state of flow, it could be an idea to consider utilizing game theory, adhering to Salen and Zimmerman's (2004) definition of games in chapter 4.2.2 on page 27.

8.2 Utilize design principles

Throughout this thesis I have covered multiple design principles including i.a.:

- Nielsen's (1995) ten heuristics of usability
- The heuristics of user needs
- Norman's (2013) theory of mental models and Dourish's (2004) theory of coupling
- Design affordances

While not a design principle per se, scaffolding is also a valuable theory to have in mind, as mentioned in chapter 4.2.5 on page 30. The right scaffolding can help a complex design to be operated more easily when presented step-by-step, supported by a tutoring person or system. (Wood, Bruner, & Ross, 1976)

Another design principle also worth mentioning is Ockham's razor (Lidwell, Holden, & Butler, 2010, p. 172); a way of stripping your design to being as simple as possible similar to the KISS principle (Janalta Interactive Inc., 2015). These principles can be utilized for "*getting the right balance between aesthetic appeal and the optimal amount and kind of information per page*" (Preece, Sharp, & Rogers, 2015, pp. 5,31) as mentioned earlier in chapter 3.3.

Adhering to these principles when creating interactive designs are likely to result in better products and user experiences in general. There are, however, limits to how strictly the principle should be applied as well:

> *One of the problems of applying more than one of the design principles in interaction design is that trade-offs can arise between them. For example, the more you try to constrain an interface, the less visible information becomes.* (Preece, Sharp, & Rogers, 2015, p. 30)

8.3 User participation

In chapter 4.6.4 on page 48 the case with the one million DDK bench serves as a reminder to involve the target group to at least some extent in the creation of a design. The Danish Ministry of culture even encourages museums through economical means to incorporate user participation in their strategies.

Simon (2010) suggests likewise that museums should be participatory-oriented. See Figure 43.

"[…] in participatory projects, the institution supports multi-directional content experiences. The institution serves as a "platform" that connects different users who act as content creators, distributors, consumers, critics, and collaborators." (Simon, 2010, p. 2)

"Traditional participatory bodies like community advisory boards and prototyping focus groups are important, but those forms of participations are limited by design. Participation has the most impact when designers can scale up collaborative opportunities to all interested visitors. This means offering every visitor a legitimate way to contribute to the institution, share things of interest, connect with other people, and feel like an engaged and respected participant." (Simon, 2010, p. 4)

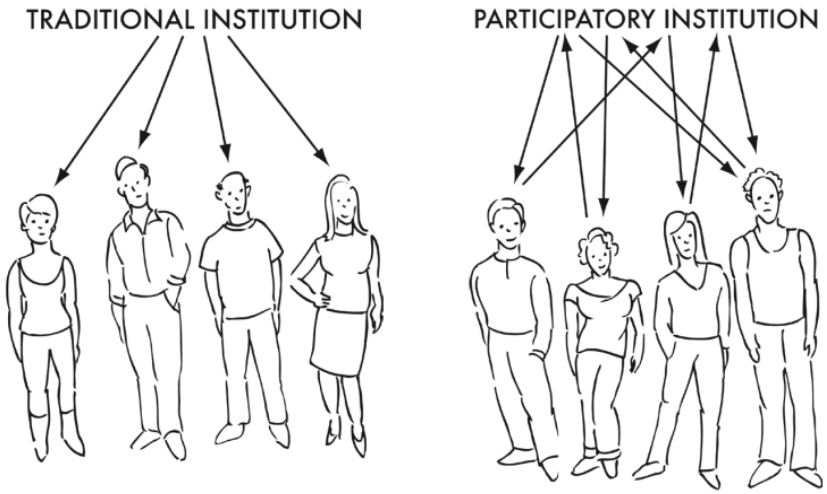

Figure 43: Traditional institutions (communication from museum to visitor) versus participatory institution (communication between museum and visitor) (Simon, 2010, p. 2)

8.4 Interaction design pitfalls

Allen and Gutwill (2004) describe five common pitfalls when working with interaction design. These guidelines mainly concerns how to approach working with multiple modalities in an interactive design, or when multiple users interact with said design:

"1) Multiple interactive features of equal priority can overwhelm visitors […]

2) Interactivity by multiple simultaneous users can lead to disruption […]

3) Interactivity, even by a single visitor, can disrupt the phenomenon being displayed […]

4) Interactive features can make a critical phenomenon difficult to find […]

5) A secondary interactive feature can displace visitors' attention from the primary one […]"

(Allen & Gutwill, 2004, pp. 202-213)

Surprisingly, I have observed very few exhibitions that suffer from being bloated with too many interactive modalities. Regardless of that fact, it is still worth mentioned that HCI practitioners should be careful to not implement too many different possible ways of interacting with a design. An example would be if the Viking game also featured voice control and physical buttons to press, all while the user has to also keep track of steering the ship, navigating and touching the monitor every now and then.

Dance with the dead in chapter 4.3 on page 32 is an example of an interactive design where too many simultaneous users lead to disruption with the Kinect being unable to correctly lock on to any one user.

Allen and Gutwill (2004) suggest these three design solutions to their proposed pitfalls:

> *"1) Limit functionality [...]*
>
> *2) Segment functionality [...]*
>
> *3) Create a hierarchy of salienc [...]"*
>
> (Allen & Gutwill, 2004, pp. 214-216)

Limiting functionality is another way of reminding to utilize the KISS principle and making sure that the main interaction featured in a design is also the most prominent one.

A HCI practitioner wanting to communicate several messages should consider segmenting functionality into multiple designs rather than a single one. Moesgaard Museum has does a decent job in their designs clearly communicating one or two things each.

Rather than removing modalities from designs with multiple ways of interaction, the less important interactions can be made less prominent, introducing a hierarchy of interaction inputs.

8.5 What can be generalised?

According to Gaver (2012), *"a great deal of design theory tends to be generative and suggestive, rather than verifiable through falsification."* (Gaver, 2012, p. 943)

Not every design principle and theory can be generalised to guarantee success in every possible context. But the matter is neither as impossible as implied by (Rudloff, 2013) in chapter 5.1.1, THE WALL, on page 52.

In Appendix F on page x-17 I describe how e.g. scaffolding, user needs, design principles and breakdowns exists across Minecraft and museums. It is given that users have different needs and motivations when visiting an online, virtual Minecraft world in comparison to when visiting a physical museum but fundamentally, both Minecraft and museum are just two different media platforms for distributing information. If a public Minecraft server provides zero scaffolding and no protection systems, users are subject to having experiences of relatively lower quality. If a national museum

provides no scaffolding, leaving visitors in anomie (Csikszentmihalyi, 1990, p. 86), they are likewise prone to having relatively worse experiences.

What cannot be generalised, is choices in design that must be made to conform the specific context, and theories that must be fine-tuned hereto as well. For instance: Flow theory includes no mathematical formula to always guarantee users to reach a state of flow. Furthermore, the theory presupposes that the user is determined on being in flow at all, which the HCI practitioner has no power of.

8.6 Closing comments

As closing comments I include this quote by Falk (2013) on the importance of utilizing design principles in museums:

> *"Many museums contain exhibitions where the objects are too high for children or individuals in wheelchairs to view; with glare from glass or low contrast labels that make it challenging for even perfectly sighted individuals and impossible for visually challenged individuals to view them; with technology that malfunctions; with audio that is difficult for individuals with hearing challenges to understand; or with interactives that are too complicated to figure out how they work, or even worse, make no sense as to why they exist in the first place.*
>
> *Universal Design principles that integrate multisensory, multimodal experiences into exhibitions, programs, and media, including special labels and interpretive materials, large graphics or supplementary audio information, can help enhance the museum visit and provide the extra assistance required so that visitors of varied ages and abilities can fully participate and have a satisfying experience."* (Falk & Dierking, 2013, pp. 124-125)

9 Conclusion

The role I have acted through in this thesis is as an interaction designer by theory in accordance with my revised model of interaction design research within HCI research in Figure 3 on page 8. (Zimmerman, Forlizzi, & Evenson, 2007)

Through observations and action research I found that certain interactive, digital museum exhibitions are plagued by i.a. unforgiving designs, dysfunctional hardware and discordance in coupling leading to user breakdowns, frustration and self-blaming. This confirms my initial hypothesis of the user being affected negatively from interaction design violations.

Flaws seem to occur in the mentioned exhibitions on all levels of the hierarchy of needs; from supporting little proficiency to others not functioning at all. Errors mainly occur either at the very moment a user initiates interaction with an exhibition or when a user wants to go back in the system; e.g. to recover from an input mistake. In the case of Dancing with the dead mentioned in chapter 4.3 on page 32, the rate of errors is linked to the size of the audience, hindering the exhibition from crowd-pleasing.

My suggestion to the reason behind why Danish museums fail to comply with the use of interactive, digital technology concerns the stakeholders associated with the creation of the research artefacts; the reason relies in a combination between a tendency of ignorance and possible scepticism towards interaction design principles and a lack of experience with the technology associated herewith.

I do not have a bulletproof formula guaranteeing how to always create successful interaction design for museums. However, I do suggest to which extent interaction design principles can be generalised across media platforms and what should be considered when working with interaction design and user experiences in general.

10 Discussion

My empirical data relies largely on my own observations and action research at Moesgaard Museum and previous observations conducted at North Sea Science Centre and Kattegatcentret in relation to my 7th semester project (Møller, Jeppesen, Sahl, & Kiel, 2014).

To support my findings I could conduct other types of data gathering such as quantitative surveys or qualitative interviews with museum staff or visitors to triangulate this data.

Throughout this thesis I have not defined any target group as such. I could either choose targeting the young people who rarely visits museums on their own initiative, which is mentioned in DREAM's (Kobbernagel, Schrøder, & Drotner, 2015) report in chapter 5.1.2. Whether I define a target group or not does not matter much after I observed the crucial design flaws in the museums mentioned earlier through chapter 4. When something as essential as a START-button does not start anything when pressed, it does not matter whether the user who pressed it is 10, 20 or 80 years old.

Concerning my critique of DREAM (2015) and Rudloff (2013) it can be discussed whether I judge their work unfairly. Perhaps the report from DREAM (2015) is only supposed to merely shed light on the fact that young Danes use computers. In that case it would be wrong to accuse them for not explaining how to utilize their data for interaction design in museums in practice.

The material I have covered for Danish museum research could be extended by also including "Dansk museumsforskning - status og tendenser 2013" by Gransgaard, Jensen and Larsen (2014).

One question from my problem statement that I have not answered clearly is: "Why does the technology and user experiences not meet the design requirements?" The research I managed to collect did not lead to a definite answer to this. To answer this question adequately, I need more empirical data; e.g. from interviews with staff or visitors at Moesgaard Museum.

To update on Csikszentmihaly's (1997) flow theory with more recent material, I could have included material Engeser (2012). This goes for Bartle (2004) as well, whose theory on player types has been criticized and revised multiple times. It would be better to then addressing this critique and following up with material from e.g. an article by Dixon (2011).

I also ended up not using "Cybermuseologi" – an anthropology by Larsen, Gade and Hansen (2015). It revolved mainly theories about museums rather than the technology featured there. The book features no in-depth material on interactives in museums and it focuses largely on arts.

11 Perspective

A question I could try to answer next is "How do you maintain people's attention at a museum exhibition?" This involves the aspects of motivation, which could include material from Amabile (1996) and Ryan and Deci (2000).

In chapter 8.3 on page 65 I briefly mention Simon (2010) and how museums should embrace participatory design. I feel like I did not cover this aspect sufficiently. Simon (2010) has more theories on participation in museums that could strengthen my argument in its importance.

To test my suggestions in chapter 8 I could make a prototype:

> "*It is when research activity is carried out through the medium of practitioner activity that the case becomes interesting. There are circumstances where the best or only way to shed light on a proposition, a principle, a material, a process or a function is to attempt to construct something, or to enact something, calculated explore, embody or test it.*" (Archer, 1995)

More core design principles could be included in chapter 8 or during my action research, such as the principles of Gestalt (Lidwell, Holden, & Butler, 2010, pp. 24,44,144,196).

The Gestalt principles are trivial though, and I did not find obvious violation of these principles during my observations.

As a final note, one attraction that I wanted to analyse was DOKK1, depicted in Figure 44; a newly opened library on the dock in Aarhus, which is said to offer interactive, digital installations. (DOKK1, 2015)

Figure 44: DOKK1 in Aarhus (DOKK1, 2015)

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Appendix A Autoethnography

On a lightly snowy day in December 2014, my family and my girlfriend have planned a trip to Moesgaard Museum. On the beforehand, I have heard positive talk about new interactive, digital installations featured on Moesgaard. Being very interested in interactive, digital experiences in general, my expectations are high. With the majority of my university projects concerning interactives, I therefore have a decent preunderstanding within this subject.

As we arrive by car around noon, we walk up to and spectates Moesgaard's newly added building. It is an impressive work of architectural brilliance. My father comments: "You can tell that this has been expensive!"

Walking inside, we scout for the wardrobe to hang our jackets whilst being amazed by the aesthetically pleasing building and interior. However, we never find the wardrobe, so we pay, enter, and start walking around with our jackets over our arms; "Maybe we will find the wardrobe on the way?" my mother suggests.

We walk down a grand stair with static, but magnificent mannequins depicting ape-like races of humankind from many years ago. The static exhibitions at Moesgaard certainly delivers – they are very appealing to examine.

Hereafter, we split into two groups; my family walks in one direction while my girlfriend and I walks in another. At this moment, I am not aware of that from here on, my experience of the visit will only worsen and my frustration rise.

I enter a section in Moesgaard called "Oldtidens udstillinger", which is about the Viking age. A movie clip projected onto a wall is playing, describing the exhibitions to come. It encourages visitors to bring a "token" with them (see Figure 11 on page 21), which hangs on a wall near the entrance. I grab two different; an info token and a worn comb.

I walk over to the first digital exhibition that I see; a big part of a globe in the middle of the room with two monitors and connected rudders (see Figure 45 on the next page). With there being a decent amount of people, I wait for my turn. Within seconds of observation, I notice that one of the receivers for tokens seem to have a loose connection; it are having issues reading the token placed on it (see Figure 13 on page 22). As I sit down in front of the device with the faulty receiver, I try my best to make it maintain a stable connection but fail. Determined on playing the game, I wait for the other machine to be available. This machine too has its flaws, but at least the connection is stable.

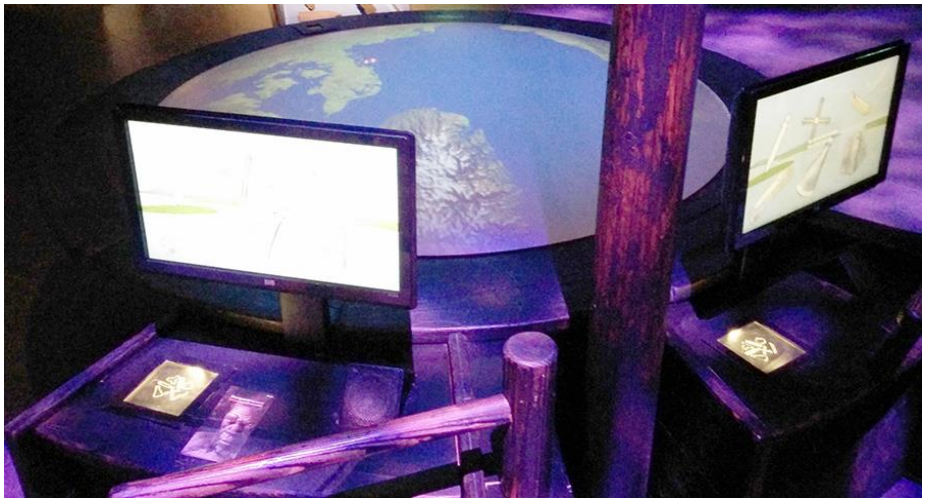

Figure 45: Viking game at Moesgaard Museum.

From experiencing this breakdown, I start noticing more and more flaws as I walk around the rest of the museum. For instance: There is a video playing on a monitor where someone has forgotten to move the mouse cursor off of the screen. Instead of being absorbed into the story being told, I am now distracted by the cursor, and so are the people around me. I overhear a woman giggling: "Look, they forgot to move the cursor!"

These beginner mistakes are plentiful throughout the museum. I walk past a monitor where the system has crashed, and is now showing a blue screen. I observe how most physical installations to be interacted with are either clunky, unintuitive or broken with very few exceptions.

One of these exceptions is an exhibition called "Dancing with the dead" (see Figure 46). It features a Microsoft Kinect and a big monitor displaying two 3D skeletons. When visitors walk in front of the monitor, music starts playing and the Kinect scans and tracks their bodies mirroring movement to the skeletons. The connection is easy to understand, and kids and adults alike are having fun with this. Nothing is broken or difficult to understand – it just works.

Figure 46: An exhibition at Moesgaard Museum titled "Dance with the dead"

My verdict of my visit at Moesgaard Museum is: “disappointing and frustrating”. Even though starting with high expectations, I did have the idea that I might not be very impressed with what I would see at Moesgaard. But I had not imagined experiencing so many violations of design in only one day.

And we never did find the wardrobe.

If I was the director at Moesgaard Museum and money was not an issue, I would hire some interaction designers to fix and maintain the current, interactive installations. Onwards, these interaction designers should serve as a permanent addition to staff as quality control for future, digital installations.

Appendix B Observation at Moesgaard Museum 21/03/2015

General notes

I had to ask in the reception for guidance to find the cloakroom. It was downstairs. An A4 printout was hanging next to the stairs saying: "*Notice! The stairs are slippery.*" They weren't wet. They were simply build out of a smooth stone material. I overheard two older women saying: "*Why would anyone build slippery stairs?!*"

No mobile signal inside the building. I had to go outside to check my messages and make telephone calls. So did others.

Okay Wifi signal inside.

Globe w/ Viking sailing game

It is the most prominent, interactive exhibitions in the Viking section of Moesgaard. See Figure 45.

Not all chip pieces can be read by the receiver – i.e. the Info piece doesn't work.

Children frantically pull the rudder.

Children don't perceive the white guideline they must follow.

Elderly does a better job at controlling their ship.

Children's ships collide with land (frustration).

The game tells a story auditory during which the frame is locked. Most people skips the story by pressing their ship. The children are more restless while the game is standing still during the story-telling.

One of the game devices prints "*Din spillerbrik er fjernet*" to the most of its players. The other game device prints this error less often.

Only a small percentage of players realize that you can touch the screen while playing, as there are no visuals promoting interaction with the monitor. Touching, holding and sliding your finger on the monitor changes the camera viewing angle of your sailing ship.

Pressing the bottom right window on the monitor makes your white guideline reappear (it fades out and disappears after some seconds of gameplay). This is actually being spoken in the game amongst other information during the game, before the storytelling.

Mom helps children. "*Sejl dén vej.*" *points on monitor*

When told to move on, children say "*Neeej, mor, det er så sjoovt!*"

Another mom's comment to when the chip piece doesn't work: "*Den duer ikke helt. […]* Jeg kan ikke finde ud af det."

The children SAY they love playing the game.

Little boy: "*Jeg vil også spille det!*" mother: "*Far er ude at finde en spillebrik*". The dad had to go all the way back to the exhibition's entrance (through a couple of rooms; or nearly a total of 100 m back and forth) to get another chip piece, which then turns out not to work, since they chose to sit at the game device with the most faulty connection.

Bug: Two children's ship suddenly sails through land.

A mom tries to skip the story. *touches screen* It doesn't work.

Young girl playing, rapidly pulling and pushing the rudder. She seems to think that the rudder must be pumped. She spends minutes pumping the rudder, and it actually gets her ship forward. Her conceptual model is off, but it works out for her!

She has figured out how to make the white guideline reappear by pressing the monitor's lower right corner. Her brother tells her, that she must turn her ship, because you are supposed to sail in the direction the wind is blowing. This is untrue, however, but neither seems to know it for sure. The girl shouts: *"Lad nu være, [M]! Jeg ved godt hvodan, man gør*!" to which her brother shouts back: *"Det virker ikke som om du ved det!"*

A dad and son ([M]) sits down at one device, next to each other. They're having issues trying to start the game because of the connectivity error between their chip piece and the game device's receiver. The mother says: "*Det var da mærkeligt den ikke gider*".

The son, [M], tries to reposition the chip piece multiple times. His dad comments: *"Prøv at hente en anden brik."*

Almost every person with the Axe chip piece completes the Viking sailing game successfully. All chip piece categories apparently have a different story and route to them in the game. People with the Axe chip piece must simply sail to the nearest random patch of land, they can find, and does not specifically have to follow a precise route.

A little boy experience the game with almost no issues. However, he keeps pressing the monitor to skip whenever the game is not playable, paused by the storytelling. It doesn't work however, and he is forced to wait.

Dancing with the Dead (Kinect Setup)

Most people passing this exhibition cannot help themselves from making a gesture, which makes two skeletons on a large screen mirror the movement.

Man to his partner: "*Den følger dig. Se, jeg er dén til højre."* *pats her skeleton avatar on the head* "*Opfør dig ordentligt".* His partner does the same. They laugh. See Figure 46.

A lot of laughter occur around this exhibition.

A young sister and brother (6 years?) goes all-in, waving their arms and moving their bodies energetically – and the skeletons does the same. The parents watches and laughs.

Brother: *"Prøv at se her, far!"* His sister laughs out loud.

When no people are around, the skeletons stand still and the music fades out until all is silent.

Older people tend to walk too close to the exhibition, which makes it hard for the Kinect to recognize and bind their bodies to the 3D-model skeletons.

The exhibition is generally more successful to families (people with children).

Technical-wise, the exhibition has a hard time working when too many people are in the room. It has potential for crowd-pleasing, but the Kinect is preventing it to.

Viking war on a table (projected image)

Move a fist-sized Viking piece of porcelain-looking material onto a ring of light on a table. Choose between a spearman, an archer or a horse rider.

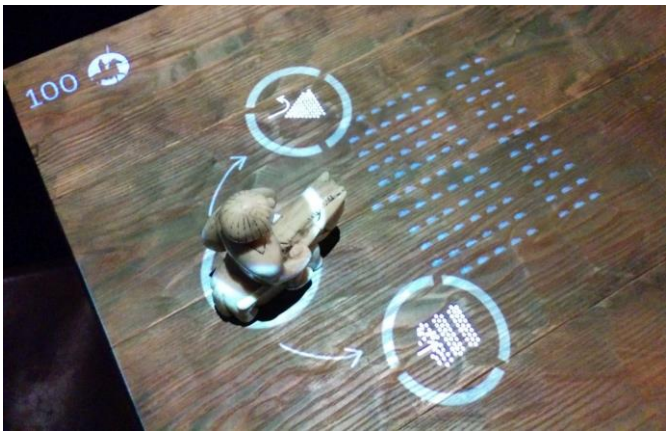

Figure 47: Viking-themed, interactive projection reacting to placement of objects

When you place the piece in the light ring, a GUI appears on the table followed by two new rings of light. See Figure 47. The GUI shows your number of warriors and your preferred warrior type. The two new rings represents two different war formations to position your warriors in.

After choosing a formation as many white dots appear as the initial number your GUI stated. An army of red dots slides in on the table, running towards your white army where after the parties fight each other. This game is about Viking war tactics.

A family with a mom, girl and boy are using the exhibition. One of the children places a game piece in the circles, starting a war sequence. After watching one sequence, the boy's reaction onwards is to trying to stop the army of red light dots with his arms. The mother ends up angry and scolds him.

Multiple children tries to touch the lights.

Room where you must wear hat, covering your eyes (headset with a storyline)

The psychology of wearing a silly hat in front of strangers.

There is sound in the hats, telling you a story while you feel a wall with embossed sculptures.

Two of the hats have no sound and is broken. This has not been fixed since I was last here one month ago.

Lab (room)

Note: A white entrance door can only be opened from one side, which seems to confuse many.

Lab (White box)

Little girl tries the device while her mom spectates. The child must give up trying to use the clipart interface. The mom takes over and completes the game, however, the child wants to open the lid herself.

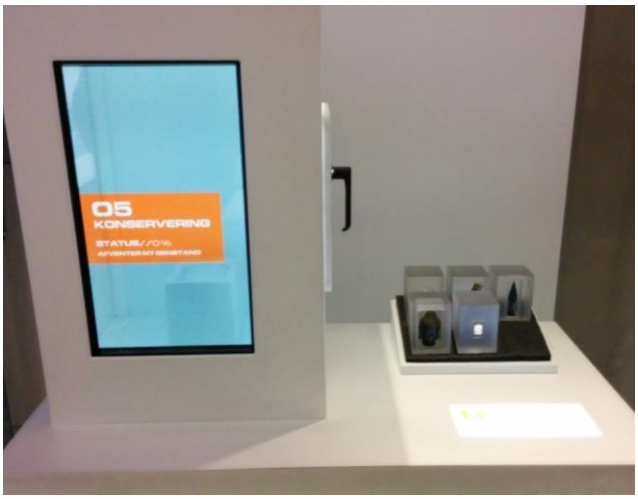

Figure 48: Interactive exhibition where users preserve assorted objects

To boys (aged 8?) tries out the device and follows the onscreen text instructions. They have no issue starting it. Their focus tend to often swift away from the device, looking elsewhere in the room they are in. They don't look emerged. Even though both boys want to try their own playthrough. They press and drags the graphical 2D icons onto where the game tells them to, following instructions. They don't speak much. When both have completed a game, they leave.

Family with mother, grandmother and daughters comes over to the exhibition. They are enough people to cover up the exhibition making any audience unable to see. Bad for crowd-pleasing. Mothers tell daughters what to do. The one non-playing daughter acts impatient. This family spend a long time at this exhibition. They're playing again and again. The one daughter playing seems to enjoy it. They realize the fact that you must press start twice to start the game. When the mother tries, she has some difficulty understanding how to press the screen. She tries to grab the onscreen tools with two fingers, rather than pressing, holding and swiping with a single finger. The children tell her how to do it right, but she doesn't truly understand it. This family now has played through all of the game units.

A father and daughter tries the box exhibition. The daughter hangs on her farther. After one quick playthrough of the machine, they leave.

Another little girl is playing. She's having difficulties controlling the tool icons.

Many children understand how to use the tool icons, but they look like as though they are waiting for something more to happen.

A little girl tries the box. To women are helping and one reads out loud: "*Det er et lille stykke gevir, som er fundet. Det skal gøre våd.*" They spend a long time, having fun.

The box has one usability flaw: The start button must be pressed twice or more for the game to start. First it is orange, then after one press it turns black, but the game does not start until pressed at least once more. I had to help a family start the game. Many people have left the device, given up because they were unable to start it.

Also, you have to be 100% correct while playing for the game to proceed to the next step. If you are told to e.g. make the game object wet, it is not enough to create water droplets on 99.99% of the object. You must be unforgivingly thorough, which caused frustration and confusion to some players.

Lab (Face recognition device with skull)

The device is bad at distinguishing and recognizing a face, when a person sits down in front of it. Often, the exhibition won't start.

Figure 49: Interactive installation supposed to track the user's skull

A boy sits down. The camera recognizes his face and tracks it as he turns his head and rotates on his chair. His younger sister sits down afterwards. The camera never recognizes her face.

An old man sits down. Looks at the device, which takes some time to lock onto his face. After beholding the exhibition for a little while, he stands up and switches with his wife.

Multiple people are frustrated that the device does not seem to work – it will not recognize their faces. An older brother ends up briefly snapping irritated at his younger brother as if it is him doing something wrong.

Lab (Log ores device)

A child and mother is trying it out. The child's focus is elsewhere. The mother says: "*wait and read*". The child wants to try more of the wooden pieces and somewhat understands the principle of the game. See Figure 50.

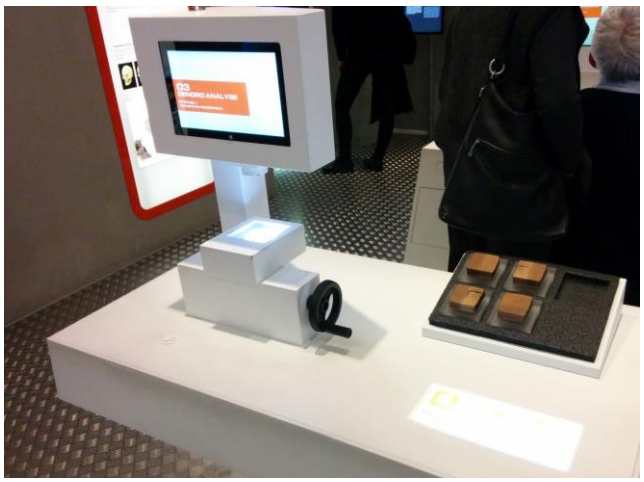

Figure 50: An installation for counting ores in fictive logs

Parents are telling their children about rings in logs.

A child comes over, asking me about the device. He tries a block. It is way too difficult for him. His dad comes over and tries to help. They fail and move on.

An older woman tries the device. She carefully reads the onscreen text and starts playing. She understands how to do. What I and many others didn't realize is, that there is a *white button* in the *white table* that you must press in order to mark the log's ores! See Figure 51.

Figure 51: White, interactive button on a white table

Children switches out the wooden pieces which sets of an alarm in the game; *beep, beep, beep…!* The onscreen text tells them that the game will end if they do not place the wooden piece back on the device. They quickly pick out another wooden piece and places it on the receiver. Nothing happens. The alarm keeps going. When the alarm stops and the timer has run out, the machine stands by. The game will not start until they remove and places the new wooden piece again. Bad usability. These

children also do not quite understand the turning mechanism and they do not see the button on the table.

A new girl with her father tries the device: She spins the wheel too quickly (and also doesn't notice the button). They leave.

Lab (UV light and bones)

Many families tries this exhibition. They easily understand that they can take a bone which is from an animal and watch it through the UV light.

Figure 52: Box with ultraviolet light and animal bones with markings

End of observation.

Appendix C Acquired knowledge from my Minecraft server project

The Danish Geodata Agency created all of Denmark in Minecraft (Geodatastyrelsen, 2014). They set up three servers to handle the user traffic, with the Denmark world split up onto these servers.

Anyone with a Minecraft account and an Internet connection could log in and everyone had full building rights and with an infinite amount of blocks to build with in Creative Mode. The only prohibited item was TNT.

The good

The concept was that everyone was welcome on this public server to build anything he/she desired. It was okay to destroy a pre-generated building as long as you built something in its place.

To make sure that people would speak nicely to each other, the Geodata Agency referred to www.sikkerchat.dk on their website.

As a mean to prevent the server from running slow, every 60 seconds thrown items on the ground was automatically removed, which could otherwise pile up and cause a hit on performance.

The bad

Many younger visitors in this virtual reality setting with the power of anonymity did not respect the referral to SikkerChat.dk. In addition, there did not seem to being any consequences when breaking any rules.

Quickly griefers learned that TNT was blocked – but TNT in minecarts were not. Placing down a dozen of TNT minecarts and igniting all at once was an easy way to crash the server. See Figure 53. Often one or all of the servers were down. It took the Geodata Agency multiple months to close the worst security holes, which were easily exploitable by most users familiar with Minecraft.

Figure 53: Destroyed portion of GST's official Minecraft server (CNN, 2014)

Besides the mass destruction of buildings and mountains of lava spread all over the starting area, also the chat was flooded with racism, sexism, other hateful comments and spam.

The Geodata Agency tried to asking players nicely to keeping a proper tone in the chat and they had to reset the world using a backup when reaching too critical a level of destruction. This inevitably led to the loss of "good" players' creations as well.

As a final solution to eliminate the physical destruction and the hateful comments, the Geodata Agency revoked all building rights and disabled the chat completely. Now nobody could ruin the game experience for others – because there were no longer such experience to ruin.

Retrospect

First, people on the internet in general can be anonymous, you are not necessarily speaking directly to their face and rules and consequences works differently than in a non-virtual society. To simply tell visitors of your server to "play nice and follow the guidelines" with no actual safety system was unthinkably naïve of the Geodata Agency, in my optic.

I am getting the feeling that they were not very interested in actually running the servers, but more into working with the geographical data, creating the world itself. It makes sense if their goal was simply to show off a proof of concept, promoting what is possible to do with the now free and public Basic Data. However, this approach does not necessarily result in a great, final product if you do not understand the user's perspective, and more importantly when users are able to interact with **each other**; understanding the user's effect on **other** users' experiences.

According to Bartle (2004), players which happiness comes from affecting and possibly ruining the gaming experience of others have their own category in player types called "Griefers". Mere guidelines or rules will not stop this player type unless faced by consequences – like the risk of being permanently banned from the game server, even to which some players do not care much about. To some griefers their goal is to cause as much havoc as possible before incidentally them being found out and suffering the penalty. When no penalty exists, though, they can carry out their mischievous acts unhindered, affecting as many other innocent players as possible.

When the Geodata Agency's only means of stopping griefers, whom there exist plenty of in the huge Minecraft community, includes mainly the above-mentioned amateur attempts, the rule-breakers could basically run loose, ruining the enjoyment for any other player type than fellow griefers.

Furious about the agency's lack of user experience knowledge and server administration knowledge, I started my own project, downloading the entire Denmark in Minecraft world and hosted the one Terabyte of data through a dedicated hosting company in France.

The Geodata Agency stated that they were forced to reset the entire server every time destructions were too extensive. I learned that almost every larger Minecraft server (with 30+ daily visitors, which would be many hundreds of servers) had installed safety plugins, which included ways of protecting the server and its players from being griefed. On my own server, I tested the most popular monitoring and grief prevention plugins including Prism, CoreProtect and GriefPrevention. Prism and CoreProtect both provide a rollback feature where an administrator can restore part of a world. Instead of

resetting the entire world of Denmark, the Geodata Agency could have just restored the destroyed areas. The process of doing so is surprisingly simple and speedy. Furthermore, all player actions are logged with Prism and CoreProtect, so the culprits responsible of the destruction could easily be identified and warned or banned.

GriefPrevention makes it possible for every player to mark an area of limited size to call his or her own. The area then becomes indestructible by any player whom is not specifically invited by the area's owner.

Summary

Had the Geodata Agency hired the right staff – for instance an interaction designer – to figure these basic things out for them, the overall gaming experience would have suffered less from the attacks of griefers and the server owners would have to spend less time and frustration on complaints by other players who had their creations destroyed. It is my belief that some would even had worked for free to support this ground-breaking concept of digitalising an entire country in a product as well-known and beloved by many as Minecraft (Mojang Synergies AB, 2015).

Appendix D Utilizing the KJ-method on results from observation #1

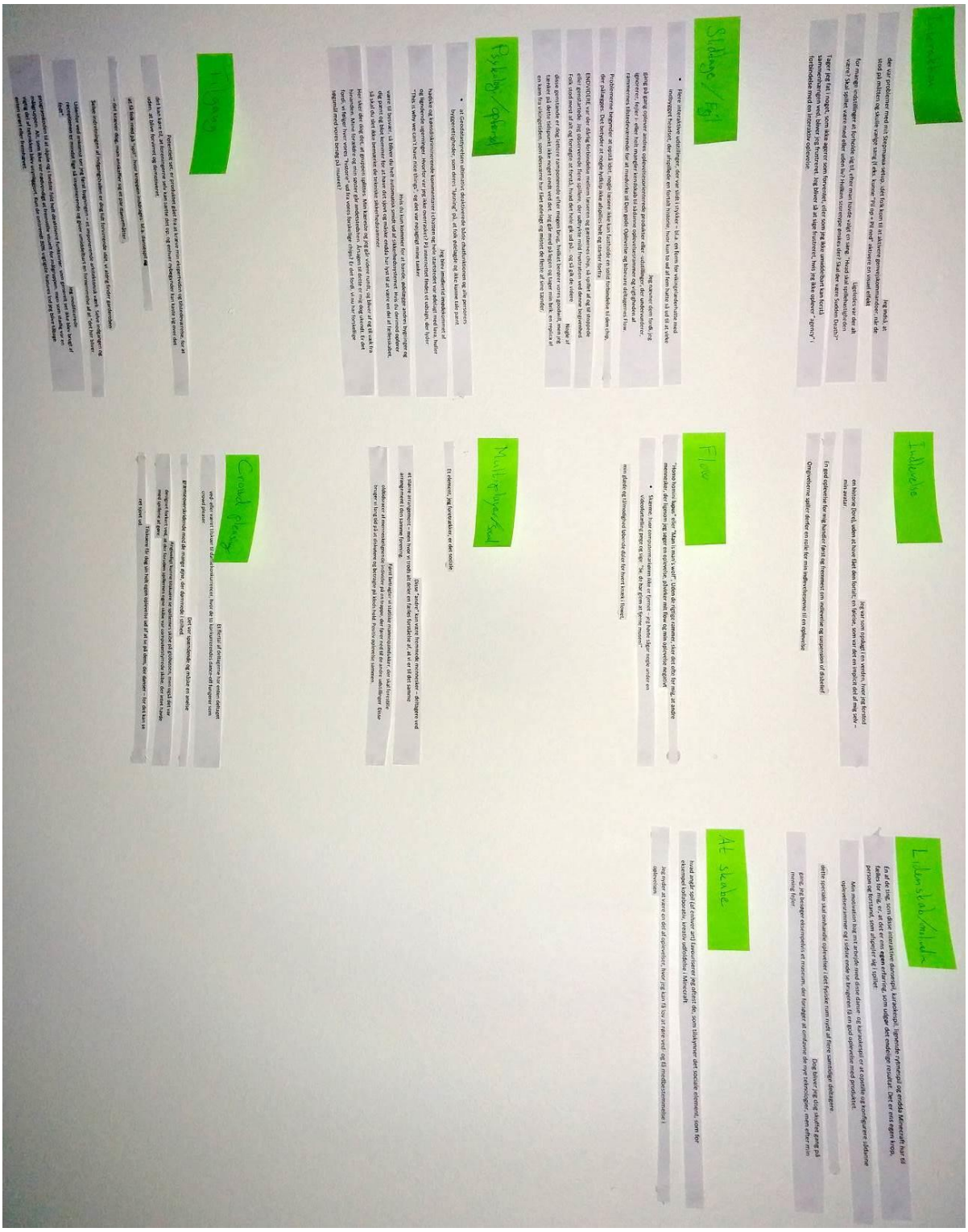

Figure 54: Utilizing the KJ-method on results from observation #1

Appendix E More game theory

Crawford (2003) uses a straightforward definition of games, which I would like to cover briefly.

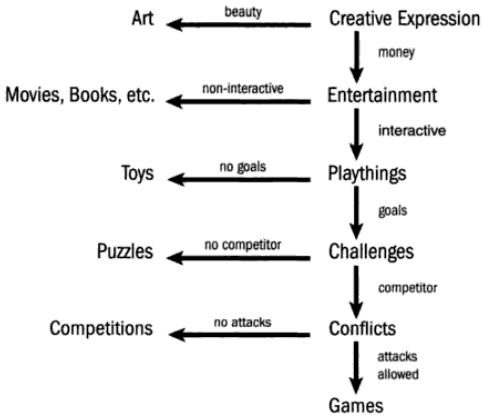

Figure 55: Crawfords taxonomy of creative expressions (Crawford, 2003, p. 6)

A game begins with a developer or artist's wish to express himself creatively. Provided his motivation is to earn money from his work, the creative expression can be considered entertainment. Furthermore, if the entertainment is interactive, has goals, competition and conflicts we are talking about a true game.

As Crawford (2003) states it himself, this definition is a simplified but crude method of defining games, and I find the model to simply being incorrect today, where games have evolved from 8-bit pixelated images making beeping noises to the broad spectre of genres existing today. I find Flower as a good example; an award-winning PlayStation 3 game from 2009 where the player manipulates wind, affecting plants in the nature and collecting flower pedals. According to Crawford's (2003) definition, this would not be considered as a game hence neither competing characters nor attacks occur during gameplay. Flower would in this case be classified only as a puzzle. This conflicts with both the genre and wording used on its page on PlayStations website; the genre is adventure and the word "game" is written several times. (Sony Computer Entertainment America LLC, 2015)

I find Crawford's (2003) definition of games too narrow, but I will briefly refer to it later in the report. The model works as an easy but superficial guideline for defining whether something can be considered a game or not.

Free-to-play

Another acting flaw in Crawford's (2003) definition is true free-to-play games, where the developer's motivation is something else than to earn money. By "true" free-to-play games, I am referring to games where gameplay and game flow does not suffer from freemium business models as a way of monetisation, which is also called pay-to-win. World of Tanks is a good example of true free-to-play whereas Candy Crush Saga is pay-to-win. (Wargaming.net, 2015) (Onyett, 2012)

Appendix F Similarities between Minecraft and museum exhibitions

When hosting public a Minecraft server certain aspects in design theory is not much different from creating an interactive museum installation. You want your users to have a good time, so that they will come again or share positive feedback to their friends and family about your design.

At the very least, the designed concerned should function in coherence with the user's mental model, perform consistently and be easy to use.

Granted, the virtual environment online and the physical environment in a museum are different context, but they do share certain common properties. In figure Figure 56 I list similarities and differences from my understanding of a free-to-join Minecraft server and a museum visit:

Minecraft	**Museum**
Virtual environment	Physical environment
Virtual, interactive design	Physical and virtual, interactive design
Breakdowns can occur	Breakdowns can occur
Users with different experience needs	Users with different experience needs
Can benefit from proper scaffolding	Can benefit from proper scaffolding
(Interaction) design theories apply	(Interaction) design theories apply
Freely and instantly accessible at any time	Costs money and aqcuires a certain amount of planning and time
Relatively low user reservoirs of goodwill	Relatively high user reservoirs of goodwill

Figure 56: Table of similarities (in green), differences (in orange) and partly similarities (yellow) of Minecraft and museums.

One of the theories that applies to both Minecraft and museums is the theory of scaffolding (Wood, Bruner, & Ross, 1976). My illustration of scaffolding on a Minecraft server is displayed in Figure 57:

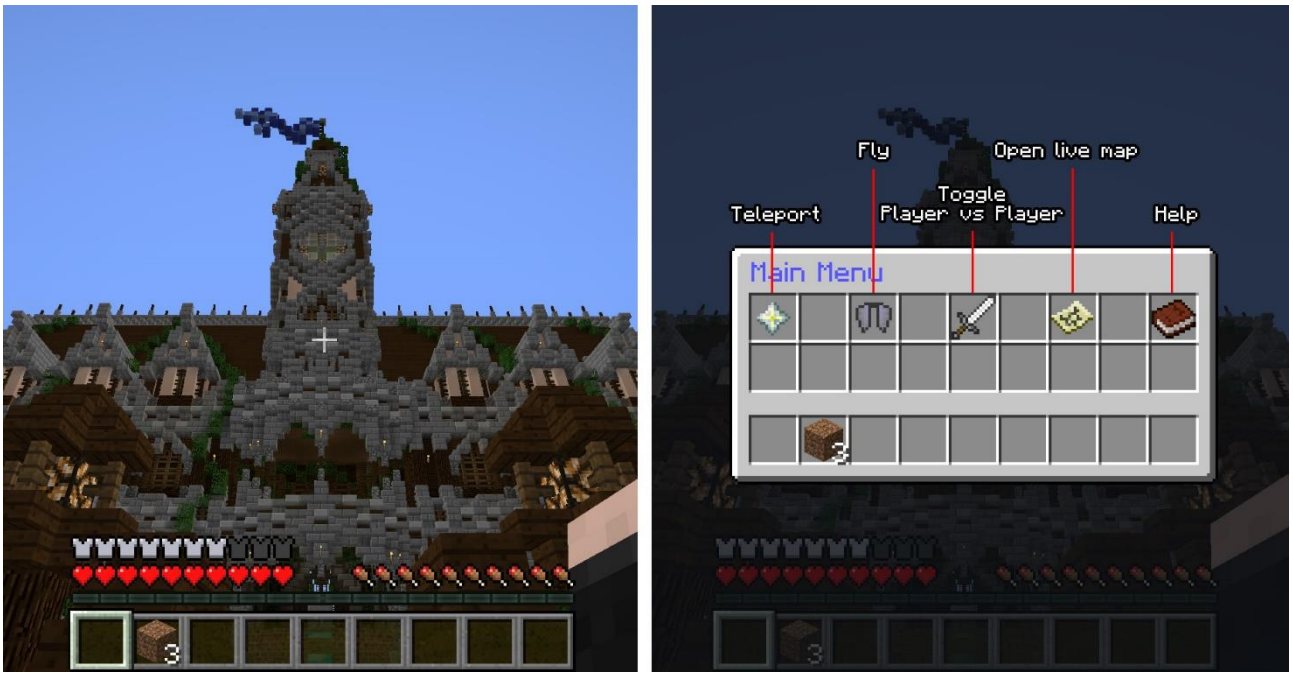

Figure 57: Scaffolding example in Minecraft.

The figure depicts a new user – left side of Figure 57 – looking upon another player's castle, wondering where to start and what to do. To the right, the user opens a menu with five options to choose from with guiding text appearing upon mouse hover. Clicking an icon leads to further instructions or actions, step by step.

Krug (2005) argues that a user should be able to instantly tell where he is located and where to begin in respect to when visiting a website. This can be generalised and applied to both Minecraft servers and museum installations as well; when a user approaches a design for the first time, does the design then communicate well enough what the general idea is with the design and how the user commence interaction?