Curating with Technology: How to Bring Old Fashion Back to Life in Museum Exhibitions

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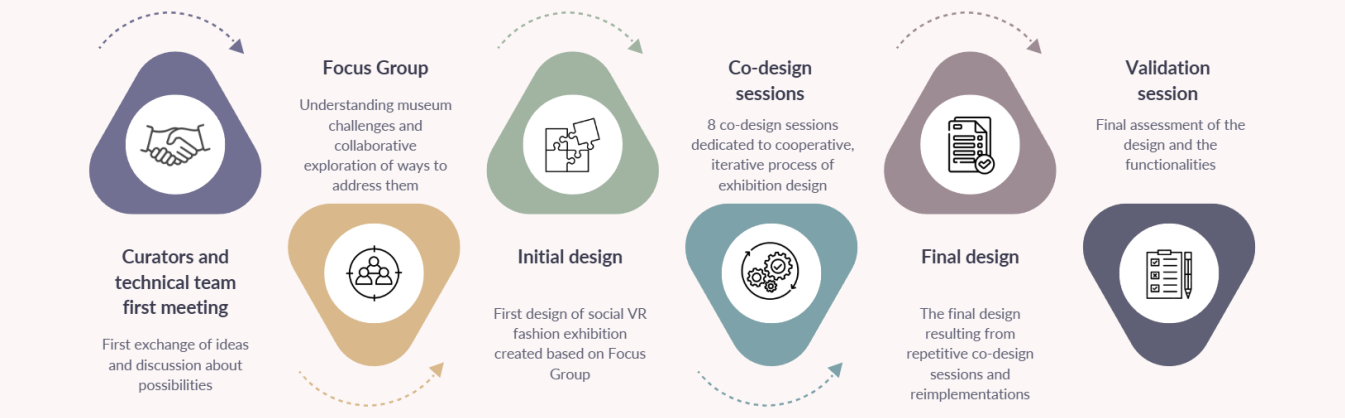

Figure 1: Timeline of the social VR fashion exhibition design engaging curators and technical experts.

Abstract

Social museums, constantly challenged by changing visitors' needs, are beginning to adopt technology in order to enrich guests' experiences. However, designing an exhibition that incorporates digital tools is not easy - it requires a new approach and expertise in both cultural heritage and technology. At the same time, there is a lack of clear guidance on how to effectively design digitally enhanced exhibitions. In this work we follow a human-centric approach, which engages both museum curators and technical experts throughout all stages of the exhibition design. The process, presented in Figure 1, starts with a focus group with curators (N = 4) aiming at understanding the current museum challenges and exploring ways to address them. Based on the workshop results, an initial design is prepared, which is later reiterated during 8 co-design sessions (N = 15). The final design is validated during the validation session (N = 6), resulting in a set of requirements important for social VR fashion exhibition design. The study provides insights for curators into how exhibitions of the future could look like and guidelines on how to design such an exhibition, engaging the technology team throughout the whole process.

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CCS Concepts

• **Human-centered computing** → **User centered design**; **Virtual reality**; *Walkthrough evaluations.*

Keywords

social virtual reality; VR design; exhibition design; user-centered process; social museum

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1 Introduction

In the 20th century, museums underwent a metamorphosis. What changed compared to previous centuries was the primary focus: it shifted from solely conserving and maintaining the exhibits to prioritizing the visitors' needs. During the 1st International Workshop on Ecomuseums and New Museology, held in Quebec City on October 13, 1984, the basis of the concept of a social museum was established. Since then, the museum has become a place of cultural democracy, social dynamism, openness and interactivity [23]. This new approach brought many new challenges, one of them becoming more attractive to visitors. In order to achieve that, the museums need to: become more interactive, fulfill the need of co-production, e.g. by consumer's active participation in the experience, fulfill the need of engagement, e.g. by immersion, and fulfill

the need of personalisation - tailoring the experience to meet user's needs through customisation, interaction and technology [25].

The switch to a social museum was not the end of the institution's transformation. Nowadays, museums have started to use digital technologies to further attract and satisfy visitors, emerging into so-called digital social museums. Digital technologies help create interactive exhibitions and "improve the relationship between the museum and the user" [23], addressing many of the issues social museums have. This study focuses on social Virtual Reality as a technology that can address the above-described challenges by introducing interactivity, thereby ensuring active participation of visitors in the exhibition, enabling access to fragile items, and assuring sociality in the experience. The chosen exhibition topic, historical fashion, can particularly benefit from the interactivity provided by VR. Visitors tend to seek more physical contact with fashion artifacts than with other objects, as clothing is among the items we keep closest to our bodies. This creates a more intimate bond and a stronger desire for interaction [28].

To take advantage of the opportunities that social VR brings, a carefully selected approach towards designing the exhibition is needed. Based on the interviews conducted with curators, museums still follow a path of exhibition design, in which they engage a technical team after the whole idea is already developed, hiring them more as "contractors" rather than co-creators. This process may lead to the loss of many potential solutions that could emerge if the technical team was involved in the process from the beginning.

This article presents a new course of designing a digital social exhibition based on cooperation between the technical team and curators throughout the whole process. Moreover, it explores elements that should be included in a social VR fashion exhibition to address the challenges museums face and create a successful museum experience.

Hence, this work answers the following research question:
RQ1: How to design a social Virtual Reality fashion exhibition engaging museum curators and technical experts?

- *RQ1.1: What elements are important in the design of a social VR exhibition focused on fashion?*
- *RQ1.2: How to implement the social aspect together with all benefits coming with sociality into VR fashion exhibition?*

By following a new, human-centered design process that established constant cooperation between experts from both cultural and technical sides, we managed to find out which design elements are crucial for social VR fashion exhibition and what are the best practices while implementing them. This study resulted in the demo exhibition that was presented at IEEE VR 2025 [37].

2 Related Work

To create the exhibition, curators need to take many elements into consideration, from the general layout of the exposition to the smallest details of the objects' presentation. The exhibit consists of two key elements: its physicality and the accompanying information. It is important to bring the visitor close to the exhibit, taking into account both of these attributes - reducing the physical and informational distance between the visitor and the object [14].

2.1 Experience

The physical distance can be minimized by allowing interactions between the object and the visitor. During the visit to a museum, the visitors hope to have the possibility to touch and experience things by themselves. It is not only the interaction with the exhibit that is important. The whole environment should be responsive and able to engage the visitor, increasing the immersion in the experience. The audience should be entertained but also sometimes physically engaged and intellectually challenged, allowing for creativity while exploring the exhibition [14]. There are many ways of implementing interactions and many benefits coming from them. An example of the interaction implementation might be via games adjusted to the topic of the exhibition. Those games can induce in visitors the feeling of achievement while providing entertainment at the same time [9]. An interesting and important case is creating interactions not with the historical exhibits themselves but with objects related to them. Those interactions often make people more interested in the main artifact, at the same time introducing another very important element in exhibition design - context [9].

It is important to mention the significance of the exhibition layout - the way people move through the space has considerable influence on the order visitors watch the exhibits, and hence their interpretation of the exhibition [33] [22]. The research suggests though that the visitors themselves like to have the freedom to decide how they will move around the museum space [14]. One example of how to accommodate the public freedom with curating the story is creating a main path, which will always be followed by the visitors, but will also include sub-paths with small experiences within the main branch, giving more freedom of choice [33]. The space layout can also induce social behaviors in people. For example, some spaces produce an effect in which people re-encounter each other, which makes the museum visit more socially exciting [22].

Sociality has a significant influence on the exhibition experience. The companion of a museum visit has a huge impact on how the individual perceives and interprets the exhibits. Sometimes the interaction with their companions can even determine if they notice something at all [22]. Social presence is proven to increase immersion [15], improve learning [26], boost well-being [30], increase engagement, and help to interact with the exhibits [25]. Some researchers argue that the social component in the museum visit is even more important than any other factor [10].

2.2 Context

The context in the case of a social museum exhibition has many angles. Firstly, the context in the information given around the exhibit - it might be the political or social situation in which the piece was created, or the reference to contemporary times. The visitors are very sensitive to the informational context while creating their opinions and perspectives [14]. Not only what the information is, but also how it is given matters. The narration should be fitted to the museum theme (e.g. patriotic or scientific) so it creates a complete whole and does not disturb the perception of the exhibition [14]. The way the museum space looks like has a huge impact on how much the audience enjoys the exhibition as well and should match the exhibition topic [14]. It also influences the emotions people develop towards the exhibit and the memory retention [32] [7].

Of similar importance are the "additional" objects that are in close neighborhood to the exhibits. They can give an intended meaning to the exhibition, that would not be visible if those objects were not included [22]. Archive materials placed around the exhibit are effective in giving information about it: what was its purpose, how was it used, what materials it is made from and so on. Giving people the context of the times they live in helps them understand the artifacts they look at and their purposes. [24].

2.3 Learning

In the case of passing information, context is only one of many aspects that should be taken into account while designing the social museum exhibition. Firstly, text is not the most effective way of communicating the message. People tend to skip reading panels in the museum, and even if they do, they are often not really attentive to what they read [32]. Adding other visual means (like pictures or posters) and auditory information is not enough. The solution is to introduce a multisensory experience - trying, touching, feeling, hearing and seeing. The information should also be given in a way that encourages visitors to think and use their imagination, which is both: pleasurable and educational [9].

2.4 Fashion artifacts

In the case of fashion exhibitions, it is very important to display the exhibit in an appropriate way. Firstly, it should be possible to see it from all sides - clothes look different in the front and in the back, and to fully appreciate them, visitors need to see the object from all angles [24]. Also, seeing garments from up-close enhances the visitor experience [36] [35]. It not only results in the excitement of seeing valuable objects from a really small distance, but also allows to see details, which is really important, as some garments might look completely different from afar [24]. One element that often restricts visitors from seeing exhibits in detail is the glass around the objects. Getting rid of the glass can strongly benefit the exhibition experience by allowing a better view of the exhibit, avoiding ugly light reflections and creating an increased sense of intimacy between the visitor and the garment [24].

2.5 Social Virtual Reality

Many of the challenges described above can be addressed using social VR. In VR the user can freely manipulate the object, which makes the experience of interacting with clothes more "real". The decision of which part of the clothing to show and how to present it would not need to be taken as the visitor could rotate the piece, disassemble it into parts, put it together, or zoom it in and out.

Another benefit of VR is the possibility to constantly display all of the exhibits. Historic clothes are prone to destruction and need to be regularly taken out of the exhibition for conservation [28]. The VR version of the exhibits would be available all year round. Moreover, it would be possible to show the visitors pieces that are never available to them in the real world because, for example, they are too delicate to be displayed in the museum [26]. VR can also provide interactivity in delivering information.

As social VR experiences are proven to positively influence the relationship between people [12], we can suspect that a social VR museum might have a big impact on building and improving connections between individuals. Moreover, as most people go to museums in pairs or groups [10], creating an experience designed for more than one person would be more fit for the context of their visit.

Figure 2: Focus Group with museum curators.

3 Focus Group

Designing social museum exhibitions, fashion exhibitions and VR experiences have well-established, scientifically proven processes and requirements. However, to our knowledge, no research has yet been conducted on how to create a successful experience combining all of these elements. To define how to do that, a focus group exploring the design process of the Social Virtual Reality Fashion Exhibition was organized. The picture from the focus group is shown in Figure 2.

3.1 Methodology

Four museum curators, out of whom three with a focus on fashion heritage, were invited to take part in the focus group. Based on the literature review, six goals were set to achieve during the workshop:

(1) Learning about challenges that fashion museums encounter nowadays.
(2) Gathering ideas about how we could answer those challenges using social Virtual Reality.
(3) Setting the requirements for the exhibits that should be chosen for the social Virtual Reality exhibition.
(4) Discussion on how to present exhibits and information.
(5) Brainstorming about interactions (user-object and user-user).
(6) Open discussion about all other design elements.

The workshop lasted 2,5 hours and consisted of a short social VR technology introduction and interactive exercises. The exercises were prepared based on the knowledge gathered during the literature review stage. The meeting resulted in ideas written on upfront prepared worksheets and a recording of the discussions. The data was transcribed and analyzed based on Constructivist Grounded Theory [8]. The data analysis mapping is presented in Figure 3.

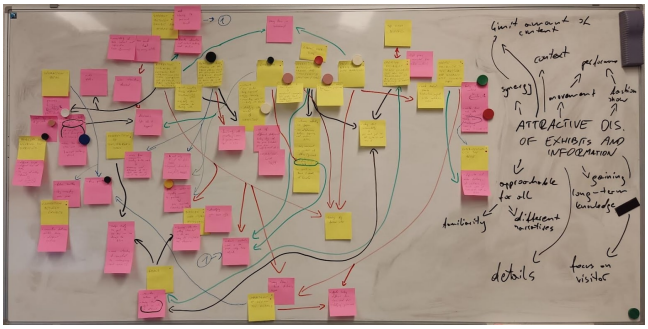


Figure 3: Focus Group data analysis.

3.2 Results

As a result of the analysis, a few concepts important for the research emerged: context, learning, experience, and vulnerability. Two of those - learning and experience - manifested as goals that the museum would like to achieve through the social VR exhibition. Vulnerability was chosen to be the main topic of the exhibition and the requirement in the selection process of the garments.

3.2.1 Experience. During the focus group, many aspects important for the User Experience emerged. Firstly, the synergy between exhibit, information and interactions turned out to be an important topic. Curators were convinced that a good balance and well-designed connection between those three elements can lead to a very pleasant, interesting and easily approachable experience. Also connection between the exhibits turns out to be of high importance. It helps to create a consistent story across the exhibition, which in turn has a positive effect on the whole experience [13] [21].

Another idea that could enhance the experience was creating a performance with the museum objects playing as props. Curators mentioned the possibility of making a fashion show or presenting to the public the "work behind the scenes" - the restoration process that normally happens behind closed doors. One of the experts mentioned an example of the exhibition she saw at the Victoria and Albert Museum in London - "Hollywood Costume"[1]. She mentioned it was an amazing experience as she could see the costumes integrated into the iconic movie scenes, and admire how they are used as props. Both of these examples, the stories and the creation of performance using the exhibits, lead to a very important element that strongly influences the experience - context [1].

Finally, according to curators, the possibility of seeing the exhibits better and interacting with them would have a beneficial influence on the experience. During the focus group, the problem experts often identified was that many museums struggle to be visitor-friendly: they are big, with many exhibits, and hence overwhelming. The way of presenting the objects is often very static and the information is communicated by long blocks of text. The interactivity might provide solutions to those problems: it might break down the routine and make the presentation of the exhibits and information more entertaining. The research already confirmed that interactivity has a huge impact on user experience and users are strongly attracted to the interactive features [31]. However, too many interactive elements can also result in losing consistency and introducing chaos into the exhibition [2]. As already mentioned, it is important to maintain the synergy and good proportions between interactivity, information and the exhibits themselves.

Another issue is crowds in museums. They can cause physical discomfort and irritability, noise and the violation of distance norms that often result in frustration [13]. When the museum is filled with people, it makes it hard to see the exhibits, which can ruin the experience. It is important to provide a good visibility of the exhibit, as it strongly impacts the amount of attention people pay to the object [18]. Moreover, seeing small details that are usually not visible from behind the glass and experimenting, maybe even discovering something about the exhibits, might improve the experience drastically. Those last findings have a significant influence on yet another important for museums area - learning.

3.2.2 Learning. As mentioned above, experience has a significant influence on visitors' learning. Watching a performance is proven to make the audience build interest in the underlying topic and makes gaining knowledge more effective compared to traditional learning methods [16] [27]. According to the literature, performing in the act and taking an active part in creating it is even more effective in sparking curiosity and developing a long-term understanding of the subjects explored in the performance [4] [17]. Using social VR could make taking an active part in historical clothing-related performances accessible for everybody, which, in the physical world, is usually not possible.

Having better access to the exhibits and seeing the details also improves learning. When there are no crowds in the museum, it is easier to investigate the object without feeling stressed out about taking too much time in front of the exhibit [13]. Lack of physical distractions, like noise and limited physical space, also helps to focus on the exhibit. When adding to that the possibility of seeing details that are difficult to spot or even not visible to the naked eye, the interest and possibilities of learning grow drastically.

3.2.3 Context. During the focus group curators emphasized the relevance of context - connecting the exhibits to events, times, locations, stories and contemporary times. Those links should enable visitors to establish emotional connections with the objects. Together with improved experience, the benefit of gaining knowledge appears. Relating the exhibits to contemporary times might improve understanding of past events, help people connect with them and treat them more seriously, which in turn can educate people on how to make (socially) responsible choices nowadays [3].

Context might be introduced to the exhibition in many ways. Let's start with performances that are a perfect opportunity to build context around the exhibit. While creating the performance the authors have the freedom of shaping the environment around the object due to their needs. They have various tools: scenography, props, lights, music, story, and more, that can make the world around the exhibit more authentic and present. During the focus group, one of the curators described a performance-based museum exhibition as follows: "It was like stepping into another world and seeing the garments and how the garments were worn, and how the actors performed into them". She also mentioned an exhibition that

[1] http://www.vam.ac.uk/content/exhibitions/exhibition-hollywood-costume/about-the-exhibition/

took part in Antwerp, in which the movement specialist and dancer worked with old garments to create an accurate fashion show. They studied the garments, pictures and times of the objects, and then replicated the way of walking of people from this period who were actually wearing this type of clothes in their everyday lives. She said it was very impressive to see how different the movement of the body was and how the material movement corresponded to this old way of walking. This is a clear, really interesting example of how the context can be used to show the information about the object that otherwise is difficult to uncover and how much positive influence it has on the experience. It is also important to note the benefit of knowledge retention here - in the end, she still remembers those exhibitions and claims they were one of the best she had seen.

Creating a story is not only achieved by performance. The curators can rely on connections between exhibits that might build the context of events, people and times. This method promotes a deeper visitor engagement with the exhibits, encouraging them to perceive these exhibits as integral components of a broader, interconnected narrative or theme, rather than as standalone items, which in turn positively influences experience and learning [5]. This is also of special relevance for social VR exhibitions, as the technology would allow the use of exhibits that are not placed at the same location but connect together and create a consistent story.

3.2.4 Fashion artifacts and vulnerability. The last, very important conclusion from the focus group workshop is the main characteristic of the garments to be chosen for the exhibition - their vulnerability. Museums own pieces that are so fragile that cannot be put on display or even touched by the curators. Placing these objects in a social VR fashion exhibition not only contributes to the preservation of the fashion and the possibility of showing people the lost garments, but also has high educational value. The garments' models can offer valuable perspectives on the initial structure and appearance of old textiles. This can enrich the understanding and admiration of these artifacts, both among experts and the broader audience, as well as provide a research tool for historians [6] [11].

Vulnerability is also a story itself. Presenting people with artifacts that cannot be touched anymore can convey a sense of transience, showing that objects are also not eternal. There are multiple studies showing that strong emotions are triggered when people perceive vulnerability in other individuals [11]. One could assume that showing the story about the fragility of objects would also cause at least a slight emotional reaction, which is desired to create a better user experience.

3.3 Design requirements

The focus group provided many requirements and important for the experience design elements:

(1) **The exhibits should be connected to each other through a well-curated story.**
(2) **The synergy between exhibits, information about them and interactions should be maintained.**
(3) **Context and interactions should be incorporated for a good user experience.**
Context, based on the results from the experiment, can be introduced using performance, showing elements familiar to the visitors or creating a story. For the interactions, curators listed two types of interactions with the objects: direct (directly impacting the presented piece, like rotation or virtual try-outs) and indirect (more focused on elements around the garments, like games or knowledge quizzes). The idea of virtual try-outs of garments was heavily discussed, however was finally dismissed based on the problem with historical accuracy: people in the 19th century had different height, shape of the body and way of walking. Showing the participants dress from these times displayed around their bodies and saying that is how they would look like in the 19th century would be a lie.
(4) **The way the exhibits are displayed and the information is given should be approachable for everybody.**
To achieve that, the concept of familiarity could be used by, for example, introducing various narratives that fit a broader audience. The curators pointed out the importance of showing the details of the exhibits, introducing context while presenting the object and giving information, but at the same time limiting the amount of content to not overwhelm the visitor. The exhibition should be focused on the visitors and allow them to gain long-term knowledge.
(5) **The scans of real garments should be used.**
Instead of using models created based on the garments, we should use the scans of actual objects. This way the visitors would be given an opportunity to see actual pieces, with all the elements exactly the way they are in the physical objects and curators would gain a chance to further study the artifacts.
(6) **While selecting the artifacts, the priority should be given to fragile objects.**
The objects selected for the exhibition should be (or soon become) too fragile to be physically displayed in the museum, so that by placing them in a VR exhibition we could still show them to the public.

All of those elements have been taken into account while designing the environment. However, during many of the co-design sessions with stakeholders taking part in the project, some of the ideas changed, were adjusted or completely dropped, while other concepts emerged. Nevertheless, many of the elements determined by the focus group were directly implemented into the final design of the experience.

4 Social VR Fashion Exhibition Design

4.1 Methodology

The focus group with curators introduced the background knowledge on what is important in the design of the experience. However, to ensure the best possible outcome, we decided to take a user-centered design approach. During the seven months of the design and development process, eight co-design sessions took place. Their goal was to consult the experts and users at each stage of the design and development process, adjusting the project based on the outcomes of these discussions. A total of fifteen people participated in the meetings in various configurations. Among the participants, there were six curators, four of whom with expertise in fashion exhibitions, an experience designer specialized in fashion, five social XR experts and three users. After the final design was ready,

the validation session was organized. The diagram showing the timeline of the design process is shown in Figure 1.

4.2 Design decisions

The starting point of our process was collecting the exhibits. In the experience, the scans of garments are used, which are not so easily available at the moment. We were limited to choose mainly from the objects that were already scanned. Only a few garments were scanned purposefully for this project to make the story more coherent. Thus, the research to find the themes for the exhibition was based on the garments that were available. After collecting the exhibits and conducting the research the curators working within the project and the designer specialized in fashion created the story connecting all of the collected exhibits into one whole. The scanned garments play the role of star exhibits. They lead the narrative, and other artefacts further expand on the exhibition story. The curators and the designer also shared with us information about the exhibits that could be placed in the social VR experience. An advantage that social VR exhibition has is the freedom to shape the space. Here it is possible to arrange the exhibition rooms in any desired way. There are no physical or financial restrictions; the only limitation is the time that is needed to develop the space. It was decided that the exhibition will consist of three rooms, each of them providing a different context. In each of those rooms a sub-story of the exhibition is told by the artefacts, together creating a bigger and more complex narrative. After creating the space the garments were placed in the rooms. After that, to introduce sociality into the experience, it was integrated with VR2Gather [34] which provides real-time user representation using pointclouds and is designed to run with Unity.

4.2.1 Experience design. The design that was concluded from all of the co-design meetings consisted of a training area and three exhibition rooms. Each of the exhibition rooms introduces a different context in a form of various design styles: a modern museum, a neutral gallery room and a historical room.

For the majority of people, visiting a museum is a social activity. It is important that the virtual museum also allows to visit the exhibition with a companion and fulfills the need for social interaction. Hence, the experience is designed for two or more participants.

After deciding on the general concept, context introduction and sociality of the exhibition, the experience timeline was created. The participants start the visit with a training where they learn how to use controllers to move around and interact with the environment. After getting familiar with the controls, the participants start their journey through three exhibition rooms. The order of the rooms was designed to introduce as little confusion as possible - hence the neutral room is in the middle between the modern and historical.

After the training area, the participants move on and explore the first exhibition room. Here, at the beginning of their path, they encounter a virtual mirror, in which they can see what they look like - for this experience, their virtual bodies are created using point cloud volumetric video, which allows their virtual selves to look exactly like their real bodies. The realistic representation of their bodies positively influences the users' immersion and sense of presence in the environment [34]. After the participants are finished looking in the mirror, they move on to the exhibits' display. There, two garments are shown. The users can closely look at and interact with them. The visitors are also provided with the basic information about the exhibits. When the participants decide that they have already explored the room and want to move to the next space, each of them needs to click the teleportation button assigned to them. This action moves them to the second exhibition room, which is designed as a neutral space. There, similarly to the first room, the visitors explore the space, interact with the exhibit and read information about it. When they are ready to go, one of them clicks the teleportation button and both visitors are moved to the last room - the historical space. Here they once again explore the space, inspect and interact with the garment and get information about it. After finishing those activities, one of the participants clicks the teleportation button and they are moved back to the training area. This is the end of the fashion exhibition experience.

4.2.2 Design of the rooms and interactions with exhibits. The design of the first room, the modern room, was inspired by a real museum, namely the Netherlands Institute for Sound and Vision (NISV) building, and it is based on the design from another project in which our team cooperated with NISV [29].
Two exhibits that are placed in this room are displayed on a wooden background. The space itself is huge and pretty dark, so a well-defined display was needed to make the exhibits well-visible. For the same reason stronger lights are pointing to the two garments. In between them one can find the information display with two interaction panels attached on both sides. The information display contains text with basic facts about the garment and a picture of it. At the bottom part of the display, one can find a button with an arrow, which allows to switch to the next information page (describing the second garment). The interaction panels consist of two rotation buttons, zoom-in, zoom-out and reset, which allow to manipulate the garments. Apart from the exhibition part, the room consists of two other important zones: training and mirror areas.

The second room was designed to have a neutral atmosphere. The colors are maintained in the grayscale, the space does not include any decoration except for the posters related to the exhibition topic. The space visible behind the window was left unchanged from the Unity's default blurred horizon and blue sky, not to disturb the neutrality of the room. The exhibit is located in the corner of the room and is placed on a pedestal. In front of it one can find an interaction panel. The interactions are exactly the same as in the previous room. The information is displayed on a black screen placed on a similar panel as the interaction buttons.

The last room was designed to recall a 19th-century house, as most of the garments chosen to be displayed in this exhibition come from the 19th century. The floor is wooden, the walls are covered with Victorian-era floral wallpaper and the ceiling is decorated with elegant tiles. Around the room one can find many objects from the epoch: a big, wooden wardrobe, a decorative chandelier or a gold-covered clock. One of the more interesting parts is the cabinet containing arsenic rocks. The reason for the presence of this additional exhibit is the history of the dress presented in the room - to achieve the deep, green color of the garment, arsenic was used. Behind the window the panorama shows Amsterdam townhouses. The exhibit is located in the corner of the room on a wooden pedestal. The interaction panel is placed on the wall

next to the exhibit. Similarly to the one in the previous room, it has zoom-in, zoom-out, rotate and reset options. The information about the garment is displayed on a semi-transparent black screen hanging in the air on the right side of the space. The designs of all of the rooms are presented in Figure 4 and the interaction panels in Figure 5.

4.2.3 Virtual museum exhibits. The garments chosen for the social VR fashion exhibition all share one important characteristic: they are very fragile, usually even too vulnerable to be displayed in the physical exhibition. The garments have been scanned using photogrammetry to ensure that they will be perfect representations of the real garments, preserving their exact shape, structure and appearance. All of the garments come from the 19th century, except for one, which was created at the beginning of the 20th century.

4.2.4 Interactions between visitors. There are three types of interaction between visitors in the experience: guided interaction, natural interaction and environment-triggered interaction. The first type, guided interaction, is represented in the experience by the teleportation mechanism in the first room. To move to the next space two of the visitors need to cooperate, as each of them has to click one of the teleportation buttons. Natural interaction is every communication, verbal and nonverbal, that emerges between the users on its own, simply because of the fact that they are in the same virtual space where they can see and hear each other. The last type of interaction - environment-triggered interaction - describes all of the actions the users take together that are directly influenced by the elements of the virtual world. An example of such interaction is trying to adjust the size of the dress by one of the participants while the other one plays the role of a model.

5 Validation

5.1 Methodology

After the design was ready and the experience was implemented, the evaluation session was organized. In this experiment, similarly to the focus group session, there were some participants whose focus lies on fashion (4 people) and some having expertise in different areas (2 people). The session aimed at discussing the design of the environment, the presentation of the objects and information about them and deciding on how to improve the whole experience. The session was divided into two parts. Firstly, the participants tested the experience in pairs. The think-aloud protocol [20] was adapted for this part of the experiment. To address the specific, important issues, some additional questions were prepared. In order not to disturb the experience, the participants were first given time to explore the room and then, before they moved to the next space, the prepared questions (per room) were asked. The questions are shown in Appendix A. For this part of the validation the sound and video recordings of the computer screen showing what the participants were looking at were taken. The reason for that was the need to know what element of the experience the participant was talking about at a particular moment.

The second part of the validation session was based on discussion. Each of the participants was asked what they think about the experience, what they find well-made and what should be improved. After each given opinion, there was a small discussion about the aspect pointed out by the speaker. The discussions were audio-recorded.

After the session the data was transcribed and analyzed using Constructivist Grounded Theory [8].

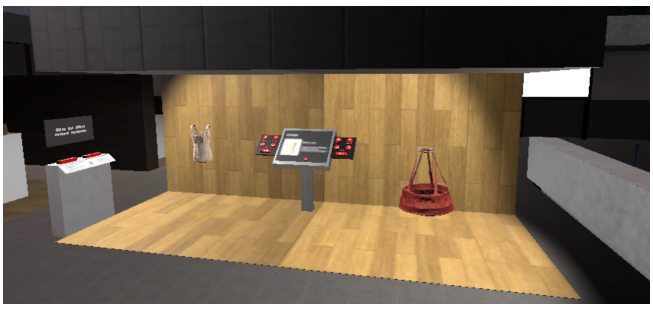
5.2 Results

Overall, the experts were impressed by the design of the experience. They liked the diversity of the rooms, found interactions enjoyable and the whole experience interesting.

The data shows that a key goal for museums to achieve through social VR fashion exhibition is to share knowledge and deepen understanding of the objects and their history. It can be achieved by allowing to present and interact with objects that cannot be presented in the physical world anymore and introducing the possibility of passing information in a more interesting way. However, as the audience is expected to be very diverse, we need to be careful to ensure the visitors pay attention and do not miss the story that the curators want to tell them. Some of the users might be mainly interested in the novelty of the technology and hence focused on the way social VR works rather than the story presented in the exhibition. Other ones can have problems with using controllers which can be disturbing and cause them to miss (part of) the narrative. During the expert validation session a few solutions to this problem have been proposed.

Firstly, synergy has the potential to help attract people interested mainly in the novelty of technology also to other elements of the experience, like, for example, the story. This time the experts mentioned mainly the connection and a good balance between technology, exhibits, narrative, space and room design (aesthetics). All of these elements should be logically tied together creating one whole, in which particular elements do not fight with each other but rather complement each other. The important element - the story - also needs to play by this rule. It is better for it to be simple, but well executed and fitting together with the whole exhibition. While talking about the synergy the participants gave examples of visually connecting the exhibit with the surrounding or adding decorations connected to the main exhibit.

Another solution to the problem of variety in the target audience is keeping the environment, interactions and the story simple. However, there are also some challenges associated with this idea. Firstly, as the curators repeated many times: "Mirroring the real world is a bad idea. You would never have an experience that is better than the real world.". According to the participants we should create something that does not resemble reality - the best idea is going beyond the schemes instead of recreating the actual museum. The problem that appears here is that creating something simple and straightforward, but at the same time creative and out of our world is difficult. Those descriptions even exclude each other up to some level - for some participants being in a weird environment might be overwhelming. It is necessary to find a balance between something simple and user-friendly and something interesting that ensures a great user experience. As it turned out during the experiment, to address this dilemma another approach is needed. The context can be used to gradually introduce the visitor to the virtual world. The visitor should start their virtual museum visit in a room designed to mirror the physical space they are currently in.



(a) Modern room design.

(b) Historical room design.

(c) Historical room design - additional objects.

(d) Neutral room design.

Figure 4: The designs of 3 rooms created for the social VR museum exhibition.

(a) Interaction panel - historical room.

(b) Interaction panel - modern room.

(c) Interaction panel - neutral room.

Figure 5: Interaction panels.

This, according to the experts taking part in the validation session, should allow for a smooth transition from the real to the virtual world. The participants will be able to learn how to interact with the environment in a safe space, without feeling of being overwhelmed. The second room should have context fitted to the topic of the exhibition. This space should already be different from the room in which visitors are physically present, but still pretty normal - something that could exist in the real world. However, some "unnatural" elements are slowly being introduced there, like floating elements or a playful way of giving information. Finally, the third room can feel unreal. During the session the participants gave a few ideas of what this space could look like: "oniric", "crazy", darkness with light just on the exhibits or space without boundaries surrounded by a never-ending horizon. According to the experts, it should make it easier for the visitors to get the full message. As the story and information will be given gradually together with visitors' growing control skills and understanding of the virtual space, they should not be so distracted by the technology or handling the controllers, and hence be able to catch more of the prepared narrative.

6 Conclusion

The presented work results in a workflow for creating digital exhibitions, which engages the museum curators and technical experts throughout the whole process. This ensures that the potential of the technology in the project is fully utilized. The study also provides a list of requirements that need to be met to ensure the exhibition fulfills important for the museum goals: satisfying user experience and successful knowledge transfer to the visitors. The next step is to build the final exhibition based on validation results, present it at the museum for public feedback, and conduct a user study on how contextual elements affect experience, learning, and social interaction. Naturally, this specific exhibition reflects the vision of the curators we worked with; however, the process and methodology are generalizable to other cultural institutions. User engagement will be measured using a questionnaire designed for cultural events, adapted to the context of the exhibition [19].

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A Appendix one

Room 1:

(1) Environment:
  (a) What do you think about the design of the room?
  (b) Is the lighting good? What do you think about colours?
(2) Object:
  (a) Are the exhibits of a good size?
  (b) Are they placed well? (position, direction)
  (c) What do you think about the interactions?
  (d) Are the buttons easy to use?
(3) Information:
  (a) What do you think about the information panel?
  (b) What do you think specifically about its: position in the room, size, readability and appearance?
(4) What do you think about the other objects that are placed in the room?
  (a) Do they fit in?
  (b) Are they positioned well?
  (c) What about their size and appearance?
(5) Navigation:
  (a) Is the moving to the next room mechanism and task division clear?

Room 2:

(1) Environment:
  (a) What do you think about the design of the room?
  (b) Is the lighting good? What do you think about colors?
(2) Object:
  (a) Is the exhibit of a good size?
  (b) Is it placed well? (position, direction)
  (c) What do you think about the interaction panel? Its size and positioning?
(3) Information:
  (a) What do you think about the information panel?
  (b) What do you think specifically about its: position in the room, size, readability and appearance?

(4) What do you think about the other objects that are placed in the room?
   (a) Do they fit in?
   (b) Are they positioned well?
   (c) What about their size and appearance?
(5) Navigation:
   (a) Is it clear how should you go on with your visit? Is the teleportation button well positioned and signalled?

Room 3:

(1) Environment:
   (a) What do you think about the design of the room?
   (b) What do you think about lighting and colours?
(2) Object:
   (a) Is the exhibit of a good size?
   (b) Is it placed well? (position, direction)
   (c) What do you think about the interaction panel? Its size and positioning?
(3) Information:
   (a) What do you think about the information panel?
   (b) What do you think specifically about its: position in the room, size, readability and appearance?
(4) What do you think about the other objects that are placed in the room?
   (a) Do they fit in?
   (b) Are they positioned well?
   (c) What about their size and appearance?
   (d) Is it clear what is shown in the showcase?