

Representing a narrative of the Maroon culture through a virtual reality art exhibition

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Abstract

The Maroon is a culture from Suriname represented in the artworks of Remy Jungerman. Cultures like the Maroon are often underrepresented in museums, this, therefore, gives a skewed perspective. To represent a narrative of the Maroon culture, a virtual reality exhibition was created because such an exhibition is always accessible and could give added value in defining the narrative. The created virtual reality exhibition tries to convey a narrative of the Maroon by giving the visitor the option to walk onto the artwork and hear sounds related to the materials they stand on. These sounds give hints about what the meaning of the material is and therefore how a narrative of the maroon is represented in the artwork.

To see whether the virtual reality exhibition represented the culture of the Maroon more than a regular exhibition, we conducted a user study. The participants were split into two groups. The first group experienced the virtual reality exhibition with the interaction of jumping onto the artwork and hearing sounds related to the material. The second group experienced the virtual reality without interactions. Both groups were given information and a video that gave hints about what the paintings represented. The time of each participant being in the virtual reality was recorded and an interview concerning what the paintings represent was held. The interviews were analyzed using content analysis. The results of the study are that the participants who experienced the virtual reality exhibition with all the interactions voluntarily spent more time in the virtual reality exhibition than the group who did not have the interactions. From the results of the interview, this group mentioned significantly more unique keywords concerning a narrative of the Maroon and the participants also mentioned important keywords such as culture, Suriname, and fabric more often than the other group. The group who experienced the interactions stated that due to the sounds and interactions with the material, they required more knowledge about the narrative than from the provided text and video. Therefore, it seems that the created interactive virtual reality exhibition represents a narrative of the Maroon better than a regular exhibition. The use of a virtual reality exhibition can thus be a pivotal tool to create a more complete perspective by representing narratives of cultures of artworks.

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List of Figures

3.1.1 A Design Process for Creative Technology	20
4.2.1 Brainstorm Process	25
4.2.2 Brainstorm Results	26
4.3.1 First concept: Zooming in using a magnifying glass	27
4.3.2 Second concept: going into the artwork	28
4.3.3 Second concept: Hearing a soundscape of the material	28
4.3.4 Third concept: Grabbing the object	29
4.3.5 Third concept: Display of pictures about the meaning of the material	29
6.1.1 Painting of Remy Jungerman(left), Normal map of the same painting(right)	42
6.1.2 3D-model of the artwork(left), a picture of the same artwork (right)	43
6.1.3 Design of exhibition space.	44
6.1.4 Mood board of exhibition space	45
6.1.5 Exhibition space before changes	45
6.1.6 3D-modeled lamps with point lights	46
6.1.7 Final exhibition space, with material and light changes	46
6.1.8 The chosen avatar of the virtual reality exhibition	47
6.1.9 Avatar from the user's perspective	47
6.2.1 Teleporter indicator.	49
6.2.2 Scaled-up exhibition of the painting.	49
6.2.3 Neos Audio Player	51
6.2.4 Neos Logix for starting sound when standing on a material	51
6.2.5 Video in Virtual reality exhibition	53
6.3.1 Pictures of the Final Product	54
7.2.1 Word cloud of the results of group A (interaction)	61
7.2.2 Word cloud of the results of group B (no interaction)	61

7.2.3 Part of the coding list of Group A (interaction) 62

7.2.4 Part of the coding list of Group B (no interaction) 62

Table of abbreviations

VR	Virtual Reality
3D	Three-dimensional
UT	University of Twente

Table of contents

1. Introduction	9
2 Background research	10
2.1 Background	10
2.1.1 Defining virtual reality in art exhibitions	10
2.1.2 Maroon culture in artworks of Remy Jungerman	11
2.2 Literature Research:	13
2.2.1 The Implementation of Storytelling in Art Exhibitions: A Literature Review	13
2.3 State of the Art	17
2.3.1 Victoria and Albert Museum: <i>Curious Alice</i>	17
2.3.2 Louvre: <i>The Mona Lisa Beyond the Glass</i>	17
2.3.3 The Museum of Other Realities	18
2.3.4 Tate Modern Museum: <i>Modigliani VR: The Ochre Atelier</i>	18
2.3.5 Bosch VR	19
2.3.6 Conclusion	19
3 Design Methodology	20
3.1 Creative Technology Design Method	20
3.1.1 Ideation Phase	21
3.1.2 Specification Phase	21
3.1.3 Realization Phase	21
3.1.4 Evaluation Phase	22
4 Ideation	23
4.1 Stakeholder Requirement:	23
4.2 Brainstorm	25
4.2.1 Process and Results	25
4.3 Initial Concepts	27
4.3.1 First Concept: Magnifying Glass Exploration	27
4.3.2 Second Concept: Going into the artwork and combining it with a soundscape.	28
4.3.3 Third Concept: Grabbing objects, gives you photos of their meaning.	29
4.4 Chosen Concept	30
5 Specification	31
5.1 Users	31
5.1.1 Target User Groups	31
5.1.2 User Scenario	33
5.2 Specification of the Final Product	34
5.2.1 Paintings in virtual reality	34
5.3.2 Virtual reality exhibition space and Software	34

5.2.3 Interactions	37
5.3 Specification Requirements	39
6 Realization	42
6.1 Virtual reality art exhibition	42
6.1.1 The gridwork paintings.	42
6.1.2 Virtual reality spaces	43
6.1.3 Lights	46
6.1.4 Avatar	47
6.2 Interactions	48
6.2.1 Going onto the painting.	48
6.2.2 Sound that gives hints about the material.	50
6.2.3 Video	53
6.3 Final Product	54
7 User Evaluation	55
7.1 Method & Techniques	55
7.1.1 Goal	55
7.1.2 Process	56
7.1.3 Participants	56
7.1.4 Experiment setup	57
7.1.5 Design & Analysis	58
7.2 Results	60
7.2.1 Age	60
7.2.3 Time Spent in the virtual reality exhibition.	60
7.2.3 Reflecting a narrative of the Maron in the artworks:	60
7.2.4 User experience	63
8 Discussion	65
8.1 Significance of the Result	65
8.2 Limitations	67
9 Conclusion	69
References:	72
Appendix A: Informed Consent	75
Appendix B: Information brochure	78
Appendix C: Information about the Virtual reality exhibition	79
Appendix D: Interview Questions	80
Appendix E: Evaluation Results	82

1. Introduction

Art has a pivotal role in society. It can be a reflection of our culture or society and is used for expressing inner thoughts, feelings, or experiences [1]. Art is used to communicate ideas and expression to people [1]. However, until recently, Dutch colonial history was mainly represented from the white Dutch elite's perspective. This, therefore, does not give the full narrative and gives a skewed perspective. To give voice to the different sides of these kinds of narratives it is important to include all cultures and especially the perspective of groups and cultures that were marginalized in the past. Art exhibitions are designed to offer an in-depth exploration of artworks and artists that were previously not shown in art exhibitions due to the white Dutch elite's perspective. However, the issue is that these exhibitions only run for a short period due to the availability of the physical space. To keep facilitating these exhibitions there is a need to explore other kinds of spaces, namely the virtual space. Virtual reality makes it possible to visit exhibitions after the physical exhibition has run out. Therefore, the virtual reality exhibition can be used in museums to allow the viewer to explore these different past exhibitions.

The main challenge is that exhibitions in virtual reality are quite distinct from physical exhibitions in the sense that there are more possibilities but also some restrictions. These restrictions and possibilities are impactful in how we can tell narratives through art. Also, because virtual reality is often looked at from only one point of view, it can influence in a way how we look at art. To make sure that art from other perspectives can be reflected upon and included more widely, it is important to incorporate the narratives of the artworks because it enriches the artwork and gives it additional meaning. For this reason, there a way to reflect this narrative in virtual reality needs to be found.

This project will make use of the artworks of Remy Jungerman which reflect on the Maroon culture, his personal journey, and the History of his ancestors. The project will focus on reflecting on the Maroon culture because it is a prominent topic in his works. Besides, his artworks with the Maroon culture represent a narrative of art that was previously not seen in exhibitions. The Maroon culture originated from escaped enslaved people in Suriname who formed their communities in the Suriname rainforest. The Maroon culture has its own traditions and rituals that are represented in the artwork of Remy Jungerman. Virtual reality exhibitions allow people to see the artworks from a new perspective and get additional information about the artwork through interaction. An important part is that in the process of giving additional value to the artworks the culture of the Maroon needs to be respected. Thus, the objective of the project is to create a virtual reality exposition of an art piece that represents a narrative of the Maroon to give added value.

The research question and sub-questions addressed in this paper are:

- *How can a virtual reality exhibition represent a narrative of the Maroon culture through art?*
 - *How is the Maroon culture represented in Remy Jungerman's art?*
 - *How can stories be told through art expositions?*
 - *How can virtual reality be used to give added value to art expositions?*

2 Background research

To fulfill the goal of creating a virtual reality exposition of an art piece that helps represent a narrative of the Maroon in Remy Jungerman's artworks, it is important to research related literature sub-questions combined with researching what virtual reality is. Having each literature sub-question answered will help in the design phase to know what the possibilities are for solving the research question and achieving the goal. Therefore, in the background research, we will look at the literature sub-questions. This is done, by first examining what virtual reality is, then which stories of the Maroon are reflected in Remy Jungerman's artworks, a literature review on how stories are told through art expositions, and lastly a State of the Art on how virtual reality is used to give value to art expositions. This combined gives the required background knowledge to start ideating on possible solutions how to achieve the research goal.

2.1 Background

2.1.1 Defining virtual reality in art exhibitions

The project goal is: how can a virtual reality exhibition represent a narrative of the Maroon through art? A key part of this objective is the use of a virtual reality exhibition; therefore, it is important to get an overview of what virtual reality entails before looking at examples of how virtual reality can give added value in the State of the art. Therefore, in this part of the background research, an overview will be made of the definition and emergence of virtual reality.

Starting with the definition of virtual reality. According to Kardong-Edgren et al., one definition of virtual reality is "The use of computer technology to create an interactive three-dimensional world in which the object has a sense of spatial presence [2, p. 30]. With the object being the user who is in the virtual reality. However, there are many more definitions of virtual reality depending on the usage. In this case, this definition works well, because the goal is to create an interactive three-dimensional art exhibition in which the visitor has a sense of spatial presence. Therefore, the visitor feels immersed in the virtual exhibition.

It is also important to know which technology is used in virtual reality for this project. The user gets immersed in virtual reality by using a virtual reality headset. The user navigates in virtual reality by the controller in which the visitor can walk or teleport to the location they want to go to [3].

An important factor for connection and learning about a narrative of artworks is experience and immersion. Virtual reality is a great way to experience and learn about things because of the immersion and interactivity that it brings [2]. On top of this, it emulates the feeling of visiting and exploring an art exhibition the best. Because both reasons, virtual reality has developed into a great tool to exhibit art in the digital landscape.

Having defined both virtual reality and the tools that are going to be used in the project, gives the required knowledge for researching how virtual reality can give added value in virtual

reality. In addition, the knowledge of why virtual reality is a useful tool for digital exhibitions is important for the design process. Because the mentioned key factors of immersion and interactivity need to be considered in the design process to use virtual reality.

2.1.2 Maroon culture in artworks of Remy Jungerman

To be able to help represent a narrative of the Maroon in Remy Jungerman's art through virtual reality exhibitions, it is important to exactly know what narratives and culture of the Maroon are represented in Remy Jungerman's artworks. This understanding of the culture is also important to be respectful in displaying a culture. As a designer trying to represent a narrative of a culture, it is important to know what the culture entails and therefore also what parts of culture to respect and what not include in the design. This understanding of the culture is also very important because the objective of the project is to give additional meaning to artworks that were previously excluded from museums.

The information about the Maroon culture in Remy Jungerman's artworks is gathered through interviews with Remy Jungerman done by museums¹, information from the Stedelijk Museum, and a direct interview with Remy Jungerman. These sources will help to answer the sub-question by first looking at the culture itself and afterward looking at how this is implemented in the artworks of Remy Jungerman.

The Maroon culture originated from West African people that were enslaved and brought to Suriname. They managed to escape Suriname's colonizers by fleeing into the interior regions of the country [4]. There they formed their religion Winti, which is a syncretization of their various religious beliefs [4]. Winti is also the name of the religion's spiritual entities. According to the Maroon, religion helps its followers achieve a state of balance between themselves and the visible and invisible forces of nature. The religion involves practices like offering sacrifices to the lower gods, which can be split into four pantheons. These are Earth, Sky, Forest, and Water [4]. Winti is preserved in oral traditions, with great differences in time and place. Therefore, it is not easily defined, and most information that is going to be used in the project is coming directly from Remy Jungerman. This is because Remy Jungerman grew up in Suriname with a Maroon mother, and Winti is part of his identity. For this reason, the Maroon culture is a big inspiration for his artworks and therefore he implements Winti through visual language by using abstract and symbolic forms.

Remy Jungerman's artworks consist mostly of works with grid work, collages, and horizontal and vertical structures. In his works, he uses the textile and materials together with patterns that are all related to the Maroon Culture [4]. An example of this is his horizontal works which represent a modernist interpretation of alters of Winti spaces that are used to commune with spiritual entities [4]. These horizontal works consist of slats of varying length, width, and color stacked atop [4]. This variance in his works manifests the balance, which is the goal of Winti. The works are often covered in kaolin. Kaolin is rubbed on the skin and face to keep negative influences away during Winti rituals [5].

Another example is his grid and panel work. The grid works reference the geometric motifs found in the fabrics worn by the Maroon and is a link to Western modernism. These

¹ "Remy Jungerman – Crossing the Water," *YouTube*. Available: <https://www.youtube.com/watch?v=KxhPy-L0TBQ> (accessed Apr. 14, 2023).

fabrics are also often used the use of rhythm in his works. Rhythm in his works is reminiscent of the repeating sound pattern of the Agida drum which is used during the Winti rituals [4].

Thus, by using approaches such as grid works, collages, and horizontal and vertical structures, he reflects parts of the Maroon culture in his works. His works also relate the 20th-century modernism a lot, because of the use of grid works. This modernism resembles his connection with the Netherlands and the United States. However, for this reason, it might be difficult for people to notice the way he reflects the Maroon in his works. Especially because he does not want to make the narrative inside his paintings obvious. He wants the visitor to explore the artworks and therefore he does not want to tell the full story right away. Therefore, the virtual reality exhibition should assist in giving hints about the narrative of the Maroon culture in his artworks. In such a way that they get interested in the culture and therefore the art gets additional meaning.

2.2 Literature Research:²

To know which tools are used to represent an idea or culture of artworks in art exhibitions to give the artworks additional meaning, literature research was done. The literature research focused on how stories can be implemented in art exhibitions because a viable tool to represent a narrative of a culture in a virtual reality exhibition could be by making use of storytelling. The literature research describes a small introduction, the definition of storytelling, the tools used, and a conclusion and discussion of the limitations.

2.2.1 The Implementation of Storytelling in Art Exhibitions: A Literature Review

Introduction

Art has a pivotal role in our society. It is a reflection of our culture and society and is used for expressing inner thoughts, feelings, or experiences [1]. Art is used to communicate ideas and history to people [1]. This is important in a world with different cultures and looks at history. Art can give a better understanding of these differences through emotion and aesthetics [6]. This is one of the purposes of the many museums throughout the world. Museums create exhibitions to give more insight by telling stories about certain artists and the history and culture around them. These exhibitions give a great opportunity for visitors to learn more about different cultures and perspectives. However, exhibitions only last for a certain amount of time. After an exhibition has ended, it might never return. This causes the visitors to not be able to see the exhibition anymore and the stories connected to it.

To solve this problem virtual reality can be used to recreate the stories of the exhibition. This is because virtual reality allows people to walk through and interact with the exhibition like in real-life exhibitions and it allows access to the exhibition at any time. Therefore, giving visitors the chance of seeing previous exhibitions. Though this seems like a plausible solution, it might not be the best solution to mimic the real-life exhibition in virtual reality. This is because virtual reality has different qualities from real life. Hence, there is a need for a new style of the exhibition while still telling the story of the original exhibition. To do this, it is important to research how stories are told in exhibitions. For this reason, the main objective of this research is to get insight into how to implement storytelling in art exhibitions.

This research consists of three parts, The first part of the research will be concerned with the definition of storytelling. The second part will focus on the different implementation possibilities of storytelling in art exhibitions. Lastly, these ways of implementation will be analyzed by looking at their advantages, disadvantages, and possible points of attention.

² The literature Research has been made in the course: Academic Writing.

Definition of Storytelling

To know how to implement storytelling in art exhibitions, it is important to define what storytelling is. According to Amangeldiyeva et al. [7] and Katifori et al. [8], it is difficult to come to a definition of storytelling that is universally agreed upon because depending on the circumstance it has a different meaning. There are two main perspectives on how storytelling should be defined. West et al. [9] and Anderson [10] define storytelling as an act of communicating or engaging an event to an audience. While Amangeldiyeva et al. [7], Katifori et al. [8], and Lugmayr et al. [11] describe the definition of storytelling as telling narratives, which entails telling about our fundamental understanding of the world around us. Amangeldiyeva et al. [7] and Lugmayr et al. [11] go more in-depth by stating that the narrative is a chain of events. This chain of events works in a cause-effect relation in such a way that human consciousness does not perceive each component but as a narrative. Hence, Lugmayr et al. [11] conclude that a story or narrative is a sum of human-inferred events. However, this conclusion does not account for the way that stories appeal to culture, history, and memory according to Amangeldiyeva et al. [7] and West et al. [9]. For this reason, it is hard to determine the exact definition of storytelling because it is influenced by different factors, however, all sources do align that storytelling is a way of conveying events to audiences. Thus, the definition of storytelling as a way of conveying events to audiences will be used throughout this literature research.

Ways of Storytelling Implementation in art exhibitions

By having defined the definition of storytelling, it is now possible to look at the ways storytelling is used. There are two main ways of storytelling used in exhibitions. The first way of storytelling in exhibitions is oral storytelling. Rich [12] states that oral storytelling is using an in-person guide or an audio-guided tour to guide the visitor through the exhibition and explain the story behind the art pieces. Lu [13] builds on this by stating that oral storytelling can connect people with stories from a world that no longer exists. Rich [12] adds on that by describing that it gives the visitor more reason to explore different exhibitions and tells you more about them. On top of that Rich [12] states that it helps to shift the visitor's perspective and creates the feeling of navigating through a whole new museum landscape. Lu [13] concludes that the use of oral storytelling offers visitors opportunities to connect with their experiences through adventure and events in the museum environment. Thus, using oral storytelling helps to convey different perspectives and more engagement, however, the sources did not mention the potential disadvantages it might have.

The second way of storytelling in an art exhibition is the theater model. Chen et al. [14] state that the theater model is based on ideas and tools borrowed from theater or cinema. The theater model uses multimedia such as video, and digital re-encasements combined with an interactive physical setting to convey a story [13], [14], [15]. Laing and Frost [16] note that this way of storytelling helps to put the artwork in the right context of the story. Chen et al. [14, p. 3] build on this by stating "It prevents visitors from being merely passive recipients of constructed memory". Laing and Frost [16] describe that the theater model works with an actor who is the staff, the setting which is the exhibition, and the performance which is the interaction between the visitor and the multimedia. They argue that the setting is the most crucial aspect because it determines how the visitors experience the exhibition. Lu [13], Laing and Frost [16], Chen et al. [14], and Palombini [15] all mention that

interaction with multimedia stories makes the exhibition more powerful because stories in a visual way are powerful tools for expressing emotions. Chen et al. [14] add to this that the visitor can more easily relate to the story because they are emotionally engaged. The use of the theater model is a great way of learning about the art piece. Therefore, it can be concluded the theater model is used to convey information through emotional relation with the art piece, however, the sources once again don't mention any potential disadvantages of using this model.

Analyzing storytelling implementation in art exhibitions

To know in what ways the storytelling methods in art exhibitions could be useful, it is important to know the advantages and disadvantages of both methods. Firstly, the advantages and disadvantages of oral storytelling need to be analyzed. As already mentioned, an advantage of oral storytelling is that it helps to offer historical, social, and political context to individual exhibitions [12]. Schwan et al. [17] build on this by stating that oral storytelling in a form of an (audio)guide increases the visitor's knowledge about an exhibition piece to a greater extent than if only written text is provided. On top of this, Schwan et al. [17] argue that it helps to let the visitor stay at an art piece for a longer time which helps to increase the meaningfulness of the art piece. However, they argue that it did not affect the perceived pleasantness of the art piece. Hence, it does not increase the emotional connection through oral storytelling. On the other hand, Rich [12] argues against this by stating that oral storytelling and in particular audio guided tours evoke emotion by guiding the viewers through the exhibition landscape in a different way. Whereas Schwan et al. [17] focus more on the educational advantage of oral storytelling because it has the benefit of that you process information in two separate channels. They argue that it creates an increased interest in the artwork itself because of the more elaborate processing of the content of the artwork which is a significant advantage for oral storytelling. Thus, by having by looking at the advantages of oral storytelling, it helps the viewer to better understand art pieces and create more meaningfulness. However, the two sources don't agree on whether it helps to convey the emotions of the art pieces.

After having analyzed the advantages of oral storytelling, the disadvantages of oral storytelling need to be analyzed. Rich [12] argues that the use of oral storytelling in the form of radio-guided tours could be more restricted because the story is in a specific way, thus forcing you to go through the exhibitions with a certain perspective. Besides that, she argues that it also can interrupt the visitor's way of learning about the piece. On top of that Rich [12] states the practical problem that if a piece changes in the exhibition the in-person guide or the audio guide needs to have the commentary changed. This could be time-consuming. Thus, oral storytelling also has its downsides, because it forces you to look at the art piece from a certain perspective. Additionally, it could interrupt a visitor's learning process about an art piece. Because only two sources were analyzed for the advantages and disadvantages, it is hard to know which statements are true, especially when they contradict each other.

For being able to compare the oral storytelling method it is also important to analyze the theater model. Chen et al. [14] and Kamariotou et al. [18] state that using the theater model has a positive effect on the immersive quality of the experience. In addition, it has a positive effect on the behavior to help create an interactive relationship with the art piece. This increases the entertainment and awareness while visiting the art piece, which results in

the visitors learning more about the story of the art piece. Besides learning more about the story, Chen et al. [14] argue that the aesthetical quality of the art piece also increased after interaction using theater models with technology such as videos. Palomino [16] builds on this by stating that the way the theater model is structured is based on common fiction, this allows the viewer to give more expression and emotion in the experience of the art exhibition. Thus, using the theater model could lead to an increase in visitors' understanding of the story. On top of that, the theater model also increases the aesthetic quality of the art piece whereas oral storytelling didn't affect it.

After having analyzed the advantages of the theater model, it is necessary to analyze the disadvantages. Chen et al. [14] argue that being so immersed in a story, especially when using virtual reality in the theater model, could lead to loneliness. On top of that Skyle [19] argues that the theater model could be problematic for elderly people. This is because it often uses various types of multimedia which they are not familiar with, and this could limit the effect of the theater model. Thus, when using the theater model disadvantages of loneliness and not being familiar need to be considered. Although multiple sources were used to analyze both the advantage and disadvantages, the theater model can be applied in various ways and therefore this analysis is generalized. This means that not every advantage or disadvantage may apply to every use of the model. Hence, some of the information found from analyzing the advantages and disadvantages might not apply to the project due to the generalization, which is a limitation of this research.

Conclusion

The goal of this literature review was to get an insight into how to implement storytelling in art exhibitions. By using reviewed sources, we saw that storytelling had two different definitions however all sources aligned that storytelling is a way of conveying events to audiences. With this, the use of this definition an overview of ways of implementing storytelling in art exhibitions was made. The ways of storytelling are Oral storytelling and the theater model. Oral storytelling helps to convey different perspectives and more engagement through an in-person or audio guide who explains the story behind art pieces. The theater model uses multimedia combined with the interactive physical setting to convey a story by putting the artwork in the right context of the story. By analyzing both methods the disadvantages and advantages of implementation could be seen. Oral storytelling increases the meaningfulness and information intake of an artwork. However, it forces the visitor to an art piece from a certain perspective and therefore could interrupt the visitor's learning process and it doesn't influence aesthetic quality. The theater model has the advantage of increasing visitors' understanding of the story of an artwork combined with increasing the aesthetic and emotional quality of an artwork. However, being immersed in multimedia could cause loneliness. On top of that, there is a limitation with the implementation of this method because elderly people are often not familiar with multimedia and therefore the method could not work. Understanding these existing methods helps to know how to convey stories in virtual reality exhibitions.

2.3 State of the Art

To understand how virtual reality could give additional value to representing a narrative of the Maroon in Remy Jungerman's art, it is important to research existing ways virtual reality exhibitions were made. From researching existing ways of using virtual reality in art exhibitions, methods can be found that could be applied to achieve the goal of the project. Therefore, in the state-of-the-art, a few of the most novel ways of applying virtual reality to give additional meaning to art exhibitions will be analyzed and researched.

2.3.1 Victoria and Albert Museum: *Curious Alice*

The Victoria and Albert Museum in London (V&A) is the world's largest museum in applied arts and decorative arts [20]. The major exhibition in 2021 was *Alice: Curiouser and Curiouser* [20] which ran from 22 May 2021 to 31 December 2021 at South Kensington. To accompany this exhibition V&A created a virtual reality exhibition. The challenge was that they wanted to tell the story of Alice in Wonderland combined with showing a gallery of illustrations, films, posters, and customs of the films, which could not be shown in a regular exhibition [21]. Therefore, they created a virtual reality immersive game called *Curious Alice* where by doing small tasks you can uncover the story of Alice in Wonderland [20]. The V&A found that exploring the story in a game-like sense boosted the curiosity of the visitor and made it also more accessible for non-museum enjoyers [20]. It also placed the gallery work in a completely new perspective and therefore it helped with telling a story [21]. Thus, the V&A used Virtual Reality to create a game-like exhibition with small tasks that serve to create a story. However, we deem the sensitive topic of representing a culture make a gaming approach less respectable.

2.3.2 Louvre: *The Mona Lisa Beyond the Glass*

The Louvre is the national art museum in Paris. It is one of the biggest museums in the world and displays 35,000 under which the Mona Lisa [22]. The Louvre created a virtual reality experience during the Leonardo Da Vinci exhibition which ran from 24 October 2019 to the 24th of February 2020 [22].

The Louvre had the challenge in that people wanted to know more about the story of painting the Mona Lisa apart from the artwork itself [22]. Therefore, the Louvre created a virtual reality experience of 'The Mona Lisa Beyond the Glass' in this virtual reality exhibition they created a 3D model of the Mona Lisa, and she then explains more about her life, the setting, and how the painting was constructed [22]. This way of telling a story is informative, however, the viewers do immerse themselves in the setting of the painting which creates additional value. Thus, the Louvre found the use of virtual reality to allow learning more about the painting. This way of telling a story could be useful for the project in virtual reality, however, the art pieces of the project are more abstract and therefore can't have a one-to-one representation as used in the Mona Lisa

2.3.3 The Museum of Other Realities

The Museum of Other Realities is a social virtual reality art showcase [23]. The visitor can download the different showcases on the online platform Steam and therefore visit different virtual reality exhibitions.

The Museum of Other Realities tried to address the challenge of creating an exhibition to support VR art and supporting artists who are challenging and redefining what is possible with technology [23]. It does this by creating a virtual environment with different 3-dimensional and 2-dimensional art pieces where the viewer can interact in multiple different ways [23]. This allows the visitor to get a closer look at the artwork and see it from different perspectives. From personal experience of the museum of other realities personally, walking into the art piece creates the feeling like you are in the world of the art piece. This feeling of being in a new world invites the viewer to explore the artwork even more and therefore it stimulates curiosity. Besides the use of sound helps to stimulate curiosity even more because it is very distinct between art pieces. On top of that visitors can visit the virtual exhibition together which creates a whole new experience. The interaction between people can increase the immersive quality of the experience.

Thus, by the use of being able to walk into art pieces combined with the sound design and interaction between visitors, the museum of other realities creates a whole new way of exploring art pieces. Some ways of interactivity such as changing artwork are not applicable, because they might change the meaning of the artwork [23]. However, the way of going into artworks could be very useful to implement in the project to show in more detail the materials Remy Jungerman uses in his artworks to represent a narrative of the Maroon.

2.3.4 Tate Modern Museum: *Modigliani VR: The Ochre Atelier*

The Tate Modern Museum is an art gallery in London, which houses the national collection of modern and contemporary art. Tate Modern created a virtual reality exhibition during the Modigliani exhibition which ran from 23 November 2017 until 2 April 2018.

The Tate Modern Museum wanted to give the visitors insight into what Modigliani's studio looked like and therefore give insights into how he made the paintings [24]. The challenge was that the studio where he worked looked vastly different now, and it cannot be used in exhibitions [24]. To solve this problem, they tried to recreate his studio from one hundred years ago in virtual reality [21]. According to Hilary Knight seeing his studio of him in virtual reality is helping people feel a connection with the artist [21]. She adds to this that is a unique way of absorbing information and makes the artist a living person [21]. Thus, showing the process and workplace of the artist in virtual reality can increase the feeling of connectedness to the artist. This does not directly apply to the project because of the style of art and the way it is created is completely different. However, showing elements of Remy Jungerman's artwork can increase the connectedness of the visitor. Also, this exhibition shows that VR is a great tool for bringing the past back to the present era.

2.3.5 Bosch VR

Bosch VR is an online art exhibition that can be always accessible. The visitor can download the different exhibitions on the online platform Steam and therefore visit different virtual reality exhibitions.

Bosch VR wanted to enhance the viewing experience of seeing a painting [9]. Therefore, it created a Virtual reality experience 'Eye of the Owl' which uses very high-quality paintings. By using VR, the visitor can zoom in on certain parts of the painting using a magnifying glass [9]. This allows the viewer to see parts of the painting in more detail. On top of that for each part you zoom in on, a soundscape is created [9]. This entails that for each part of the painting you get different: voices, music, and other sounds. The use of the soundscape allows the painting itself to tell a story because the visitor can zoom in and hear the events from each part of the painting. Thus, by using a soundscape and being able to zoom in on the paintings virtual reality enhances the visitor's experience and tells a story. This element could be very useful for the project. This is because of zooming in: Remy Jungerman's materials can be highlighted, and the soundscape could tell the story of what the material refers to.

2.3.6 Conclusion

In conclusion, having analyzed different ways in which virtual reality can be used to give additional meaning to exhibitions, helps the design process of the project. However, The project has different goals and constraints from the analyzed virtual reality exhibitions because it is more focused on telling the story which reflects a culture and uses vastly different art styles. The solutions of other exhibitions by the use of different ways of interactivity such as walking through or zooming into artwork, and the use of sound are great ways to enrich the story of an artwork. These virtual reality exhibitions can be used in the design process of possible ways to approach the project goal.

3 Design Methodology

This chapter describes the design methods that will be used throughout the graduation project.

3.1 Creative Technology Design Method

The used method is based on the paper 'A Design Process for Creative Technology' by Mader and Eggink [13], which illustrates the creative technology design method which is also illustrated in Figure 3.1.

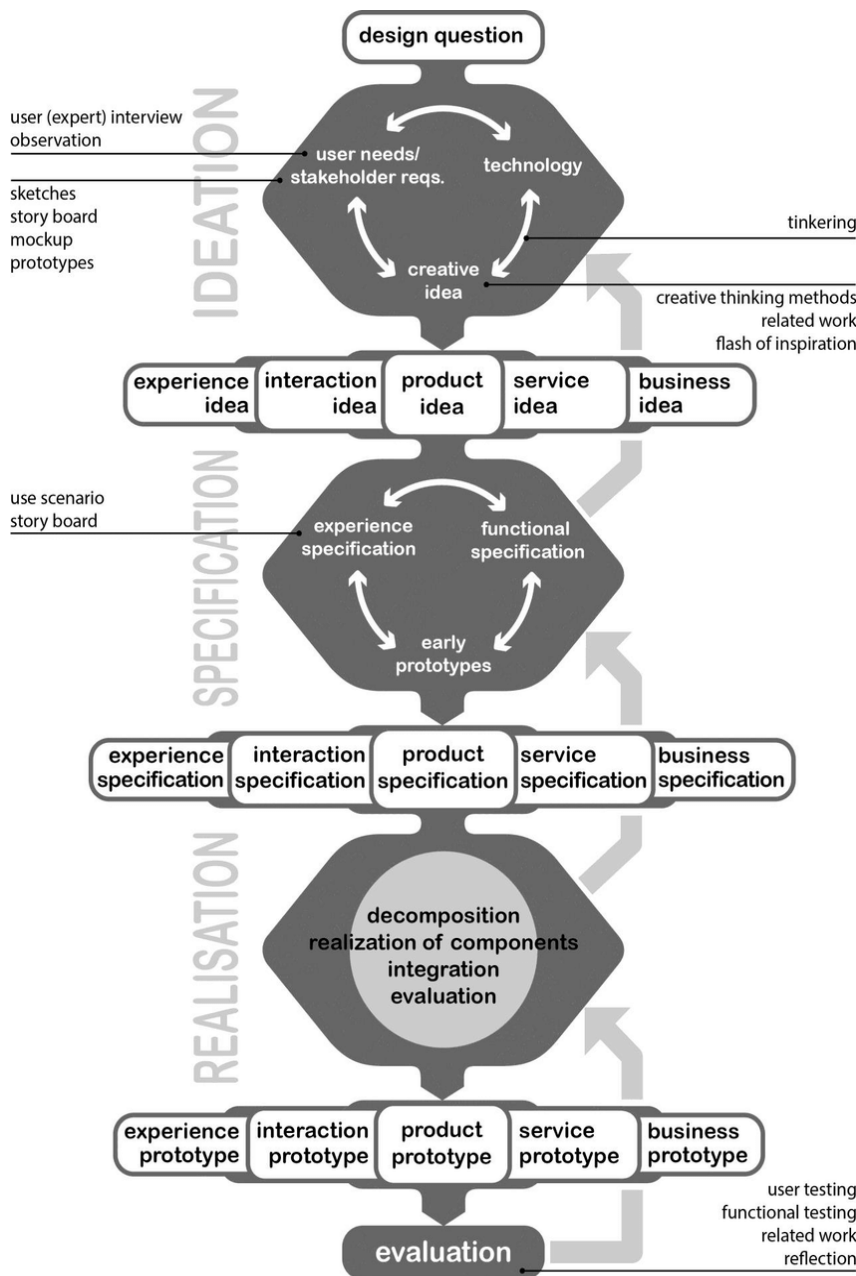


Figure 3.1.1 A Design Process for Creative Technology

The creative technology design process works with four main phases: Ideation phase, specification, Realization phase, and evaluation phase [13]. For each of these phases, the goals and process are described down below.

Each phase makes use of divergence and convergence. In divergent steps, the designer opens up thinking about the breadth of the design phase [13]. This entails coming up with a lot of different options or ideas on the topic. After that, the convergence is used to try, based on the current knowledge to define the best option before coming into the next phase [13]. This allows the designer to first come up with a lot of different options to, later, decide which one is the best fit for the project.

Apart from using divergence and convergence, the ideation and specification phase also uses spiral models. Spiral models are a way of ensuring an iterative process in these phases which is essential for a reflective and transformative design process [13].

3.1.1 Ideation Phase

The goal of the ideation phase is to get an elaborate project idea combined with setting up the problem requirements [13]. The result of this phase could be an idea of experience, interaction, business model, or service [13]. Using the spiral model, the flow of the ideation phase could go in multiple ways. An example of this could be starting with the stakeholder requirements, creating an idea, and then finding the correct technology to accompany it. However, the ideation could also start with multiple iterations of identifying novel ways to apply existing technology and testing how well it solves the problem, which is called 'tinkering'[13]. Mader and Eggink state that "In this sense the approach bridges between technology and user needs, which is in this form not provided by any other discipline" [13, p. 4]. On top of that, the ideation phase uses inspiration from many sources, however, especially background research is a key inspiration for the ideation phase [13].

3.1.2 Specification Phase

During the specification phase, prototypes or scenarios are made to explore the design space [13]. These prototypes serve for testing the functionality of the design and if it achieves the correct experience. The phase uses short evaluations and feedback loops, so each prototype is discarded or improved into a new prototype [13]. The prototypes often focus on a specific aspect of the future product. The result of the specification phase is a final set of requirements that should be applied in the realization phase [13].

3.1.3 Realization Phase

In the realization phase the requirements given in the specification phase will be realized [13]. It uses a linear model which makes it easier to track back to previous steps [13]. It describes how the components of the realization of the project are created and which design considerations there were made [13]. Within this phase there will be an evaluation, to see whether the realization meets the specification requirements.

3.1.4 Evaluation Phase

Lastly, there is the evaluation phase. The evaluation phase evaluates whether the requirements made in the ideation phase are met and whether the functionality is met with the functional requirements of the realization phase [13]. To test the user requirements, the project is tested by doing user testing. And the state-of-the-art will be reflected upon, to see where it fits in the current work. In the end, the student will reflect on the limitations and reconsider the decisions that were made [13]. Thus, the evaluation phase assists with deciding to which extent the project succeeds in achieving the set goal.

4 Ideation

4.1 Stakeholder Requirement:

Before starting to come up with the concepts, it is essential to analyze who the stakeholders of this project are and what their requirements are. To be able to do this, a table will be made with each stakeholder, what their connection is to the project, and their requirements.

The requirements will be analyzed using the MoSCoW method. The MoSCoW method is a tool to prioritize requirements [14]. This allows the project to know the difference in the importance of requirements, therefore it is easier to know in which order the requirements should be implemented into the system. Each requirement belongs to a category of the Moscow method, these categories are:

- **Must have:** The minimal requirements for the project.
- **Should have:** The important but not necessary requirements of the project.
- **Could have:** The requirements that are wanted but less important.
- **Won't have:** The requirements that are out of the scope of the project.

Having every requirement in an overview and categorization helps to structure the design and realization process. The requirements come from different stakeholders and therefore also different sources. The main requirements come from Remy Jungerman and these requirements are based on an interview that was done with him. An overview of each stakeholder and their requirements can be seen in Table 4.1.1. The MoSCoW analysis of these requirements can be seen in Table 4.1.2.

Table 4.1.1 Stakeholder Requirements

Stakeholder	Relation	Requirements
Remy Jungerman	Remy Jungerman is the client for which the virtual reality exhibition should be created. Therefore, he is the main stakeholder and decides the main requirements	<ol style="list-style-type: none"> 1. The project must be a virtual reality exhibition of his works. 2. The project must link the Maroon culture and the art pieces, 3. The project must give hints about the Maroon culture. 4. The artworks and space need to be respected and not changed. 5. The virtual reality exhibition should have interactions.
The visitor of the virtual reality exhibition	The visitors are also important stakeholders because they are the target group for the virtual reality exhibition.	<ol style="list-style-type: none"> 1. The virtual reality should be understood within 2 minutes. 2. The virtual reality exhibition must not cause harm. 3. The virtual reality exhibition should give added value to the artwork.
Museum	Apart from the artist museums could execute the virtual reality exhibition in the museum or make the virtual reality exhibition possible through an online platform.	<ol style="list-style-type: none"> 1. The virtual reality should be set up within 3 hours.

Table 4.1.2 MoSCoW Analysis

MoSCoW Category	NR.	Requirements
Must Have	1	The project must be a virtual reality exhibition of his works.
	2	The artworks and space must be respected and not changed.
	3	The project must create a link between the Maroon culture and the art pieces,
	4	The project must give hints about the Maroon culture.
	5	The virtual reality exhibition must be safe
Should	6	The virtual reality exhibition should have interactions
	7	The virtual reality should be set up within 3 hours.
	8	The virtual reality should be understood within 2 minutes
	9	The virtual reality exhibition should give added value to the regular exhibition
	10	The virtual reality exhibition should give added value to the artwork
Could Have		-
Won't Have		-

4.2 Brainstorm

To be able to come up with the idea of how to create a virtual reality exhibition that represents a narrative of the Maron in Remy Jungerman's artworks, it was essential to do a brainstorming session. A brainstorming session allows people to come up with as many ideas as possible. Afterward figuring out which idea has to most potential in solving the challenge.

4.2.1 Process and Results

The brainstorming process was done in a group with two other students who are also working on a virtual reality exhibition. This was to make sure that during the brainstorming phase as many ways of solving the project were discussed. It, therefore, allowed for many new ideas to come in which were used in the initial concepts.

The brainstorming made use of the basis of the brainwriting method. In this method of brainstorming each participant writes their ideas in a 6-minute timeframe. Afterward, each participant will look at other persons' ideas and tries to add ideas based on this. In this case, the brainwriting method was altered into a 10-minute timeframe where each participant writes down their ideas and looks at the other participant's ideas at the same time to come up with different ideas. Therefore, combining the two steps of brainwriting into one, we found that this alteration worked the best in our case to come up with the project concepts. It allows us to come up with many different ideas for the project, which serves as a good basis to create the initial concepts. However, there were many other concepts based on different perspectives, so it was necessary to group them. Grouping the ideas helps to define the main concepts on which the project can rely, this can be seen in Figure 4.2.1. After having grouped the ideas, each idea was discussed and given a star if one of the participants liked the idea. Then, all the ideas with a star were put next together. This allowed the ability to create three initial ideas as the outcome of the brainstorming (Figure 4.2.2). These three initial ideas will be further worked out in the next section through the use of illustrations. A thing to note is that each one of the initial ideas is part of a different group during the brainstorming process. For this reason, grouping the ideas helped to create diversity in the ideas.

In conclusion, brainstorming with other participants helped the project to come up with numerous ideas from which the most promising ones could be chosen and combined into initial concepts.

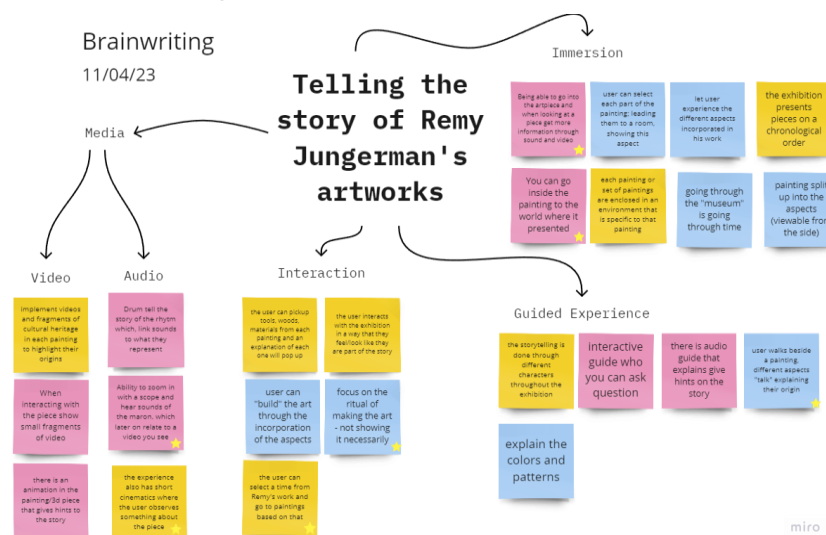


Figure 4.2.1 Brainstorm process

Initial concepts

- By zooming in or going into the painting, hearing parts of Remy Jungerman's Story and then seeing them at the end in a video.
- Zooming or going into an artwork and seeing a cinematic/video about the story based on the material highlighted.
- Picking up materials around the artworks shows you pictures of the meaning

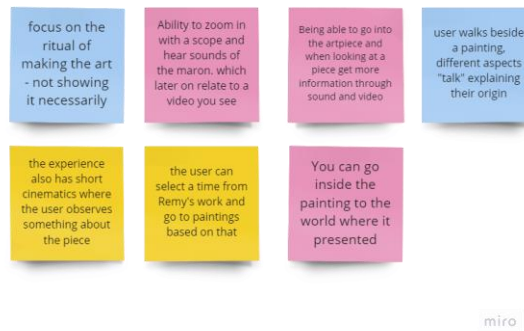


Figure 4.2.2 Brainstorm Results

4.3 Initial Concepts

The outcome of the brainstorming was three initial ideas. This section will further develop these three initial ideas into concepts. This is done by describing them in more detail and creating sketches. By doing this one final concept could be chosen which serves as a basis for the solution of the project.

The three initial ideas were created based on the research into how the Maroon culture is represented in the art of Remy Jungerman. Also, it was based on using oral storytelling and the theatre model to represent a narrative in art which was found in the literature research. Besides, the interactions were inspired by the research done in the state-of-the-art where we could see that zooming in, hearing sounds, and going into the artworks were introduced successfully to create more meaning to the artwork.

4.3.1 First Concept: Magnifying Glass Exploration

The first concept is the idea that the visitor can zoom in on Remy Jungerman's artworks using a magnifying glass. If the magnifying glass highlights a texture, pattern, or material, it plays a video that correlates and shows indirectly the meaning behind it.

The magnifying glass is a tool that can be created in virtual reality which helps to zoom the artworks; therefore, it reveals the patterns, and textures even better. It also incentives to explore the artwork, because when using a magnifying glass, you can only see parts of the artwork. On top of that, the ability to display a video helps to know parts of the culture related to the artwork, which enriches the artwork's meaning. The style video will be in the same style as Remy Jungerman used in his earlier exhibitions: it shows something about the Maroon culture; however, it is open to the viewer what they take away from it. In Figure 4.3.1 you see what the concept of the magnifying glass combined with the video will look like.

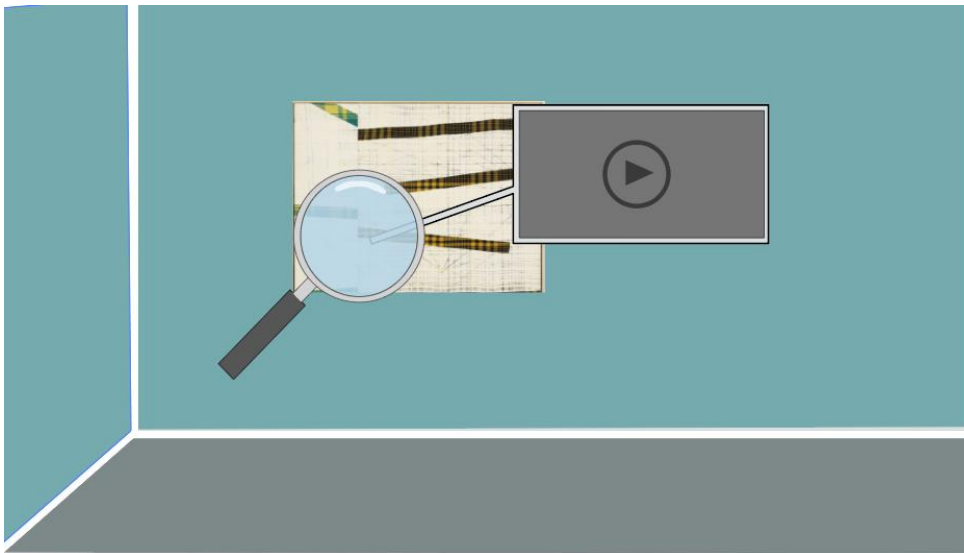


Figure 4.3.1 First concept: Zooming in using a magnifying glass.

4.3.2 Second Concept: Going into the artwork and combining it with a soundscape.

The second concept is about being able to go into an artwork or on top of a painting (*figure 4.3.2*). When you are on top of the painting you hear sounds related to the material or texture that you walk on and interact with (*figure 4.3.3*). When you leave the painting and go to the end of the exhibition, there is a video where that shows the visuals behind some of the sounds you heard while you were in the painting.

This encourages the visitor to go into the artwork and hear the different sounds and explore the artwork in a completely new way. Afterward, when they see the video, it gives the artwork and sounds more meaning. On top of that, it encourages the visitor to go back to the artwork to experience it again. When visiting it again the visitor has the added knowledge of the meaning of the sounds. This resembles the requirements of giving hints about the meaning while also letting the visitor interact with the exhibition a lot. Being able to inside the artwork and hearing the changes of sounds utilizes the strengths of a virtual reality exhibition compared to a normal exhibition.

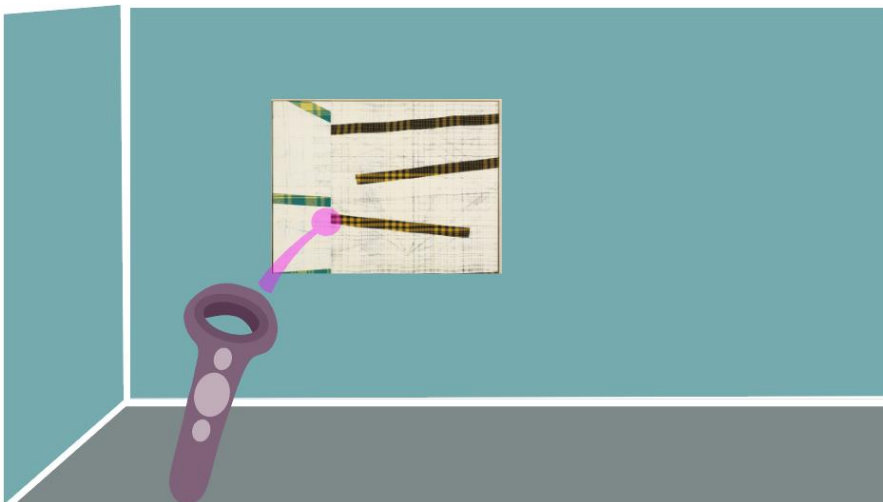


Figure 4.3.2 Second concept: going into the artwork.



Figure 4.3.3 Second concept: Hearing a soundscape of the materials

4.3.3 Third Concept: Grabbing objects, gives you photos of their meaning.

The third concept is that the textures and materials that are used in the artworks are lying down on the floor of the exhibition (see *Figure 4.3.4*). As a visitor, you can grab those objects and then a screen pops up (see *Figure 4.3.5*). This screen displays the name of the material and photos related to the meaning behind the material.

This allows the visitor to get to know more about certain materials they are interested in. It also allows for more interaction and exploration in the exhibition itself by letting visitors look for the materials. Besides, the pictures give hints at the meaning of those materials, however, it is still very open in how the visitor interprets it. Therefore, it can give additional meaning to the artwork, because knowing more about each material, makes the way they are used in the artwork more interesting.

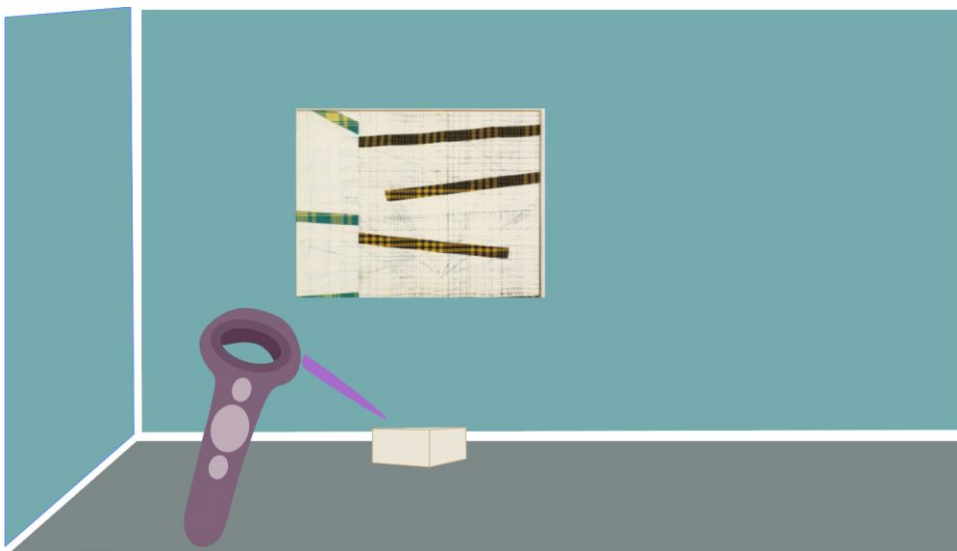


Figure 4.3.4 Third concept: Grabbing the object

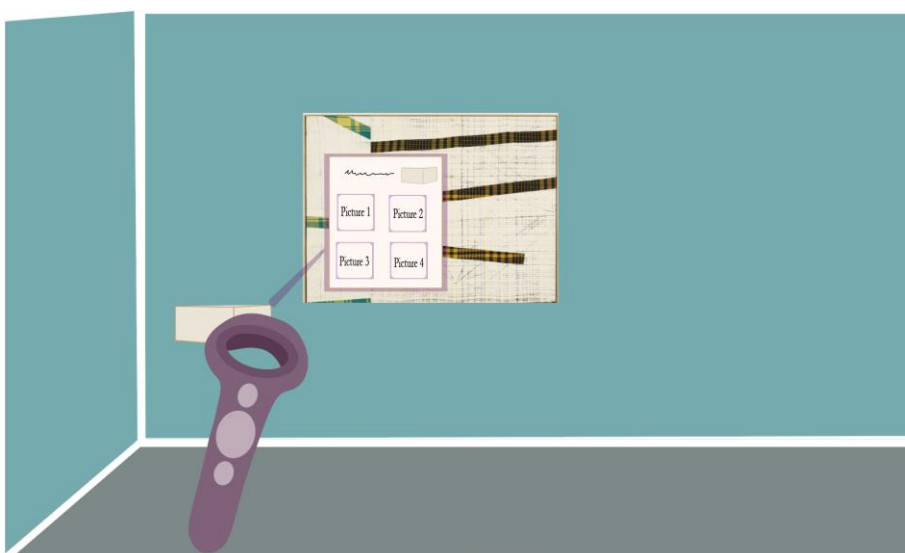


Figure 4.3.5 Third concept: Display of pictures about the meaning of the material

4.4 Chosen Concept

Having the three initial concepts worked helped a lot in the ideation process. Working out those ideas together with creating illustrations helped to show the strengths and drawbacks of each idea. In this way, a well-reasoned decision could be made on which concept would solve the research question the best. The second concept of being able to go into the artwork and combining this with the soundscape achieved the project goal the best.

The chosen concept solved the issue in a new creative way where virtual reality can be used to its best extent while also conforming to the requirements that were set. The chosen concept allows people to go into the artwork, see the texture and materials and hear the soundscape of the Maroon culture that relates to it. Afterward, the visitor sees the video which corresponds to the soundscape. Therefore, not only does the experience while exploring the painting get enriched but the narrative of the Maroon also gets represented. On top of that it makes the viewer curious to go back to the painting, to hear the soundscape, and see the materials again with the new knowledge they have about the meaning. Thus it addresses the research question, conforms to the requirements, and could enhance the exhibition. Therefore, this is the chosen concept that in the specification phase will be further explored.

5 Specification

After having chosen the final concept in the ideation phase, it is important to develop the idea into a well-defined envisioned product and develop the preliminary requirements into functional and non-functional requirements. This is the main purpose of the specification phase. This is done by creating user scenarios and making conclusions from prototypes of parts of the product. This helps to understand which requirements are necessary for the final product to fulfill its purpose. After writing the requirements down, it is important to categorize them based on their importance. It helps to define which requirements need to be met to get a minimal viable product and therefore which requirements need to be focused on. Besides having written down the requirements it is important to look to specify to product more. Specifying the product through different methods can help in the process of the realization of the product. On top of this, it helps gives the stakeholders a good mental image of what the envisioned product will do.

5.1 Users

The users of the virtual reality art exhibition play a key role in the project because the product needs to give added value by representing a narrative of the Maroon to achieve its goal. Therefore, it is important to define the target user and the requirements which correspond with the target user. Apart from this, it is also important to analyze how the user might interact with the product, to see which key requirements are necessary for the interaction to be successful and how the product achieves its goal. Therefore, in this subchapter, the target users and a user scenario will be addressed.

5.1.1 Target User Groups

Virtual reality exhibitions can be used by a variety of people varying from old to young. However, it is essential to realize some groups of people benefit more from the product than others. While it is still important to cater to those other groups, it is good to focus on the persons who will be the main users of the virtual reality exhibition.

The main target users of the virtual reality exhibition are adolescents aged 16-24 who are interested in art. This is the reason that 63% of adolescents are interested in using virtual reality which is more than two times as high as people of older ages [28]. An interactive virtual reality exhibition could be a reason for them to visit more exhibitions. Therefore, they can learn more about the narrative behind the art pieces. On top of this, the virtual reality exhibition can function as a steppingstone for the younger generation to be interested in art exhibitions. This target group could benefit from having virtual reality exhibitions that tell the story of the artist.

To make sure the virtual reality will be interesting for the target user the virtual reality exhibition must cater to the interests of the adolescents. This means that it would not have too much text and should have enough interaction [29]. If this is not the case the user might lose interest, and this can mismatch with the goal of representing a narrative of Maroon

through a virtual reality art exhibition. To solve this issue a requirement in case of such information is that the information about the way virtual reality exhibition works is explained by using a form of media(visual/audio). Another requirement is that the virtual reality exhibition should have enough interactions to keep the interests of the adolescents so the goal of representing a narrative of the Maroon can be achieved.

Another important target group is people who visit Remy Jungerman's exhibition and come across the virtual reality exhibition. They can vary from many different ages and therefore it is important to try to cater to most of them. On top of that it is important to look at which motivations the visitors must go to museums, to try to make sure that the virtual reality exhibition fulfills these motivations.

As mentioned, the age range of visitors to the exhibition can vary a lot. For this reason, it can be important to have the choice to simplify things in certain parts of the exhibition. This is because elderly people can have a hard time understanding different types of media [19]. Therefore, it could be helpful for a user to be able to change some types of media and interactions to text. This tries to give an alternative for people who are less skilled in interacting using media.

Analyzing the motivation of visitors has been important for being able to realize the expectations visitors might have in the virtual reality exhibition. The main motivations for people to go to an exhibition are learning, discovery, passive enjoyment, social interaction, restoration, and self-fulfillment [30]. Not every motivation can as easily be fulfilled in a virtual reality exhibition as in a real-life exhibition. However, the motivations of learning and discovery could be key parts of the virtual reality exhibitions. Trying to tell the stories of Remy Jungerman and reflecting on Maroon culture is a key part of the product which can fulfill the learning motivation. Being able to discover the virtual reality exhibition could be done by letting the user try to interact with things and not giving all the information about what might happen. However, this could cause confusion which could stop them from learning about the stories of Remy Jungerman [30].

The last group which could benefit from the virtual reality exhibition is people with physical disabilities [31]. The virtual reality exhibition allows them to explore the exhibition on their own and therefore giving them additional freedom [31]. Although most of the requirements that are necessary to facilitate people with physical disabilities to use virtual reality are in the physical exhibition, a few can be fascinated by the virtual reality exhibition itself. The first requirement is that virtual reality can be used from different physical positions: standing, sitting, etc. The other requirement is that people can change the way they navigate, such as changing which buttons are used to walk. This is to make sure that people who cannot navigate using the regular settings have the option to navigate through the exhibition in other ways.

5.1.2 User Scenario

In this part of the specification, a user scenario is described. The user scenario helps to demonstrate how the virtual reality exhibition might be used and how the goal of representing a narrative of the Maroon in Remy Jungerman's artworks can be achieved. On top of this, it serves as a tool to consider the possible specifications that need to be done to make the initial idea achieve its goal.

Brandon is a 20-year-old student who is interested in art. Because of his interest in art, he visits multiple exhibitions about the art styles he likes. He, therefore, visits the exhibition of Remy Jungerman. He enjoys the exhibition and wants to learn more about the artwork and the meaning behind it. At the end of the exhibition, he notices a virtual reality exhibition which might give additional meaning and information about the artwork. Brandon asks the art supervisor about the virtual reality and if he could try it. The art supervisor assists Brandon with putting on the virtual reality headset and controller. When Brandon enters the virtual reality, he sees a video explaining the way to navigate and the possible interaction of going into the painting when you are walking close to it. He has also given the option to read through the given information once again if something was unclear, however, he understood everything and wants to explore the exhibition. For this reason, he moves from the introduction room into the exhibition. In the exhibition, he looks at all the different paintings and sees the video about Maroon culture. He notices that the paintings and the Maroon culture correlate with each other. To further explore it, he makes use of the described interaction and walks up close to the painting. This teleports him to the top of the painting. The painting is scaled up a lot and therefore he can walk around and see the materials in close detail. He also hears different sounds corresponding to which parts of the painting he stands on. An example of this is that he hears the Maroon drums on parts that represent the rhythm in the paintings. From this, he learns that the rhythm in the painting reflects the drums. When he is done exploring the painting, he goes back to the main exhibition and sees the video once again. Now he realizes that the drums which he heard in the painting are used in the Maroon culture. Therefore, he suspects that the rhythm in the paintings represents the drums that are used in the Maroon culture. When he is done exploring all the different paintings, he leaves the virtual reality. Due to the virtual reality exhibition, he has been given a new insight into the stories behind the paintings which made them rich and interesting. Therefore, he would like to explore the regular exhibition once again to see how stories are implemented in other works of Remy Jungerman.

5.2 Specification of the Final Product

After having defined what the possible users of the product will be and how the product in an ideal scenario should be used. It is now important to specify what the product exactly does and how it will do it. This together with the previous sections help to define the specification requirements which will guide the realization process.

To specify the product, it is split up into different parts. For each part, prototypes have been made to be able to weigh different options of realizing the part against each other. By doing this, each part has a specified approach and evaluated approach on how able to realize this in the next stage of the project. For the specification, the virtual reality exhibition has been split into the following different parts: three-dimensional artworks in virtual reality, virtual reality exhibition space, and interactions.

5.2.1 Paintings in virtual reality

An important factor for getting the product of the virtual exhibition to work, is to get show the fabrics and rhythms in his works. Therefore, is necessary to try to recreate the artworks of Remy Jungerman to look as close as the original ones.

For being able to do this Remy Jungerman sent 4 of his grid artworks as pictures. These grid artworks fit the idea well because they incorporate rhythm and use different styles of materials such as fabric. On top of this, these artworks were sent already quite early in the project which allowed us to already research the meaning, and have been used in the prototype phase to recreate them in virtual reality. Thus, due to having already tested different ways to recreate it in virtual reality and having the use of rhythm and material in it, the grid works paintings of Remy Jungerman will be used in the virtual reality exhibition.

To make sure the gridwork represents a narrative of the Maroon culture it is important that in the exhibition if a visitor is walking on a certain material the sound that will be triggered gives meaning to the specific material. This is essential for the project to work, and therefore it is important to take a look into the meaning of each material of the painting. For this reason, a requirement is that the sounds must correspond to the material the user is standing on.

5.3.2 Virtual reality exhibition space and Software

One of the most important factors in creating a virtual reality exhibition where the visitor can jump onto the painting to explore the meaning of materials is creating the virtual reality exhibition itself. Therefore, the way this virtual reality exhibition is made must facilitate the functions necessary to achieve the goal of the project. To make sure this is the case different virtual reality software were considered and tested by making prototypes of a virtual reality museum. On top of that making small prototypes and doing a user scenario of the idea also helped to consider what rooms are necessary in the virtual reality exhibition.

Virtual reality space:

Starting with creating the rooms for the virtual reality exhibition. The four gridworks all need a room where the visitor can walk onto the scaled-up painting. Therefore to facilitate the gridworks the virtual reality exhibition will have six rooms, see Figure 5.2.3 for an overview. The first room is an entrance room before entering the exhibition itself. In this room, there will be a video explanation of how to navigate and interact in virtual reality. This tries to make sure that the visitor knows how the virtual reality works before entering the exhibition. This will hopefully result in the visitor can focus on the artwork and interaction instead of the navigation. The second room will be the exhibition itself, where four of Remy Jungerman's gridworks are displayed. The style of this room will resemble the way the exhibition of Remy Jungerman looked at the Stedelijk Museums exhibition, therefore with a wood floor and ceiling and with white walls. The four other rooms will have each one of the four works of Remy Jungerman which are scaled up and rotated so the user can walk on top of the painting. These rooms will only be accessible with the use of teleportation, which will be explained in the next section of the specification. The style of the rooms apart from the scaled-up painting will be the same as the main exhibition because it is part of the exhibition. The rooms will be made using the 3D-modeling software Blender because it can create objects with great detail, allows one to change objects easily, and gives a good preview of how the virtual exhibition looks before exporting it to the virtual reality software. The way the paintings and video in the exhibition room are arranged depends on which arrangement will help to achieve the optimal user scenario, as described in 5.1.2. However, this can only be tested once the exhibition room is made in virtual reality.

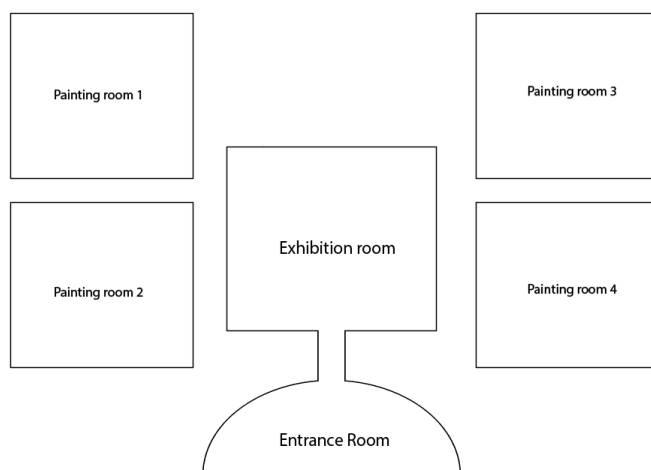


Figure 5.2.3 Basic sketch of the Virtual reality space

Virtual reality software:

The virtual reality software is also an important factor in the product because it determines how the user interacts with the exhibition and how the workflow of creating the virtual reality exhibition goes. The project will use the virtual reality software Neos VR. Neos VR is a virtual reality software where the user can build and change the exhibition while the user is standing in the exhibition and using the virtual reality headset. This allows for directly changing the position of objects based on the experience of the virtual reality exhibition. There are multiple reasons for choosing Neos VR as the virtual reality software. The first reason is that it can create all the interactions necessary for the product to work without too much setup time. Therefore, it allows us to test these interactions quickly and optimize them for the user experience. The second reason is that the user can use both with and without virtual reality. Although the exhibition is designed to be used with a virtual reality headset, it is great that it can be used without a virtual reality headset in case someone is susceptible to virtual reality sickness. The third reason is that it is a cloud-based system. Which entails that it can be accessed from anywhere. This will make it easier for Remy Jungerman to share and use the virtual reality exhibition because you don't have to download a new version each time there is an update. The last reason is that it allows multiple visitors to explore the exhibition at the same time and interact with each other. This is something outside the scope of the project, however, could be a very interesting option for Remy Jungerman. All these reasons combined with that added quality that it is specifically made for virtual reality make it more fitting than other software.

Avatar:

An important thing to consider is what kind of avatar the user can choose. An avatar in virtual reality is the way the character of the user looks. This is important to consider because based on the avatar the height, and way of experiencing the exhibition are altered. For example, a child might have to look up at the painting while an adult can just see the painting while looking horizontally. This change of view can influence the way you look at the artwork completely. On top of that avatars can be used to express people, however, it is then important that there are a variety of avatars to choose from. This is because if you only have several avatars to choose from the installation can be discriminated against people or cultures that are not included.

So, avatars can play an important role in the experience of virtual reality. Because the virtual reality exhibition is focused on representing perspectives of the Maron through interactions, it is important to let the avatar not distract from that. Therefore, an avatar selection menu can be distracting and for this reason, the virtual reality should only have one avatar. The avatar should have roughly the height and view of an adult person because the exhibition is targeted at adolescents and older. On top of that, the avatar should be not a human, because otherwise, it can be discriminatory.

5.2.3 Interactions

After having discussed how the paintings will be recreated in virtual reality and how the virtual reality exhibition will roughly look, it is important to discuss the interactions of the exhibition. As mentioned in the user scenario the key interaction in the exhibition is that the user will be able to go onto the paintings and hear the sounds related to the material. Later, they can recognize the sounds back in the video. This will give hints about the meaning of the material and rhythm which will increase the richness of the painting. This interaction consists of 3 key factors: going onto the painting, hearing different materials, and reflecting with the use of a video.

Going onto the painting

Going onto the painting is an important factor for the interaction because it allows the visitor to see the painting from close and notice the different details in rhythm or material which otherwise can't be seen. To facilitate this the virtual reality exhibition will teleport the visitor to another room where the painting is scaled up and therefore the visitor can walk on top of it. Other options such as rotating the player and decreasing its size have been considered, however, this can disorientate people using virtual reality which can lead to virtual reality sickness. Teleporting the user to a different room has also the benefit of making the sounds associated with the painting work better. Thus, for those reasons, the virtual reality exhibition will use teleportation to another room to be able to go onto the painting.

An important factor to consider with using teleportation is how to let the visitor know that it can teleport and how it should teleport. Because people of different ages should be able to use the virtual reality exhibition, it should be intuitive and easy for the visitor to use teleportation. For this reason, the visitor should be teleported if they walk in a certain area of the exhibition space. This will cause the visitor to only know the walking controls to use the virtual reality exhibition and thus the teleporter. Because it should be intuitive to use, there should be a visual indicator of where the user should stand to get the teleporter. It would have been a possibility to use an audio indicator, however, this could interfere with the sounds from the video which can disrupt the exhibition.

Hearing the sounds related to the textures and rhythms.

After the visitor has been teleported onto the painting, the visitor can explore the painting and the sounds related to the textures and the rhythms of the Maroon. For this reason, there should be specific sounds activated if you walk on a texture. The sounds must correlate to the meaning of the material. Also, the sounds should be coming from an area of that texture, because if visitors walk away from the texture, they can hear the sounds coming from the texture and still relate the sounds to the texture. To make it more user-friendly, knowing which materials have sounds should be intuitive. Therefore, on top of the painting, there are visual indicators on the locations where possible sounds are. If this is not the case the user might miss the sounds and does not get the full interaction. Thus, by having these requirements the user could be able to correlate the sounds to the paintings and textures.

Creating the video in a virtual reality exhibition

The last part of the interaction is when the visitor leaves the painting by teleporting to the edge of the painting and seeing the video again. With the knowledge about which sounds correlate to the materials, the visitor can link those sounds again to the visuals in the video and therefore figure out the meaning of the materials. The video should mimic how it is used in the Stedelijk Museum; therefore, it should be on a loop, so it is always active when visitors walk into the exhibition. The video that will be played will be the same style of video that Remy Jungerman also used in his Stedelijk Museum exhibition. In this video, you can see the textures and other parts of the Maroon culture. In this way, the visitor can, by doing the interactions, get to see the paintings up close and gets hints about the Maroon culture behind the materials and rhythms.

5.3 Specification Requirements

One of the main goals for the specification phase is to get a list of specification requirements. These requirements will serve as a kind of blueprint for the realization of the product. Therefore, these requirements will be used as a guide to know what should be in the final virtual reality exhibition and how this should be accomplished. By revising the preliminary requirements in the ideation phase, analyzing the target user and the user scenario, and having specified the virtual reality the specification requirements can be made. These requirements will be classified based on their importance using the MoSCoW method, which is explained in section 4.1.

Apart from classifying the importance of the requirements, it is also important to organize the requirements by their purpose. Functional requirements describe what the product does, and Non-functional requirements describe how the product does it. During the ideation phase, most of the requirements were functional requirements because the idea was still quite rough. In the specification, non-functional requirements were made based on prototypes to carry out the functional requirements. Therefore, with the addition of the non-functional requirements, the product can be realized and evaluated.

The specification requirements are shown in Table 5.3.1.

Table 5.3.1 Specification Requirements

No.	Moscow	FR or NFR	Requirement
1	Must have	FR	The virtual reality exhibition must show 3D recreations of Remy Jungerman's artwork.
2			The user must be transported on top of the painting through an interaction near the painting
3			The exhibition must show links between the Maroon culture and the artworks.
4			The exhibition must not tell the full meaning of each artwork, but rather give hints about the artwork's meaning.
5			The user must be able to walk on scaled-up paintings.
6			The user must hear sounds relating to the materials of the painting.
7			The sounds must be activated based on the material the user is standing on.
8			A video must give additional hints about the meaning of the materials used in the artwork.
9		NFR	The project must be a virtual reality exhibition of the works of Remy Jungerman.

10			The virtual reality exhibition must be used from both a sitting and standing position to facilitate safety .
11			The artworks must not be altered apart from applying textures .
12	Should have	FR	The virtual reality exhibition should have at least 2 interactions
13			The exhibition should show Remy Jungerman's Gridworks
14			The virtual reality exhibition should give visitors the possibility to visit different spaces .
15		NFR	The virtual reality exhibition should be made using Neos VR
16			The virtual reality exhibition should have a video explanation if the text is more than 5 lines.
17			The virtual reality should be set up within 1 hour .
18			The virtual reality should be understood within 60 seconds
19			The transportation of going onto the painting should be done using teleportation .
20			The teleportation should be activated by the user navigating a designated area .
21			There should be a visual indicator to signify how the user can teleport.
22			The virtual reality exhibition should have an entrance room and an exhibition room
23			There should be at least four different paintings that the user can interact with/walk onto
24			There should be at least two sound interactions per painting .
25			The sound interactions should have a visual indicator .
26			The sound should be coming from the location of the material .

27			The used avatar should be non-human .
28			The video should loop .

29	Could have	FR	The virtual reality exhibition could show different types of Remy Jungerman artwork
30			The virtual reality exhibition could facilitate interaction between two visitors using it at the same time.
31		NFR	The virtual reality could include 3D artworks of Remy Jungerman
32			The virtual reality exhibition could facilitate interaction by letting the visitor make gestures or talk to another visitor .

33	Won't have	FR	The virtual reality won't be a replication of an actual exhibition of Remy Jungerman
34		NFR	The virtual reality will not have all the different artwork as Remy Jungerman's regular exhibitions.

6 Realization

After having specified the virtual reality exhibition and having created the requirements which come with these specifications it is time to realize the product. This will be explained in the realization chapter, which includes the process and decisions made when realizing the product. The realization chapter will also look at the requirements that were set and sees to what extent it matches them and why. To do this, in this chapter, there will first taken a look at the creation of the virtual reality art exhibition, then look at the interactions, and lastly, the final product in which the requirements will be evaluated.

6.1 Virtual reality art exhibition

The realization of the virtual reality art exhibition happened in several steps. First, it was important to recreate the gridworks, then to make the exhibition spaces, then to realize the lighting, and then choose the avatar.

6.1.1 The gridwork paintings.

To try to recreate gridwork paintings in virtual reality, different methods were tried such as recreating the height and depth of the painting manually. However, this caused the painting to look quite different from the original. Therefore, the preferred method of recreating the paintings is to import the picture into three-dimensional space and then add what is called a 'normal map', which can be seen in Figure 6.1.1. This normal map can be applied as a texture to the paintings which makes it three-dimensional. This is because the normal map is a calculation map of how the light interacts with the painting in real life. This then can be applied in virtual reality to make it more three-dimensional.

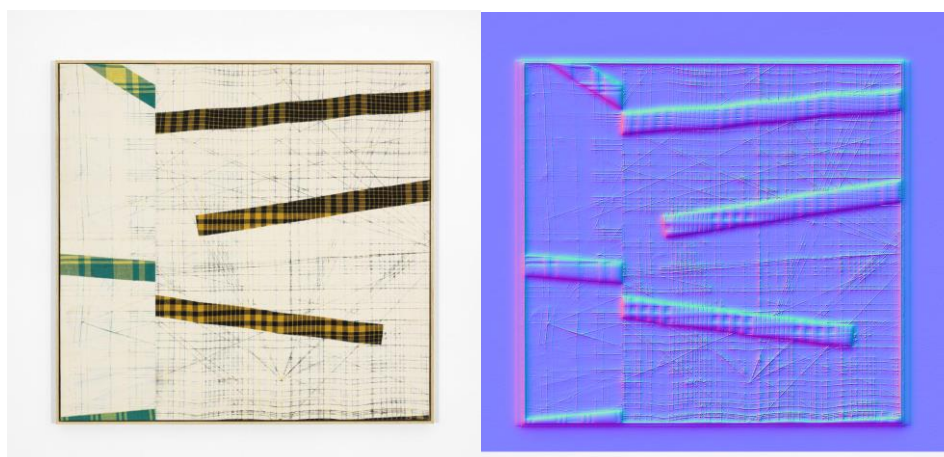


Figure 6.1.1 Painting of Remy Jungerman(left), Normal map of the same painting(right)

Apart from this, the painting will be given different textures for the different materials. This is because Remy Jungerman uses various materials in the grid artworks, which all resemble different meanings. To create the materials, textures were made using the same program as the 3D models which is Blender. These textures were created manually based on the reference on the picture and knowing which material it is. This will allow it would possibly look slightly different in virtual reality than in the real-life exhibition. However, it will allow for a high-quality texture. Figure 6.1.2 illustrates the difference between just using a picture compared with recreating the painting using the explained methods.

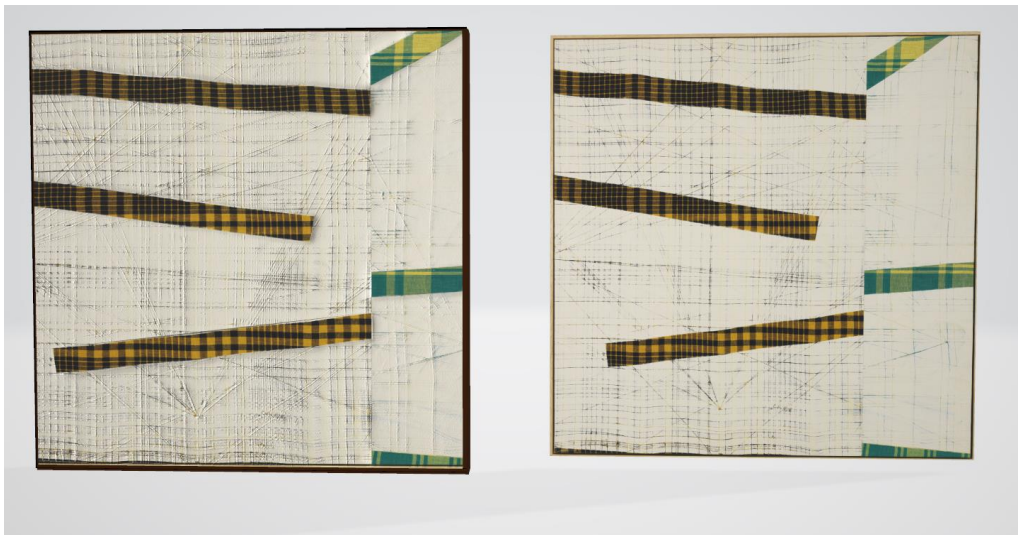


Figure 6.1.2 3D-model of the artwork(left), a picture of the same artwork (right)

6.1.2 Virtual reality spaces

Design of the exhibition:

To realize the virtual reality spaces, the description of the specification, which can be found in 5.3.2, was used as a starting point. This stated there should be one main exhibition, an entrance room, and 4 spaces where the scaled-up paintings should be. The first step was to decide how the main exhibition should look. Because the space will make use of teleportation and a video, it was important that the paintings have enough space between them. For teleportation, this is important because otherwise, the visitor might teleport into the wrong painting. For the video, this is important because otherwise the sounds and images might distract people from seeing all the paintings. To adhere to all these requirements, the design, which can be seen in Figure 6.1.3, was created. This exhibition space separates the video by using a wall and has enough space between the paintings to make sure there will be no issues while using teleportation. It also makes use of diagonal walls. This is because Remy Jungerman utilizes them in his exhibitions to create curiosity and interest. Therefore, it will be used in the virtual reality exhibition to create more curiosity for the gridworks and the video.

The entrance has a round design with a hall in the middle which guides the visitor subconsciously to the exhibition space. To go to the exhibition space, they first need to be

familiar with the controls. This is done so they can focus on the paintings when they are in the exhibition. By guiding the viewer and letting them be familiar with the controls, the entrance space has served its purpose.

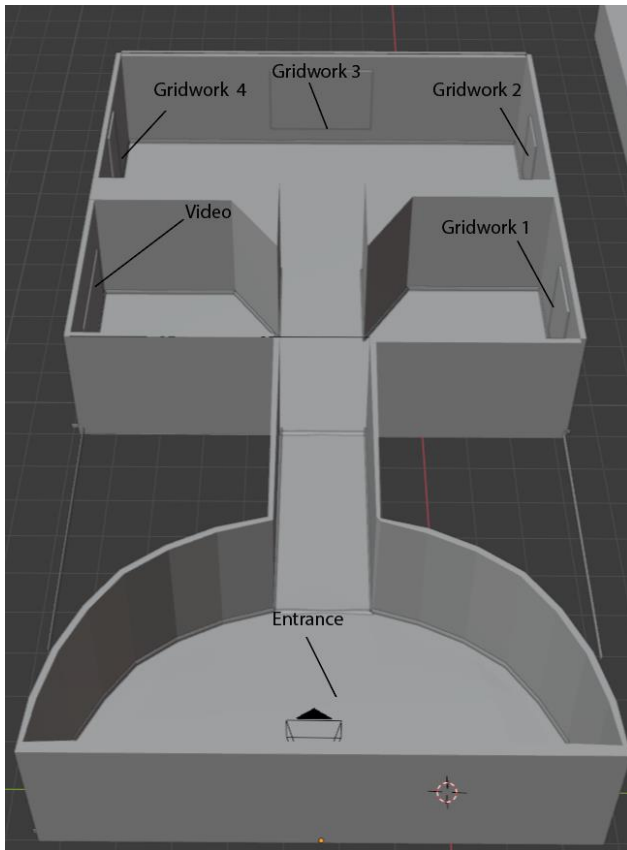


Figure 6.1.3 Design of exhibition space.

After having designed how the main exhibition space should look, it was important to design how the scaled-up exhibition spaces should look. The decision was made to make them simple cubes because the visitor should look at the paintings and therefore other shapes might be distracting for the visitor.

Creating the exhibition space:

After having designed the exhibition space it was the next step to create the space by adding the paintings, adding materials, and objects which give the feeling of an actual exhibition space. To get an idea of how the exhibition should look, a mood board was created, which can be seen in Figure 6.1.4. The mood board helped with deciding that the exhibition space should have: a wood floor, white concrete wall, wood skirting boards, and spotlight lamps to create the feeling that you are in an actual exhibition.

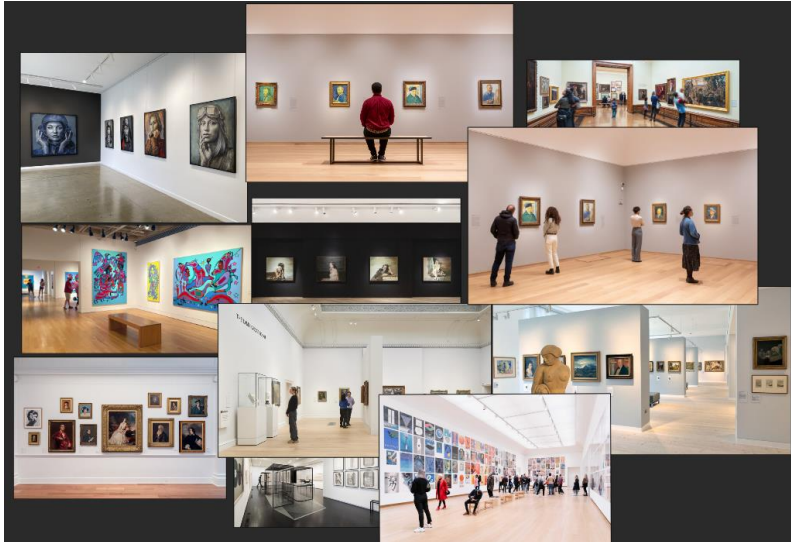


Figure 6.1.4 Mood board of exhibition space

After having decided how the exhibition should look, I started creating the new objects and materials using the previously mentioned software, Blender. Creating the objects and materials was an iterative process because each small change had an influence on how the paintings looked and thus the overall experience. After I was satisfied with the result, I exported the exhibition to the virtual reality software Neos. Neos uses different rendering technology, which entails that the exhibition looked different. Therefore, based on feedback, the exhibitions (which will be discussed in 6.1.3) lights, and materials were changed. In Figure 6.1.5 you can see how the exhibition looked before the changes and in Figure 6.1.7 you can see how the final space exhibition looks.



Figure 6.1.5 Exhibition space before changes

6.1.3 Lights

A key factor in getting the exhibition space to look right and for people to be able to notice the textures and patterns was lighting. Adding lights into the world works in multiple steps in Neos VR which we use for the virtual reality exhibition. The first step was by adding the spotlights. These lights can be created in Neos and adjusted on their strength and radius. They serve to highlight the paintings and videos in the exhibition to direct the visitor's attention to them. In Figure 6.1.5 you can see how the exhibition looks by only using these spotlights. However, you can also notice that the exhibition space is quite dark. To solve this problem skyboxes were used. Skyboxes in Neos decide what the natural light in the world is. This natural light goes through walls and therefore influences the inside of the exhibition. Therefore, to make the exhibition space lighter and more fitting, a different skybox was used. The last step was to make it look like the light from the spotlights was coming from the 3D-modeled lamps, see Figure 6.1.6. This was done by adding point lights to each lamp. This makes it look like the light is coming from the lamps which helps with creating the immersion that you are in an actual exhibition.



Figure 6.1.6 3D-modeled lamps with point lights



Figure 6.1.7 Final exhibition space, with material and light changes

6.1.4 Avatar

The last important part of virtual reality that has little to do with the interaction is the avatar. As mentioned in the specification phase it was important that the avatar was not distracting and that it was a non-human. The chosen avatar for the exhibition is the default avatar from Neos, which can be seen in Figure 6.1.8. It is a floating virtual reality headset with two floating hands. In Figure 6.1.9 you can see how the avatar looks from the user's perspective. The benefit of this avatar is that it is non-human therefore it does not cause discrimination. This is because if the avatar was human, people with different attributes than the avatar might feel discriminated against. The other benefit is that it has floating hands. This means that it will not take up much space on the screen and therefore the viewer can focus on the interaction and the artwork. Still having hands as an avatar helps the visitor to know where the virtual reality controllers are and give them the feeling of being able to touch the materials in the paintings.



Figure 6.1.8 The chosen avatar of the virtual reality exhibition

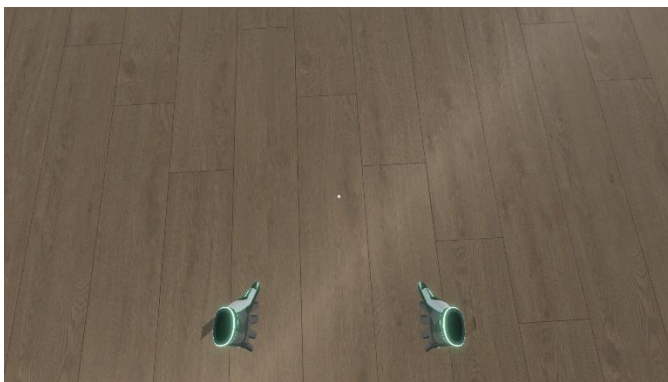


Figure 6.1.9 Avatar from the user's perspective

6.2 Interactions

The main benefit of the virtual reality exhibition is that through interactions the visitor can learn more about the Maroon culture and the meaning behind the artworks of Remy. Therefore, after creating the basic version of the virtual reality space it was most important to implement the interactions. In this subchapter, you will read how the interactions from the specification were realized and which decisions were made to try to make sure these interactions were user-friendly and achieved the goal of representing the narrative of the Maroon in Remy Jungerman's artwork.

6.2.1 Going onto the painting.

The first and main interaction in the exhibition is that you get teleported onto the scaled-up painting and therefore can walk on it and notice the materials. A requirement for this is there should be an intuitive way for the user to teleport to the other space. To do this, the virtual reality exhibition makes use of box collider objects. A box collider object is an object which can detect when a user is walking through it. The virtual reality exhibition uses this to detect whether the user is walking close to the painting. If the box collider object detects a user, it runs the 'character teleporter' function which is attached to the object. This function teleports the user to the location of another object.

Therefore, to teleport the user to the scaled-up painting, it should use a box collider to detect the user, then run the 'character teleporter' to an empty object at the location of the scaled-up painting.

Using a box collider object is better than other options to detect if the user wants to teleport because the user does only need to walk close to the paintings and does not have to do other actions. This makes it easier for visitors to use the virtual reality exhibition, because they only need to know how to navigate. On top of this, it gives the visitor the feeling that they are jumping onto the painting.

Apart from making it possible to teleport, it is also important to make it intuitive how and where to teleport. The issue is that if you add lights or sounds it might interfere with the artwork itself. To solve this issue, the box collider which is used to teleport has a transparent white material and is placed underneath the painting, which can be seen in Figure 6.2.1. So, if the visitor walks into the transparent cube, they will get teleported to the scaled-up version of the painting, see Figure 6.2.2. If they then want to teleport back, they walk on the transparent cube again in the scaled-up painting exhibition and are then teleported back to the main exhibition.

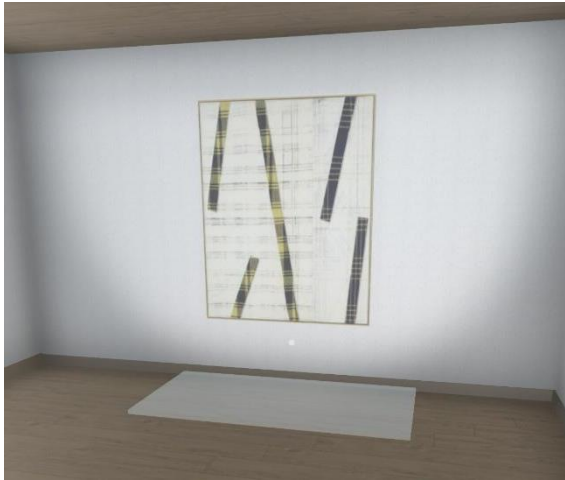


Figure 6.2.1 Teleporter indicator.



Figure 6.2.2 Scaled-up exhibition of the painting.

Reasons for signifying the interaction by using a transparent material is that often in games it is also used to signal interactions and it grabs people's curiosity. Therefore, people who are used to playing games already know that there is an interaction. However, you do not have to play games to get curious about the transparent box on the ground and want to walk on it. Then after they walk on it, they get teleported. After this experience, they learned that if they walk on the transparent box, they will get teleported. The visitor can link this to the similar interaction of teleporting back via the transparent box in the scale-up room.

6.2.2 Sound that gives hints about the material.

Obtaining the sounds:

After the user gets teleported onto the scaled-up version of the painting, the next interaction is that the visitor walks on specific materials and hears sounds that reflect the meaning of the materials.

The first step of realizing this was getting the sounds that correspond to the different materials on the painting. The initial idea was to use the sounds of the video that Remy Jungerman used in the Stedelijk Museum. Remy Jungerman did provide the video to use, however, it had music underneath instead of sounds of the Maroon culture. For this reason, the sound had to be obtained in a different way. I used sounds from online videos of the Maroon Culture.

To get the meaning correct of the materials, the research done for chapter 2.1.2 was used. On top of this, the resources used in the research: the Stedelijk Museum document and interviews were revisited to get the meaning behind the materials [4]. The conclusion from this was that in his gridworks: the lines refer to the rhythm which relates to the Agida drums; the yellow fabric is used to symbolize the rainforest; the blue fabric is used to symbolize the sky and the red fabric is used to symbolize the earth [4]. On top of this Kaolin is used throughout the gridwork, but because this is throughout the whole gridwork it is too difficult to assign it to a specific point on the gridwork. For this reason, this is left out of the interaction.

By knowing which sounds need to be gathered, the sounds from the online observatory videos could be gathered. The sound of the Agida drums was used from a video where people were playing the drums and singing³. The sounds of the rainforest, sky(which is translated into wind), and earth were used from an observational video of the lives of the Maroon⁴. After collecting the sounds, they were each individually imported into Neos VR for being able to use them in the exhibition.

Creating the sound interaction:

If you import sounds into Neos VR, it will create an audio player, see Figure 6.2.3. This audio player allows you to change a lot of audio settings. The first important setting was the spatial audio. This fulfills the requirement of hearing the audio coming from the material even if you are not on the material. So, even after they leave the visitor can still create a link between the audio and the material. The second important setting is the roll-off setting. This will cause the volume to decrease the further the visitor is away from the sound. This will give even more spatial knowledge of the sound and makes sure the sounds do not interfere with other sounds. The last important setting is that it can be activated through the collision boxes mentioned earlier.

³ L. Kuipers, "Traditional Maroon Drumming", *YouTube*, Apr. 1, 2017. Available: https://www.youtube.com/watch?v=E6Cz58j5AqQ&ab_channel=LudoKuipers (Accessed Jun. 7, 2023).

⁴ "Suriname- Land of the Marrons", *YouTube*, Feb. 26, 2018. Available: https://www.youtube.com/watch?v=LFvUg99OJ78&ab_channel=4ever2wherever (Accessed Jun. 7, 2023).

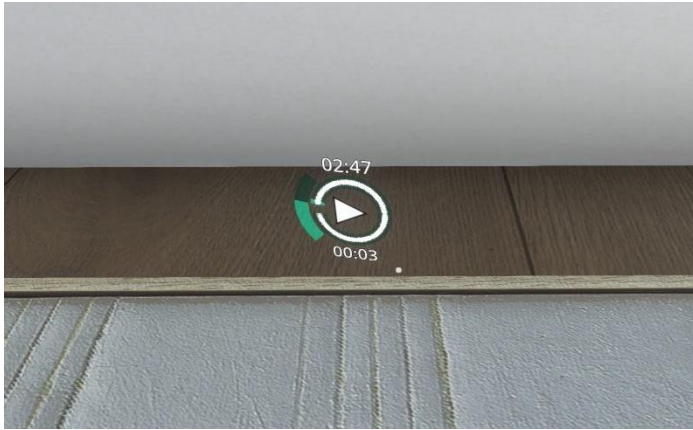


Figure 6.2.3 Neos Audio Player

Neos Logix is a node-based way of programming which allows you to create many different interactions. In the virtual reality exhibition, it is used both to create the interaction for starting the audio when a visitor walks on the material and stopping the audio when they leave the scaled-up exhibition space.

To create the interaction of starting the sounds if you stand on the material, it is first important to detect whether the user is standing on the material. To do this a box collider, which was explained in more detail in 6.1.2, is used. However instead of, making it transparent it is invisible because the user should be able to see the material clearly and should notice that the sounds started playing when standing on the material. The box collider covers most of the material and therefore if the visitor walks on the material, it will detect it.

The next step is to use Neos Logix. The interaction should be that if the user stands in the box collider it should start playing the sound. Therefore, in the Logix, it should be that if the box collider detects a collision, it should play the playback of the sound. In Figure 6.2.4 you can see that the box collider from the material when there is a collision starts the function 'play', which starts the playback of the audio. This will therefore cause when a person walks on the material it starts the audio which gives the meaning of the material. This same Logix is used for each audio clip which gives the meaning of the material.



Figure 6.2.4 Neos Logix for starting sound when standing on a material

Stopping the sounds when leaving the painting:

It is important if a new visitor comes, the sounds should be not playing anymore. This is because it otherwise takes away from the exploration of what the materials mean. To solve this, the sounds should all stop playing when a visitor leaves a scaled-up painting space. To do this the same box collider which teleports you back to the main exhibition is used. This box collider detects when a person leaves the scaled-up paintings and therefore it is a great way to know when to stop the sounds. To stop the sounds, the same Logix to start the sound is used, however instead of the function 'play' the function 'stop' is used. This Logix therefore will stop the sounds when leaving the scaled-up painting.

Signaling the sound interactions:

A requirement for the sound interactions was that it should be intuitive where the sound interactions are. Different options have been considered, such as making a transparent cube above the material with an audio interaction. However, most of the options interfered with the experience and influenced how you see the material. To still let the visitor, know which materials have a sound interaction, the audio players are placed above the materials. This signals that there is something special there, which might intrigue the visitor. If they then walk on the material close to the audio player, they realize that if they stand on a material with an audio player above it that there is a sound interaction.

6.2.3 Video

After you hear the sounds and teleport back the last part of the interaction is that you walk up to the video and watch it again, now with the added knowledge of the sounds. The video should give visuals to the sounds you heard in the scaled-up exhibitions.

To realize the video, Remy Jungerman supplied the video he used for the Stedelijk Museum, however as mentioned before it had no sounds but rather music. However, it was still important to let the music play in the exhibition when you walk near the video. This is because Remy Jungerman had designed it so the music would fit with the video and the music will grab the visitor's attention.

To let the video play in virtual reality, the video player of Neos VR was used. To give them the same experience as in the regular exhibition the video was played on a loop. This is because, in the Stedelijk Museum exhibitions, the video also runs on a loop. It also might get the attention of the visitor easier if it is already playing. The sound was set to be heard only if you are walking near it, therefore the music would not influence the experience of seeing the paintings. In Figure 6.2.5 you can see how the video was placed in the exhibition.



Figure 6.2.5 Video in Virtual reality exhibition

6.3 Final Product

In this chapter, I described how based on the specifications and requirements I created the final product. The final product is a virtual reality exhibition in which through going onto the paintings, walk on materials and hear sounds that reflect the meaning of the materials. When you come back into the main exhibition you can see the video which gives you visuals of the sounds that you heard. The goal of the product is to represent a narrative of the Maron through the artworks of Remy Jungerman. In Figure 6.3.1 you can pictures of how the final product looks after the realization.



Figure 6.3.1 Pictures of the Final Product

7 User Evaluation

The goal of the graduation project is by the use of a virtual reality art exhibition to represent a narrative of the Maroon culture in the artworks of Remy Jungerman. After realizing the virtual reality exhibition in the previous chapter, it is necessary to test whether the goal of the project is achieved. On top of this, it is important to get to know what points of improvement the virtual reality exhibition has, and which parts of the virtual reality are essential for its success. To do this, a user test needs to be done. Therefore, in this chapter, in the first part, we describe what methods & techniques are going to be used for the user evaluation, and in the second part the results of the user evaluation.

7.1 Method & Techniques

To make sure the user testing happens properly it is extremely important to write down the method and techniques that are going to be used before starting the test. This helps to make sure the process of testing goes well and helps to remove bias or uncertainty when analyzing the data. The method and process that will be mentioned in this subchapter to perform the user study were given a positive advice by the Computer & Information Sciences (CIS) Ethics Committee before carrying out the user study.

7.1.1 Goal

To start, it is important to set the goal of the testing and what the process is to achieve the goal. As mentioned before the graduation project's goal is to create a virtual reality art exhibition to represent a narrative of the Maroon culture in the works of Remy Jungerman. Therefore, it is important to test whether the created virtual reality exhibition represents the narrative better than a regular virtual reality exhibition. This gives us the main evaluation question:

Does the virtual reality exhibition with interaction represent a narrative of the Maroon in Remy Jungerman's work better than a regular virtual reality exhibition?

Another goal of the evaluation is to see which points of the virtual reality exhibition could be improved upon and which points give value to the exhibition.

7.1.2 Process

To achieve the main goal, the participants will be split into 2 groups A and B. Participants of group A will get the full experience with all the interactions. group B will experience the virtual reality exhibition without interactions. Therefore, group B will not be able to teleport into the paintings and hear the sounds of the material. group B's experience is only the video, the information brochure, and the paintings in the main exhibition. At the start of every 10 persons a coin will be flipped to which group the first participant will be assigned, after that group A and B will be alternating until there are 5 persons in group A and 5 persons in group B. This will minimize implicit bias because the persons are already assigned randomly to a group before they start the test.

A room will be reserved for the user testing. When a participant walks in they are asked to read and sign a consent form, which you can see in Appendix A. To give groups A and B an equal chance to get the narrative of the Maroon, the participant will be asked to read the information brochure. This is based on the text of the Stedelijk Museum, which can be seen in Appendix B [4]. It explains who Remy Jungerman is and how he represents the Maroon culture in his gridworks. After they read the brochure, the participant will be asked to put the headset on. In putting the headset on he will be assisted, because it is essential that the headset fits well for being able to see properly. Once the headset is correctly on, the controls will be explained depending on which group they are in. To keep this consistent the text will be read from a paper each time, which can be seen in Appendix C. Once the visitors start walking a stopwatch is set to track the time and observations will be made. The visitor will be able to explore the exhibition by themselves. Once they think they have seen it all or want to stop, the stopwatch will stop. Then they will be assisted with taking off their headset and then asked to do an interview. After the interview, the experiment ends. The experiment is estimated to take 20 minutes; however, this depends on the time the user spends in virtual reality.

7.1.3 Participants

Participants are essential for getting the user test to work well. Therefore, it is important to think about who the participants should be and how they are going to be recruited. The minimum target for this test is to get 20 total participants, this means 10 participants in group A and 10 in group B. This is not a big enough sample size to make definitive conclusions, however, it is big enough to help to see if it is something worth evaluating in the future. On top of this, due to constraints relating to the project, it is not feasible to recruit more than 50 participants and run 20-minute tests for each of them. The participants can be of any sex. However, sex could influence how they interact with the virtual reality exhibition, which will be explained more in 7.1.5.

The target group of the project is adolescents from 18-24. Therefore, most participants who will be asked to use the test will be adolescents. Therefore, the mean age will be roughly around 21. However, because the exhibition should also be accessible to

various age groups, the age variance could differ a lot. For this reason, age will be taken as a demographic during the test.

Apart from discussing the age, it is also important to set the inclusion criteria. This means the criteria which the participant should meet to be able to do the user tests. This criterion is set to reduce harm and to make sure the participants are able to fully participate in the experiment. The inclusion criteria are:

- The participant should be above 18 years old.
 - If they are under 18, they cannot give consent.
- The participant should have dominance over their upper body.
 - This is mandatory for being able to use virtual reality glasses.
- The participant should be able to make choices independently.
 - This is because cognitively impaired people could receive harm from using the virtual reality exhibition. On top of that, they can't fully participate in the experiment.
- The participant should not suffer from epilepsy, extreme motion sickness, or any other side effect of VR.
 - This is to make sure the virtual reality exhibition does not harm the participants.

Another important part is the recruitment of participants. As mentioned in 4.2, two other students are also working on creating a virtual reality exhibition for Remy Jungerman. To make sure enough people could be recruited, the recruitment of testing will be done together. This is because there is almost no learning effect between the exhibitions, and it allowed a user to test multiple exhibitions which resulted in more participants. The main way of recruiting is through an online interest form, in which a person could reserve a slot in which they want to participate. This interest form will be put into the studies WhatsApp group chat; send to friends and put as a QR code on a poster which will be spread across the university campus. Sending it to a friend could lead to bias, however having a randomly assigned control group reduces this bias.

To compensate the participants for helping with the user tests there will be snacks for them to take before or after the user tests. It also helps them to feel the incentive to stick around longer and do more user tests, which will increase the number of participants.

7.1.4 Experiment setup

The experiment setup and the technology used are also important in the outcome of the experiment. Therefore, it is good to state what the experiment setup is. The experiment takes place in a reserved room with a dedicated area of 3 meters by 3 meters space for the participants and a table for the interviewers. The equipment that will be used was a Windows 11 laptop with a Wireless Oculus Quest 2 which was connected to an ASUS Rapture Router. The equipment of the headset can make a significant difference in quality and blurriness for the visitor. Therefore, doing the test with another headset might lead to slightly different results. The software that will be used is: Neos VR, for the virtual reality space; Oculus Rift, for connecting the virtual reality headset, and Microsoft Teams for transcribing the interviews.

7.1.5 Design & Analysis

The last part of the methodology is the design of the experiment and analysis. As mentioned in the process the participants will be split into two groups (between-group analysis). The way the two groups will be tested is mainly through an interview. This is because it is the most fitting way of getting the information of what the participant thinks the artworks reflect. A questionnaire could have worked, however, using an interview, more information could be obtained about what the participant thinks the art reflects based on their experience. On top of this, the answers could be a lot of variation between the responses which could be easier captured by an interview. The interview is recorded as text by using the transcript function of Microsoft Teams and writing the responses down during the interview.

The interview questions were made on the basis of getting information on what they think the artwork reflects based on their experience. In Appendix D you can find all the interview questions.

The only demographic question that was asked was the participant's age. This is because age can be a factor in how familiar you are with virtual reality, and it decides whether you fit in the target group.

The three questions after the demographic question is about what the user thinks the artworks reflect and how they came to that conclusion. These questions were based on the Terra foundation and are essential for answering the main evaluation question [33]. Because it validates whether they learn more about the Maron culture and the reason how they learned it.

The last three questions are concerning the favorite and most frustrating parts of the exhibition. These questions help future work in which parts of the exhibition need to be improved to create a better experience.

Apart from the interview questions, observations were made, and the time that a participant spent in the virtual reality exhibition was measured. The goal of the observations is to see whether the interactions are intuitive and see what they find the most interesting parts of the exhibition. The goal of timing how long the user spends in the virtual reality is to see if they spend more time in the exhibition with all the interactions versus the regular exhibition. The reason is that the observations were made during the first day that people are spending longer in the full exhibition than in the regular one. Therefore, from participant 6 the time spent in the virtual reality was measured to see if this was the case.

Analysis:

After having designed the experiment it is also extremely important to decide how this data is going to be analyzed. Because of the sample size of both groups, it will not be possible to draw direct conclusions however the results could indicate that there might be a pattern that is worth further investigation.

The age will be analyzed by getting the mean age of both groups A and B and their variance of them. If this is a difference in mean age, it could have had an impact on the result. However, if this is roughly the same, we can assume that this did not have an impact on the result.

The time the person spends in the virtual reality exhibition will also be compared between the groups. This could be done using a t-test, however, due to the possible big variance and the low sample size (which entails not a rich population), it could lead to wrong conclusions. Therefore, in this case, the mean of time they spend in virtual reality and variance will be compared. If there is a big difference it might give information that there would possibly be a pattern between the difference in time spent per group.

The user experience questions and observations, which relate to points of improvement and favorite parts will be summarized and put into one table. This allows you to see what went well and what needs to be changed very easily. Also, the points of user experience will order by frequency and the frequency will be put in front of it. Therefore, if for example 8 people agree with something it might be a more valid argument than if one person agrees with it. By making these tables it gives a good overview of what the experience did right and what it needs to improve.

The last part and the main question of the evaluation that needs to be analyzed is to what extent the virtual reality exhibition with interactions represents a narrative of the Maroon more than the regular virtual reality exhibition. To evaluate these three questions relating to the meaning of the artwork and artist were asked. To analyze this qualitative data the content analysis method as described by the documentation of Columbia University will be used [34].

This content analysis method uses coding, which is labeling certain keywords. In this case, the keywords will be the things that the participant says about the meaning of the artworks (e.g., rainforest, Maroon) and where they got the information from (e.g., video, sounds). This helps to get a good understanding of what they learn about the narrative and how.

Coding can be done in different ways; therefore, it is important to set the rules of coding. In this case, the coding will be on a word and phrase level [34]. Because it is important to catch apart from keywords, key phrases such as (the fabric relates to the video). Also, the coding will be done on the existence and not frequency per participant [34]. This means if a participant says the word 'culture' 10 times, it will only count as one. This is because it is important that each participant understands the narrative and not how many times, they repeat the narrative. Lastly, the coding will be both implicit and explicit. This means that if they use synonyms or describe the word, it also counts as the word. For example, in this case, the word 'fabric' can be described as a textile or a checkered material. However, because they mean the same thing all these will be coded as fabric.

After doing this coding a list can be created with the coded words, if a word is coded 10 times, then everyone in the group has mentioned the word to describe the art. This way you can compare it between groups. Also, a word cloud will be made to see the difference in the number of words and the keywords itself between Groups. This will create a good overview of the difference in knowledge about the narrative of the Maroon in the artworks between groups.

7.2 Results

Based on the methodology which is described earlier in the chapter the user tests were carried out. In the end, 10 participants were assigned to group A (users with all the interactions) and 10 participants from group B (users without the interactions). Each participant played out the full interaction and answered every question. The questions and observations are analyzed. The table of the results of the user evaluation can be found in Appendix E.

7.2.1 Age

Starting with the demographic age, group A (users with all the interactions) had a mean age of 22.6 and an age variance of 7.2. While group B (users without the interactions) had a mean age of 20.8 and a variance of 5.3. Therefore, group A had in general older people testing than group B. This could have implications for the result because older people might have more interest in art and know less about virtual reality. However, because the mean age difference is less than 2 years, and they are both in the target group, it should not matter as much as other factors such as: how interested you are in art as a person. Nonetheless, it is still good to keep this in mind when discussing the results of the two groups.

7.2.3 Time Spent in the virtual reality exhibition.

After having discussed the differences in mean age, it is time to look at the differences between the time spent in virtual reality exhibitions because it might influence how much they learn about a narrative of the Maron in the artworks. In Appendix E you can find the individual times the participants of each group spend in the virtual reality exhibition. Group A spend an average time of 6:40 minutes in the virtual reality exhibition while group B spent an average time of 2:44 minutes in the virtual reality exhibition. From these results, it looks like the persons who have the interactions of jumping into the painting and hearing the sounds are spending significantly more time in the virtual reality than the persons without those interactions. Therefore, they spend less time trying to learn what the artwork reflects. A note has to be made, that only at the 6th person of testing the time was recorded which reduces the sample size. On top of this, the time varied a lot between the participants depending on how interested they were in the art. However, the difference that group A spends more than two times as long in the exhibition than group B is still significant. This means that they spend more time looking at the art and have more time to learn more about the narrative of the art.

7.2.3 Reflecting a narrative of the Maron in the artworks:

The main objective of the virtual reality art exhibition is to represent a narrative of the Maron in the artworks of Remy Jungerman. Therefore, the results of what the participant thinks about the narrative between groups A and B are extremely important. The interview results

knowledge about what the artwork reflects. group B did not have the sounds; therefore, it is natural that other things gave them the information. However, group A did have, apart from the sounds, also the brochure and video. Therefore, it was very interesting to see that in the exhibition the sound was more impactful and gave more information than the video and brochure.

As mentioned above there is a difference in the amount and type of words between groups A and B. However, some keywords are frequent in both groups A and B, such as culture and fabric. Therefore, you might argue that the exhibition with interactions does not reflect these keywords more than the exhibition without interaction. This is however not the case, and this is due to the shortcoming of using a word cloud. As can be seen in the coding list in Figures 7.2.3 and 7.2.4, the word 'culture' is mentioned by every participant from group A while only 6 participants have mentioned 'culture' in group B. The same goes for the word 'fabric'; 8 participants have used the word fabric to describe the artworks in Group A and only 4 participants have used it in Group B. Therefore, by looking at the coding list you can see that words like 'culture' and 'fabric' are better reflected in the exhibition with interactions. It also shows that almost all participants of group A had roughly the same main idea of what the artworks reflect and were divided in the details, whereas in group B there was already more division on what the main idea is.

<input type="checkbox"/> Culture	●	Manage Groups +	10
<input type="checkbox"/> Sounds	●	Manage Groups +	10
<input type="checkbox"/> Fabric	●	Manage Groups +	8
<input type="checkbox"/> Suriname	●	Manage Groups +	7

Figure 7.2.3 Part of the coding list of Group A (interaction)

<input type="checkbox"/> video	●	Manage Groups +	7
<input type="checkbox"/> culture	●	Manage Groups +	6
<input type="checkbox"/> brochure	●	Manage Groups +	5
<input type="checkbox"/> patterns	●	Manage Groups +	5
<input type="checkbox"/> fabric	●	Manage Groups +	4

Figure 7.2.4 Part of the coding list of Group B (no interaction)

Thus, based on the analysis done by coding and utilizing the word clouds. It seems that the virtual reality exhibition with all the interactions represented a narrative of Maroon better in the artworks than the virtual reality exhibition without the interactions. Therefore, it seems that the exhibition achieved its main goal. As mentioned before, we cannot take this as a full conclusion because of the sample size. However, the exhibition leans towards representing a narrative of the Maroon more than a regular exhibition. Therefore, this is important to do more research into this field.

7.2.4 User experience

After having concluded that it seems that the virtual reality exhibition represents a narrative of the Maroon in the artworks better than a regular exhibition, it is important to look at how the user experience could be improved. This is done based on the results of the interview and observations, see Appendix E for every point the participants made.

Favorite part of the exhibition:

To start it is important to know what the favorite part of the exhibition is. With this information, we can know where the success of the exhibition comes from and therefore which things do not remove. Most of the people in group B, which didn't have the interactions, said their favorite parts of the exhibition were being able to walk around in virtual reality and see the paintings. They also mentioned that the video was interesting for them. One person also mentioned that it was interesting to see the depth of the fabrics in the paintings. Most of the people from group A said that they liked the spatial sound that relates to the material the most and that they liked being able to walk on the paintings. Thus, from this, we know that the spatial sounds relating to the material; walking on the paintings; the video and being in virtual reality were the favorite parts and therefore key to the success of the exhibition.

The most frustrating part of the exhibition:

It is also important to know what the most frustrating part of the exhibition is so this can be changed for future work. The main point from both groups was that the movement was disorientating. Therefore, for future work, using different movements than the joysticks to walk and rotate should be explored to decrease this frustration. Other main points were that the audio was too low, and the paintings were often blurry in virtual reality. The blurriness in virtual reality was a big frustration, especially for people who could not wear glasses when using the virtual reality headset. Therefore, in future work, a solution could be found so people with impaired vision can still use virtual reality and a solution could be found to increase the quality resolution in virtual reality. The last thing to note is that one person got stuck into the wall of the exhibition, which was a frustrating moment of the experience. Therefore, for future work, the exhibition spaces should be tested on these glitches, so they can be prevented.

What would you change about the exhibition:

To make the exhibition more user-friendly the question was asked what they would change about the exhibition. Most of the people in group B said that they would change nothing. However, some participants wanted to have more information about the painting (e.g., title, year). This is a valid point because no text in the virtual reality exhibition says this. group A was divided in their answers because some wanted to have the video at the start while others at the end. However, the video placement might need to be changed because a several participants wanted to change it. Some people wanted to have it at the start to give additional information about the paintings, while others wanted to have it at the end. Other points that were made in both groups was that the exhibition should be longer and with different artworks. For now, only one type of artwork was used, because it made it easier to tell the narrative, however for future work this could be interesting.

Observations:

The last part of evaluating the user experience was based on observations. These observations helped a lot in determining if the interactions were intuitive and if the full user scenario was done. The results will mainly focus on group A with all the interactions because the most important thing is to see if all the interactions were successful. From group A, 9 participants noticed the indicator for teleportation directly, and they stepped on it so they could be teleported. All the participants found the sound triggers and 8 participants went past all the audio clips. So, the majority found the main interactions intuitive, and it worked well. There was a difference in how people went through the exhibition, some participants waited for more than 10 seconds for each audio clip while others instead watched the video for a long time. There were also some participants who came back to the video in the end and linked the sounds directly to the material. Thus, from the observations about the interactions we can conclude that the interactions were intuitive, however, there is a difference in how people go through the virtual reality and how well they connect the sounds to the material.

Apart from the interaction observations, there were also observations made about the avatar that was chosen. The chosen avatar has a green glow which can only be noticed if a person is standing close to the wall. However, when a person is standing close too to a painting it gets a green glow. This can interfere with the user experience because they cannot see the full painting correctly. Thus, from this observation, we can conclude that the avatar that will be used in the virtual reality exhibition should be altered.

8 Discussion

After having stated the results, it is important to describe the significance of the result and recommendations for continuing this project. It is also important to describe the limitations of the user study because otherwise, some conclusions will be susceptible to faulty interpretations. Therefore, the discussion chapter will first go over the significance of the results which gives a recommendation about future work and then the limitations.

8.1 Significance of the Result

The main result regarding the project's goal is that people who experience the full virtual reality exhibition learn more about a narrative of the Maroon culture than people who are experiencing a regular exhibition of Remy Jungerman. On top of that, people are spending more time in the virtual reality exhibition with interactions than in the regular virtual reality exhibition. This implies that by walking on the paintings and hearing the materials' sounds in virtual reality, the narrative is represented better than in a regular exhibition. It is very interesting to see the difference in outcome based on the experience because by people being immersed in the world of the painting by walking on it and hearing, people seem to have a much clearer understanding of the main narrative. Therefore, by creating an immersive experience through sound and interaction, virtual reality can be utilized to learn about narratives of cultures and artworks.

This knowledge is very meaningful for different fields. Starting with art, by utilizing this people get more interested in the artworks by knowing the narrative and experiencing the art. This will allow the visitor to create a connection with the artwork which makes the artwork richer for them. On top of this, by having this experience of interactions and sounds people seem to engage longer with the artworks. Therefore, by using this experience as an artist, you can have the visitors engage longer with the artworks and therefore create more meaning.

For underrepresented cultures, this knowledge is also really meaningful. By actively engaging with culture through a virtual reality experience with interactions and sounds it seems that people learn more about the narrative than by only reading or watching a video about it. For this reason, this knowledge can be utilized to represent the narratives of cultures in art and other fields.

Lastly, this knowledge is also very meaningful for virtual reality exhibitions. Suppose you compare the product to an existing virtual reality exhibition from background research. In that case, you can see that some utilize the function of going into the painting and hearing sounds when looking at parts of the painting. However, when you come onto the painting and hear sounds depending on the material, it creates a more immersive experience where the narrative of an artwork can be represented. Therefore, future virtual reality exhibitions can make use of this knowledge to represent the narrative of their artworks and make it a more immersive experience.

The results of the user experience questions are also very helpful to look at what made this added interaction work and things that need to be improved.

The most surprising thing about virtual reality exhibitions is how well the sound clips work. Many of the participants mentioned that the sound helped a lot with the connection to the culture and meaning of the artwork. This was not expected because the sounds were gathered from online documentaries of the Maroon culture and were not from the artist itself. However, due to the high quality of surround sound of the virtual reality headset and the sounds being from the Maroon culture, it created the experience as if the visitor was there. Thus, from this, a conclusion can be taken that the usage of sound in virtual reality can contribute in a major way to creating an immersive experience.

On top of this, an intriguing thing was that almost every participant who did the full interaction noticed the teleporter indicators and the sound clip indicators. This made the exhibition intuitive for the visitor because when interacting with these indicators, they learned how the teleporter and sounds worked. This resulted in, that the visitor could explore the exhibition himself and didn't need much explanation beforehand.

A thing that did not work as well as expected was the movement in virtual reality. The movement of walking with your left joystick and rotating with your right stick was often disorientating for the participants. Some measures were taken to make the movement better before starting the first user tests: letting the visitor turn in increments instead of smoothly and incentivizing them to rotate in real life rather than with the controller. However, it was still disorientating for the visitor. Therefore, other ways of movement need to be found to improve the experience.

Lastly, looking back to the project's goal, of representing a narrative of Maroon culture through a virtual reality art exhibition, it is important to assess whether this is achieved. By looking at the results of the evaluation it seems that the goal of the project is achieved because the participants with the full virtual reality exhibition learned more about the narrative of the Maroon represented in the artworks than the participants with a regular exhibition. If then taking a look at the product specification, the virtual reality exhibitions fulfill almost all the measurable specifications that the product must have and should have. The only specification that the product should have had was an introduction video at the start explaining the possible interactions in the exhibition and controls in case there were more than 5 lines of explanation. This was left out of the exhibition in the realization because the full explanation was a bit over 6 lines and it could interfere with the existing video. Other requirements that ended up not in the exhibition were the 'could have requirements'. These requirements were meant as possible improvements to the exhibition in case there was time left. The project was, however, focused on making the exhibition adhere to the main requirements and make everything work properly. For this reason, these are not included. Thus, the project achieved its main goal and fulfilled most of the measurable requirements.

8.2 Limitations

The results of the evaluation point to that the virtual reality exhibition represents a narrative of the Maroon culture better than a regular exhibition. However, there are some points of limitations in the evaluation which could cause faulty interpretations. Therefore, it is important to lay out the possible limitations of the study to make sure the results will not be overgeneralized.

The first limitation of the user study is the number of participants. Both groups A and B had 10 participants which makes a total number of 20 participants. This number of participants is not sufficient enough to take full conclusions because it is not a big enough sample to represent the population. Therefore, the results are pointing to a possible conclusion instead of taking it as a definitive conclusion.

The second limitation has also to do with the participants. The way the participants were recruited was by sending an interest form in the studies group chat, sending the interest form to friends, and spreading posters around campus. This resulted in a good number of participants already having familiarity with technology because they attend technological studies at the university. Even though most of them have not used virtual reality, they might have already been more familiar with how to move and interact in a 3d space. On top of this, these students might have less familiarity with art than people from other fields. Therefore, the sample might not represent the population of all adolescents between 18-24 perfectly. This thus needs to be taken into account when making conclusions from the results.

The third limitation of the user study is that the gender of participants is not asked during the evaluation. I had decided to not ask the person's sex because its sensitivity could lead to the person not wanting to answer that and maybe answering less openly in other questions. However, a person's sex plays a significant role in how susceptible somebody is to virtual reality sickness. This is because women are 40% more susceptible to virtual reality sickness [32]. This, therefore, has a big impact on the experience and therefore it has a big impact on the results. The observations mention if a person got virtual reality sickness to gain more insight into the affected experience. However, because based on gender the experience could be influenced, it should have been asked in the demographic questions.

Another limitation of the user study is the way the participants were randomized. As mentioned in the evaluation methodology, at the start of each 10 participants a coin will be flipped to determine to which group the first person belonged. After that, each person will alternate between groups until there are 5 in group A and 5 in group 5. However, this only happened in the second group of 10 participants. The first group of 10 participants had on the first day 4 people in Group A and 1 in Group B, and the other way around on the second day. This was done to see if the virtual reality exhibition with all the functions worked well at the start of the week. However, this can influence the results due to changes in conditions between the first and second day, and therefore it is important to be mentioned and considered this when taking conclusions from the results.

The last limitation is the possible bias when analyzing the results. The way the results of the interviews were analyzed was my first cleaning-up transcript. The transcript of Microsoft Teams had errors in some interviews, therefore the manual transcription that was made during the interview was mostly used. The transcription of Teams was used to correct the phrasing and add information in case this was not written down during the interview. After this, it was time to do the coding of the words according to the set rules. This was done by assigning each new keyword per participant with a code and ending up with a list of codes and word clouds that are represented in the results. During the cleaning up of the transcription, there could be some bias and human error, because the transcript of Teams had with problems some responses, and therefore mainly transcription during the interview was used. However, this bias was not that big, because most of the manual notes lined up perfectly with the Teams transcription in case it worked well. There could be also bias during the coding because I have to decide which keywords are unique and which keywords belong to the same coding group. Therefore, there could be a bias there, however assigning the keywords to the code was done as unbiasedly as possible. Thus, the bias during the cleaning up of the transcription and coding could have led to slightly different results. Therefore, it is good to keep this in mind when taking conclusions from the evaluation and for future research a more neutral coding can be used to minimize the potential bias for coding.

9 Conclusion

The goal of the project was to create a virtual reality exhibition that represents a narrative of the Maroon culture through the links present in the artworks of Remy Jungerman. Art has extremely important in our society, however, until recently, Dutch colonial history was mainly represented from the white Dutch elite's perspective. This gives a skewed perspective and therefore museums try to include exhibitions to represent other cultures which in the past were not represented. However, exhibitions run out after a while which means there is no representation of the culture anymore. Therefore, a new way of representing a narrative of culture in art needs to be found. For this reason, the project tries to represent a narrative of the Maroon culture in artworks by using a virtual reality exhibition.

To do this it was first important to do background research based on the research sub-questions. The first sub-question was about what the narrative of Remy Jungerman's artworks is and how they represent the Maroon culture. To answer this question research was done by looking at existing interviews, reading documents, and having a direct interview with him. This gave the required knowledge of how the Maroon culture is represented in his works and therefore also what needs to be represented in the virtual reality exhibition. The second sub-question was about how stories can be told through art expositions. This sub-question was answered by doing a literature review on this topic. The result of this literature review was that there were two main methods of telling a story in art exhibitions. These were by using audio to tell the story and by using the theater model which entails telling a story due to interactions with media. Knowing this gave insight into how to tell a story in art exhibitions. Therefore, it also gave insight into the methods of storytelling that can be amplified using virtual reality which was used to represent a narrative of the Maroon culture in the virtual reality exhibition. This brings us to the last research sub-question which was about how virtual reality can be used to give added value to art exhibitions. This question was answered by doing state-of-the-art of current virtual reality exhibitions. From this state-of-the-art, a lot of knowledge was gained on how virtual reality can be used for art exhibitions and therefore served also as an inspiration for the interactions and design of the virtual reality exhibition. The state-of-the-art research was used as an inspiration for creating the interactions of zooming in, going into the paintings, and using audio in the virtual reality exhibition. The state-of-art research also showed that the goal of creating a virtual reality exhibition that represented a narrative of cultures was novel and therefore this graduation project was worth pursuing.

After obtaining the required knowledge in the background research it is time to start the design phase of the project. To make sure this design phase went well a methodology chapter was created which described the iterative phases of the design process the project would take, these were: ideation, specification, realization, and evaluation. After describing the methodology, it was time to start the design process by creating the concept for the virtual reality exhibition in the ideation phase. This was done by multiple brainstorming sessions which resulted in 3 different concepts. These concepts were shown to the supervisors and the client and based on their feedback one of the concepts was chosen as the final concept. The final concept is that in a virtual reality exhibition, the user can go onto the paintings and walk on them, if the visitor is standing on a material, they can hear sounds

relating to that material which will represent a narrative of the Maroon in the artworks. When the visitor comes back out of the painting, they can see the video which ties the audio and materials together with visuals to represent a narrative.

Based on the final concept it was now possible to create a well well-defined envisioned product and to develop the preliminary requirements into functional and non-functional requirements, which was done in the specification phase. This was done by first analyzing the target users which are adolescents, people who visit museums, and people with physical disabilities. Each group had their own requirements for the virtual reality museum. After analyzing the users, it was also important to describe the user scenario to get to know every requirement which is necessary to facilitate the envisioned experience. After this, based on multiple small prototypes, the specifications of the virtual reality exhibition and the interactions were stated. This is to create a well-envisioned product that in the virtual reality exhibition can be realized. To conclude the specification, the requirements based on the users and the envisioned product were listed and ordered amongst importance. This served as a guide for realizing the virtual reality exhibition.

The next step was to create the virtual reality exhibition in the realization phase. This was done based on the requirements and the envisioned product in the specification phase. In the realization phase, different decisions had to be made and justified to create to achieve the goal as best as possible and to make it user-friendly. An example of these decisions was: how the interactions should work and how the virtual reality should look. The realization chapter therefore also explains how the virtual reality exhibition was made by going over every aspect. The result of the realization phase was a virtual reality exhibition in which the user could walk onto the paintings, explore different sounds related to the material and go back to a video to see the visuals of the sounds which represent a narrative of the Maroon.

To see whether the goal of the project by the created a virtual reality exhibition a user evaluation was carried out. To see if the created virtual reality exhibition represents a narrative of the Maroon in the artworks, the 20 participants were split up into two groups. Group A experienced the full virtual reality exhibition with all the interactions, and group B experienced the virtual reality exhibition without the interactions. Each participant was timed for how long they were in the virtual reality exhibition. Afterward the experience, an interview was held to ask questions regarding what they thought the artworks represented and what their opinion on the experience was. The data from the interview was analyzed using a content analysis method. The results of the evaluation are that it seems that participants going through the full virtual reality exhibition with all the reactions learned more about how the Maroon culture is represented in the artworks of Remy Jungerman. On top of that people are spending more time in virtual reality exhibition will at the interactions and therefore are more engaged with the artworks. The results from the user experience are stating that the sound and walking onto the paintings were their favorite part and helped them the most with understanding the narrative. The main point of improvement was the way you move around the exhibition should be changed because now it can be disorientating.

The results which came from the evaluation entail that it seems that people learn a narrative of a culture better through the interactive virtual reality exhibition than through a virtual reality exhibition without interactions. Therefore, by using a virtual reality exhibition, a narrative of a

culture can be represented in a better way, and it can be more accessible because virtual reality exhibitions don't run out. This can give more insight to visitors into cultures that were underrepresented in the past. By learning about these cultures people will change their behavior towards them which results in fewer ethical divisions in our society [35].

The results of the evaluation also have significance in the way art is presented in the future. Artists might also utilize virtual reality art exhibitions more because the narrative of artworks can be better represented and therefore visitors create a deeper connection with the art. Thus, by the use of a virtual reality art exhibition, the narratives of an artist and culture can be better represented. This could help fix the skewed perspective which is presented in museums for centuries and therefore give more understanding of cultures and artists which were underrepresented in the past. Thus, by using virtual reality exhibitions, the narratives of artists and cultures can be represented; therefore, it can be a pivotal tool in the future to create a more complete perspective and to help to prevent ethnic divisions in society.

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Appendix A: Informed Consent

VR Exhibition: Reflecting the stories of the Maron through virtual reality art exhibition

Dear reader,

In this letter, we would like to inform you about the research you have applied to participate in. This research focuses on a Virtual Reality (VR) exhibition created by the researchers which displays the works of Remy Jungerman, a Surinamese artist who creates unique pieces to tell stories and display feelings of the Maron culture and traditions. The goal of this research is to test and evaluate if the design choices in building the VR environment enhance the user experience in line with the researcher's questions. As a participant, you will interact with the system by equipping a VR headset and walking around the virtual exhibition. During the process, the researchers will take notes on observations.

After the interaction, you will be asked a series of questions related to your experience. In particular, you will be asked questions regarding what kind of story you came across during the VR exhibition. This is to examine whether the VR exhibition conveyed the story which it intended to tell.

Your participation is and will remain voluntary at all times and you can withdraw from the research and end your participation at any point during the research. You can also withdraw from the research after you have initiated it, within 24 hours of the starting point. During the experiment, we will observe your interactions with the system and take notes on it. After the experiment, you will be asked a series of questions, where your answers will be both recorded (audio recording) and written down. No Personally Identifiable Information will be gathered. The information gathered will consist of age, occupation, and responses to questions.

Since this research deals with VR, there are possible risks involved. If you have had previous experiences with VR in which you experienced any sort of motion sickness, dizziness, or any side effect, we advise you not to participate. If you choose to participate, the researchers will monitor you (the participant) during the whole duration of the experiment. If you still experience any sort of sickness, you are free to back out of the experiment at any time and the researchers will assist you if necessary.

Yours sincerely,

Research leader:

Jesper Hoogenkamp
Email: j.n.hoogenkamp@student.utwente.nl

Research assistant:

Lilly Stelzer

Email: l.m.stelzer@student.utwente.nl

Felipe de Andrade Ramires

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Coordinator:

Carolien Rieffe

Email: c.j.rieffe@utwente.nl

Informed Consent

"I hereby declare that I have been informed in a manner which is clear to me about the nature and method of the research as described in the aforementioned information brochure. My questions have been answered to my satisfaction. I agree with my own free will to participate in this research. I reserve the right to withdraw this consent without the need to give any reason and I am aware that I may withdraw from the experiment at any time. If my research results are to be used in scientific publications or made public in any other manner, then they will be made completely anonymous. My personal data will not be disclosed to third parties without my expressed permission. If I request further information about the research, now or in the future, I may contact Jesper Hoogenkamp."

If you have any complaints about this research, please direct them to Jesper Hoogenkamp, email: j.n.hoogenkamp@student.utwente.nl.

Signed in duplicate:

Name subject

Signature

I have provided explanatory notes about the research, I declare myself willing to answer to the best of my ability any questions which may still arise about the research.

Name researcher

Signature

Appendix B: Information brochure

Information about Remy Jungerman's Artworks

Remy Jungerman (1959) was born in Moengo, Suriname. His mother was a descendant of the Bakabusi people known as “the people behind the forest”, who escaped enslavement under the leadership of the Granman, the paramount chief, following a fierce battle with colonizers.

To honor his mother's culture, that is Surinamese Maroon culture, Jungerman has since devoted his practice to its exploration. Jungerman makes connections between Surinamese Maroon culture and 20th-century modernism, with the geometric patterns of traditional textiles playing a key role. Finding these connections and juxtaposing materials and imagery drawn from different cultures are part of his efforts to find an autonomous visual language that does justice to the cultures of the countries and regions that define him: Suriname, the Netherlands, West Africa, and the United States

The virtual reality exhibition is focused on showing the grid works of Remy Jungerman. The grids referenced the geometric motifs found in fabrics worn by the Maroons, among others, during Winti (the religion of the Maroon) rituals. The grids are also covered in kaolin, a fine white clay material mined in Moengo and used in Winti as a purifying agent. An additional layer of meaning can be found in the geometric layout of the colonizers' plantations, which looked like a grid overlay on the map of Suriname. The basic geometric structure is also a link to Western modernism as conceived by artists like Piet Mondrian and Agnes Martin.

Appendix C: Information about the Virtual reality exhibition

Information about the Virtual reality exhibition (this will be read to the participant):

The virtual reality exhibition consists of artworks by Remy Jungerman. You are free to explore the virtual reality exhibition by moving with the joystick on the left controller and looking around with the joystick on the right controller.

Interactions:

By interacting with the paintings, you will be teleported to another room where you can see the paintings up close and explore the painting and sounds that are associated with the painting to get a new perspective on the artworks. There are blue sound markers visualized when going onto the paintings, they give notice where there are sound cues that relate to the material.

Appendix D: Interview Questions

Virtual reality exhibition: Remy Jungerman

What is your age?

What do you think the artworks reflect?

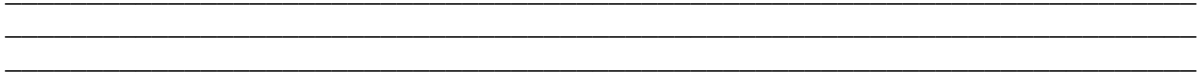
What do you see/experience in the artworks and exhibition that make you say that?

What did you learn about the artist and his works from the virtual reality experience?

What was your favorite aspect of the virtual reality exhibition?

What was the most frustrating aspect of the virtual reality exhibition?

If you could change anything about the virtual reality exhibition, what would you change?



Appendix E: Evaluation Results

Results Group A(interaction):

Age sample:

28, 22, 21, 23, 26, 23, 20, 22, 19, 22

Time:

4:17, 3:51, 6:48, 7:15, 8:31, 9:40

Favorite part:

- [8] The spatial sounds that reflect the materials.
- [5] Being able to walk over the paintings.
- [2] The video
- [1] Being able to see the materials closely.
- [1] Being able to explore a museum from your home.
- [1] The technical parts of how the virtual reality was created.
- [1] The combination of the audio and being on the painting.
- [1] Being able to jump into the paintings.

The most frustrating part:

- [4] The controls/movement, because quite disorientating
- [1] The teleporter is quite high up, which means you fall from a high place.
- [1] you cannot laser point.
- [1] That you couldn't walk into the video
- [1] Blurry vision because you are unable to wear glasses.
- [1] The layout of the exhibition
- [1] The video has too many pictures
- [1] The sound audio was too low
- [1] The meaning of the sound was sometimes unclear
- [1] The paintings were too similar
- [1] You can hear sounds from other materials which interfere with each other.

What would you change:

























- [1] The controls, because quite disorientating
- [1] Make the teleporter lower
- [1] you cannot laser point.
- [1] Change the video location to the start.
- [1] Being able to walk into the video
- [1] The exhibition space, because it feels unnecessary.
- [1] Adding a bit more textures to the paintings.
- [1] Give additional information about the paintings.
- [1] Make the exhibition more interesting with moodier light.









































- [1] Nothing
- [1] Put emphasis on the video
- [1] Change the sounds
- [1] Add other types of paintings
- [1] Once you walk away from the material the sound stops.
- [1] Try to make sure there are no glitches while moving.

Observations:

- [9] Notices indicator teleport
- [8] Goes past all the audio clips
- [4] Waits for more than 10 seconds with each audio clip
- [4] Watches the video at the end once again
- [3] Watches the video for a long time
- [3] Links the sounds to the material.
- [3] Notices that the fabrics are important.
- [2] Came back to the video after the interactions and said 'this ties the whole story together
- [2] Dancing to the drums playing.
- [1] Asking how to teleport
- [1] Trying to jump into the video, but realizes they can't
- [1] Has difficulty with movement.
- [1] Listens to 1 or 2 audio clips per painting

Coding of the meaning of the artworks:

<input type="checkbox"/> Name	Color	Groups	Quotatio... ↓
<input type="checkbox"/> Culture		Manage Groups +	10
<input type="checkbox"/> Sounds		Manage Groups +	10
<input type="checkbox"/> Fabric		Manage Groups +	8
<input type="checkbox"/> Suriname		Manage Groups +	7
<input type="checkbox"/> Drums		Manage Groups +	5
<input type="checkbox"/> Material		Manage Groups +	4
<input type="checkbox"/> Hearing sound related to the textiles		Manage Groups +	4
<input type="checkbox"/> Singing		Manage Groups +	4
<input type="checkbox"/> Feeling		Manage Groups +	4
<input type="checkbox"/> Nature		Manage Groups +	4
<input type="checkbox"/> Video		Manage Groups +	4
<input type="checkbox"/> Tribe		Manage Groups +	4
<input type="checkbox"/> Abstract		Manage Groups +	3
<input type="checkbox"/> People		Manage Groups +	3
<input type="checkbox"/> Rainforest		Manage Groups +	2
<input type="checkbox"/> African		Manage Groups +	2
<input type="checkbox"/> Perspective		Manage Groups +	2
<input type="checkbox"/> Clothing		Manage Groups +	2
<input type="checkbox"/> Traditional		Manage Groups +	2
<input type="checkbox"/> Rhythm		Manage Groups +	2
<input type="checkbox"/> green fabric might mean something with the rainforest		Manage Groups +	2
<input type="checkbox"/> Text		Manage Groups +	1
<input type="checkbox"/> Colors		Manage Groups +	1
<input type="checkbox"/> Water		Manage Groups +	1

<input type="checkbox"/>	Industrial sounds		Manage Groups +	 1
<input type="checkbox"/>	New York		Manage Groups +	 1
<input type="checkbox"/>	Process of creating the materials		Manage Groups +	 1
<input type="checkbox"/>	Greenish-blue fabric.		Manage Groups +	 1
<input type="checkbox"/>	Authenticity		Manage Groups +	 1
<input type="checkbox"/>	Insight into what the culture is like.		Manage Groups +	 1
<input type="checkbox"/>	Message of Suriname in a piece of art		Manage Groups +	 1
<input type="checkbox"/>	Maroon		Manage Groups +	 1
<input type="checkbox"/>	Modern		Manage Groups +	 1
<input type="checkbox"/>	Dancing		Manage Groups +	 1
<input type="checkbox"/>	Community		Manage Groups +	 1
<input type="checkbox"/>	Daily life		Manage Groups +	 1
<input type="checkbox"/>	Religion		Manage Groups +	 1
<input type="checkbox"/>	Removed from society		Manage Groups +	 1
<input type="checkbox"/>	Geometrical patterns of the fabric.		Manage Groups +	 1
<input type="checkbox"/>	Mondriaan		Manage Groups +	 1
<input type="checkbox"/>	Deforestation		Manage Groups +	 1
<input type="checkbox"/>	Wind		Manage Groups +	 1
<input type="checkbox"/>	Blue might relate to something with a car.		Manage Groups +	 1
<input type="checkbox"/>	Experience		Manage Groups +	 1

Results Group B (No interaction):

Age sample:

26, 23, 19, 21, 19, 22, 20, 19, 19, 20

Time sample:

1:21, 1:07, 2:10, 2:00, 4:10, 2:30, 4:11, 3:26, 3:47

Favorite part:

- [5] Being able to walk around in a virtual reality exhibition and see the paintings
- [4] The video
- [1] Being able to see the fabric and its depth

The most frustrating part:

- [4] The movement, issues with walking/turning
- [2] Little explanation about the video and artwork
- [2] Quality of the VR paintings, If you walk closer to the painting the resolution stays the same
- [1] Motion sickness
- [1] The video was lagging
- [1] Not being able to wear glasses.
- [1] The vision was kind
- [1] Being stuck in the wall
























What would you change:

- [4] Nothing
- [2] Create more information texts in virtual reality.
- [1] Make the exhibition longer
- [1] Put the video at the start before showing other artworks.
- [1] Lower the paintings
- [1] Put the video at the end

Observations:

- [9] Watching the video and hearing the music of the video
- [6] Taking some time with each painting
- [3] Goes through the paintings very quickly
- [3] Having difficulty with the movement
- [3] Going first the yellow painting
- [3] Going up close to the paintings to see the details.
- [2] Going back to the video in the end.
- [2] Watching the video multiple times
- [1] Struggling with putting on the VR headset.
- [1] Spending a lot of time per painting, before going to the next one.
- [1] Going back and forth between the paintings and the video
- [1] When first trying gets stuck into a wall.

Coding of the meaning of the artworks:

<input type="checkbox"/> video		Manage Groups +	7
<input type="checkbox"/> culture		Manage Groups +	6
<input type="checkbox"/> brochure		Manage Groups +	5
<input type="checkbox"/> patterns		Manage Groups +	5
<input type="checkbox"/> fabric		Manage Groups +	4
<input type="checkbox"/> abstract		Manage Groups +	3
<input type="checkbox"/> parts of life		Manage Groups +	3
<input type="checkbox"/> Suriname		Manage Groups +	2
<input type="checkbox"/> Dutch		Manage Groups +	1
<input type="checkbox"/> modern		Manage Groups +	1
<input type="checkbox"/> home country		Manage Groups +	1
<input type="checkbox"/> experiences		Manage Groups +	1
<input type="checkbox"/> minimalism		Manage Groups +	1
<input type="checkbox"/> geometry		Manage Groups +	1
<input type="checkbox"/> digital work		Manage Groups +	1
<input type="checkbox"/> Mondriaan		Manage Groups +	1
<input type="checkbox"/> The painting		Manage Groups +	1
<input type="checkbox"/> people wearing similar patterns		Manage Groups +	1
<input type="checkbox"/> juxtaposition form our world to compare to how it was.		Manage Groups +	1
<input type="checkbox"/> colonization		Manage Groups +	1
<input type="checkbox"/> slavery		Manage Groups +	1
<input type="checkbox"/> Surinamese plantages in relation to modern times.		Manage Groups +	1
<input type="checkbox"/> fashion		Manage Groups +	1