



# SANDBY

B O R G

# X

DIGITAL PRODUCTION  
2018



**Sandby borg X**

**Sandby borg – A Virtual Connection**

**Creating a Relevant Dialogue Through Cultural Heritage with Virtual Reality**

Swedish Title 'Sandby borg – en virtuell koppling. Samhällsrelevant dialog genom kulturarvet med Virtual Reality'  
Riksbankens Jubileumsfonds kommunikationsprojekt 2017



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# **Sandby borg X**

## **Sandby borg – A Virtual Connection**

**Creating a Relevant Dialogue Through Cultural Heritage with Virtual Reality**

**Riksbankens Jubileumsfond (RJ) Bank of Sweden Tercentenary Foundation**

**Communication Project 2017**

**Fredrik Gunnarsson, Madeleine Kusoffsky & David Sellin**

**Sandby borgs skrifter 10**

# Abstract

*Keywords: Archaeology, Digital Archaeology, Digital Heritage, Difficult Heritage, ICT, Virtual Reality*

This project aimed to communicate difficult heritage through visualisation and virtual reality (VR). Digital communication tools are well suited to increasing accessibility and participation in archaeology, and virtual reality offers the unique potential of immersive experience where the user gets to feel the history with their senses. This project was connected to the research project *'Frozen in Time - histories of life and moments of death at Sandby borg'* and related to these research questions in the project connected to 'difficult heritage'. Through a collaborative effort between the Dept. of Museum Archaeology at Kalmar

County Museum, RISE Interactive and Linnaeus University, a VR demo was produced with the aim to engage the user in the story of Sandby borg through interaction, storytelling, and an immersive virtual experience. The VR demo was used as material to initiate dialogue about difficult topics like violence and the mentality of war in a difficult cultural heritage like Sandby borg, in relation to contemporary society. In many cases the VR demo made an emotional impact and test user got an immersive, intimate experience but also felt they learnt more about Sandby borg. The project also aimed to function as a stepping stone for potential future developments of VR products made to communicate through archaeology and cultural heritage.

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**The location of Sandby borg on Öland, Sweden.**

## Sammanfattning (Swedish Summary)

Det här projektet utforskade hur man kan kommunicera kring ett svårt kulturarv med hjälp av visualisering och virtual reality (VR). Verktyg för digital kommunikation passar utmärkt för att öka tillgängligheten samt deltagandet i det arkeologiska källmaterialet och VR erbjuder en unik möjlighet för användaren att få uppslukas av upplevelsen och att få känna historien med sina sinnen. Projektet knyter an till forskningsprojektet *'När tiden stannade - livsöden och dödsögonblick i Sandby borg'* och kommer att beröra dess forskningsfrågor kopplade till 'svåra kulturarv'. Föreliggande projekt är ett samarbete mellan Museiarkeologi sydost vid Kalmar läns museum, RISE Interactive och Linnéuniversitetet. Sa-

marbete mynnade ut i en VR-demo, framställd med syftet att engagera användaren i berättelsen om Sandby borg med hjälp av interaktion, storytelling och en uppslukande virtuell upplevelse. VR-demon kan användas som ett hjälpmedel för att diskutera svåra ämnen som våld eller krigets mentalitet genom svåra kulturarv i relation till dagens samhälle. I många fall påverkade VR-demon testanvändarna på ett emotionellt plan och de fick en uppslukande, intim upplevelse samtidigt som de kände att de lärde sig mer om Sandby borg. Projektet syftar också till att fungera som en språngbräda för utvecklandet av framtida användningsområden för VR ämnade att kommunicera genom arkeologi och kulturarv.

# Introduction

This project was funded by Riksbankens Jubileumsfond (Bank of Sweden Tercentenary Foundation, RJ) and carried out in 2017 as a close collaboration between Dept. of Museum Archaeology (MA) at Kalmar County Museum (KCM), RISE Interactive (RISE) and Linnaeus University (LNU). The project explored how communication through archaeology and cultural heritage with the use of Virtual Reality (VR) technology can be done. Using the archaeological site of Sandby borg (SB), this project aimed to convey knowledge through storytelling, and initiate dialog with the general public via emotional experiences in the virtual world.

This is the end report for the project outlining the results from three joint workshops, a VR demo and a public event at KCM in October 2017, where the VR demo was tested, and the public could give feedback. The report contains a background description, a technical description of the production process, results from the evaluation process and the experiences of different users, collected from the demo testing. Finally, there are some concluding remarks followed by recommendations for potential future development. The results from this project will also be further analysed and published as a case study in the licentiat thesis of Fredrik Gunnarsson concerning digital archaeology and its potential in society (the Ph.D. is part of the graduate school GRASCA, Link 1).

This communication project was closely connected to the larger research project *'Frozen in Time - histories of life and moments of death at Sandby borg'* (P15-0138:1) also funded by RJ. *'Frozen in time...'* is an ongoing and carried out between 2016 – 2018. The research project aims to gain new knowledge from the archaeological site of Sandby borg, as well as to examine the role of SB in contemporary society and explore how history can be conveyed in an ethical way. Focus is put on the meaning making and the communication of "difficult heritage", defined as traces of traumatic events that can be difficult to understand and recon-

cile with. How can we visualise and tell the story of the horrible events taken place in SB and use it for communication around topics relevant for today's society? The SB research project is a collaboration between MA, Stockholm University (SU) and LNU.

## Aims

This project focused on how communication of difficult topics today could be raised through the SB events. How to tell stories about gruesome violence but also about the daily life through VR storytelling. VR offers the possibility of an immersive experience, perfect when one wants to transport the user into another mood and context to increase the understanding of the site and potentially make an emotional connection within the user. The VR demo will be used as a catalyst to initiate thoughts, dialogue and possibly discussions.

- Use VR storytelling to find new ways of communication concerning difficult topics relevant today within the frames of a difficult cultural heritage.
- Produce a VR demo and present it for the public.
- Evaluate possible future target groups for further product development.

## Questions

- How can VR be used as a communication tool and work as a link between difficult heritage and today's society?
- Can the users level of understanding and empathy be increased through such an experience?
- Which target groups is the VR experience suitable for?

# A Virtual Connection

Today, cultural heritage sites and archaeological results are often inaccessible for the public in several ways. The heritage site can be difficult to reach physically and even if you manage to get there, it's often very little to see and hard to understand it without help. There are often difficulties in getting informed of the site and its hidden stories. The archaeological results from excavations are usually presented in a basic report, not easy to understand if you are not an archaeologist (Börjesson et al 2016).

This project wants to challenge how to create storytelling that gives people some added value, where they can be more than a receiver of information in a mediation process. We also want to create something that survives the traditional limitations of a project and takes it further. We want the story told, relevant for that person today, in his or her own life. We want to create a virtual connection.

The Valletta (1992) and Faro (2005) conventions have called out to archaeology and the heritage sector to make better communications efforts and share their results about our common past. Cultural heritage belongs to society at large and should therefore be available and of relevance to all, it's a question of communicating the stories archaeology uncovers, as well as making them useful and relevant to the society in our time. The political goals for cultural heritage

in Sweden, has for a long time been to make cultural heritage more democratic through participation and availability (Agenda kulturarv 2003; Aronsson 2003:69). Furthermore, the Swedish legislations concerning contract archaeology from the National Heritage Board now contains phrases concerning demands on mediation of archaeological results (KRFS 2015:1, pp 10).

Digital tools offer new ways in which this can be accomplished, but there's still much to do and development in the field of digital communication of archaeological results is constantly needed, this is also the case in Sandby borg, even though the project work continuously with these issues, using a range of communication tools, including digital (Gunnarsson et al 2015; 2016). The Sandby borg project does not just want to make the archaeological data accessible but also to make visitors/users feel something and connect with the heritage and if possible to their own life or others situation. Such an emotional connection will not only make the storytelling stronger but also has the possibility to encourage dialogue about topics larger than cultural heritage. Virtual reality is a highly immersive tool which make the storytelling experience powerful for the user and perfect to achieve goals of making an emotional connection with the user.

# Sandby borg – A Difficult Heritage

At one of Ölands ancient ring forts, several spectacular discoveries have been made between the years 2010–2017. It all started after suspected looting pits were discovered in 2010. This led the local administrative board to commission a metal detector survey of the site to retrieve and protect any valuable artefacts still in the ground. This resulted in many extraordinary finds such as five jewellery caches containing exclusive gold, gilded silver brooches as well as other rich finds such as beautiful pearls (Victor 2015b). The treasure finds, dated to the Migration Period (c. AD 400-550), have been carefully hidden inside the ring forts houses (Alfsdotter et al 2018).

Since the discoveries in 2010 up until 2017, MA has conducted archaeological excavations at the site

and excavated c. 6% of the ring forts surface (Dutra Leivas & Victor 2011; Victor 2015a, 2015b; Victor et al 2013; Papmehl-Dufay & Alfsdotter 2016; Gunnarsson et al 2016). Except for treasures, something completely unexpected was also found. Human skeletons.

The archaeological evidence shows that Sandby borg was used mainly during the Migration period and that there in the later part of AD 400, a massacre took place that killed the inhabitants and left them where they fell. Remains of at least 26 humans have been found on the floors and streets but there are probably many more to be discovered. No one ever came back to bury the dead and the archaeological traces suggests that no one could or wanted to enter the ring fort after the massacre. The place became taboo



**Figure 1. House 40 is being excavated in 2015. A stone pavement, the outer wall and post holes are visible. Photo: Kalmar County Museum, Daniel Lindskog**

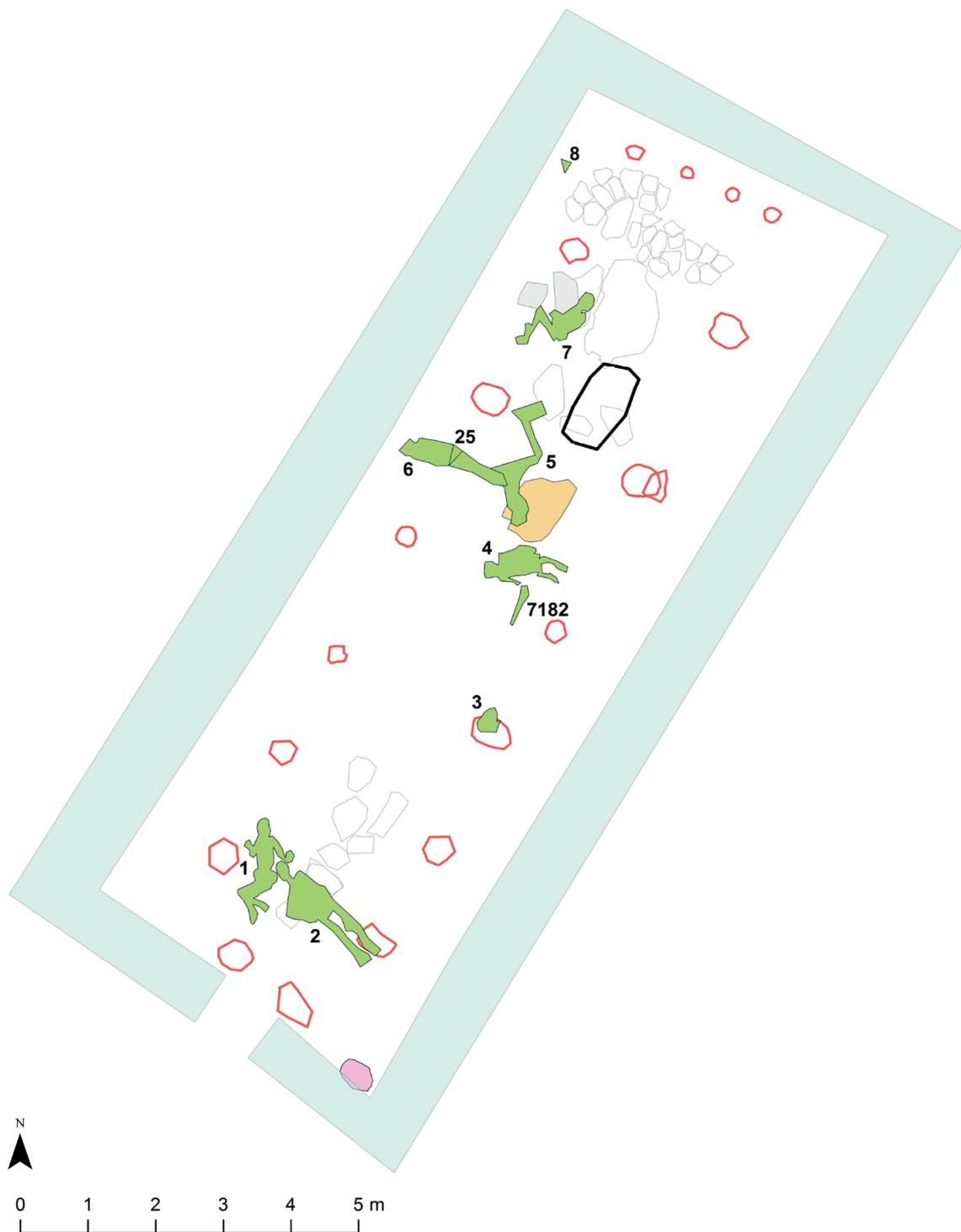


Figure 2. Parts of house 40 and some of its archaeological material including structural features (red, black) and human skeletons (green). From Gunnarsson et al 2016:61.



**Figure 3. Human skeleton from a young individual when unearthed during excavations of house 40 in 2015. Photo: Kalmar County Museum.**

or forbidden. During this period there were turbulent times all over the European continent due to the fall of the Western Roman Empire in AD 476. On the island of Öland there seem to have been a power struggle that resulted in the Sandby borg massacre and that the people responsible for the deed became the new political elite (Viberg et al 2014; Victor 2015a, 2015b; Pappmehl-Dufay & Alfsdotter 2016, Alfsdotter et al 2018).

### House 40

Hereby follows a closer description of the archaeological results from house 40 because of the focus putting into this house in the VR demo. This is the first house that was fully excavated in the ring fort of Sandby borg and where the archaeological data been most analysed and the story most developed. It's also where most effort have been done digitally up to this VR project started out 2017. The house has been virtually reconstructed based on the archaeo-

logical remains from excavations such as post holes, walls or other features and finds (Gunnarsson et al 2016, pp 23).

The house was excavated in different phases during the time period 2011–2015 (fig. 1). The archaeological remains after the structure included 12 post holes, where the posts had been holding up the ceiling, two other posts had been holding up the door frame and four smaller ones in the far end of the inner part, probably holding up a bench of some sort. There was also traces of a room seclusion of some sort, probably not a wall, but something else like a drapey or lighter structural element. In the inner part, there was a stone pavement surrounding an area with lamb bones and in the front part of the house, a stone pathway (fig. 2). Finds from loom weights suggest that there has been a loom standing in the inner part of the house. Finds like pottery, a roman gold coin, a treasure depot, beads, metal objects and much more has been found giving the archaeologists clues to who the people in Sandby borg were and

how they lived before they died (Gunnarsson et al 2016; Alfsson et al 2018). Some finds were reconstructed in the VR demo and can be discovered when interacting with the environment (pp 24).

There have been finds of human remains from 9 individuals in house 40 (fig. 2, 3) and the archaeological evidence shows that they been killed by sharp force trauma by sharp or blunt weapons. The individuals have been of all ages, and in the cases where gender could be decided, all male. The youngest child being just an infant between 1,5–3 months old and another child 3–7 years old when killed. Several skeletons from animals was also found which indicates (Gunnarsson et al 2016; Alfsson et al 2018).

## **Difficult Heritage**

A “difficult heritage” is a term used when heritage sites can be linked to the events of deaths, catastrophes or atrocities. Events that can be difficult to understand and reconcile with (Logan 2009; Macdonald 2009; Lehrer et al 2011). These places are often a part of the human collective memory and part of a so called “dark” tourism (Biran et al 2011). The events taken place in Sandby borg definitely qualifies as a ‘difficult heritage’. The topic of massacre and terrible fates are difficult in themselves but also when it comes to how the stories should or should not be communicated. How can the violence and the terrible events e.g. be visualized in an ethical manner without being a gory depiction from a horror movie?

# Virtual Reality (VR)

VR has been around since the 1960s but has not yet lived up to all futuristic promises made (Bimler 2014). Nevertheless, the recent trends in VR products like VR headsets, provides a brighter future for VR to excel to its initial promises. More advanced hardware and platforms makes it accessible for developers to create virtual environments that render smoothly, reducing “VR sickness” that was common in earlier generations of VR headsets. VR offers the possibility to create immersive environments combining visuals and soundscapes with embodied interaction. VR can revolutionise the future of communication by providing opportunities for immersive 3D telepresence (Fuchs & Bazin 2014). Inspiration from films and storytelling can be employed in a virtual environment where setting, lighting, sound and dialog convey mood, information and context. Beyond the limitations of traditional film, VR offers additional benefits of immersivity. In this case, recreating the scale of SB without needing to physically travel there, as well as enabling interaction and exploration of virtual space and objects. In addition to games, VR is being used in many new contexts such as medical training (Seymour 2002), cognitive therapy (Wallach 2009) and education (Kaufmann 2003).

## VR in Archaeology

Within the cultural heritage sector and archaeology, VR has been used over 25 years (e.g. Barceló et al 2000). Archaeology started to use 3D visualization in the 1980's and has since then mainly used it as tools for analyses or recreation of archaeological features like buildings, monuments, landscapes and even whole cities (Morgan 2009; Lanjouw 2016). These models are often “*sophisticated interfaces to present discoveries or famous monuments*”, and VR is also used “*as an experimental tool for visualization*

*and analysis of data*” (Pujol Tost 2008). In the beginning of this development there was no interaction with the models and it cannot be said that this virtual archaeology was fully comparable to what we mean with an VR experience today (Barceló et al 2000). Up until the last couple of years, the technology didn't get as much attention. Now leading IT manufactures are producing VR hardware and software for a wider audience and the interest and possibility to consume and create VR are much higher than before.

What is currently lacking in the VR products from the sector of archaeology is the human perspective, interactivity and storytelling. The virtual worlds being presented are often missing human representations or other life forms and are “dead” in that sense (Pujol Tost 2008). These dead worlds do not inspire users to interact with it, take part in a story or to make a connection with it. Recreation and visualisation of archaeological data has been the main goal for the developers of products, to show what cannot be seen. The storytelling has not been enough prioritised and fallen into second place. But what did the humans of the past feel or think and who were they?

With this project, we want to change that relationship and put the aspect of storytelling and the user experience first. Today 3D visualisation is a natural part of the archaeological documentation process where image based modelling and virtual recreations are common and which gives the modern archaeologist new powers for interpretation (Börjesson et al 2016:6) and communication. This data production also opens for possible reuse in other applications such as VR. The SB project has produced a lot of data including 3D models and GIS-data which some has been imported in the VR environment. In this project, the archaeological reconstructions are not the aim but merely the foundation in the exploring of emotional storytelling.

# The Workshops

Through a series of joint workshops between MA/KCM, RISE and LNU, a VR demo was produced. This demo was not intended to be used as a fully-functional stand-alone prototype in an exhibition setting, but rather for discussion purposes in controlled demonstrations with test public, researchers or at conferences. RISE was responsible for running the 3 workshops involving project team members across archaeology, heritage studies and interaction design together with members of the scientific board. There were also some invited guests with other relevant knowledge regarding e.g. storytelling and pedagogy. The workshops included: A Kick-off meeting to gain understanding of each other's areas of expertise as well as exploring potential target groups; a storyboarding workshop where scenarios and script ideas were developed for the VR demo; and a hands-on VR tutorial workshop with the aim to transfer knowledge as to how archaeology researchers can continue working with VR after project end.

## Workshop I – Kick off

**Date:** Feb 9, 2017

**Location:** RISE Interactive Institute C-Studio in Norrköping, Sweden

**Participants:** Central Project Team

Fredrik Gunnarsson (KCM/LNU), Helena Victor (KCM), Bodil Petersson (LNU), Thom Persson (RISE), Madeleine Kusoffsky (RISE)

The first workshop was organized by RISE Interactive C-Studio in Norrköping with the aim to answer the questions:

- How do we communicate difficult heritage in VR?
- What moment will we convey in the VR demo?
- Where should it take place?
- What will we show and not?
- What are the target groups?

The goal was to produce three scenarios or story line concepts, which we were supposed to choose one at workshop II. After an introduction of the workshop, project leader Helena Victor held an introduction to the case of Sandby borg. We also got the chance to listen to Bodil Petersson addressing the issue of difficult heritage and Thom Persson talked about the technical strengths and limitations of virtual reality. The day resulted in fruitful discussions and a creative process ending up with different scenarios of what the VR demo could be (fig. 4).

## Results from Workshop I

The story outline began to take shape and it was decided that the goal with the experience for the user should consist of an insight that the inhabitants in the fort have been killed and it was a terrible event. Before that, the experience would be that of discovery and interaction with the environment in the present and in an alternative past. It was decided that the fully excavated house 40 in the ringfort should be the centre of attention (pp 10). The demo should further try to give the user an insight in both daily life as well as the reality of violence at the site (fig. 5). Another aspect put forward was the possibility to show the archaeological process and make it more transparent, to show that it's not so straight forward as one might think, but rather a result from ongoing discussions between archaeologist and different researchers about what the traces in the soil represents.

## Target Group(s)

One of the projects aims was to evaluate which target groups that would be suitable for the VR experience and at workshop I the first decision to narrow



**Figure 4. Discussion during workshop I at RISE C-Studio. From left: Bodil Petersson, Fredrik Gunnarsson, Helena Victor and Thom Persson.**

down the target group to people between the age of ca 17–50 was made. There wasn't any pedagogical part in this project that could create and evaluate a good experience for children, we thought that the experience could be somewhat scary and unpleasant and didn't want the age bar to be set too low. Another point was that this age group is not the one usually the visiting museums. Could this demo be part of bringing them to the museum in the future? The project did not have the possibility to address questions regarding availability for persons with disabilities within the framework.

#### ***Duration***

It was decided that the VR demo/experience shouldn't be too long, but around c. 5–7 minutes, depending on how long the user choose to interact in the environment. The rather short length was thought to be good to avoid VR sickness and still be sufficient for the projects purpose of telling a compelling story.

#### ***Interaction***

Ideas about what kind of interaction there could be in the VR experience was emerging and the large number of archaeological finds in house 40 seemed like the perfect material to create triggers for different kind of 'memories' of the site like sounds or make the upcoming scene start, driving the story onward.

#### ***Characters***

To make the VR experience a story we needed some characters and the project team came up with several initial ideas. We thought that the user itself could be some sort of *spirit*. This would give us the freedom to be flexible in what could happen without being restricted to expectations of a "reality". This could refer to the character itself or the surroundings in the experience. It was also clear in an early phase that there must be *other human figures*, dead or alive, in the story as well. we wanted to tell the story of the inhabitants of Sandby borg and what happened

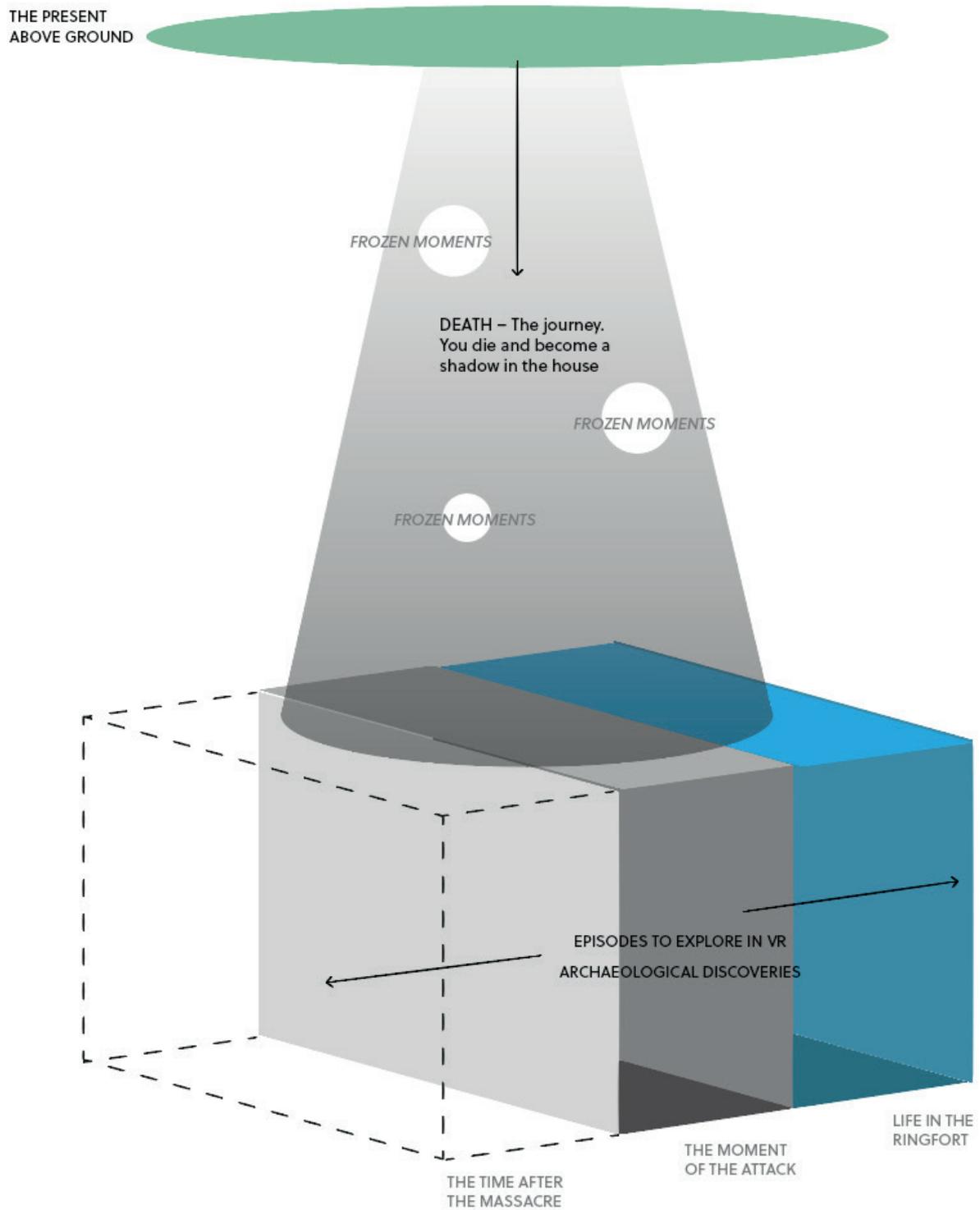


Figure 5. Conceptual figure describing the initial idea of the VR experience developed in Workshop I.



Figure 6. Concept sketch. How the characters would be visualised was still to be developed.

to them and so that they could be represented in some way. Another suggestion was to try and show the archaeological interpretation process in some way, which meant that *the archaeologist* could be a character, represented visually or with other media. The approach was meant to lead away from the mediation, a type of communication where an expert present “facts” to a non-expert. This could also encourage the user to create their own theories of what happened in Sandby borg. Characters could also be something else like abandoned *animals* etc. The characters were developed alongside the storyline as the project proceeded.

### *Soundscape*

Sound was early on acknowledged as crucially important for the VR experience where the user could get emotionally attached. Terrible sounds, like from the massacre itself, would of course have its place, but also the *sound of silence* was thought to leave its

clear mark in the user experience. Noise cancellation head phones could make the user feel fully immersed and maybe a bit uneven, more aware and closer to the experience. Other parts of the soundscape could be music soundtracks to get the feeling of a game or movie experience. This could differ depending on where the user found itself in the virtual world. It was also thought of just as important to have *natural sounds* like sound from the fire, winds or birds.

One of the most important sound aspects was going to be different triggers, which mean that when the user interacted with an object, transporter or action a sound is played. To get the VR experience to be one were the user feel that it brings the story forward and not only is a passive observer was central for the projects aims (pp 6).

## Workshop II – Storytelling

**Date:** Mars 2<sup>nd</sup>, 2017

**Location:** Visualiseringscenter & RISE Interactive C-studio in Norrköping, Sweden

**Participants:** Central Project Team + guests

Fredrik Gunnarsson (KCM, LNU), Helena Victor (KCM), Bodil Petersson (LNU), Jonathan Lindström (KCM), Thom Persson (RISE), Madeleine Kusoffsky (RISE), Arianit Kurti (RISE), Claes Ericson (Interspectral)

The aim of the second workshop was to explore scenarios and take the conceptual storyline developed in Workshop I, further and create a more refined storyboard. It was also an opportunity to gather feedback from outside the central project team and get some new inputs.

To get everyone on the same page, this second workshop started off with intros to the subjects of Sandby borg and “difficult heritage”. After that followed a summary of how far we had gotten. One of the guests was

the author Jonathan Lindström, known for publishing popular science books on archaeological mysteries and to be a good storyteller. He held a speech of how to tell a story and what could be the traps when telling the very specific story of the Sandby borg massacre in such a visual medium as virtual reality. Another presentation was done by Claes Ericsson from Interspectral (Link 3) working with software to get data from CT scans more interactive and useful for both researchers and visitors at museums.

The team then tried out some VR in the C-studio to get inspiration and an idea of what is possible (fig. 7). In the afternoon, the group was divided into two smaller ones, the task was to work out a storyline suitable for a c. 5–7 minutes long VR experience. The results were then presented to the larger group and a way forward was chosen from that discussion. The development team now had enough to start their work on creating the VR demo.



**Figure 7.** The immersive experience of VR made Jonathan Lindström lay down on the floor to enjoy the virtual grass.

### Workshop III – Demo testing/VR tutorial

**Date:** April 20<sup>th</sup>, 2017

**Location:** Kalmar County Museum, Kalmar, Sweden

**Participants:** Central Project Team + KCM personnel + guest

Helena Victor (KCM), Fredrik Gunnarsson (KCM/LNU), Madeleine Kusoffsky (RISE), Thom Persson (RISE), Bodil Petersson (LNU), Örjan Molander (KCM), Per Lekberg (KCM), Ludvig Pappmehl-Dufay (KCM), Carolina Jonsson Malm (KCM), Helen Andersson (KCM), Pia-Lena Björnlund (KCM), Helen Eklund (KCM), Delia Ní Chíobháin Enqvist (Bohusläns museum).

The aim of Workshop III was to test an early version of the demo developed from the storyboard created in Workshop II. The VR demo had a beginning and an end, but the scenes weren't nearly as developed as they would be in the finished version. Still, some feed-

back from the personnel at Kalmar County Museum was valuable for further development. After some introductions to the project and VR, all participants could try out the demo in its current state (fig. 8). They took part of the soundscape with headphones and teleported themselves within the experience, interacting in the different scenes.

After demo testing, the group was divided into two smaller focus groups which, for about 20 minutes, discussed thoughts regarding the project and how the idea could be further developed. The group members were mixed between the different professions represented: archaeologists, pedagogues and museum management. The results from the smaller discussions were presented to the whole group and the discussion evolved from there.



**Figure 8. Demo testing with museum personnel at Kalmar County Museum. Helena Victor with the VR equipment on and Thom Persson holding the connecting cable.**

## Feedback from Personnel

The feedback was very mixed and something that one individual saw as a positive aspect another saw as negative (fig. 9).

+ /Positive	- /Negative
<p><b>In general</b></p> <ul style="list-style-type: none"> <li>• A grand visual experience</li> <li>• The feeling of seeing archaeological source in this way</li> <li>• Good immersion</li> <li>• The outside environment was striking</li> <li>• The feeling of falling in one segment</li> <li>• Good storyline - if altered a little bit</li> <li>• The uneven feeling of that something bad happened here</li> <li>• The darkness – could focus better on the light</li> </ul>	<p><b>In general</b></p> <ul style="list-style-type: none"> <li>• User needs a support person holding the cable and giving instructions</li> <li>• “The grid” that the HTC Vive software produces when the physical space is approaching - too dominant</li> <li>• Confusing story</li> <li>• Too dark in the house</li> <li>• A podium where a coin was lying – unnatural in the environment</li> </ul>
<p><b>Silhouettes</b></p> <ul style="list-style-type: none"> <li>• Nice looking human shapes – an elegant way of visualising the dead</li> <li>• Association with ghosts/spirits</li> <li>• Particles surrounding them</li> </ul>	<p><b>Silhouettes</b></p> <ul style="list-style-type: none"> <li>• Should be no faces on the figures</li> <li>• The white contours were too sharp and took over</li> <li>• The silhouettes should have volume so you feel that it is humans – no 2D</li> </ul>
<p><b>Soundscape</b></p> <ul style="list-style-type: none"> <li>• Sounds like a videogame</li> <li>• The music – good for the mood</li> <li>• The scary sounds – effective</li> </ul>	<p><b>Soundscape</b></p> <ul style="list-style-type: none"> <li>• Sounds like a videogame</li> <li>• The music – needs to be combined with other sounds</li> </ul>
<p><b>Interaction</b></p> <ul style="list-style-type: none"> <li>• Great to be able to lift objects and study them</li> <li>• Activate sounds when interacting with objects</li> </ul>	<p><b>Interaction</b></p> <ul style="list-style-type: none"> <li>• Unclear what the user is supposed to do</li> <li>• The teleporter</li> <li>• Couldn't interact with the candle lights</li> <li>• Too dark</li> <li>• If you dropped the coin you couldn't pick it up</li> </ul>

Figure 9. Feedback from personnel at Kalmar County Museum. Gathered comments from group discussion.

## *Suggestions for Change*

### In general

- Work on the timing of when things appear and when scene shifts
- Start the experience outside and walk into the house instead
- Fix incorrect features in the 3D reconstructions
- Make the storyline less abstract and make it a proper time travel experience
- Add a “at your own risk” in the beginning so the user is warned
- Add the destruction phase of the fort to the experience – burning houses etc
- Make it more pedagogical – answer the questions: where am I and what is going on?
- Empathy – make it horrible, because it was. Give the people a voice, because they can't
- Make it a more human experience and less a video game

### Silhouettes

- Add volume to the silhouettes

### Soundscape

- Add more environmental sounds
- Try different sounds and evaluate them with different audiences to get the perfect soundscape
- Have suitable music to the different scenes
- More human sounds – child screaming, people talking/arguing etc

### Interaction

- Have a segment where you fall or fly – effective
- Show where to go with arrows and add clues to show what to interact with
- Add a map in the corner so you can navigate easier
- Make the candle lights possible to interact with

### *Specific Questions Apart from the Discussion*

- *Walk around vs. use the transporter – what was difficult and why?*

It was hard to know how far you could get with the transporter even though you could see the marker showing that, it was too dark to see how far it reached. Maybe change the marker to something else or use zones that is lit or use a torch/flashlight instead.

- *Describe what you learnt at today's workshop: any new insight about Sandby borg through the VR experience? How would you describe it?*

The spatial effect was great and the immersion very convincing: the roof height was low and the house felt smaller in some cases than expected. To see the dead in an upright position together with the skeletons visible had a strong effect. The house was too dark even if it probably was very dark in reality.

- *Did you notice you were stepping on dead people/skeletons, did you avoid them?*

The visual depiction of the individuals standing up took over so the skeletons in the ground was hardly noticed by some. One suggestion was to freeze the rest of the scene in a destructive phase, so it's no longer possible to interact with the surroundings and you understand that something terrible has happened. Make a more distinct transition from the daily life to death.

## Conclusions

We got a lot of great feedback from workshop III which was very important for the final development phase. In this project, as in future ones, user testing like this is crucial to get a constructive development phase so a product as good as possible, can be produced. We learned a great deal, like that there is no need to keep the horrible segments or other strong experiences in the VR demo at a too sensitive level.

The soundscape can be more elaborate and is a vital part for the final demo to turn out great when it comes to the emotional aspect as well as the interactivity. The visual aspects of interactivity also needed further development to get the experience more user friendly. The house needed to have a brighter light setting overall and instructions for movement should be clearer.

# Production of the VR demo

RISE Interactive, C-Studio in Norrköping, Sweden, was responsible for the technical production of the demo. RISE Interactive is an experimental IT & design research institute that conducts applied research and innovation. The technical production in this project was constantly developed in dialogue with the archaeologists and researchers so that the story and the technical possibilities were weighed against one another.

## Archaeological Data

Much of the material used to produce the VR demo had already been produced in previous projects. Either as part of the documentation process during excavations in Sandby borg or as virtual reconstructions of the site and its contexts. This was a great advantage and the reuse of data models took this demo further than would have been possible otherwise within the given frameworks. Focus could now be put on the user experience instead of too much time-consuming 3D modelling.

3D models had for example been generated from pictures taken during archaeological field work, that could be generated with the technical process of photogrammetry. Photos had been taken both from ground level as well as with drones from above which together can generate a 3D model in a software. This is a natural part of the modern archaeological documentation process and generates useful data for this kind of digital productions. There were 3D models both from smaller contexts such as the trench, skeletons or pottery, but also of the whole ring fort and its surrounding landscape. A lot of the 3D modelling had also been done in a previous project carried out in 2015 in a collaboration between KCM, The Swedish Exhibition Agency (Riksställningar) and Kulturmiljö Halland (KH) (Gunnarsson et al 2016b). These models became important resources and consisted of a 3D reconstruction of the whole ring fort, created by KH (fig. 10), and one of house 40 reconstructed by MA at KCM. A lighter version of this models was also published online at the website Sketchfab (fig. 11, Link 2) to be explored by anyone with internet access.



Figure 10. 3D reconstruction of the ring fort created with the software *Unreal Engine* (from Gunnarsson et al 2016b:21)



House 40, Sandby borg, Öland, Sweden

Figure 11. A reconstruction of house 40 published on the website Sketchfab reused for this project (Screenshot from Link 2).



Figure 12. The roman gold coin as seen in the VR demo.

Different models could be imported and combined in the Maya software (pp 25), it didn't end up with the best resolution but was sufficient. In a future larger project, the models could be altered to the better.

There were also new 3D features created, like this roman gold coin that has been found during the excavations of house 40 (fig. 12). The coin could be modelled using pictures of the coin and measurements to produce good textures, applied on a simple generated 3D cylinder, made the virtual reconstruction come to life. Other reconstructed features were a lance, pottery and a standing loom.



**Figure 13.** The HTC Vive was chosen as hardware. The equipment functioned well throughout the project and the team didn't experience any problems with it, except for a little annoyance about the attached cable.  
**Photo:** Daniel Lindskog

## Hardware & Software's

### Imaging – Photoshop

Adobe Photoshop was used to handle photos that worked as base for some of the texturing of virtual objects such as the roman gold coin.

### Simplygon

To reduce the models in size, suitable for the game engine, *Simplygon* was used on most of the 3D models. The software comes as a plug-in to *Maya* and reduces the amount of points in the model geometry. This means that the computers graphic card doesn't have to work as hard and the rendering gets more effective. This gives them less resolution, a compromise that had to be made to create a good user experience.

### 3D Modelling – Maya

The *Maya* software was used to manage the 3D models used in the project. The models derived from different sources and needed to be managed together before putting them in to the game engine. It was all about giving the models correct material, texture, alter their shape and scale to fit the story and above all to make the models reduced in data size and complexity. *Maya* software was chosen because of the teams' pre-knowledge of using the program. *Maya* also has a good compatibility with *Unity3D* and standard models can be exported/imported with ease between the two software.

### Game Engine – Unity3D

The software in which all data was put together into one virtual world, later experienced in the VR headset. A game engine was a suitable solution to avoid

unnecessary programming. With this method one gets the VR rendering, interaction, data modelling, sound scaping etc, ready to use in an easy way. If programming were to be done from scratch with a graphic API e.g. *OpenGL*, a larger freedom in creation would be possible but it would also be much more time-consuming. Another software that could have been used would have been *Unreal Engine*, but the team had better pre-knowledge of *Unity3D*. Another factor was that *Unreal Engine* does not give as good support for VR. A disadvantage with *Unity3D* is that the software doesn't create rendering on the highest level.

## Production Evaluation

VR has high demands on a computer performance and therefore it would have been easier, from a programmers' point of view if the 3D models would have been customised for VR from the beginning, this is something for archaeologists to keep in mind when creating their models in the future. One also must think of not use too much heavy effects or have too much virtual content. The VR product is hard to optimise afterwards.

Before starting the development of the VR application it's a big advantage to have a clear idea of who the end user will be and how accustomed to VR the user is. If you make it for museum visitor for example, a lot of tutorials and help might be needed 'in game'.

For an experienced user, this can be a disturbing feature, taking a lot of the immersive experience away. One solutions could be to have the level of help adjusted depending on the user.

The creation of a VR application is an iterative one between design and development that takes time. It can be hard for the developer in the design phase to know how it will look and feel like in VR when working on a regular screen. Similar development for flat screen applications allows the developer to draw a 'frame' of how it will look like exactly but with a VR application a lot is different in the user experience. The wide field view of the display in the VR headset is the main reason for that. In this VR demo, we used unnatural elements such as particles, figures, unnatural sounds, fog, lighting etc. All these add-ons needed constant testing and evaluation in the user experience. If development takes place on a screen, for a screen, this process is simpler.

If possible, it could make a better experience if the story was created in the way where the user didn't have to teleport too much but instead moved physically around the given space. This would probably create a more immersive feeling and could also be better for the user that is not fully accustomed with the hardware.

Sound effects are very important for the immersion. Everything needs it.

# The Demo – Final Version

Here follows a description of the final version of the VR demo, scene by scene. But the reader doesn't need to limit itself by just read about it, one can also experience it for themselves by downloading the demo at the Sandby borg homepage (Link 5). The demo shows how VR can be used to communicate archaeology and approach "difficult heritage", using the material from the SB project as a case study. The results and evaluation of this demo will be a resource for further work after the end of the project.

## Duration

The target for the duration of the experience was initially 5–7 minutes. This was to avoid motion sickness and an overload in experience. One can of course interact as long as they want to in the virtual world, but it's still good to have something to aim for. The VR demo's final version takes approx. 7–15 minutes depending on the user. The duration was not an issue for the users and no one gave a negative comment about it. This means that it wasn't too long and the that we managed to keep the story exciting enough for it to work the whole amount of time it takes to play.

## Interaction

A big challenge with interactive storytelling is to get the user to do what you want them to do to move the story forward. You can't control the users view or position in VR; the user is deciding for itself where to look and move in the virtual world. This can lead to that the user's attention is directed elsewhere when things happen somewhere. To avoid this kind of problems, scenes doesn't start in the demo until the user is looking in the right direction from the intended position.

In the VR demo the user can interact with its environment in several ways. A tutorial starts when the demo

begins. It shows how the user can transport itself by pressing the large button with its thumb and how to interact with objects by reaching for them and pressing the 'trigger' to grab them.

The most important part of the interactive experience is the embodied experience. If an object is located on the floor, the user must really crouch to reach it. The VR experience does not reward a passive user and the user must drive the story onward by discovering its surroundings and interact with it.

## Soundscape

To assist the user in exploring the spaces and to interact with it, sound was used to boost e.g. interaction with particles connected to objects or to transport the user to a specific place. The sound has a 3D positioning, so the user can hear where features are located and on what distance. This makes the user turn to the 'right' direction in an intuitive movement, which leads the story forward.

The soundscape ended up being a complex one with music, sound effects, recorded tracks, all very important for an emotional experience. The soundscape also improved the visual experience for the user.

## Characters

The main character and the most important one is the user itself. Other characters are archaeologist, only present via the soundscape and Iron age humans represented by silhouettes. They play a central role in the story and are shown as white sketched depictions (fig. 14). The figures are anonymous and do not show a clear gender but come in different sizes telling the user of different ages. The attackers have action positions with their weapons drawn but it's hard to detect their faces. This was all on purpose



**Figure 14. Human figures sketched in white and with a certain amount of transparency.**

and the figures was meant to show humans and their fate, but not to go into how their costumes or faces had look like in reality. The reconstruction of people was not in focus and a more visual depiction of the inhabitants and the attackers would have made the production much more time consuming and expensive.

## Scenes

1. *The Excavation.* The user starts at the excavation of house 40 and can see the ringfort in the surrounding landscape and hear sounds from archaeologists working. Standing in the trench, the user is given a tutorial showing the user how to use the equipment. The game is urging the player to search the trench for interesting objects. In this part is possible to discover how to pick up and study a spade, a pickaxe, ceramics and some stones. After a while the sun is setting and the only light visible becomes a moving one over the hearth stone. This is a portal that will transport the user, when walking into the light, in to another setting, scene 2.
2. *House 40; Remains of Daily Life.* The user find itself once again, in house 40, but this time not on the excavation but in an alternative reality where the house is still in use. The user stands in the dark end of the house and when looking around it can see different features to interact with. Its hands have become light particles, just as the objects in which the user can interact. Among other things there is a standing loom, a shelf with different ceramic pots on it and a coin available for the user to discover. The soundscape is mixed between a background music track, environment sound like fire crackling and interaction sounds from the ceramic vessels, the roman gold coin and the loom. The scene shows clues from the daily life in Sandby borg, without the living attending in person.
3. *House 40; the Battle/Massacre.* Something is changing, the environment and the soundscape mood get darker and colder. Someone or something is banging on the door, a red light moves together with particles. Sooner or later the user is leaving the interaction with objects and starts to move to the front door, checking what's going on. When approaching the door up front, the

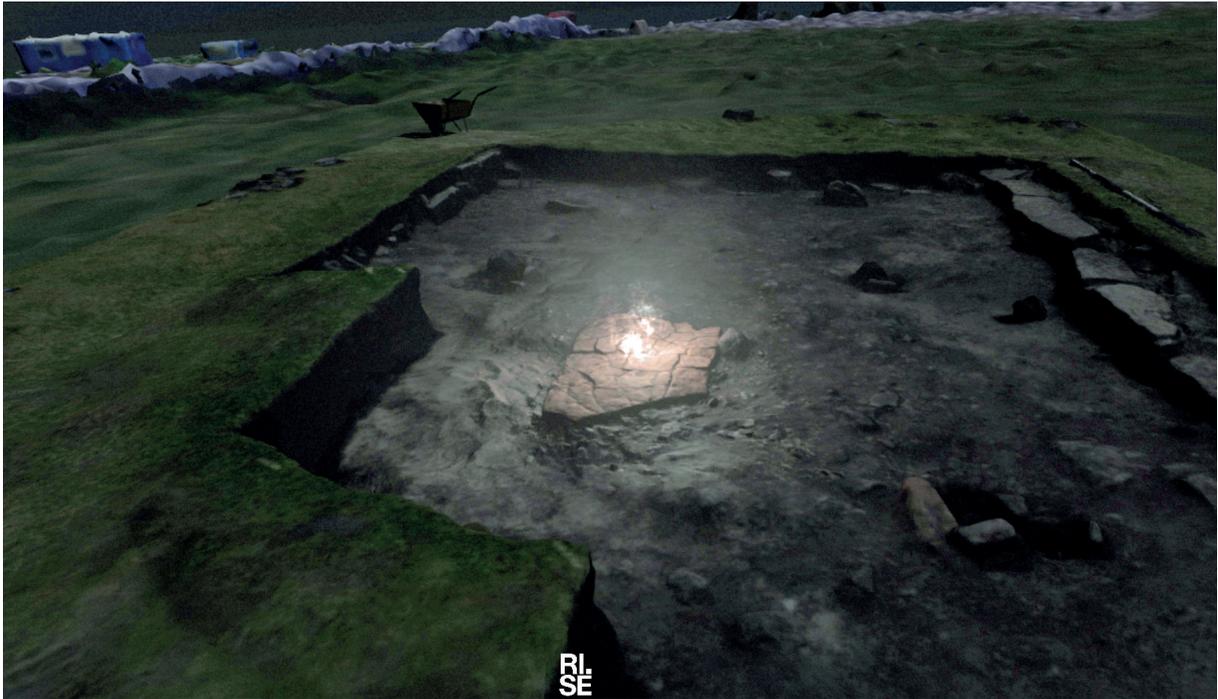


Figure 15. Scene 1: The Excavation. The portal is a light source connected to the so-called hearth stone in the trench. The user is transported when entering the light.



Figure 16. Scene 2: House 40; Remains of Daily Life. Interaction is possible with ceramic pots, a lance and standing loom among other finds.



**Figure 17. Scene 3: House 40; the Battle/Massacre.** The attackers (sketched figures) approaching from the front door and moves fast further in to the house, slaying the people in its way.



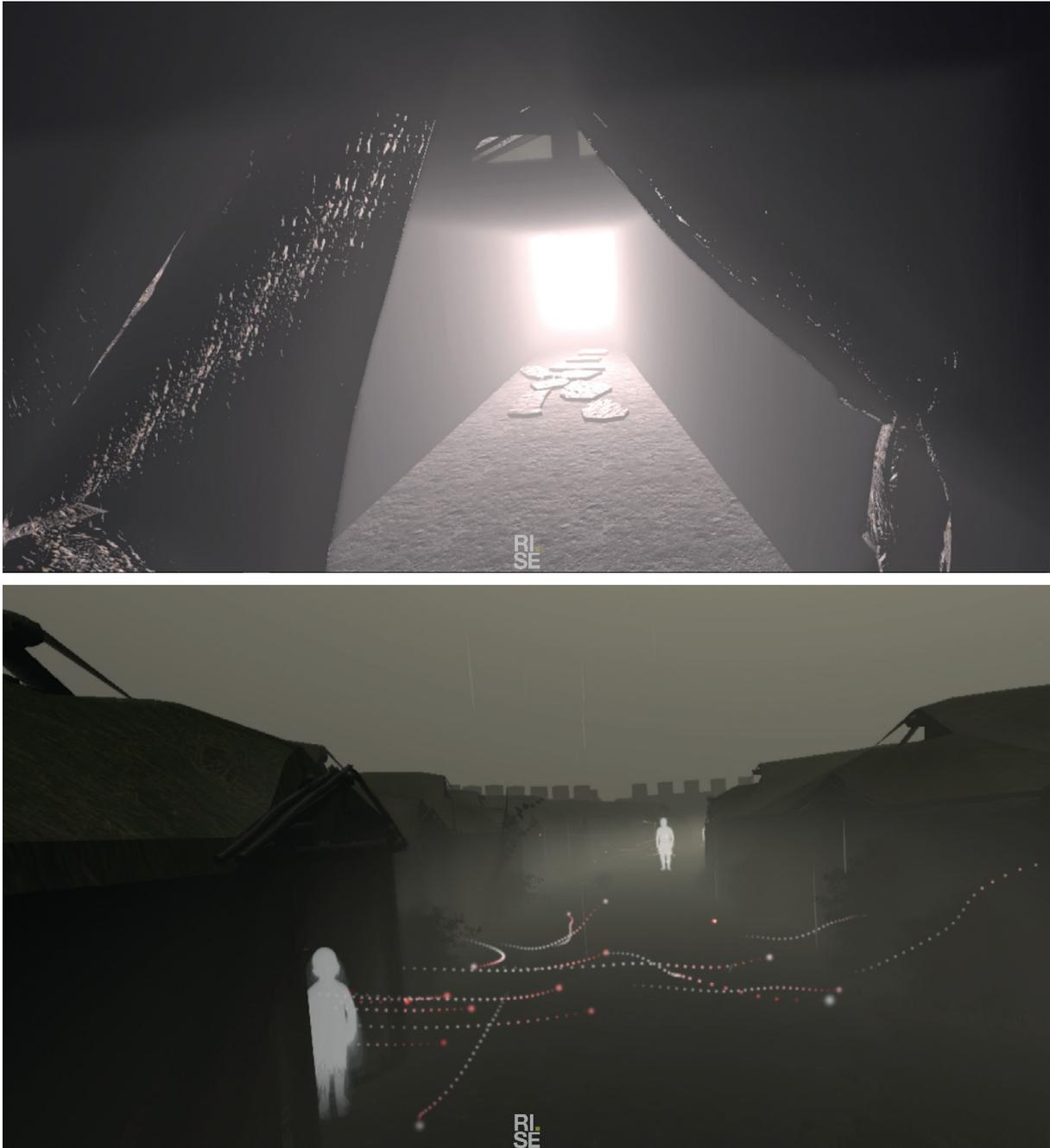
**Figure 18. Scene 3: House 40; the Battle/Massacre.** Skeletons can be seen when approached after the battle scene is finished.

light fades out and the sound changes to a battle alarm. The door is closed so the user must turn around to see what there's to do. While doing that, the silhouettes of standing human figures has appeared (fig. 14). The user is frozen in position while a scene is played. An animation shows the inhabitants being slayed by the attackers, one by one. Strong emotional sounds now play with a woman screaming louder and louder un-

til it all stops. When the battle scene ends, the light particles are back, showing something in the inner part of the house. When the user is approaching the lights, three skeletons gets visible on the ground and a narrator's voice describes the cause of death and age (in Swedish). The user can know understand the consequences of the battle scene and study the archaeological remains for themselves.

4. *The Revelation*. When the interactions with the skeletons is finished, the front door opens and the user is encouraged by a light to transport itself through it and walk outside. The user finds itself on a street, in a ringfort, and many other human silhouettes appears and light particles

are moving out from them. It's raining and the music has changed to a more ambient track. The perspective has now shifted and the realisation is made that the violent deed in house 40 was not isolated, but part of a larger event all over Sandby borg.



**Figure 19. Scene 4: The Revelation.** The user starts the end scene by entering the light (top) and walk outside where it rains (bottom). Realising that the violent act was not an isolated event in one house but all over.



**Figure 20. Scene 5: Final Scene. User view from the air. The whole ring fort is visible and human silhouettes are everywhere.**

5. *Final Scene*. The user is starting to levitate from the ground and is soon hovering over the ring fort. Scale is shifting once more and the user can now see the whole fort from above and can observe many human figures representing the dead which are everywhere to be found. A massacre has taken place.

# Demo Event at Kalmar County Museum

After completion, the VR demo was presented to the public at KCM in October 2017 (fig. 22). People had the opportunity to announce their participation on beforehand, 25 slots were available and were all filled up. Information were handed out via social media on beforehand telling people about the event and with instructions of how to list themselves as tester. There were also some additional users dropping in, filling some extra empty spaces. In total, the VR demo was tested by 33 people. The number of participants depended on the time limits. If we were to manage the event in one day only a certain amount of people would have the possibility to try the VR demo. After testing, the participants were asked to fill out a form (Appendix 1) created to collect some basic data of who the users were and if the VR experience affected them emotionally as intended. Media was also invited to a press conference, starting the day, where the project was presented, and the press got to try the demo. This resulted in 4 newspaper articles and video clips online (fig. 21).

## Target Groups

The project management realised early on that the target group evaluation started even before VR demo user tests was held in Kalmar. Because of the violence and with no preparation accounted for when it comes to the target group of children, that group was excluded early. We reasoned as they do in cinemas in Sweden and decided on an age limit of 11 but only with parents' present, otherwise the user had to be 15+. With the VR experience, we also wanted to reach out to visitors that were not regulars at the museum. Children often visit museum through schools, elderly people and families with parental leave are also well represented in the visitor numbers. People working day time doesn't have the same opportunity or time to visit museums as often. Could this target group between 18–50 be attracted by something like this?



Figure 21. Example of a local newspaper (Barometern) article about the VR event. From oct 4<sup>th</sup> 2017.



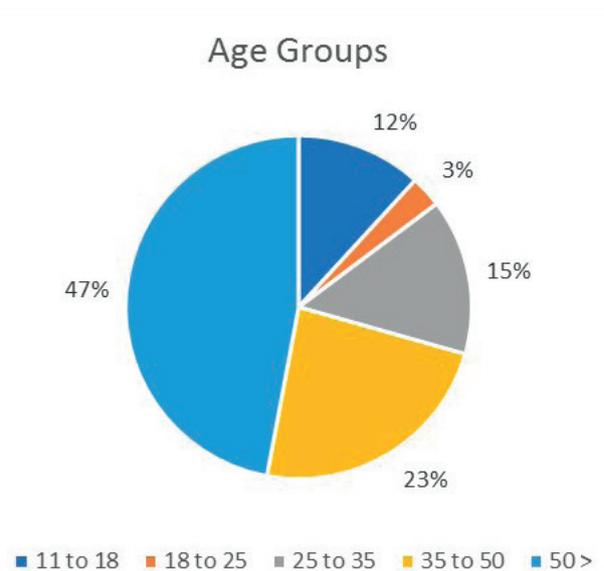
**Figure 22.** The demo testing was carried out at the Kalmar County Museum. The participants got an introduction of how to use the VR equipment before entering the virtual world. Photo: Kalmar County Museum, Daniel Lindskog.

### Feedback from Participants

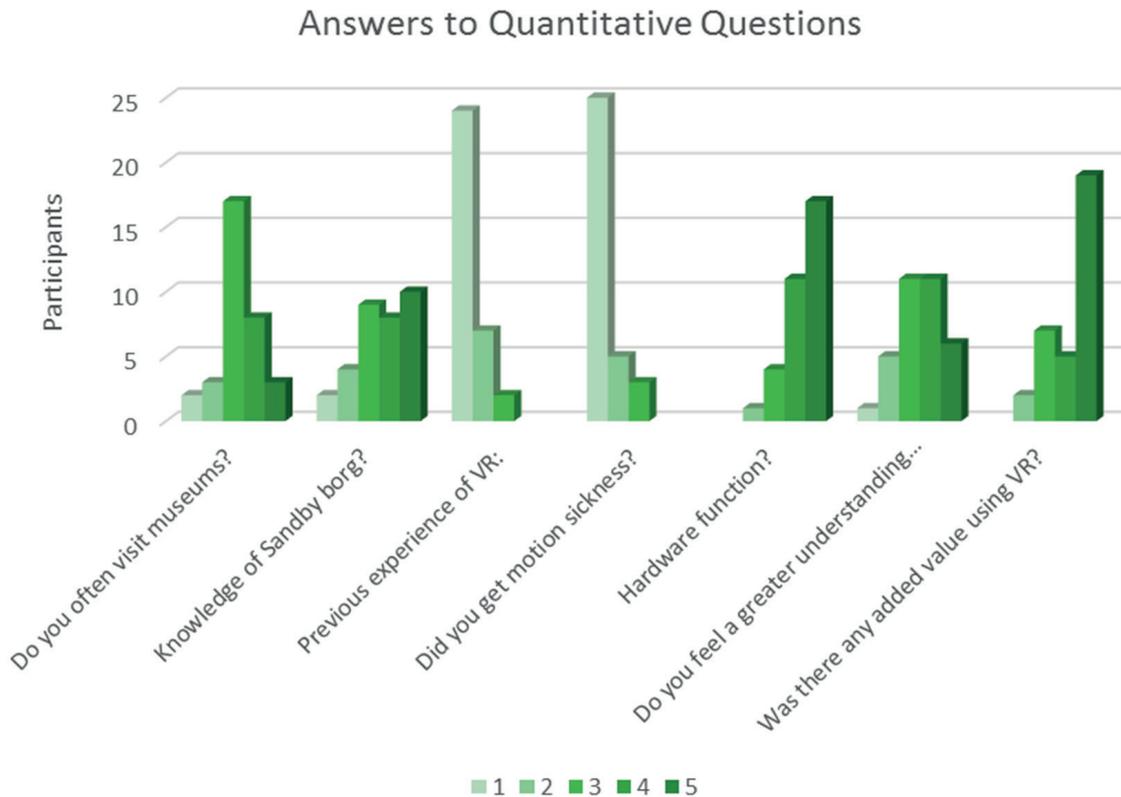
Each participant of the VR event was asked to fill in a user questionnaire (Appendix 1), which helped us gather data of who they were and what they thought of the experience. 33 volunteers participated in the VR experience and in filling out the form afterwards. The questionnaire had both quantitative and qualitative questions where they could both grade their answer according to a scale with five values and another section where one could elaborate in text.

### Participants

One of the projects aims was to see if new target groups could be attracted with the use of VR technology, people that don't visit museums on a regular basis. The largest part of the participants was over 50 years old (fig. 23), a group that is also well represented in visitor numbers at the museum otherwise.



**Figure 23.** The represented age groups that took part in the VR event. Users over 50 were highly represented. Two participants were as young as 11.



**Figure 24. Diagram summarising the results from the quantitative part of the user questionnaire (Appendix 1). 1 representing ‘No/None/Bad’ and 5 representing ‘Yes/Good’.**

But the VR event also attracted people between the age of 18 to 50 (41 %). This is regarded as a positive result since many in this age groups took time of their daily work/routine to come and try out the experience. The many elderly people could more easily make time since many of them are retired. 70 % of the participants were female and 30 % male.

#### Summary of Quantitative Answers

The answers to the qualitative questions shows more of who the demo test persons were and what they thought of the experience. Most of the participants visit museums now and then and have some knowledge of the Sandby borg story. Many are followers

of the SB project and wanted to see this new thing for themselves. But there were also participants that didn't know that much and wanted to learn more. In each case most of the test persons felt that they learnt something new to some degree, and more importantly, felt a greater understanding of the events taking place, than before.

With few exceptions, there were almost no one that had used VR before. Even so, almost no one felt the effects of VR sickness or did find the hardware difficult to use. The majority also thought that there was an added value in using VR compared to other media because of the interaction and immersive experience.

### Summary of Qualitative Answers

Numbers below does not represent number of individuals but merely the number of times the answers appeared. Some of the participants didn't answer everything and others said a lot of things.

Questions and the most common answers:

Was there some part of the VR experience where you thought it was hard to navigate/orientate yourself?

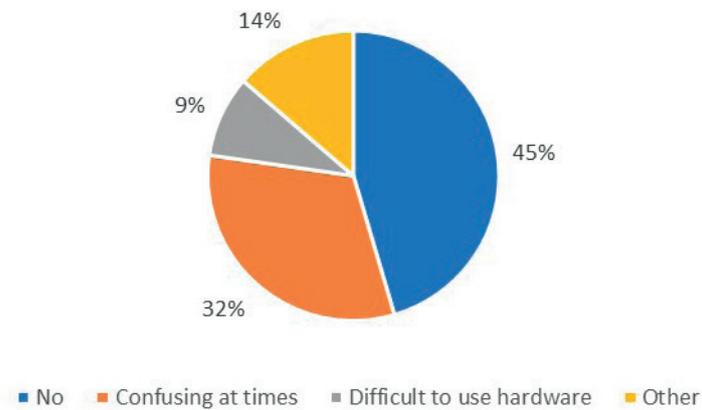


Figure 25. Most of the participants did not experience any difficulties, while others felt that it was hard to know what to do at times, which got confusing. A minority found difficulties in using the controls but learnt after a while.

What kind of feelings emerged when you engaged in the VR world?

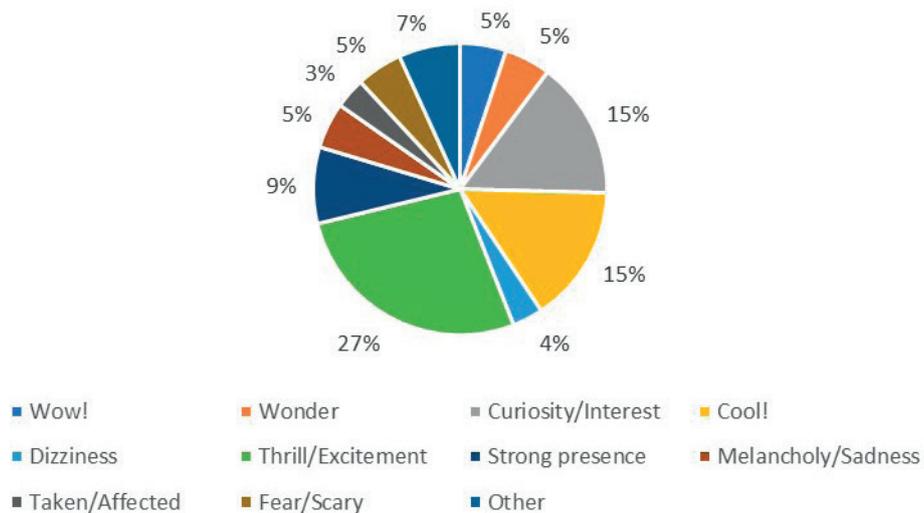


Figure 26. Users had lots of different experiences, but the most common answer was that they felt thrill/excitement of being in another world, discovering it. Some people also felt a stronger empathy for the Sandby borg inhabitants and was taken/affected by the story or felt melancholy/sadness for them.

Which part of the VR experience evoked the strongest emotions? Why is that?

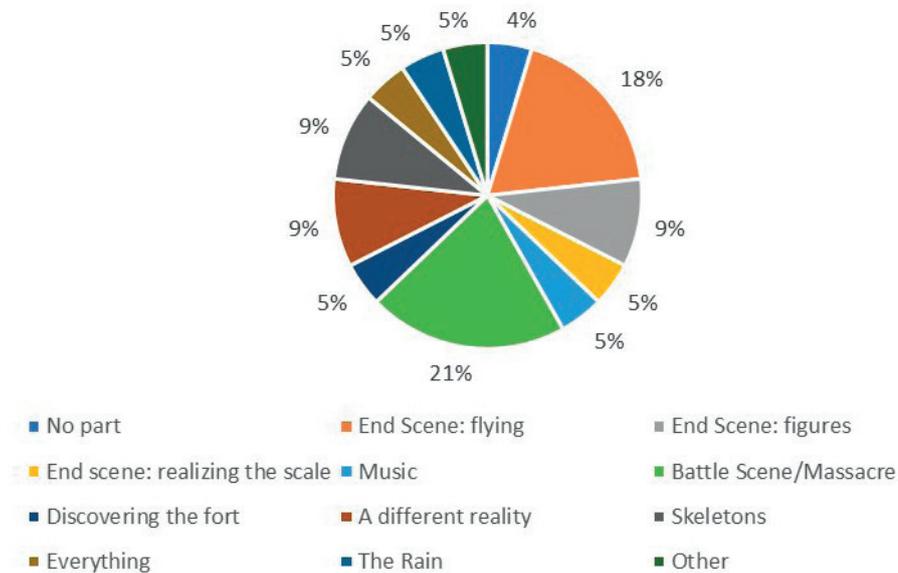


Figure 27. The strongest emotional impact got the battle scene/massacre and the following realisation that they were so many victims. Flying evoked strong emotion of it being real, that they really were flying, some even experiencing the feeling of vertigo.

Do you feel a greater understanding of what happened to the people in Sandby borg? In what way?

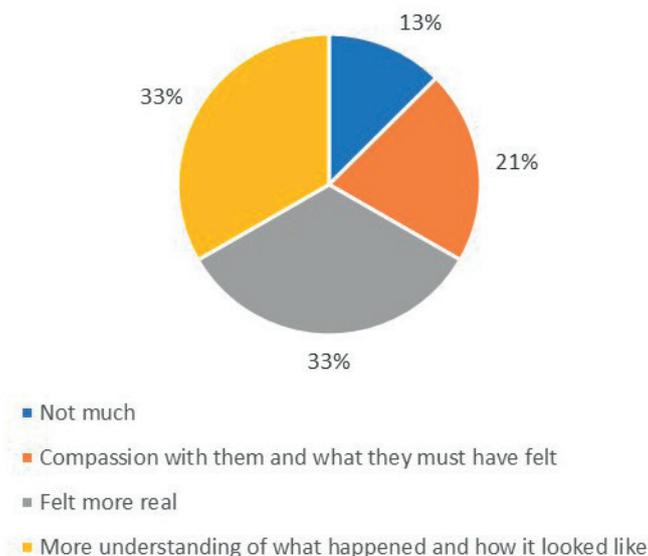


Figure 28. Most of the users felt they got a greater understanding of Sandby borg in some way. 21% felt emotionally attached to the story while others felt closer to the site and understood more just by being in the data instead of watching it from outside. 13% didn't feel anything special or thought that it gave them more understanding.

Was there any added value in using Virtual Reality compared to regular media like film etc? Why?

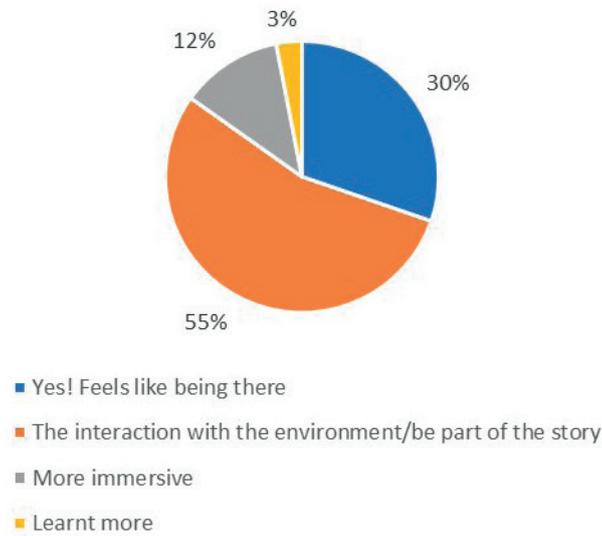


Figure 29. Everyone thought that VR gave added value to the experience compared to regular media. The interaction in the story and the feeling of being there was thought of as a stronger experience than for example watching a movie.

How would you like to follow up this experience?

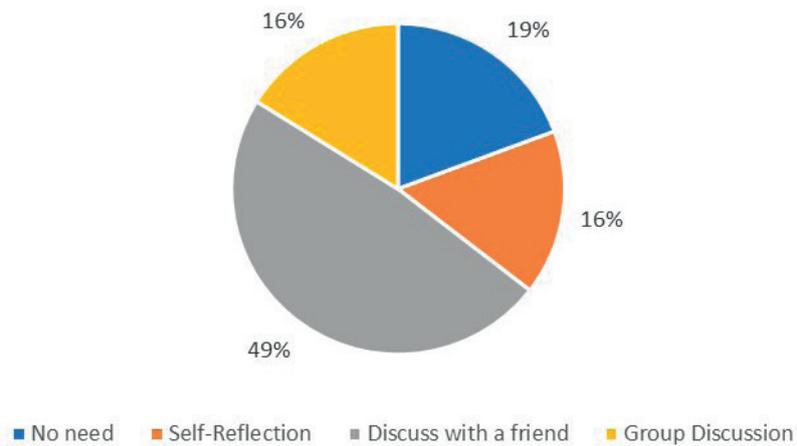


Figure 30. Of the participants 49 % wanted to discuss with a friend while 16 % wanted to have a group discussion.

The project management had the pre-conception that most users would answer 'Group Discussion' to this question and that this would probably be the way to suggest forward in a continuation of the project. 49 % of the participants instead gave the answer that they would prefer to 'Discuss with a friend'. When going through the answers one can see that the experience evoked a lot of feelings, many of them personal and not a comfortable subject for a group discussion. For many, the VR experience seemed to be almost too intimate. The reason for that may be the great sense of immersion the VR experience brings the user. The users feel like they're being there, alone, with their thoughts and emotions. Something to share with your closest maybe, but not to anyone. A scenario where users could meet in the virtual world, in a social VR, would probably give different answers. Because then one would share the experience with others from the start.

### *Theories*

The user questionnaire ended with two questions regarding what the user think happened in SB and why (Appendix 1). This was not part of the research, other than to see if the experience could evoke some theories from the user. The purpose was merely an invitation to the public to express themselves on theories

surrounding the site. This is something many visitors wanted to do and we got some interesting answers.

On the question:

- *What do you think happened in Sandby borg? Who were the attackers and why was the inhabitants brutally murdered?*

The majority thinks it was some sort of power demonstration by a neighbouring ring fort or another type of enemy. The inhabitants of Sandby borg clearly must have agitated someone. One interested answer went one step further and stated the idea that: *"The attackers were invited to a great feast like a wedding and then killed their hosts when they were least expecting it"*.

- *No women have been found amongst the dead so far, what do you think happened to them?*

Almost everyone thinks the attackers brought the women with them to be kept or sold as slaves. But there was also some who thought that they are still waiting to be found at future excavations in the ring fort. One thrilling answer was the one from a 14 year old female: *"...but it could also have been the women killing the rest!"*

## Concluding Remarks

So, did the project manage to create a virtual connection, an emotional connection with the story that made the users feel something and learn more about what has happened in SB and what the archaeology can tell us? Many of the users did an emotional connection for sure, as seen in the answers. During the VR event, one user cried openly and wanted to hug afterwards. VR worked effectively as a new type of communication tool for emotional storytelling. It linked “difficult heritage” of the past to the present and worked as a catalyst for further exploration of what it can mean today. The dialogue didn’t take place between people first and foremost, even though there was some spontaneous discussion at the demo event. The dialogue through the cultural heritage instead emerged mostly between the user and the story. The past was speaking without words and the user answered with emotional reactions. For many the VR experience was an intimate one and the need to discuss feelings and thoughts in group didn’t seem very attractive for most. The tool seems very powerful and could work as a great starting point for discussions, but hopefully the experience got stuck with people to the extent that the discussion didn’t need to be orchestrated by an archaeologist or pedagogue but could live on in people’s daily life afterwards.

When it comes to the question whether the VR demo could increase the level of understanding and empathy, the answer is yes. Virtual reality is a powerful tool combined with strong emotional storytelling. The developer can affect the user physically and mentally in several ways which create a virtual connection to the story and makes it attached to the users in a new way.

A VR experience seems suitable for most, even though people with less gaming experience needs more training in using the controls and understand what interaction means in this case. The oldest people participating in the testing experienced the biggest challenge and the youngest, being just 11 years

old had no technical issues. This project wanted to attract a target group that does not visit museums a lot, people between the age c. 18–50. 41 % of the participants belonged in these age span and almost everyone thought that a VR experience added something more than other media. These age groups would most definitely come visit the museums more often if VR storytelling was part of the exhibitions.

### Impact

There is big national and international interest in the SB story. The project has often been mentioned in media and the subject of articles in big magazines like National Geographic, Archaeological Magazine, Filter and GEO Magazine with readers from all over the world. When this text is written, the SB Facebook page has over 3600 followers. Further on, the project holds about 50 lectures a year and guided tours during excavation with hundreds of visitors every day and has a smaller exhibition at Kalmar County Museum.

The project’s process and results was distributed using existing channels such as the SB web page with over 250 unique visitors per day (Link 5) and the Facebook page (Link 6) as well as the RISE website (Link 4). Traditional media was also invited to the VR demo which took place at KCM (pp 32). The project was presented at the international seminar: *‘Memories of Violence and Oppression’* in Kalmar, in May, organised by the research project *“Frozen in Time...”*. The participants came from different fields within the humanities such as cultural heritage management, archaeology and the artist world. The VR demo has also been presented and gotten good reviews as part of an open house at RISE C-Studio in Norrköping and at a conference for museum archaeology in Halmstad during the fall of 2017. The project would also like to see a continuation of the dissemination of results in a peer-review article, produced in 2018.

## **Future Possibilities**

We wish to continue the close collaboration between KCM, LNU and RISE to create more innovative experiences in the future. This project gave us the opportunity to build a foundation for future development of VR products into a useful digital communication tools, communicating with visitors on a deeper level. The results of the project fits well into the larger communication plan of the SB project and can be used as a resource to give the visitors to the museum or others a new experience. The VR experience can, even though it's just a demo, be part of the exhibition at KCM already, possible part of the existing pedagogical program including guided tours and lecture bookings. In a future project, a VR experience could be developed more with an exhibition in mind from the beginning and possible also for online usage. A VR experience could e.g. be a social one, with people from all over the world meets in the virtual world as avatars and sharing the experience.

## **A Multidisciplinary Approach**

The collaboration between archaeologist, academics and ICT specialists was very fruitful and the concept could be developed further with more specialists taking part in the VR storytelling creation. They could be specialists in learning, like pedagogues working with cultural heritage. Another very important resource can be a psychologist specialising in human behaviour and how to handle difficult issues in more depth. This expertise together with the archaeologist's knowledge on how to create good storytelling with source material and the ICT programmers which in this project gained much new knowledge in how one can really affect a user emotionally with VR/AR/MR, would make a strong team and have the conditions to create something great and very special.

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## Online Resources

Available 2018-05-22

Link 1. GRASCA – Graduate School of Contract Archaeology  
<https://lnu.se/en/education/PhD-studies/archaeology/grasca/>

Link 2. 3D reconstruction of house 40 on Sketchfab  
<https://skfb.ly/LZqQ>

Link 3. Interspectral  
<http://www.interspectral.com/>

Link 4. RISE Interactive website  
<https://www.tii.se/>

Link 5. Sandby borg project website  
[www.sandbyborg.se](http://www.sandbyborg.se)

Link 6. Sandby borg Facebook page  
<https://www.facebook.com/sandbyborg/>

Link 7. Sandby borg – a Virtual Connection. VR demo  
[https://www.dropbox.com/s/z332sdawos48yd4/Sandbyborg\\_release.zip?dl=1](https://www.dropbox.com/s/z332sdawos48yd4/Sandbyborg_release.zip?dl=1)

# Technical and Administrative Information

<b>KCM: s Project No:</b>	A1706
<b>Client:</b>	Riksbankens Jubileumsfond (Bank of Sweden Tercentenary Foundation)
<b>Personnel:</b>	<p><i>Project Leader and Coordinator:</i> Dr. Helena Victor, archaeologist, Dept. of Museum Archaeology, Kalmar County Museum.</p> <p><i>Assistant Project Leader:</i> Doc. Arianit Kurti, Studio director at RISE Interactive, C-studio.</p> <p><i>Project Manager:</i> Ph.D. Candidate Fredrik Gunnarsson, archaeologist, Dept. of Museum Archaeology, Kalmar County Museum and GRASCA at Linnaeus University.</p> <p><i>Coordinator of Workshops:</i> Madeleine Kusoffsky, Interaction designer at RISE Interactive, C-studio.</p> <p><i>ICT Designer:</i> David Sellin, Software developer, RISE Interactive, C-studio.</p> <p><i>ICT Designer:</i> Thom Persson, Software developer, RISE Interactive, C-studio.</p> <p><i>Scientific board members:</i> Doc. Bodil Petersson, archaeologist, Dept. of Cultural Sciences, Linnaeus University. Ph.D. Candidate Jonathan Lindström, archaeologist, Dept. of Museum Archaeology, Kalmar County Museum and GRASCA at Linnaeus University</p>
<b>Documentation:</b>	All documentation is archived at Kalmar County Museum.

# APPENDIX 1. QUESTIONNAIRE FOR PARTICIPANTS IN VR EVENT (WITH TRANSLATION)

'Sandby borg – en virtuell koppling'  
(Sandby borg – a Virtual Connection)

Användarformulär  
(User Questionnaire)

## Grundinfo (Basic Info)

Min ålder: \_\_\_\_\_  
(My Age:)

Man  
(Male)

Kvinna  
(Female)

Annan  
(Other)

(ringa in rätt alternativ)  
(circle the correct alternative)

Besöker du museum ofta?  
(Do you visit museums often?)

1                      2                      3                      4                      5  
(Inte alls ofta)                      (Väldigt ofta)  
(Not very often)                      (Very often)

Hur mycket kan du om Sandby borg?  
(How much do you know about Sandby borg?)

1                      2                      3                      4                      5  
(Ingenting)                      (Jag är ett fan!)  
(Nothing)                      (I'm a fan!)

Tidigare erfarenhet av Virtual Reality:  
(previous experience of Virtual Reality):

1                      2                      3                      4                      5  
(Obefintlig)                      (Stor)  
(Non-existence)                      (Huge)

## Teknisk feedback (Technical Feedback)

Blev du illamående vid något tillfälle?  
(Did you get motion sickness at any stage?)

1                      2                      3                      4                      5  
(Inte alls)                      (Väldigt)  
(Not at all)                      (Very much)

Hur bra fungerade utrustningen? (VR hjälm, handkontroller)  
(How well did the equipment work? VR helmet, controllers)

1                      2                      3                      4                      5  
(Dåligt)                      (Mycket bra)  
(Bad)                      (Very good)

Var det någon del i upplevelsen (i VR världen) där du tyckte det var svårt att navigera/orientera dig? I sådana fall, varför?

(Was there any part of the VR experience where you thought it was hard to navigate/orientate yourself? In that case, how?)





Sandby borg on the island of Öland is an Iron Age ringfort where archaeological discoveries since 2010 have altered our understanding of the history on Öland. The finds of five fantastic hidden treasures, dated to the late 400s, was the starting point of the excavations that were initiated in 2011. Soon it became clear that the ringfort held a terrible secret: it was the site of a massacre where many individuals were killed and left where they fell. Large quantities of finds from near and far tell the story of life and death in the ringfort. This project aimed to communicate difficult heritage through visualisation and virtual reality (VR). A VR demo was produced aiming to engage the user in the story of Sandby borg through emotional storytelling and an immersive virtual experience.

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