Interacting with changing abstract modern art

An interactive Mixed Reality museum experience with Effingham I

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Summary

The design project described in this report explores the use of Augmented Reality (AR) as a way of interacting with abstract modern art in a museum context. The project focuses specifiably on one painting, Effingham I (1967) by Frank Stella (see figure 1), a colour field painting that has undergone visible material changes over time due to the degradation of its pigments, including fluorescent ones. These changes influence the visual impact of the painting and raise questions about how such artworks can be experienced, interpreted, and contextualised for museum visitors today.

The goal of this project was to design and prototype an interactive AR museum experience that allows visitors to explore how changes in visual elements affect the perception of Effingham I, while maintaining respect for the original artwork and its context. This includes the temporal change that happens, but goes beyond that by applying change in multiple visual aspects. Rather than providing information through labels or guided explanations, the experience invites visitors to actively engage with a virtual representation of the painting, layered onto the physical artwork, and to experiment with change in visual aspects that contribute to building up the painting such as colour, shape, depth, fluorescence, and size.

The project followed an iterative research-through-design approach. A literature review and desk research were conducted to establish a theoretical foundation in museum experience design, human–computer interaction, authenticity, and art perception. These insights were complemented by explorative experiments, museum visits, personal observations, and prototyping. The design builds on principles of embodied, tangible, and spatial interaction, as well as the concept of experiential authenticity, to create an experience that fits within the "white cube" environment of a modern art museum while introducing opportunities for interaction and experimentation.

The outcome of the project is an interactive AR experience in which visitors use physical objects and bodily movement to interact with and alter a virtual version of Effingham I, while being provided a voice-over narrative giving background information about the painting and painter. Through this interaction, the experience communicates three interconnected narratives: the temporal change of the artwork, Frank Stella's modernist principles, and the visitor's own exploration of how visual change influences perception.

This project contributes to the field of Design for Interaction by demonstrating how a combination of AR and simple tangible interactions can support reflective and exploratory engagement with abstract modern art in a museum setting. It gives an example of how interactive technology can function as a non-invasive, reversible layer that enhances meaning-making and experiential understanding, while preserving the authenticity of the original artwork.

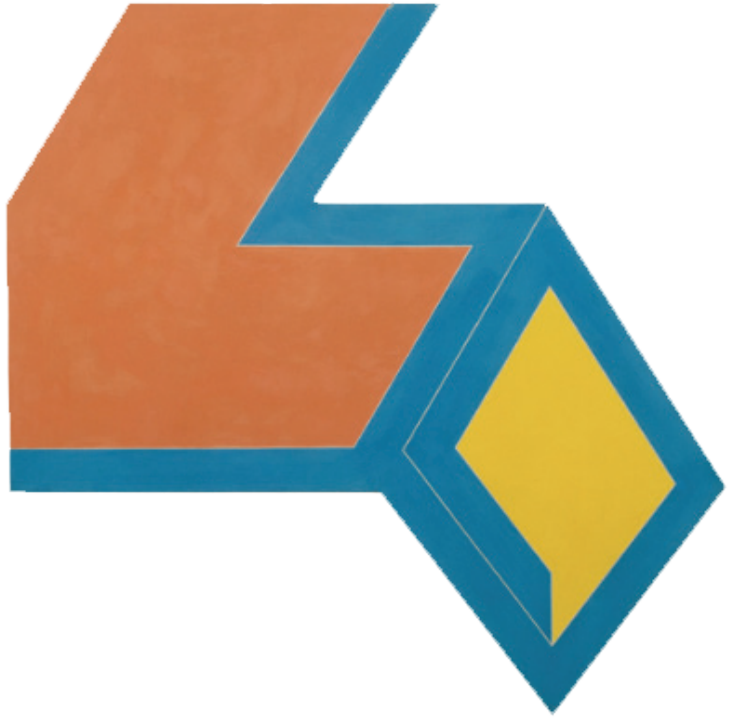

Figure 1: Effingham I (1967) by Frank Stella

Acknowledgements

This project would not have been possible without the support of many people. First of all I want to express my gratitude towards my graduation team, Willemijn Elkhuizen and Sylvia Pont for their support, insights and feedback throughout process. I want to thank Stefanie de Winter for her input, provided knowledge and for her work inspiring this project. I want to express my gratitude towards the XR-zone staff for providing me with the tools and support to work with AR and Unreal Engine, with a special thanks to Jeroen Boots. Furthermore I want to thank everyone who contributed to and participated in the ideation and evaluation of concepts and ideas. A special thanks to my mom and dad for their continuous and involved support throughout this period. Lastly I want to thank my friends Frédérique and Marit in particular, giving me the confidence, support and positivity getting started with, and continuing this project.

Figure 2: Interpretation of the design project, drawn by Jan Roozenbeek (2025)

Glossary

Extended Reality (XR)
Immersive technologies such as Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR).

Augmented Reality (AR)
A technology that overlays digital content onto the physical environment. In this project, AR is used to add a virtual, interactive layer to the museum space while keeping the physical artwork visible and central.

Head-Mounted Display (HMD)
A wearable device that allows users to experience AR or VR content through a headset.

Unreal Engine
A 3D development engine for creating interactive and immersive experiences. In this project, Unreal Engine was used to develop and prototype the AR experience.

Authenticity
A concept referring to the perceived genuineness of an artwork or experience. In this report, authenticity is discussed in relation to both the material artwork and the visitor's experience.

Object Authenticity
Authenticity related to the physical integrity and originality of an artwork.

Experiential Authenticity
Authenticity based on the quality and sincerity of the visitor's experience rather than the material originality of an object.

Temporal Change
The process by which an artwork changes over time.

Abstract Modern Art
Art that emphasises form, colour, and material over representational imagery.

Colour Field Painting
A style of abstract painting characterised by large areas of flat colour. Effingham I by Frank Stella is an example of this approach.

Modernism
An art movement focused on formal exploration and medium-specific qualities.

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Project outline

Origin of the project

This project came into existence as part of an on-going post-doc project from Stefanie de Winter, an art historian exploring aging in Colour Field painting as an art historical problem. With her current project Interdisciplinary Reconstruction of Art project (IRECONA) she is investigating a new type of conservation method using Augmented Reality (AR) (IRECONA | Stefanie de Winter, n.d.).

The project focuses on Frank Stella's Effingham I (1967), a painting where colour degradation is both visible and significant (see figure 3). Especially visible in the fluorescent paints that are used in the painting. There is an opportunity in using AR to digitally revive the painting's original vibrancy, allowing audiences to engage with the artist's intentions and experience the effects of degradation in art. This project introduces new possibilities to interpret and interact with the paintings in AR. This is where design comes into play, to explore interactions between museum visitors, art and (AR) technology.

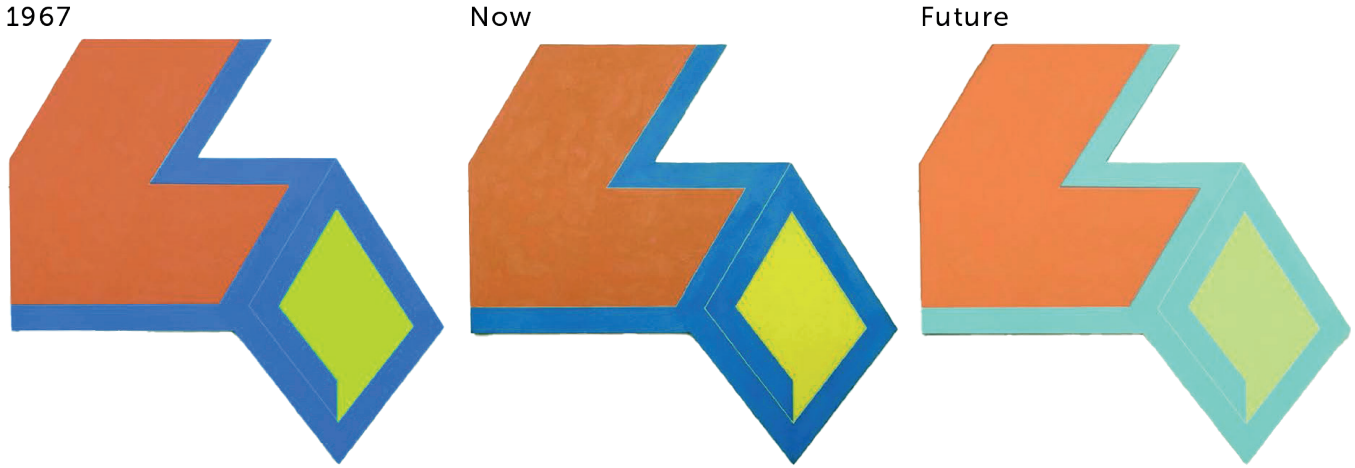


Figure 3: Effingham I in stages of degradation (interpretation), De Winter, n.d

Extended Reality

In this project Augmented Reality (AR) is used to create an experience existing in between the physical and the virtual world. This technology makes use of a pass-through feature (figure 4) , which allows for the real world to be visible with the addition of virtual augmented elements.
The pass-through ability and thus AR experience is instrumental for this project because it allows for the painting and museum environment to remain visible adding an interactive virtual content, not creating an entirely virtual environment but keeping the actual painting and location alive.
To access the virtual elements a head mounted display (HMD) needs to be worn (see Figure 5).
Extended Reality (XR) prototypes for this project are made using Unreal Engine, a 3D engine which allows for the creation of different types of content, including Virtual Reality (VR) and AR projects.

Figure 4: AR pass-through ability, a virtual copy of effingham I visible in the real world environment

Figure 5: Varjo XR-4 Head mounted display, (Varjo Technologies, 2025

Initial design goal

At the start of this project the design goal was:

"To design a Virtual Reality experience to show and inform about degradation of colour field paintings using fluorescent colours for museum visitors in a museum environment."

Throughout the first exploratory part of the project and information collected this goal is later re-envisioned into:

'Create an interactive AR museum experience, showing the effects of changes in visual elements and their effects on the perception of Effingham I'

Project overview

The research-through-design path taken throughout this project is visualized in figure 6. The figure shows the different steps taken and methods used during the project. The first part of the project was dedicated to collecting information and exploring possibilities. This will be described in the **Explore** chapter. The chapter **Define** collects the gathered information and (re)defines the design project and goal. In Chapter **Create** the ideation process and concept development will be explained. The project leads to the creation of a final design, described and validated in chapter **Final design**. The **Conclusion** chapter concludes the project discussing the outcome and providing recommendations for further research or development.

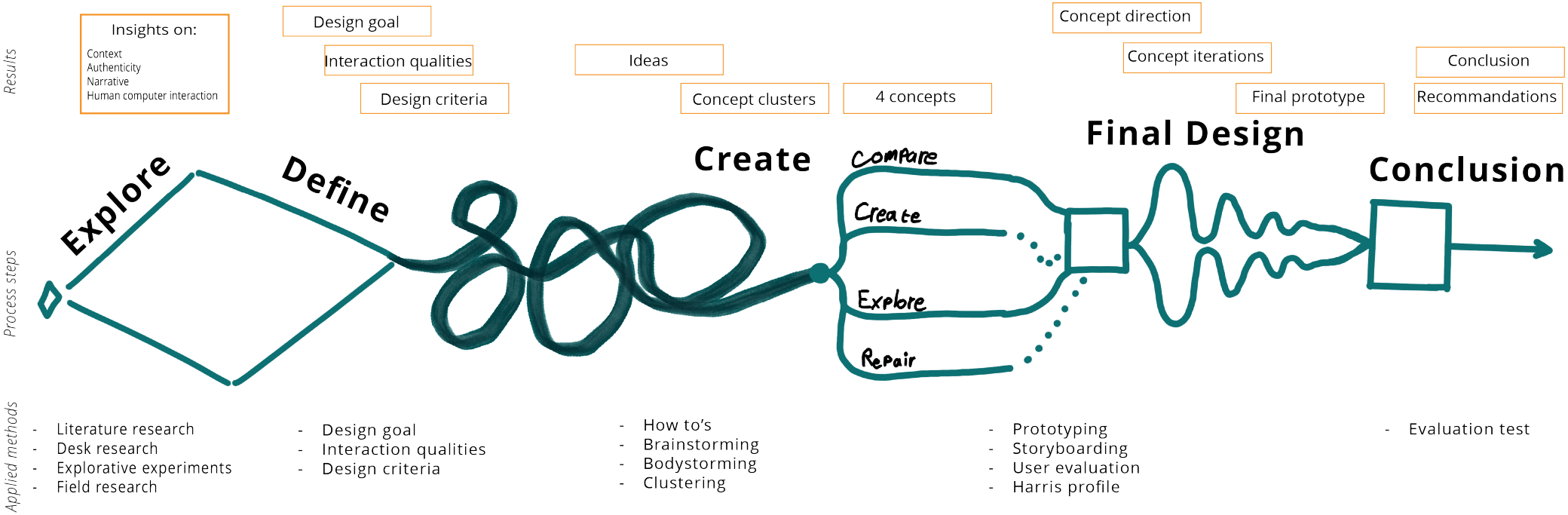


Figure 6: Research and design project journey

Explore

This chapter presents the research and insights from the first exploratory part of the project. Leading towards a redefinition of the design goal, a concept direction and design criteria.

This chapter explores to the following topics and give answer to connected research questions:

The chapter is divided into 4 parts, which together form the knowledge foundation for the creation of an interactive experience. The narrative, The context, Human Computer Interaction (HCI) and Authenticity (Figure 7). All parts are connected and influence each other and together form the bedrock for the creation of the experience.

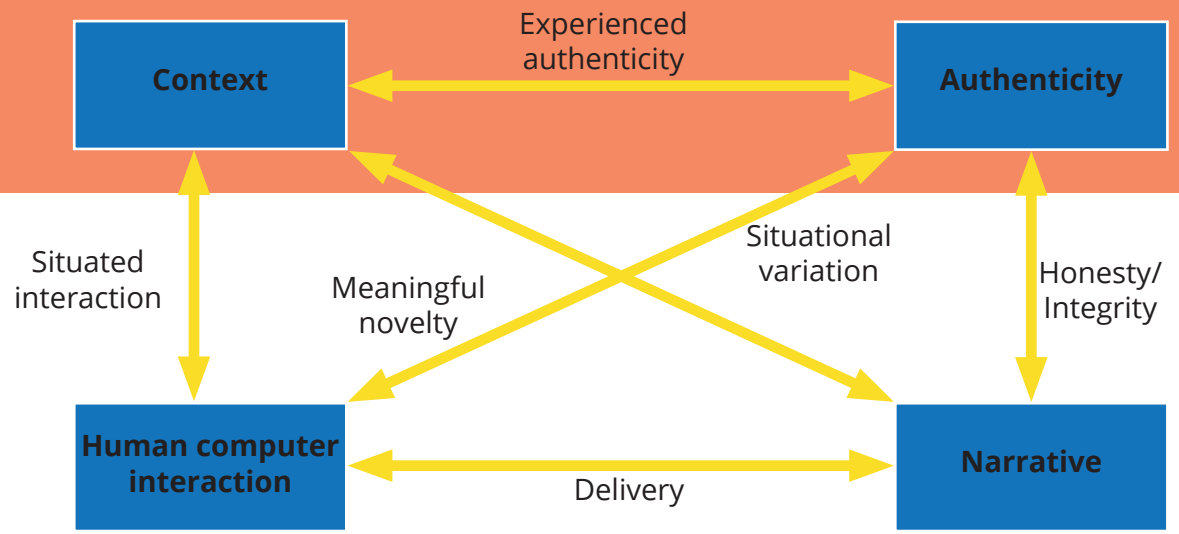


Figure 7: The relationships between Context, Authenticity, Human–Computer Interaction, and Narrative.

The Context part explores the location, people and social context for/in which the experience will take place.
RQ1: What does the museum context (People & environment) look and feel like?

The Human computer interaction section explores the type of interaction possibilities the use of AR enables.
RQ2: How to apply human computer interaction in an AR experience

The Authenticity chapter explores the implications of working with digital replicas of original artworks and the creation of an experiential authentic experience.
RQ3: How to create a sense of authenticity?

The Narrative sections investigate the story to be told surrounding Effingham I and Frank Stella and how to transfer the narrative to users.
RQ4: What were Stella's intentions with his paintings?
RQ5: What narrative surrounding the painting (Effingham I) that could be provided?
RQ6: How to deliver the narrative in the interaction?

Research activities

For the exploration phase, the goal was to gather insights into elements needed to create an interactive museum experience. This is done through multiple activities.

Literature review

A literature review was conducted to establish a theoretical foundation in order to design an AR museum experience and position this within existing research on art perception, museum experiences, XR technologies and connect to the relevant painter and painting. The review focusses on the present museum context, Human computer interaction, authenticity and experiential authenticity and the narrative behind the art and how to deliver this.
Relevant literature was identified through databases including: ACM Digital Library, Scopus and Google Scholar. Search terms combined keywords related terms like augmented reality in museums, human–computer interaction in art, embodied interaction in mixed reality, and HMDs and social interaction. Additional searches focused on museum visitor intention, visitor profiles, and archetypes of art visitors to understand how different audiences engage with museum experiences.
ather than aiming for an exhaustive overview, the literature was analysed thematically, focusing on relevance to interaction design, embodied experience, and museum practice. Insights from this review informed the formulation of design principles, guided early explorations, and provided a theoretical lens for evaluating the final AR experience. The literature review remained iterative throughout the project, allowing new sources to be integrated as the design focus evolved.

Desk research

Alongside the literature review, desk research was conducted to gain additional contextual insights into the background of Effingham I and the intentions behind Frank Stella's work. The reviewed materials include recorded artist talks, lectures, and interviews in which Stella discusses his approach to painting, as well as commentary by art historians and curators reflecting on his work and its place within modernist painting.
Although informal in nature, these materials helped to contextualise Effingham I beyond written sources alone. Hearing Stella and others speak about the work supported a more nuanced understanding of the painting and painter. The reviewed materials include podcasts such as: 'NEA Art Works Podcast (National Endowment for the Arts, 2010), and multiple videos available on Youtube such as: 'Frank Stella: A Retrospective" (Modern Art Museum of Fort Worth, 2016)

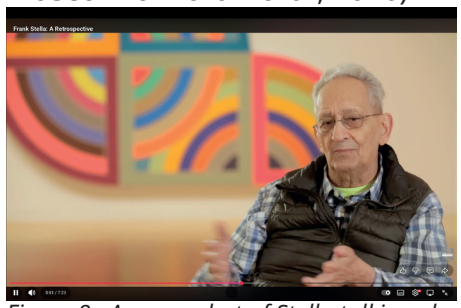


Figure 8: A screenshot of Stella talking about his work, Modern Art Museum of Fort Worth, 2016)

Explorative experiments

To get familiar with aspects of an interactive AR experience a variation of explorative experiments were carried out during the explore phase. These experiments are used to gain a better understanding of the technology and possible design directions. These experiments provided knowledge and a few insights and idea directions into the creation of the interaction.
- Experimenting with temporal changes, giving insights into how to possibly visualize the temporal change in the painting.
- Experimenting with half transparent mirror, exploring the possibilities of augmenting reality in a more physical manner.
- Experimenting with shape, exploring visual properties of the painting and experience how depth and composition play a role in the painting and how playing with the painting can play a role in creating room for contemplation and reflection.
- VR /AR experimentation, providing knowledge and insights into the use of Unreal Engine, possibilities with AR and desired use of the technology.
These activities can be found in appendix B.

Personal observations & talks

A great resource in this project was Stefanie de Winter, providing first-hand information on her research and knowledge of Effingham I and Frank Stella. Providing and validating information and insights collected and created during the project.

To get a better understanding of both the context and the views of people on the painting. During the project 2 museums were visited and insights gathered based on self-observation.
Several people were asked about their thoughts and view on the painting, to get an idea on how people react to the painting and what sparks interest (appendix C).

These activities are used to gain a personal insight into the context and to confirm and enrich literature findings with personal experience.

The context

RQ1: What does the museum context (People & environment) look and feel like?

Since the experience will take place in a modern art museum, it is necessary to understand the characteristics of this context: the visitors, their expectations, and the environment itself. Gathering this knowledge ensures that the experience fits both the existing setting and visitor expectations.

The museum context can be divided into three interrelated components: personal, physical, and social (Falk & Dierking, 2016). According to their model (Figure 9), each context contributes to the overall museum experience, although not always in equal measure. The physical context encompasses the museum's built environment, including its architecture, exhibitions, objects, and any technologies or interpretive tools provided to visitors. These environmental elements shape what visitors can access, how they navigate the space, and the conditions under which the experience occurs.

The personal context refers to the visitor's prior knowledge, interests, experiences, and motivations, which influence how they interpret what they encounter. Each visitor brings their own expectations, preferences, and learning history, resulting in unique interpretations of the same exhibition.

A museum visit also occurs within a social context. Whether visitors explore with companions or simply share the space with others, social interactions, such as conversations, observations, and shared expectations, affect what they notice and how they make meaning. This social dimension therefore plays a role in shaping the experience (Falk & Dierking, 2016).

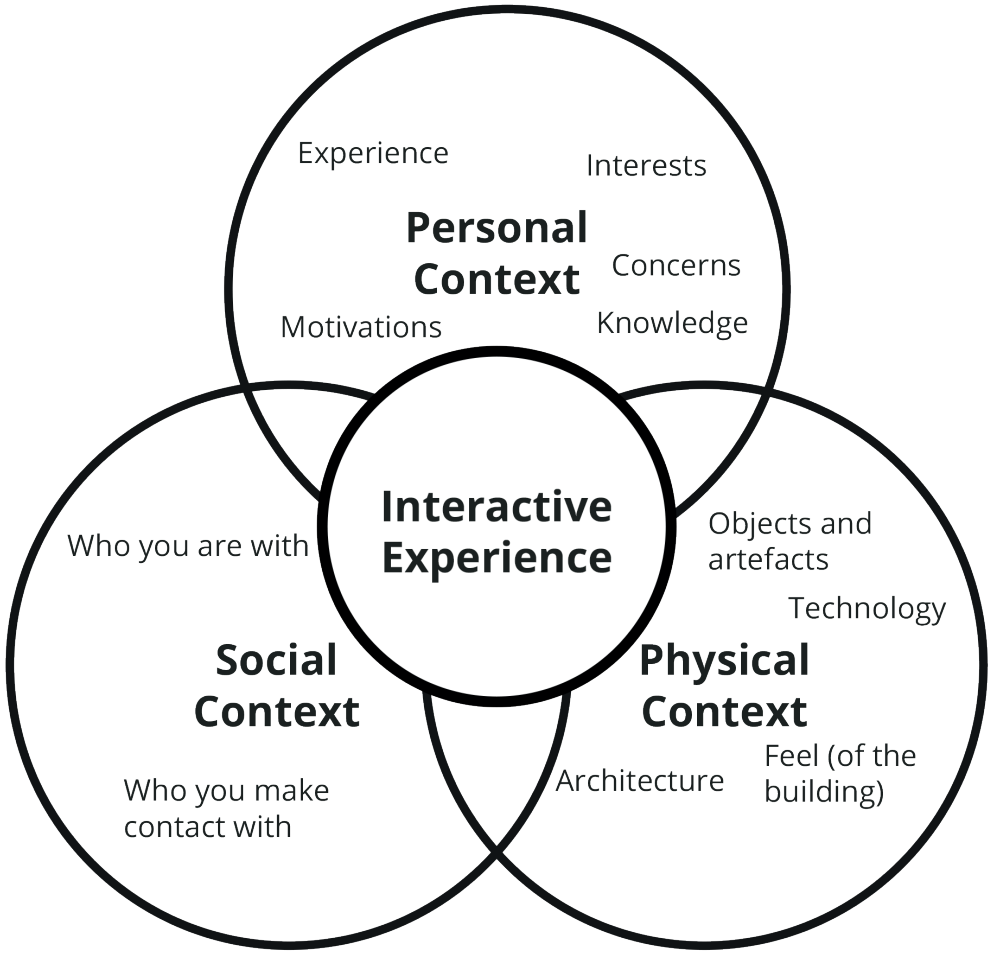


Figure 9: Interactive experience model, Falk & Dierking (2016)

The personal context

Museums attract a wide variety of visitors, all come with their own ideas, history and expectations. It is difficult to describe one user profile which will interact with an experience. Looking at this visitor group, in his research Falk (2009) identified 5 broad visitor types based on the experience they seek:

- Explorers, who are motivated by curiosity.
- Facilitators, who want to facilitate the experience of others.
- Experience-seekers looking for a special experience.
- Professionals and hobbyists who seek to deepen their knowledge or engage in their passion.
- Rechargers, for whom the visit has a restorative or contemplative aspect.

These categories are not mutually exclusive; a single visitor may shift between them depending on mood, context, or exhibition (Hornecker and Ciolfi 2019). In addition, Sheng and Chen (2011) describe visitor expectations in terms of easiness and fun, cultural entertainment, personal identification, historical reminiscence, and escapism.

This implies that the experience should not target one visitor type exclusively. Instead, it would be good to remain flexible, allowing visitors to engage at their own speed and depth and allow them to engage in "free choice" learning, where the visitor has control over what, when, and how they learn, rather than being heavily guided by a structured curriculum or instructor. This is driven by the learner's own interests, needs, and curiosity (Falk & Dierking, 2016). Across all groups, however, two common motivations emerge: the search for enjoyment and knowledge. These are to be experienced in an open a varied setting.

Figure 10: A varied audience with various expectations

The physical context

While every museum has its own character and approach to engaging visitors, certain general patterns can be observed. The type of museum shapes visitor behaviour and creates what Hornecker and Ciolfi (2019) call "behaviour settings", It is tempting to see "the museum" as one type of institution there are different genres of museums (figure 11). These types of museums tend to look different and have a different base of visitors; furthermore, expectations of visitors of what to expect and how to behave Hornecker and Ciolfi (2019). Since this project is situated within a (modern) art museum, the relevant setting is the so-called "white cube" environment.

In this context, artworks are typically displayed in isolation, meant to be observed from a respectful distance. Visitors have learned that art is precious and fragile; it should be observed quietly but never touched. As a result, behaviour in art museums often resembles that of a church: people move slowly, pause to look, and remain silent so as not to disturb others (Hornecker and Ciolfi 2019).

A visit to Kunstmuseum Den Haag and Escher in het paleis, provided additional insights and confirmation of this "white cube" environment from personal observations. What seemed true for both visits was the relatively silent, serious and contemplative environment. Relatively empty rooms with paintings on the wall accompanied by written descriptions. The main ways of providing a narrative to the works were: informational signs, guided tours and on-screen video material.

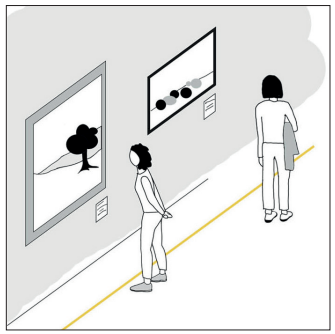
A wandering behaviour of visitors did seem present in both museums, visitors appeared to

choose their own route and explore rooms in their own order, often seemingly avoiding other groups of people.

There are of course exceptions to this “white cube” atmosphere (I.E. interactive storeys at Escher in het paleis or Wonderkamers in Kunstmuseum Den Haag) and it becomes more common for museums to include interactive exhibitions (Hornecker and Ciolfi 2019). Still with the 2 examples given, both were physically separated from other exhibitions and a separation between the art and the interaction appears. The “white cube” remains but besides an “interactive cube”.
AR has the potential to increase the museum experience and facilitate access to information without isolating the visitor from the real space (Karayılanoğlu & Arabacıoğlum, 2020). With this project the aim is to find a way to incorporate the interaction into the “white cube” atmosphere, instead of separating the two.

Although the experience will be situated in an art museum, the desired interactions are more in line with that of a science museum, exploratory and embodied learning. It will be interesting to see if a bridge can be forged to adhere to the environment and qualities of an art museum and add the explorative qualities of the science museum. Think of experimentation, multi-sensory design, invite to touch and hands on interaction.

Art Museum



Core focus: Aesthetic and reflective engagement with art objects.

Behavioural characteristics:
- Moving quietly and slowly, often alone or in pairs.
- Observe rather than touch — the main mode of interaction is visual and interpretive.
- Space supports contemplation: sparse sound, subdued lighting, clear sight-lines.
- A reflective or introspective Interaction frame (“What does this mean to me?”).

Design implications:
- Large open spaces or white walls emphasize focus on the artwork.
- Physical barriers or distance subtly signal “do not touch”.
- Interactive technology must respect the quiet, personal rhythm of the visit.

Behavioural setting: Contemplative and interpretive.

Science Museum

Core focus: Experimentation, discovery, and embodied learning.

Behavioural characteristics:
- Touch, try out, manipulate, and experiment.
- Social interaction is encouraged — talking, laughing, comparing outcomes.
- Activities are hands-on and often collaborative.
- The interaction frame is playful and investigative (“Let’s see what happens if…”).

Design implications:
- Open layouts with distributed interactive stations.
- Multi-sensory design (sound, movement, light).
- Invites physical engagement — no “do not touch” barriers.

Behavioural setting: Exploratory, playful, and social.

Natural history museum

Core focus: Knowledge transmission and structured observation of the natural world.

Behavioural characteristics:
- Reading panels, observe exhibits, and follow linear routes.
- Interaction is primarily informational, not physical.
- Social behaviour is restrained, often family groups or school classes.
- The interaction frame is learning-focused (“What can I learn from this?”).

Design implications:
- Displays organized chronologically or thematically (e.g., evolution, geography).
- Glass cases, labels, and guided paths reinforce a sense of authority and order.
- Interactive elements are didactic, guiding understanding rather than exploration.

Behavioural setting: Educational and observational.

Figure 11: 3 different types of museums (Hornecker and Ciolfi, 2019) (illustration by Katharina Bartholomäus)

The social context

A museum visit is often done in a social setting; visitors often attend in pairs or groups. Even within the “white cube” environment, where silence and distance are expected, visitors share impressions, point out details, and compare interpretations with fellow visitors. This social layer contributes significantly to meaning making. Through conversation, visitors actively construct and negotiate the significance of what they see (Falk & Dierking, 2016). The architecture and behavioural setting of art museums can conflict with this social tendency. The white, neutral gallery space encourages solitary behaviours, such as standing quietly before artworks (Hornecker & Ciolfi, 2019).

The social dimension has effect on the creation of interactive exhibitions. On the one hand, digital tools can provide shared engagement. For example, mobile guides, interactive screens and interactive apps often encourage joint exploration and discussion (Yang et al., 2024). On the other hand, technologies such as head-mounted displays (HMDs) may isolate the wearer, limiting opportunities for real-time social interaction. This creates a challenge for an XR-based experience, creating an immersive, individualized experience while still supporting the social nature of museum visits. The social context and social interaction will not play a sizable role in the creation of this project as the focus is on creating a one-person experience but it is still taken into account. The outcome of this project desirably would fit within the social environment or contribute to it.

Design insights

Looking into the museum context provide insights for designing an AR museum experience. Considering the appearance, the goal of the experience and contextual implications.

The personal

As the literature suggests there is not one specific visitor type, this suggests that the target audience is broad and varied. With the experience the goal is to engage not a single group but for it to be educational and entertaining for a broader audience. Visitors should be able to interact and learn based on their own interests and desire. This would mean the design would be relatively open and allows for engagement on different levels.

The physical

The researched literature suggests that the physical context of the experience, an art museum, is an environment that supports contemplation. This includes a white, serene aesthetic and a general idea of 'do not touch', a Behavioural setting which is contemplative and interpretive. This suggests that the experience should respect the quiet, personal rhythm of the visit.
This project aims to extend this setting a bit further and nudge interaction where visitors feel invited to Touch, try out, manipulate, and experiment. According to the literature this is indicative in a science museum. For the development of the interactive experience the in art museum present atmosphere should be respected and elements of a science museum should be used to create an environment that is both contemplative and interpretive as well as exploratory, playful, and social.

The social

The literature suggests that museum visits are inherently social. During a visit there are almost always other people around. The design will mainly focus on the creation of a personal experience but it would be desirable if it takes the social context into account or even contains elements to support social interaction.

Engage a varied audience

The experience should engage the various visitor types and expectations, allow for free-choice learning and self-exploration. There should be variation in how to interact and freedom in what to engage in.

Educate and entertain

The experience should provide the user with new knowledge and should be perceived as fun and engaging.

Adhere to the white cube

The aesthetic of the experience and its parts should fit within the existing atmosphere of the (modern art) museum.

Bridging the gap between white cube and interaction

The experience should break down the "do not touch" behaviour often present in modern art museums and bring interaction to the "white cube environment".

A social museum visit

It would be preferred if the experience allows for and/or engages the social aspect of a museum visit.

Human computer interaction

RQx: How to apply human computer interaction in an AR experience

With the project involving AR there unavoidably will be an interaction with the digital world. To create a meaningful interaction, this chapter will investigate what AR is and how it can be applied.

Extended Reality

Figure 12 shows the Reality-virtuality continuum (Milgram et al., 1994), showing the spectrum and differences from reality to a fully digital world. All allowing for different kinds of immersion from real to virtual. This project is positioned in the AR part of this continuum as it allows for the real world to be visible but adds on to it using virtual elements. Thus, keeping the actual painting and location alive, emerging the user just enough into the virtual. The AR experience is meant to enhance/repair the art instead of creating a fully digital replacement, attempting to maintain a sense of authenticity.

The head mounted display

For virtual elements to become visible a head mounted display (HMD) has to be worn by the user. This HMD is a gateway to the vritual world, allowing for creating a relatively novel experience. In this case the Varjo XR-3 and XR-4 were used to develop and test the interaction. Figure 13 shows the capabilities of the Varjo XR-4. These capabilities enable, inspire and frame the interactions for the experience. The various elements allow to interact with multiple human senses allowing for interesting multisensory ways to interact within an XR experience.

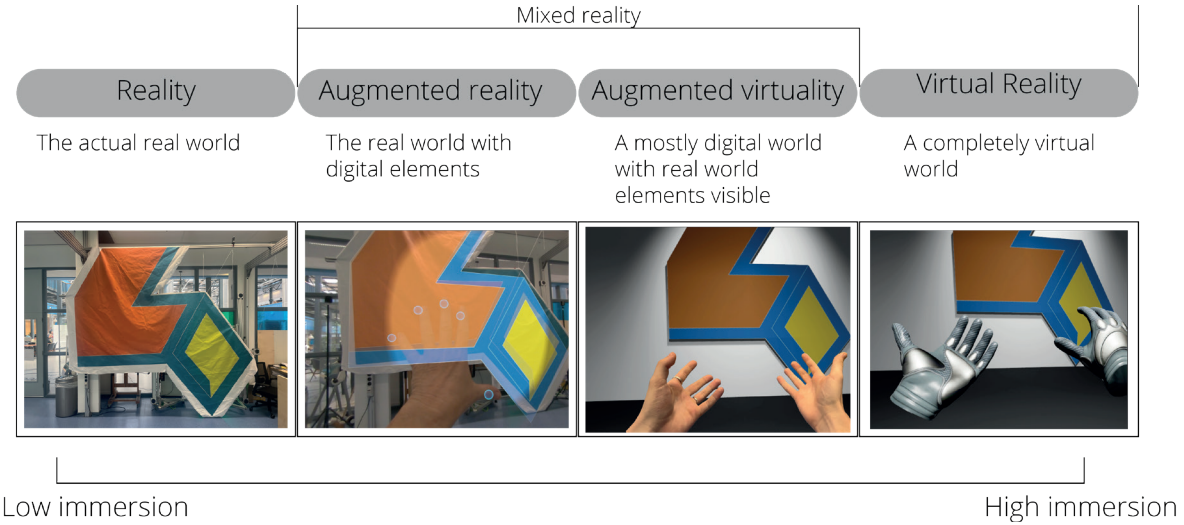


Figure 12: Reality-virtuality continuum, based on (Milgram et al., 1994)

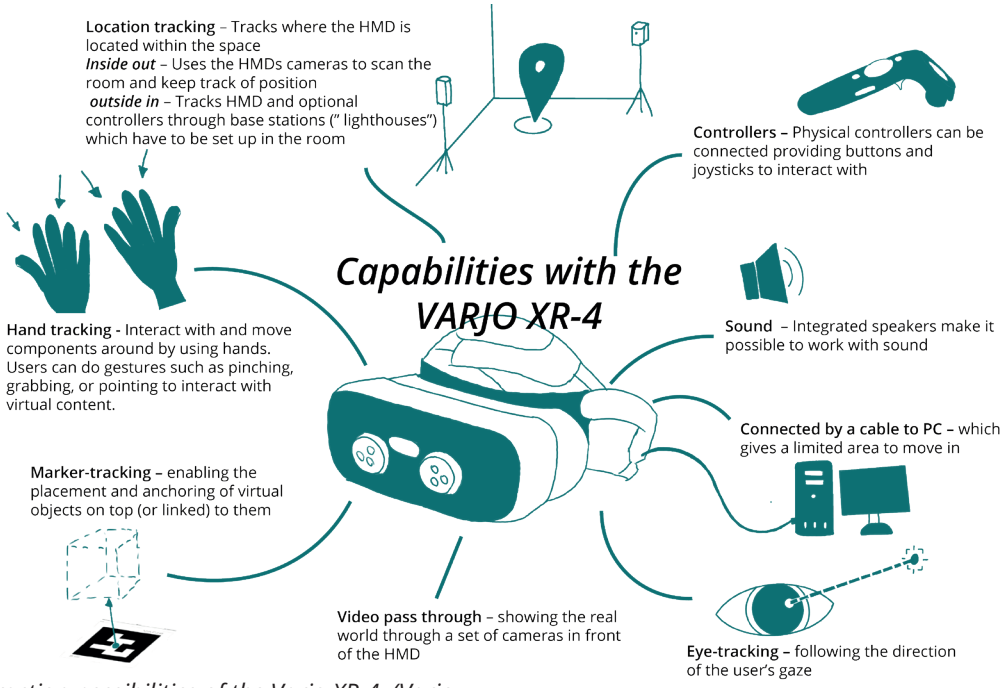


Figure 13: Interaction possibilities of the Varjo XR-4, (Varjo Technologies, 2024

Applying extended reality in museums

A wide variety of interactive exhibitions have been displayed in various museums. HCI research highlights the opportunities and challenges of using digital technologies (including AR) to provide context in museums. Digital overlays can supply dynamic and layered information, but they also risk overwhelming visitors or distracting from the already existing aura of the artwork (Hornecker & Ciolfi, 2019). The design challenge lies in offering just enough to support meaning-making while maintaining the integrity of the original experience.

Analysing 18 articles between 2010 and 2023, focusing on visitor behavioural intentions towards VR technology in museums YiFei & Othman (2024) discovered that most people show a favourable view of the use of VR technologies. However VR differs from AR, most notably VR being visually cut out of the real world, it can still provide useful insights. With their research they uncovered 4 factors that guide visitors' behavioural intentions.

Perceived usefulness:

When users perceive VR as a valuable tool for achieving their personal goals within the museum, their intention to actively engage with it naturally increases (YiFei & Othman, 2024).

- Does it work well?
- Does it enhance knowledge gathering?
- Does it enrich the museum experience?

Information quality:

Accuracy and richness, interface design, and information guidance impact how users navigate and embrace the experience (YiFei & Othman, 2024).

- Is the information accurate?
- Is the provided information rich enough?
- Does the interface design look aesthetically of high quality?

Perceived ease of use:

Ease of use is a crucial element influencing acceptance and willingness to explore. High-quality information and intuitive interface design become pivotal allies, assisting users in learning and operating in the virtual environment (YiFei & Othman, 2024). The experience thus should remain simple and direct, it should be very clear what to do without the need for extended explanation.

- Is it clear what to do?
- Is it clear how to interact?
- Does interaction require much effort?

Psychological cognition:

Besides the technology and information provided lies "psychological cognition". Emotions, perceptions, and mental processes play a significant role in user engagement within the museum. This influences the desire to explore and learn within the virtual environment (YiFei & Othman, 2024).

- Does it evoke curiosity?
- Does it offer an immersive experience?
- Does it provide cognitive engagement?

Embodied and Tangible Interaction in AR

Embodied, tangible, and spatial interaction highlight how the body, physical artefacts, and the environment shape the way users engage with digital systems. Unlike traditional interfaces, which commonly rely on screens and abstract input devices, these interaction paradigms draw on natural human abilities (movement, touch, perception, and spatial awareness) to create immersive and meaningful experiences (Hornecker & Buur, 2006; Ishii & Ullmer, 1997). With the use of AR in an art instalation, these principles enable visitors to actively participate in the experience, blending digital and physical layers into a coherent whole.

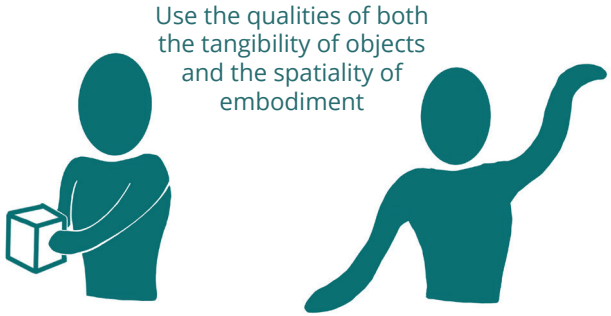


Figure 14: Tangibility and Embodiment

Embodied interaction

Embodied interaction involves using the body itself as a medium for interaction, where physical movements, gestures, and postures become components of the user experience. Bodily movements are captured by technology and interpreted as input, allowing users to control digital systems in a natural and intuitive way. In AR, for example, users navigate virtual content through walking, moving or gesturing, creating a interplay between the physical and digital environments (Hornecker & Buur, 2006). Such engagement allows users to perceive spatial relationships and digital compositions directly, enhancing their understanding of scale, depth, and context within the augmented environment. Beyond navigation, embodied interaction can create emotional and cognitive connections with digital content, as users' physical involvement encourages active exploration, experimentation, and reflection. By grounding interaction in the body, AR experiences become more intuitive, immersive and meaningful, offering an intuitive bridge between physical actions and digital outcomes (Hornecker & Buur, 2006).

Tangible interaction

Tangible interaction focuses on physical objects as mediators for digital information, transforming everyday materials into tools for engaging with virtual content. Tangible User Interfaces (TUIs) allow users to manipulate digital information through direct physical interaction, creating a more hands-on and intuitive experience (Ishii & Ullmer, 1997). In AR, tangible artefacts can guide users' engagement with virtual layers of an artwork, grounding the experience in something touchable and easily understandable. TUIs often leverage object affordances (I.E., shape, texture, or positioning) to suggest possible actions.

By embedding digital content in real-world objects, tangible interaction makes abstract information more intuitive, supports creativity and learning, and fosters deeper immersion within interactive environments (Hornecker & Buur, 2006).

Interacting in a space

AR introduces a form of interaction different from more traditional HCI (through keyboards, controllers, or touch screens). By leveraging spatiality and embodiment, AR allows users to become part of the interface itself, interacting with both digital content and the surrounding physical environment (Zhang, 2025). Here, space becomes the interface, shifting from 2D screen-based interaction to fully 3D, bodily engagement.

Physical space contains inherent affordances that guide interaction. Light, material, geometry, and contextual cues all shape how users move, perceive, and engage. Zhang (2025) identifies that spatial computing interfaces often underutilize these possibilities, highlighting conflicts between traditional Human-Computer Interaction and architectural approaches:

1. Objectives - HCI is task-driven; architecture is **activity-driven**.
2. Immersion - Digital interfaces treat space as an external object; architecture **integrates users as part of the interface**.
3. Attention - HCI demands constant focus; architectural spaces **support ambient and background experiences**.
4. Affordances - Minimalist digital design removes **contextual cues**; physical environments embed them in material, lighting, and social context.

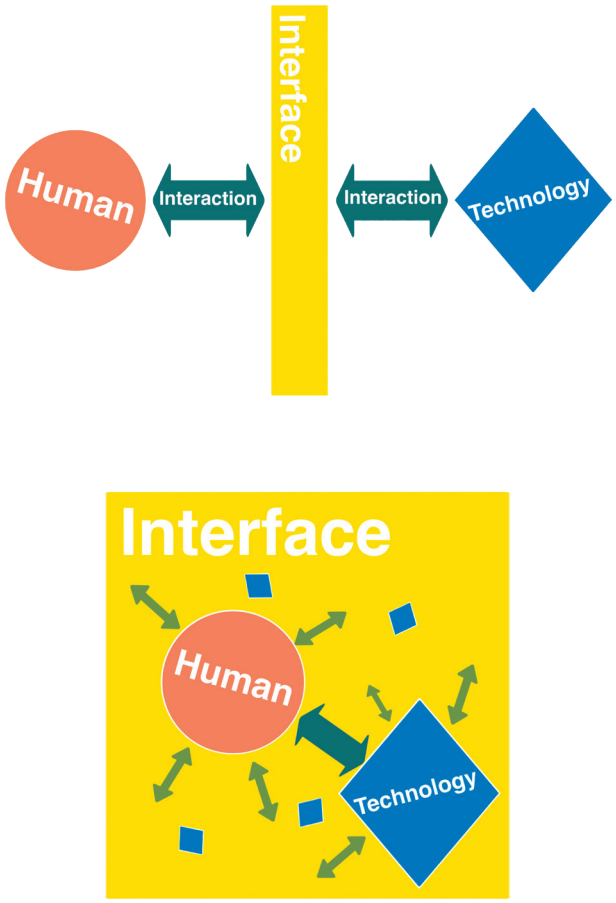


Figure 15: 'Traditional" HCI (top) compared to desired spatial HCI (bottom), figure based on model by Zhang, 2025.

Embodied, tangible, and spatial interaction are closely interconnected in AR experiences. When combined, they enable users to engage with digital content in ways that are physically, cognitively, and spatially meaningful. Embodied interaction allows users to navigate and manipulate virtual content through their own bodily movements, fostering natural engagement and a sense of presence (Hornecker & Buur, 2006). Tangible interaction grounds these digital elements in physical artefacts, providing tactile anchors that make abstract information more accessible and intuitive (Ishii & Ullmer, 1997). Spatial interaction places both the body and tangible objects within the three-dimensional environment, encouraging exploration,, and contextual awareness while leveraging the inherent affordances of physical space (Zhang, 2025).

Applying these principles to AR design requires a holistic approach. Digital content is placed onto real-world objects or locations, encouraging users to move through and manipulate the space naturally. For example, AR interfaces can allow users to explore virtual structures by walking around them, interact with physical props to trigger digital effects, and discover hidden layers based on spatial positioning. By integrating embodiment, tangibility, and spatiality, AR experiences become more intuitive, engaging, and memorable, bridging the gap between physical and digital worlds.

Design insights

For the creation of an interesting and engaging interactive experience in AR, HCI plays a key role. It is important that users are able to understand and use the various interactive elements and that they are applied well. Besides that, it is interesting to explore what the use of AR could bring to the table in the field of design, for interactive museum exhibits and explore the various ways it can afford interactions with cultural heritage.

Using AR an Varjo technology

From the beginning of the project the intend is to create an experience in AR. The use of the Varjo HMD allows the interaction to make use of a multitude of affordances. To create an interesting and engaging experience the design should explore these affordances and attempt to make use of what AR and Varjo technology allows.
The use of the HMD also appears to bring 2 limitations: A limited interaction distance, due to the cable and the experience possibly hindering social interaction, as the HMD hides away the users face.

Use of AR and Varjo possibilities

The experience should make use of AR and Varjo affordances like hand tracking, marker tracking and the mix of reality and virtuality.

Create an attractive AR experience in a museum

To make sure the experience is and appears desirable to use literature suggest to take into account 4 factors: Usefulness, meaning the experience works well, enhances knowledge and enriches the museum experience. Information quality, meaning the information is accurate, rich enough and is aesthetically convincing. Ease of use, meaning it is clear what to do, how to do it and does not cost too much or too little effort. And cognitive activation, meaning the experience should activate curiousness, create immersion and cognitively engages users.

Usefulness

The experience should enrich the museum experience, enhancing knowledge gathering compared to a “normal” museum visit.

Quality

The information provided should be rich enough and aesthetically feel & look convincing.

Ease of use

There should be clarity in how to use (interactive) elements in the experience and it should not require too much effort.

Psychological cognition

The experience should activate the users thoughts and imagination.

The ways to interact.

The literature explores 3 ways of interaction Embodied, tangible and spatial.

Applying Embodiment within the experience should enhance understanding of scale, depth, and context and increase intuitiveness, immersion and meaningfulness

Making use of tangible objects adds something touchable and easily understandable, brings inherent object affordances, which could be interesting to enable interaction. This should make abstract information more intuitive, support creativity and learning, and fosters immersion within interactive environments

Literature research into spatial design suggests to use the environment as interface. This introduces possibilities for the interaction to: 1. Be task driven, creating an interesting interaction instead of focussing on the end goal alone, 2. Integrate the space and user as part of the interface, 3. Divide focus between interface, space and painting, instead of focussing on an interface alone, 4. Make use of affordances present in the space around.

Embodied and tangible

The experience should provide an interplay between embodied interaction and tangible interaction.

Object and context affordances

The experience should make use of present context affordances and the affordances added objects bring.

Activity driven

The experience is preferably focussed on doing an activity rather than reaching an end goal.

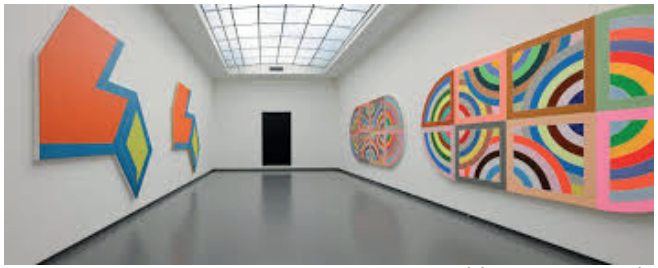
Balancing attention

There should be a balance in the amount of attention towards the different aspects of the experience - painting, virtual elements, Objects and Environment.

Authenticity

RQ2: How to create a sense of authenticity?

At the centre of this project stands the original painting. When working with original work and creating copies or additions onto it, a question of authenticity comes into play. Besides retaining the authenticity of the painting, it is valuable that the experience creates an authentic experience. Both object authenticity as well as existential authenticity will be explored in this chapter.



(Van Abbemuseum, n.d.)

Maintain object authenticity & enhance experiential authenticity

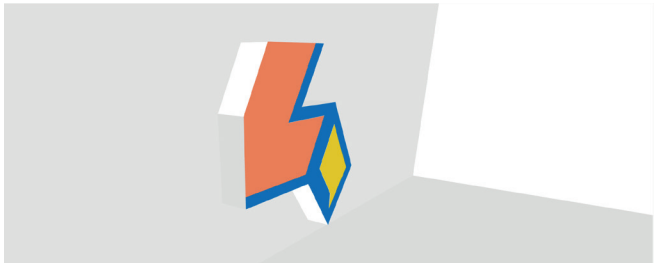


Figure 16: From actual authentic painting to a virtual experiential painting

Reconstruction of art

When working with reconstructions and/or preservation of artworks, some guidelines have been defined which can be listed in five issues (Pietroni & Ferdani, 2021):

- Respect for aesthetic and historical value
- Compatibility
- Recognition of intervention
- Reversibility
- Minimal intervention

In the case of this experience, where AR is used and the original does not need to be touched, only 2 of them still play a significant role. Respect for aesthetic and historical value, the meaning, history, and authenticity of the cultural asset should be preserved.
Recognition of intervention which concerns the legibility of the original parts. Integrations should be recognizable.

As a museum is expected to show real artworks and visitors want to experience authentic artworks it is necessary to maintain a level of authenticity, giving observers the sense they are looking at / experiencing something "real". Which forms a challenge when working with digital augmentation. This is where genuine authenticity starts to touch experiential authenticity.

Experiential authenticity

There is a distinction between object authenticity: which describes the genuine object with its history and existential authenticity: which is more about the "aura" and the emotions evoked (Penrose, 2018), (Kenderdine & Yip, 2018).

Object and existential autheticity together create experiential authenticity: 'the belief and sensations of having experienced something genuine and 'real' (Penrose, 2018).

To increase this sense of experiential authenticity a few factors play a role:

- Personal identification – finding a way to relate to what is being presented.
- Effective storytelling – Telling the story in an engaging manner.
- Stimulating imagination – becoming active partners in the narrative.
- Accuracy – when claiming something, this must be true.
- Intention, honesty and integrity – being honest about something being real, recreated or imagined.

As the actual painting is not to be touched in this case, only the existential authenticity is affected with the interaction. It is not about creating a perfect replica but about engagement in the narrative, creating understanding and creating a connection between visitor and painting.

Design insights

For the experience to work well in collaboration with the genuine painting and to create an authentic experience a few elements need to be considered.

Object authenticity

The design will cooperate and be an added layer to the real painting. This means that the experience should not distract or take away from the original art piece. To maintain and expand the object authenticity the explored literature suggests that the design should respect the original painting and give recognition to intervention

Respect the original authenticity

Additions or alterations should respect the aesthetic and historical value of the original artwork.

Recognition of intervention

Additions, alterations or interpretations should be conveyed clearly and what is presented must be accurate and honest.

Experiential authenticity

Besides the realness of the object the experience itself should also be felt like an authentic experience. Visitors should feel like they have experienced something 'real'. Literature suggests that this can be increased through: The 2 factors mentioned with object authenticity, effective storytelling, stimulating the imagination and creating a personal connection.

Effective storytelling

The narrative should be provided in an engaging manner.

Stimulate imagination and contemplation

The experience should activate imagination and contemplation, going beyond users absorbing information and include the users own thoughts and ideas.

A personal connection

The experience should provide a way to get a personal connection with or relate to what is being done, shown and/or told.

The narrative

RQ4: What were Stella's intentions with his paintings?

RQ5: What narrative surrounding the painting (Effingham I) could be provided?

This chapter describes the narrative that will be provided when engaging with the experience. It investigates the painting Effingham I, Frank Stella's goals and intentions and a theme of change, experimentation and evolution connected to Stella and his ways of working.

Figure 17: Picture of Frank Stella, source: ArtWizard.eu, 2019

The artist: Frank Stella

Frank stella (1936-2024) is an American artist best known for his contributions to minimalism and abstract art. Stella kept reinventing himself and his artistic style changed over the years. What kept relevant was his use of "normal" house-painter brushes, tools and paints and his respect for materiality. He is interested in the necessities of painting; it is non symbolic (Kajiya, 2014). As he stated:" What you see is what you see" (Glaser, 1964)

With his art in the end his main goal seemed to be: To create something, with a certain logic. He approached this through the creation of anti- or abstract illusionist art.

"The basic issue with art and making art ultimately is to make something beautiful, but you don't always get there. Sometimes you're happy you get close, and sometimes you make something that you feel is beautiful and you hope that you can share that with others." ~ Frank Stella. (Toledo Museum of Art, 2011)

"All I want anyone to get out of my paintings, and all I ever get out of them, is that you can see the whole idea without any confusion" ~ Frank Stella. (Glaser, 1964)

Effingham I

The painting, subject of this project is Effingham I (1967) (figure 18), a colour field painting created by Frank Stella. This painting is part of his Irregular Polygon series, in which he created paintings on irregular, asymmetric shaped canvases displaying large fields of vibrant colours, including fluorescent ones, see figure 19. The titles are drawn from small towns in New Hampshire, where Stella and his father went fishing (De winter, 2020). Every shaped canvas is made in four-fold and are numbered in the order in which he painted them (De winter, 2020). The titles of his works carry little value, they are just meant as identification tags Baker, 2004.

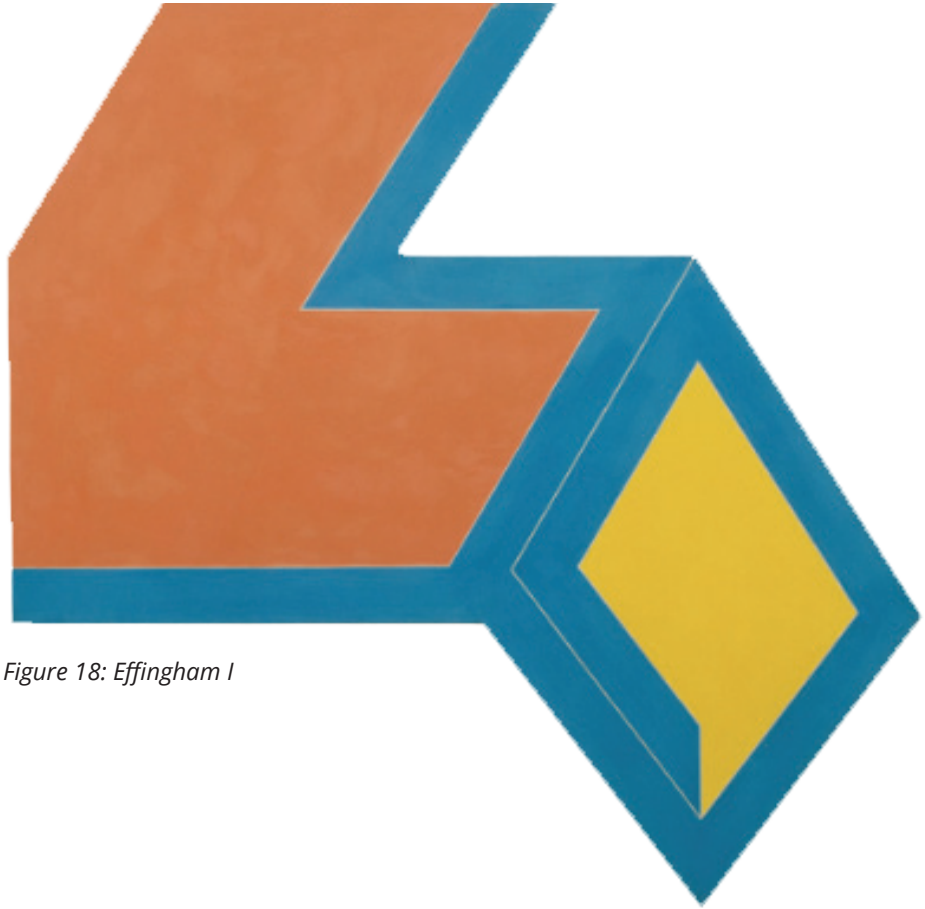
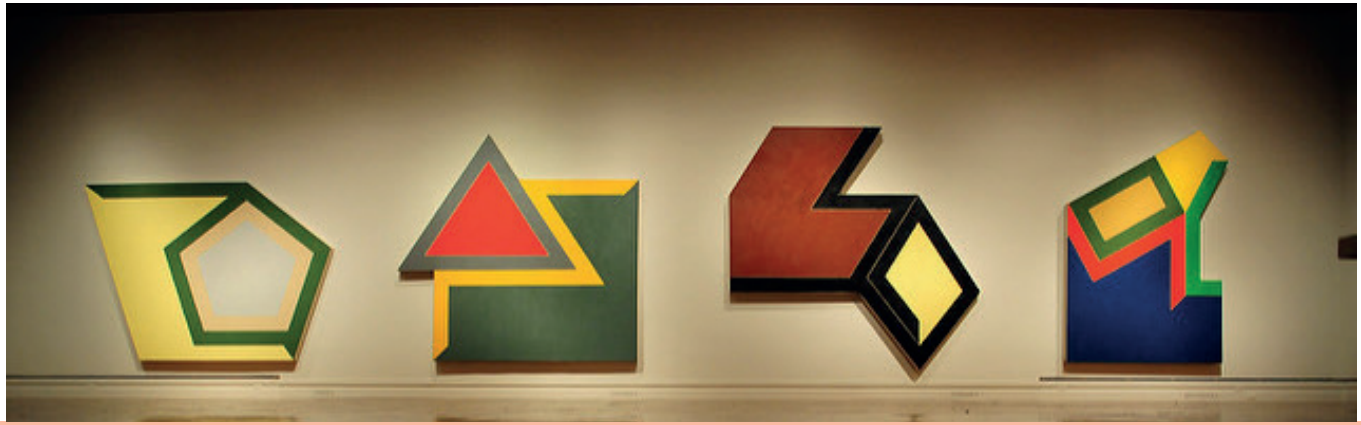


Figure 18: Effingham I

Figure 19: A few paintings from the irregular polygon series "Ossipee II" (1966), "Chocorua IV" (1966), "Effingham IV" (1966) & "Moultonville I" (1966), (Cué, 2017)



Anti-illusionism & abstract-illusionism

At the start of his career Stella's goal with his paintings was to eliminate any form of illusion (De winter, 2018). He created his artworks according to a certain logic and a goal of anti-illusionism, the ideas behind these modernist principles stem from the theories of Clement Greenberg, where art should focus on its own medium and be self-critical (painting must emphasize its flatness and materiality). Stella takes this theory and literalizes it in his paintings. (De Winter and Wagemans, 2022, De Winter, 2018).

This goal of anti-illusionism can be described in 4 principles, which can be referred to as the modernist principles.
In his Irregular Polygon series Stella began to explore a new kind of abstract-illusionism (De winter, 2020). This move was not an abandonment of his modernist principles but rather a reinterpretation of them.

Stella's 4 modernist principles can be described as follows:

Flatness
The aim to eliminate any type of spatiality or 3D-illusion on the canvas, creating a flat surface, emphasizing the 2D nature of a canvas. With this Stella also aimed to show surface, structure, and materiality (De Winter & Wagemans, 2022).

Instantaneousness
The idea that a painting is grasped all at once, without the need for reading or interpretation. The painting is perceived all at once at an instant (Rubin, 1970).

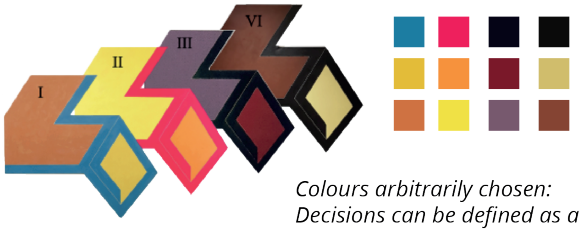
All-overness
Stella made sure his paintings were covered from edge to edge with simple geometric patterns, filled with colour, this should, according to the artist, create an all over experience. Viewer should not have one singular area of focus, but the eye is freely wandering around the work. Every part of the canvas is treated equally, without any fixation points (De Winter & Wagemans, 2022)

Self-referentiality
The art refers to itself and only itself, it does not represent something, no narrative or symbolism. It emphasizes form over content and focusses on what it is itself. "What you see is what you see" (Glaser, 1964). For Stella this meant a certain respect for his materials. The materials should be recognized as themselves (National Endowment for the Arts, 2010).
Looking back at the titles of the paintings there seems to be a conflict, as the names do refer to something external, Stella stated that the titles really are just identification tags (Baker, 2004). Still there seems to be some friction.

The 4 principles are not stand alone elements but affect each other. Stella applied a variation of techniques and elements to try to get to the modernist painting he aimed to create. Figure 20 shows techniques applied in Effingham I by Stella to reach his goal.

Bold colours:
Instantaneous, as they have an immediate visual impact

Self-referential, as the colours are arbitrarily chosen



Colours arbitrarily chosen:
Decisions can be defined as a system but in the form of trial-and-error

Non-linear
Working on multiple works at the same time

White space between shapes:
Flatness, as they clearly separate the colored surfaces preventing spatial overlap or depth suggestion

Instantaneous, as this speeds up recognition of the structure

Self-referential, as the white space (created with cheap masking tape) shows the canvas layer, referring to the canvas

Large scale:
Flatness, as the huge shape becomes a wall-like object, reinforcing flatness

All-over, Scale allows the entire composition to spread evenly.

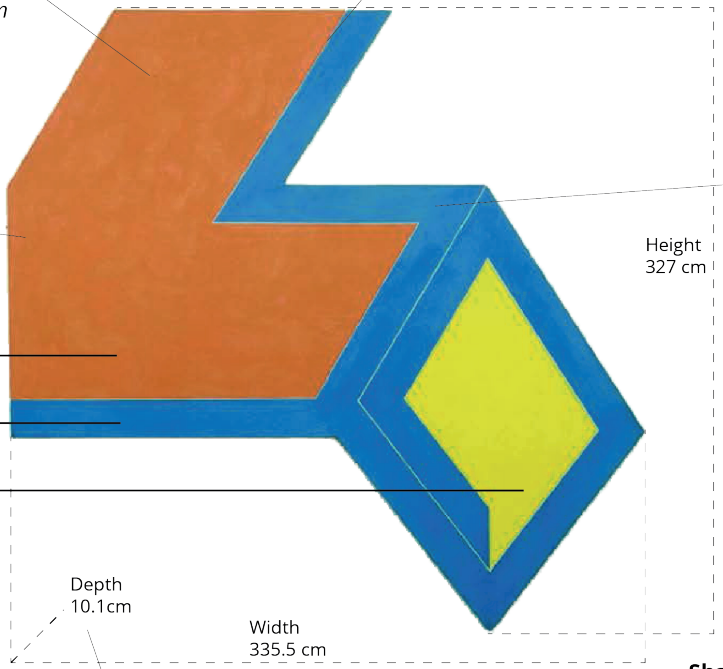
Instantaneous, it demands attention and contributes to immediate impact.

Self-referential, as it emphasizes the paintings' objecthood.

Application of paint:
Self-referential, as Stella distanced him as a person from the painting by applying paint uniformly.

Self-referential, as the paint is applied thinly showing the canvas underneath

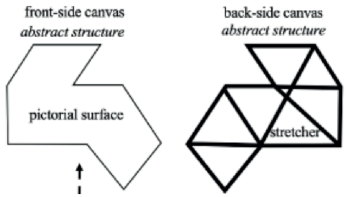
Household tools:
House-painter brushes, cheap masking tape -> absence of a creator / signature



Completely covered:
All-over, The layout follows the shape of the canvas, distributing attention across the edges rather than toward a central point.

Flatness, large planes of colour with no shading or modeling

Material effect paint:
Self-referential, as the material properties shows what it is



Shaped composition:
Flatness, as it eliminates the conventional rectangle "window", making the perimeter part of the composition

All-over, Each segment has a similar visual weight; nothing dominates.

All-over, the blue band guides the viewer across the entire painting

Instantaneous, simple shapes are quickly recognizable

Depth of stretcher:
Self-referential, as it places the object away from the wall

Flatness as it emphasizes the pictorial surface

No representational imagery:
Self-referential, The painting does not show anything or looks like anything else.

Figure 20, Analysis of Effingham I with techniques applied to adhere to Stella's 4 principles, information derived from de Winter's research

Temporal change

In his paintings Stella used self-referential, publicly accessible household paints. These paints were easier and cheaper, particularly when working on larger pieces. In the case of Effingham I, a mix fluorescent and 'regular' paint was used.

For most artworks material changes are accepted as part of their historical narrative. For Colour Field paintings this is perceived differently. Their impact and meaning depend heavily on their specific materiality and visual effects.
The specific colours and material effects are essential to their intended experience. If material qualities change, the artwork loses its essence. It becomes something different from what the artist envisioned (de Winter, n.d).

"It was kind of natural, and it just seem to work for me" ~Frank Stella (Modern Art Museum of Fort Worth, 2016).

Currently it looks like the fluorescent effect is less remarkable (figure 21), as the colours lost their original brightness (De Winter, 2020). The loss of this effect eventually transforms the painting into a faded-out version, leaving little of its original appearance. What the painting actually looked like and will look like remains uncertain but is currently further investigated by de Winter.

The visual effects of this painting thus have changed, but according to Stella himself this does not really matter.

"I think the colors still look pretty good today - It was really all about the transparency and the way that it allowed the canvas to be visible. The paint layers are thin, but they still offer sufficient visual presence" ~Frank Stella (De Winter, 2019)

But if looked at, the painting has changed. It can thus be expected that the effect it has on people also changes.
This raises the question: How do visual changes, affect the effect of a painting on an observer?

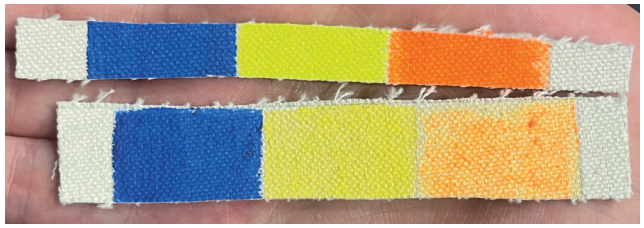


Figure 22: Sample of artificially aged paints on canvas (Original colours shown on top, bottom shows aged colours)

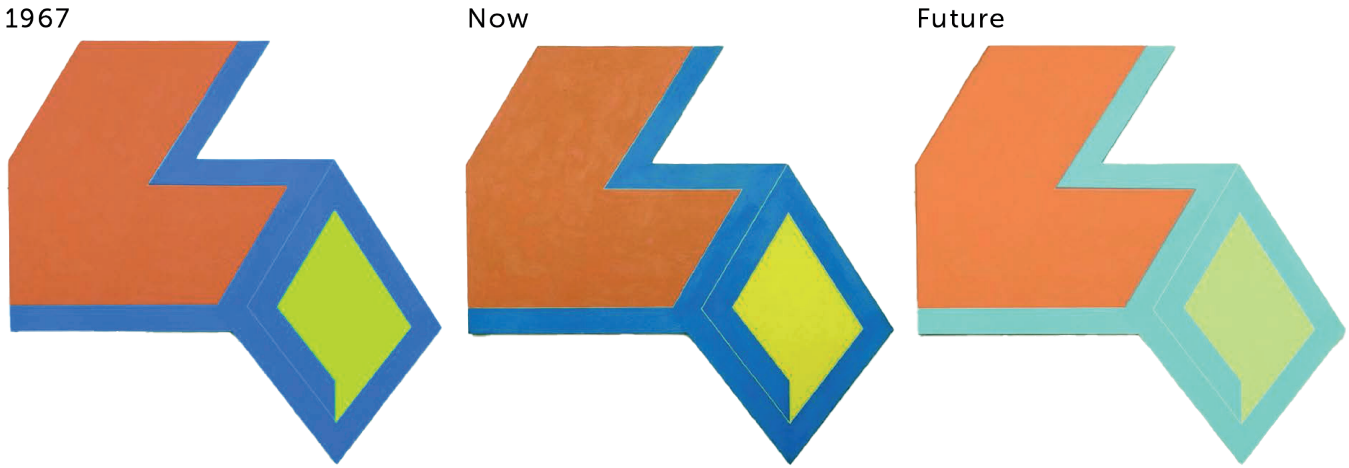


Figure 21: Effingham I in stages of degradation (interpretation), De Winter, n.d

A theme of change

Throughout his career Frank Stella has always kept evolving. Every piece of art was an attempt to create something beautiful but not always got there (Toledo Museum of Art, 2011). He experiments, and every piece offers new insights. But when looking further, even his style and interpretation of his principles seem to change over time (figure 23). Comparing a painting from his first big series, where a lot of emphasis lies on flatness, totally differs from his later works, shifting into making 3-dimensional sculptures, with the irregular polygon series being there somewhere in the middle.

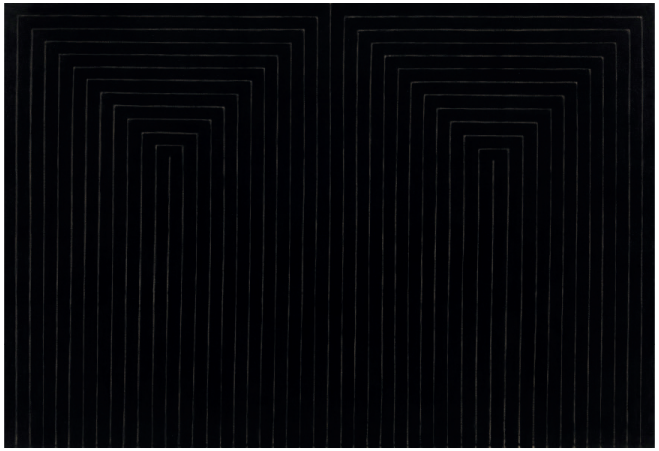
Stella cautiously develops his paintings, demonstrating the evolution of his concepts stepwise. He investigates each new addition or change with the other interventions that have proven effective and contributed to his modernist logic. This means that he does not change his approach drastically from one series to another. Instead, each series represents a next "logical" step in his exploration of abstract-illusionism (De Winter, 2020).

Stella's journey from two-dimensional painting to three-dimensional constructions was not a rejection of painting but a logical extension of its material possibilities. His early insistence on flatness and objecthood evolved into spatial presence and real structure (Rubin, 1987).

"The flatness was sort of giving up on me or I was giving up on it" ~ Frank Stella (National Endowment for the Arts, 2010)

As previously mentioned, in the end he just wanted to create something and did this the way that seemed best to him. According to a certain logic but always changing, experimenting and evolving.

"I am motivated by the desire to make something, and I go about it in the way that seems best" ~ Frank Stella (Glaser, 1964)



Frank Stella
The Marriage of Reason and Squalor, II (1959)

Frank Stella.
Irregular Polygons: "Ossipee II" (1966), "Chocorua IV" (1966), "Effingham IV" (1966) y "Moultonville I"I (1966)

Frank Stella
K.54 (2008)

Figure 23: The change in style shown in 3 artworks

Narrative frames

Looking into Frank Stella and his works shows there is a lot to of information and a lot that can be told. Not everything can and should be transferred in one experience. 3 narrative frames have been selected to define the experience narrative.

Temporal change

The changes Effingham I has undergone over time stand central in this project. This piece narrative should thus be transferred to the user.

Stella's anti-and abstract illusionism

Get familiar with Stella's 4 modernist principles: Flatness, Self referentiality, All-overness and Instantaneousness.

Visual aspects

Engage the user by exploring what contributes to building a painting and the effects of changing visual aspects. Experience what comes into play when building an artwork like Frank Stella.

Delivering the narrative

RQ6: How to deliver the narrative in the interaction?

The narrative provided about Effingham I and Frank Stella is important but equally as important is the manner in which this is delivered to an audience. This chapter explores how visitors perceive art, how they react to seeing Effingham I and how to effectively transfer the desired narrative through an interactive experience.

Providing information with art

According to Bordens (2010) viewers typically show lesser liking to non-representational, modern art styles compared to more conventional, representational art. The addition of information can have a positive effect on understanding and enjoyment of art (Bordens, 2010).
The lack of previous experience or a personal connection to art can cause for a disconnect and disinterest. Providing contextual information might bridge this knowledge gap and increase the enjoyment and engagement with the art. When visitors engage in "free-choice" learning (Falk & Dierking, 2016), they learn about what they find interesting.

The most conventional way of providing information to visitors is by the means of exhibit labels, texts on walls or sometimes video, which instead of free, are very guided and structured. In addition, research concludes that the average visitor does not read labels (Falk & Dierking, 2016). With the creation of the experience the contextual information should be provided in a more interactive manner, learning by doing.
Research on museum learning in art galleries points out that, the learning experience is less likely to centre on the accumulation of facts and more on reflective engagement, interpretation, and the reshaping of how visitors perceive objects and meaning (Donald, 1991). Studies show that measures like "time at exhibit" (holding power) or "how many people visited" (attracting power) don't capture the cognitive activity of the visitor and thus are not proof of learning. In a fine arts context, learning often involves aesthetic or intellectual provocation, self directed exploration, and opportunities for reflection. This suggests that in designing an interactive AR experience for a fine arts museum, one should emphasise active visitor engagement, meaning making, and choice, and evaluate success not just by viewing time but by how visitors articulate, manipulate or reflect on the artwork's meaning.

Reactions to seeing Effingham I

To get an idea of how people look at Effingham I, various people (N=10), with various backgrounds were asked to look at and give a reaction to a copy of the painting (see appendix C).

It became apparent that people tried to find an explanation for the painting, all kinds of assumptions are made. They try to identify shapes, objects or a deeper meaning. This is in line with other visitor observations. Visitors try to relate what they are seeing to their own experiences and that it can be difficult for the average visitor to understand the intended messages (Falk and Dierking, 2016).
The way people see the painting seems contradicting with what Stella wanted with his painting, for it to be grasped all at once. Still, both interpreting the painting on your own and starting to understand the painter's intention, seem to be interesting and valuable interactions.

I am interested to know about the thoughts behind the painting, I find it hard to place it. ~ P1

I find the combination of colours daring, a lot of contrast, very bright/hard. I also wonder if the shapes are based on something and if there is a certain story behind the painting. ~P2

What I would like to know is why the artist chose to sometimes do the blue double and sometimes leave it away, because it now looks like it is not finished on the left side, or is this chosen on purpose? ~P3

(A few quotes from people reacting to Effingham I)

A framework to teach about visual arts

Frank Stella aimed his paintings to be understood immediately “What you see is what you see” (Glaser, 1964). This does not seem to be that straight forward. With the experience a supporting narrative seems needed.

In their research Wijntjes and Van Middelkoop (2024) present a framework that can be used to teach perception through visual arts. The framework analyses material, texture, colour, light, space and material. These aspects can be analysed on the medium and the motif. And a 3rd dimension on content/context adds semiotics and iconography (see figure 24). With Effingham I and the context of Frank Stella this framework can be taken as the basis of teaching about the painting. What is interesting with Stella’s work is that medium and motif refer to each other and Stella avoids semiotics and iconography in is work, with it being self-referential.
The framework provides the basis structure of constructing the narrative, what to tell and what to experience.

This framework is based on various formal frameworks in art. Combining certain aspects into one. For the development of concepts and to connect elements of Effingham I and Frank Stella specifically (see figures 25 & 26) some of the framework elements are divided into multiple parts. Resulting in the following visual aspects: Colour, Shape, Depth, Light (Fluorescence) and Size.

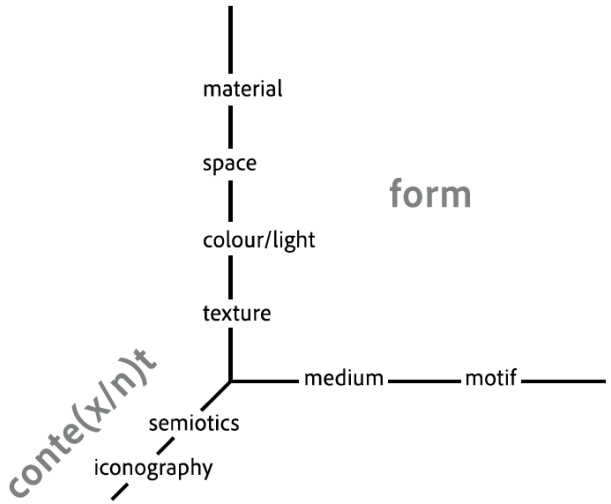


Figure 24: Vision & Depiction framework (Wijntjes and Van Middelkoop, 2024)

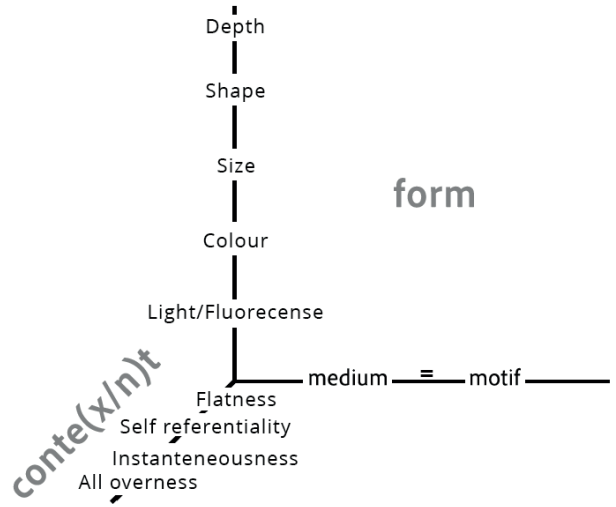


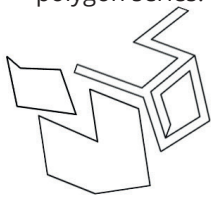
Figure 25: Interpretation of the framework combined with the selected narrative frames

Colour

As stella experimented with colour himself. Creating 4 of each shape, trying out different colours arbitrarily.

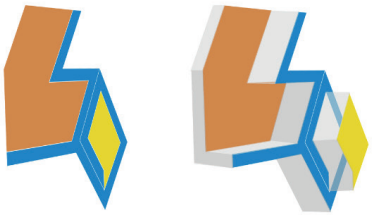
Shape

As Stella worked with irregular and different shapes within the irregular polygon series.



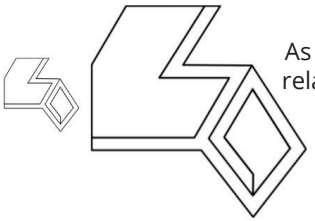
Depth

As Stella started with a focus on flatness but in later works increasingly started to create more 3 dimensional artworks.



Light/fluorescence

As the paints Stella used contain material effects, fluorescence being a prominent one in the irregular polygon series.



Size

As Stella worked on relatively large scale canvases.

Figure 26: How the visual aspects connect to Stella and his work

Design insights

To engage the user in the experience it is important to effectively transfer the narrative. This can be done in a variety of ways; in this case the Vision and Depiction Framework will be the bedrock. To transfer the narrative in an engaging manner a couple of elements should be considered.

Self-interpretation & providing information

The experience should provide information but more importantly allow for self-reflection. Users learn through reflective engagement, interpretation, and the reshaping the perception objects and meaning.

Free choice learning

Users should decide what they want to engage with the experience will play into a visitor's individual interest and support in creating a personal connection

Stella through the Vision and Depiction Framework

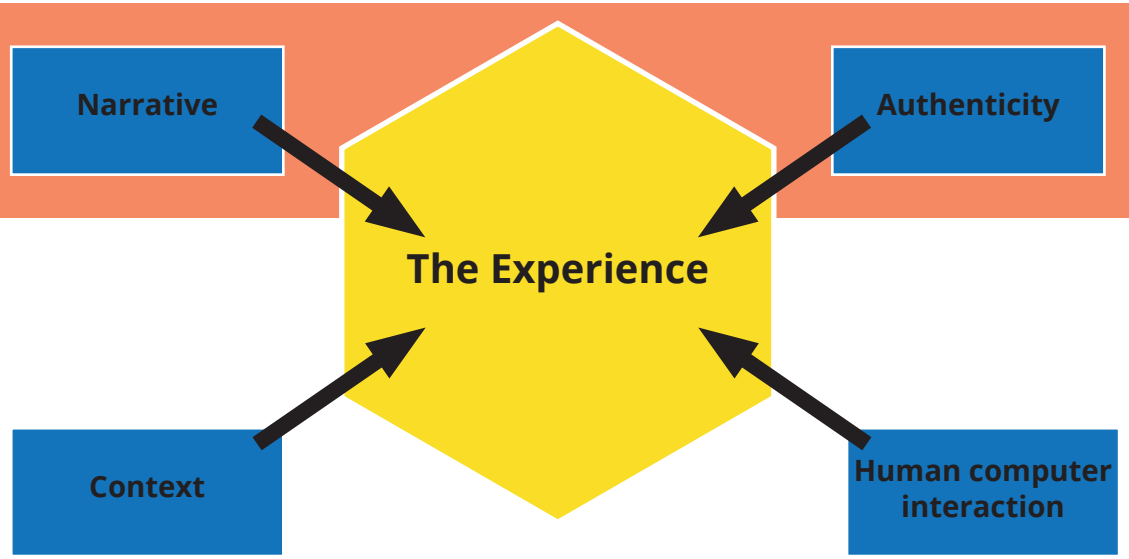
The experience builds onto the vision and depiction framework, combined with visual factors present in Stella's work and intentions. Users interact with: Colour, Shape, Depth, Fluorescence and Size. The other dimensions of the framework will be used in the generation of the shown/told narrative.

Multi-sensory

The user should be engaged through doing, seeing and listening. Through multiple senses: touch, vision and sound.

Define

This chapter combines the information gathered in the explore phase and bundles the 4 topics to define the future design. It redefines the design goal, introduces interaction qualities and defines a list of criteria. This leads into the concept direction which will inform the design process.



Refined Design Goal

With all the information and new insights gathered the goal has been adjusted to more effectively come to a desired design outcome.

The design goal has been redefined to:

‘Create an interactive AR museum experience, showing the effects of changes in visual elements and their effects on the perception of Effingham I’

This new design goal should accommodate users to gain a better understanding of Effingham I and Frank Stella’s intentions.

Interaction Qualities

To capture the mood and feeling the interactions with the experience should provide, a set of interaction qualities is defined. These qualities give a description of what the interaction should be like and inspires and informs further ideation.

Contemplative:
An activity that makes you think and imagine.

Self-led:
You make the decision on what to do based on own interest and likings.

Discovery:
Along the way you find out new information.

Freedom:
There are multiple ways to get to where you want but the choice is yours.

Spatial:
You make use of the space around you and are not bound to one position.

The aesthetic

As the experience is to take place in an modern art museum, with it’s ‘white cube’ environment. To capture this atmosphere and guide the design process a mood-board is created based on the information gathered from literature and during museum visits , informing future aesthetic choices. This gives direction into the stylization of the concept, prototype and elements within them.

Figure 27: Mood-board capturing the intended aesthetic of the experience.

The theme of change

With the goal to provide a narrative with the painting and the collected information on Frank Stella and Effingham I, the theme of 'change' was selected as a leading narrative. This includes the temporal changes in Effingham I but expands into changing other visual aspects based on the vision and depiction framework.

The narrative to be transferred can be divided into 3 groups:
1. The story of degradation of art, The temporal change affecting the look of Effingham I.

2. The story of Frank Stella, Stella's modernist principles and building of his paintings.

3. The self created story, the 5 visual aspects and how their change affects the effect of the painting.

The narrative frames should be part of a connected story. The three frames are connected to each other and support each other they are connected in the following manner: Temporal change is the starting point of the experience, this is what is happening to the painting, it changes. This change is further explored through the 5 visual aspects, here users engage with how change affects the painting and the effect on them as a viewer. Connected to each visual aspects is one of Stella's principles, giving an insight into what the painter considered and took into account building his paintings. All of Stella's principles have an effect or connection to almost all visual aspects and vice versa, figure 29 shows how and why the principle is connected to which visual aspect.

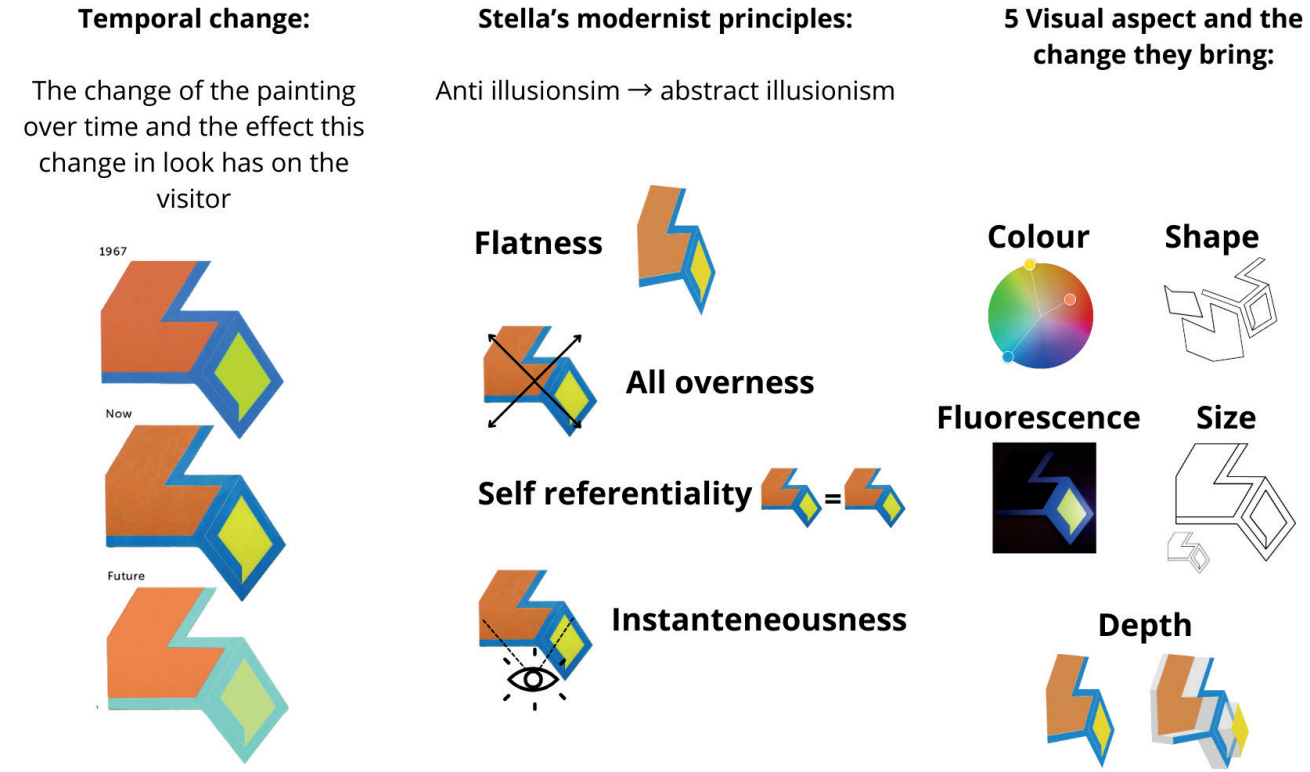
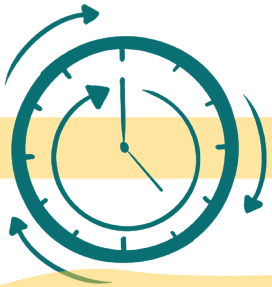


Figure 28: The 3 selected narrative frames

Starting point - Change over time: The experience starts with the explanation of the effects of time and how effingham I and thus the effects on the viewer by the painting changes. How the painting is perceived and what it did to a viewer is different now from what it was before.



Temporal change

The change is the starting point and continues into making more changes, perceiving and feeling the effects of visual change and what it means when perceiving and reacting to the painting.

Principles & visual aspects

Fluorescence and self-referentiality:

This is the only material aspect which will be described in the experience. Stella deliberately made use of 'effect' materials, as they are meant to show what they are, giving the material a literal and self-referring meaning. For this reason the change in material effect of fluorescence is chosen to carry the principle of self-referentiality.

Colour and arbitrary selection & experimentation:

Throughout his work Stella kept evolving and experimenting. Within the closer context of his irregular polygon series this is visible in his experimentation with colour. Stella did not select the colours the painting should contain but rather created multiple works applying different colours as an experiment, finding out what works for him and what does not. This is why the change of colours is connected to the narrative of his experimentation and arbitrary selection.

Shape and all-overness:

The way Stella distributed and divided the various shapes as well as the entire shape of the painting play a role in it's presentation. The manner in which shapes come together, guide sightliness and are separated with white lines play a role in how a viewer perceives the painting. Due to shape and vision-guidance being are connected the all over principle will be transferred with the change of shape.

Depth and flatness:

Stella worked with flatness on the pictorial surface and abstract illusion in his works. Especially in his irregular polygon series the tension between the two came forward. The changing aspect of actual depth is in this way logically connected to his relation with and emphasis on flatness.

Size and instantaneousness:

There are multiple elements playing a role to perceive a painting instantaneously but the size of a painting contributes massively to this effect. Due to the canvas size there is no way to look over the painting or are required to take a close and detailed look, for this reason instantaneously is linked to the changing of size.

The experience ends with repeating the change over time and a reflection on the combination of personally changed aspects put together.

Temporal change

Figure 29: Connections between principles and visual aspects

Design criteria

Based on the gathered design insights in the explore chapter a list of design criteria is defined. These criteria will guide in the development of ideas and concepts and eventually acts as a leading structure to validate the final design outcome.

Criteria are derived from one or multiple insights mentioned in the previous chapter. The coloured dots show where the criteria are derived from.

- Context
- Human computer interaction
- Authenticity
- Narrative

Story

- The experience should convey the temporal changes Effingham I undergoes.
- The experience should convey Frank Stella's 4 modernist principles:
  - *Self-referentiality.*
  - *Flatness.*
  - *All-overness.*
  - *Instantaneousness.*
- Users should engage with the 5 visual aspects and get an insight into how the painting is built up.
  - *Users can affect the colour in the painting*
  - *Users can affect the size of the painting*
  - *Users can affect flatness/depth in the painting surface*
  - *Users can affect the shape of the painting*
  - *Users can affect the 'light'/fluorescence in the painting.*

Interaction

- Interactive elements should be easy to understand and use.
- The interaction should make use of embodiment, tangibility and spatiality.
- The experience should be activity driven (not goal oriented)
- The experience should activate multiple senses.
- The experience makes use of the affordances of AR an varjo technology.

Psychological

- Users should feel like they learned something from the experience.
- Within the experience there should be room for contemplation.
- The experience should enable users to engage in "free choice" learning.
- The experience should stimulate imagination.
- The interaction should provide a way of personal identification.
- For the duration of the experience, the user should feel engaged.
- The experience should provide an authentic/novel experience.
- The experience should create a sense of curiousness.

Context and authenticity

- The experience should feel enriching to a museum visit.
- The experience should be engaging for a varied audience.
- The experience should respect the original painting.
- The experience should give recognition to changes & intervention.
- Context, painting and technology should be present on an balanced level.
- It would be desirable if the experience provides an element of social interaction.
- The experience should have a serene appearance, fitting with a modern art museum (see appendix D).
- Elements and information within the experience should feel aesthetically convincing.

Create

This chapter describes the ideation process and concept development. Based on the collected insights from the previous chapters a set of ideas is generated using various design methods. These broad ideas are clustered into more clear concept directions, leading to a set of 4 concepts. These are further developed and validated with on screen prototypes through a user test and validation methods. The outcome is one concept with a final prototype.

Ideation

How to's

Goal: Generate a set ideas connected to themes from the experience.

To generate ideas based on specific aspects of the experience the how-to method was used (Van Boeijen et al., 2020). First a set of "how to" questions is created and written down on paper, after which all ideas that come up are written around the question (see appendix E). The result is a paper full of initial conceptual ideas, which can be used for future concept generation. This method was performed with the help of 2 fellow industrial design student to generate a broader set of ideas.

Brainstorming

Goal: Generate conceptual and loose ideas for (parts of) an interaction

As a start to generate ideas on full interactions and loose aspects, a free brainstorm is done (see appendix F). This resulted in a couple idea directions, which can be (partly) used for further ideation. This brainstorming was not completely connected to the theme of 'change' with the goal to generate ideas a beyond the scope resulting in a larger set of ideas, from which elements still could be useful.

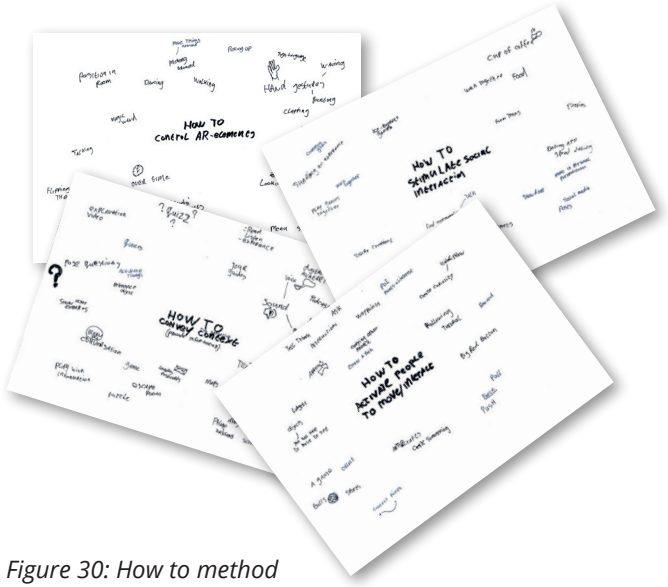


Figure 30: How to method

Bodystorming

Goal: Explore embodied and spatial possibilities

Bodystorming was used to explore how bodily movement, spatial orientation, and physical interaction could shape the experience of engaging with an artwork. Given that the final concept involves embodied interaction, movement within an exhibition space, and tangible objects, bodystorming was an appropriate method to investigate experiential qualities that are difficult to assess through sketches or verbal ideation alone. 2 Sessions of bodystorming were held.

During the first session participants were asked to interact with the painting to accomplish certain goals or make things happen with the painting.
Participants used their body to show how they imagined interacting and used their voice to convey what would happen.
This session led to various insights, both on what how to interact with and what could happen with the painting (see appendix G).

A second bodystorming session was held with 2 participants, where the start of 4 concepts had been generated (See appendix I). This led to a more directed session with clearer interactions as the concepts provided more directed outcomes, aiding in the development of the 4 concepts (see appendix J. During this bodystorming it was found that it was hard for the participants to imagine and interact with the digital layer, and thus the effect of the interaction. This is later improved by using visual (screen based) prototypes.

The bodystorming sessions resulted in several insights. First, it became clear that bodily movement plays a crucial role in how visitors experience agency and engagement. Allowing visitors to move freely, rather than limiting the interaction to a fixed position, seems to support a more personal and exploratory experience.

Second, the physical act of holding an object introduced a sense of focus and directed control. Suggesting that tangible interaction could serve as an effective entry point into the AR experience.

It appears that participants need time to interpret the painting on their own, participants appeared to take the time for personal meaning-making which is possibly important during the experience.

The bodystorming gave insight into how to possibly interact in the experience. Using: recognizable gestures like punching, waving or grabbing, various bodily movements such as stepping closer and away from the painting, The use of objects to point at, highlight or layer elements in the painting.
Furthermore the bodystorming generated a few ideas which are clustered together with the outcomes of the brainstorming and how-to method.

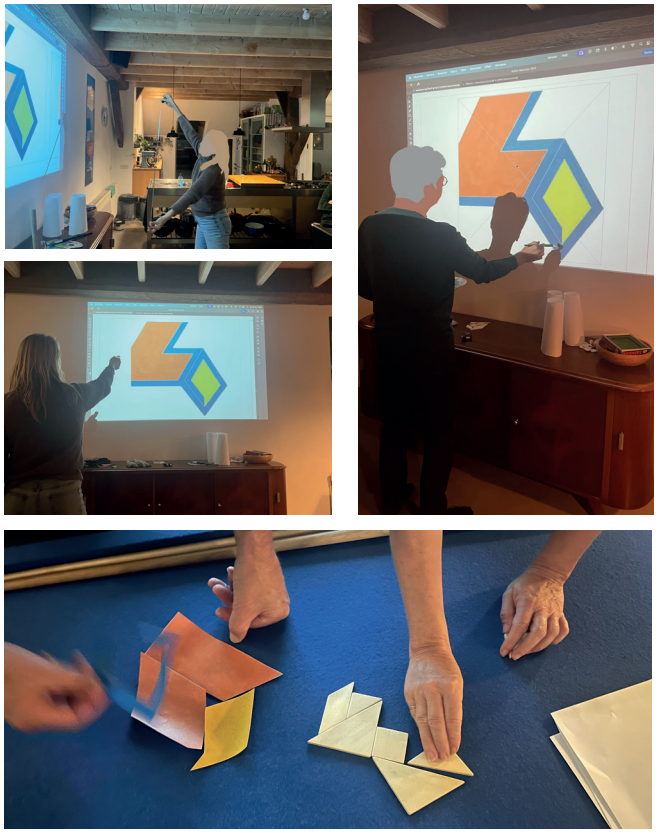


Figure 31: Bodystorming with props

Clustered ideas

With the various methods a quantity of ideas was generated. To generate meaningful and more clear concept directions the loose ideas plus insights gathered from the explorative experiments are clustered into categories and groups. These clusters inform the creation of 4 concept directions: Exploration, Collection, Creation and Comparison (see appendix H & I).

Create

Make something

Ways of control:

Using objects

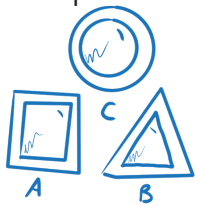
Using body movement

Using room position

Automatically

Making choices:

Multiple lenses

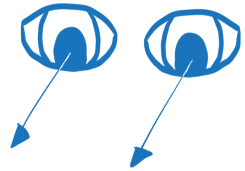


Quizzed

Delivery

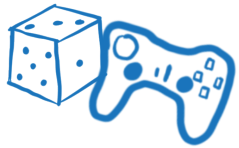
Read

See



Listen

A game - by doing

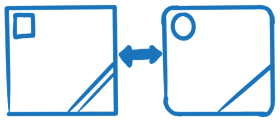


Learn

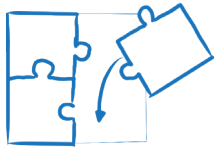
Discover

Absorb

Compare



Collect



Concept direction

The clustered Ideas are formed into 4 concept directions. With the goal to create 4 distinct themes that differ in interaction, ways of control and outcome. The concept directions will be further developed into concept prototypes to be evaluated. Figure 32 shows the 4 themes and the elements connected. Not every individual cluster is used, some are combined in one theme, some were found less valuable and some are brought back in a later stage of concept creation.

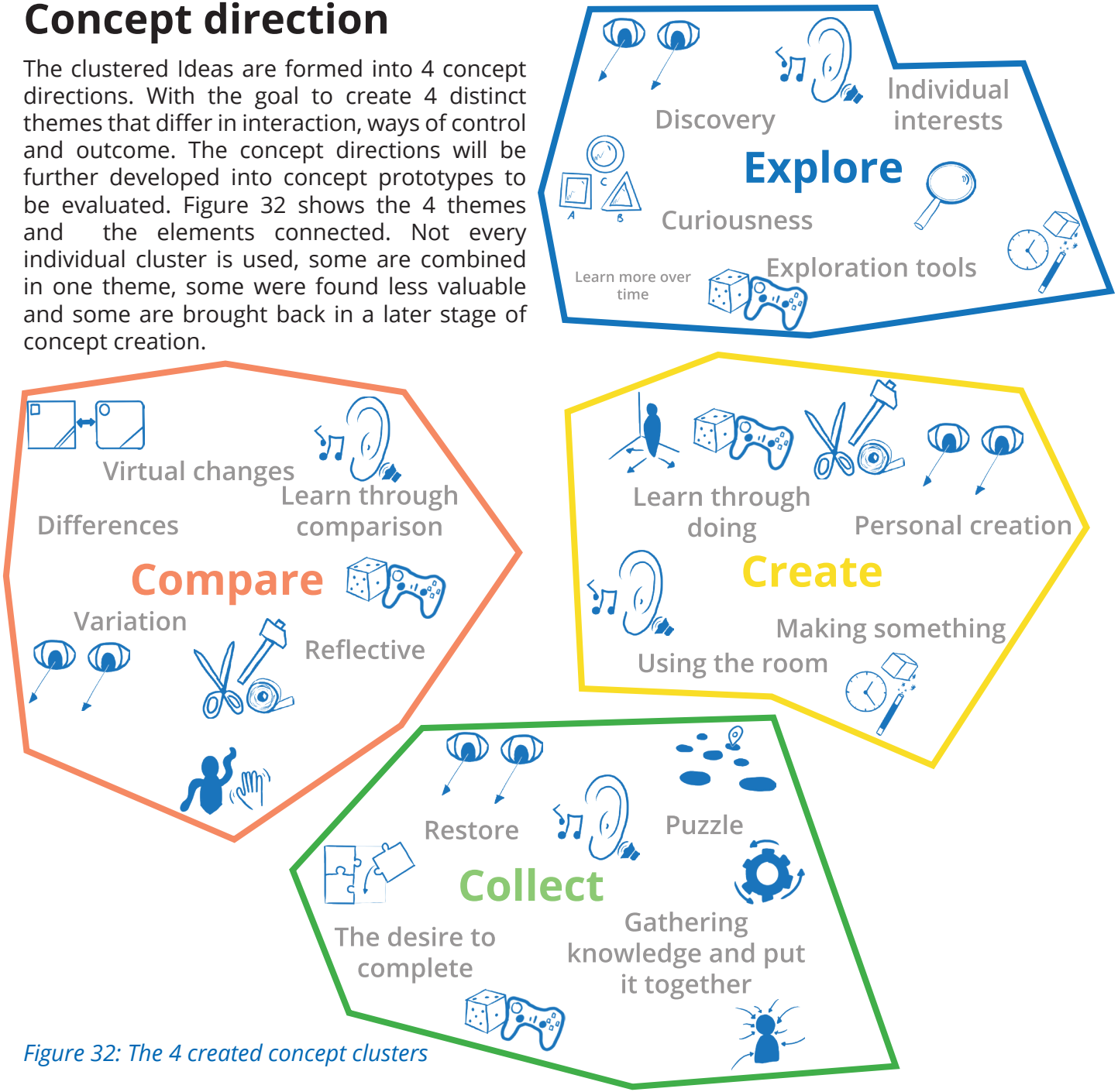


Figure 32: The 4 created concept clusters

Prototyping

To further develop and test the 4 concepts, prototypes are created. These prototypes consist of storyboards in combination with interactive digital p5.js interactives, video and voice over elements providing the narrative. This way the flow, interaction and story can be shown and interacted with. An interesting element to figure out with these concepts was the balance between virtual and physical elements, all concepts approach this in a different way. In this chapter the 4 concepts and qualities are displayed and the concepts are evaluated with users and evaluation methods. Figure 34 shows an overview of the interactions for each concept, the full storyboards and written narrative can be found in Appendix M.

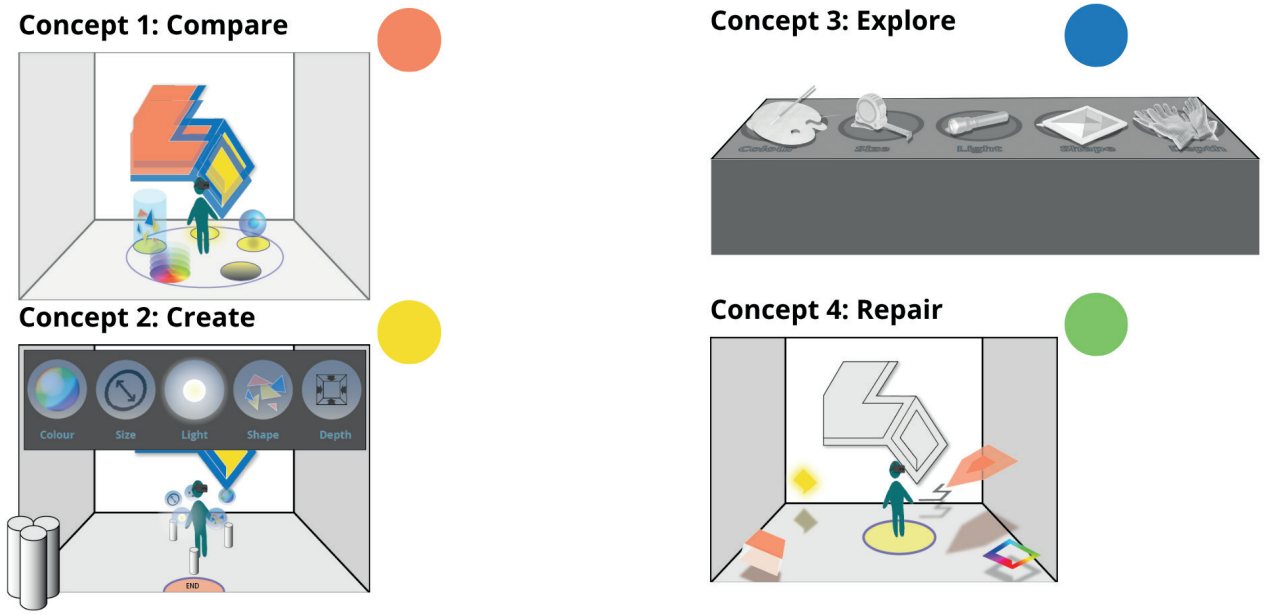


Figure 33: Visualization of the 4 concepts as shown in the evaluation storyboards

The concepts

Concept 1: Compare

Key elements:
- Visible circle on the ground
- Separation of each visual aspect in their own creation space
- Comparison of the alterations made on each visual aspect at the end
- Interaction elements fully virtual

Concept 1 is based on the cluster of learning through comparison. By affecting the different visual aspects all in their individual interaction environments the user experiences changes Effingham I individually. During which the user will hear about the selected narrative elements. At the end of the experience all changes can be compared side by side, allowing for contemplation by comparing 5 unique new creations all with their own change.

Concept 2: Create

Key elements:
- Using abstract tangible elements as means of control
- Using the floor as interface
- A 'personal' creation at the end combining all visual elements interacted with.

Concept 2 is based on the cluster of creation and is done by using physical abstract objects (pillars) in the room. By selecting a visual aspect and moving 3 pillars around the room changes are made to the painting. During which the user will hear about the narrative surrounding Effignham I. At the end of the experience all changes are combined into a by the user created "Effingham". Users can reflect on their selection. Of individual changes and compare it to the original Effingham I.

Concept 3: Explore

Key elements:
- Using recognizable tangible objects as means of control
- Exploring each visible element separately

Concept 3 is based on the cluster of discovery and the use of physical objects. By connecting each visual aspect to a recognizable object, with inherent affordances each aspect gains their own "controller". The user picks up one of the items and with an interaction unique to this object explore and make changes in the painting. While exploring the user will be told about the different narrative elements connected to the painting and the individual visual aspect.

Concept 4: Repair

Key elements:
- The painting losing its look, breaking down into different parts
- Collecting of 'puzzle pieces' slowly bringing elements of the painting back
- Completely virtual

Concept 4 is based on the cluster of collection. At the start of the interaction the painting falls apart in 5 puzzle pieces. The user walks around, collects the pieces and reassembles the painting. With each piece collected the painting shows the effect of a change in the visual aspects and talks about narrative elements.

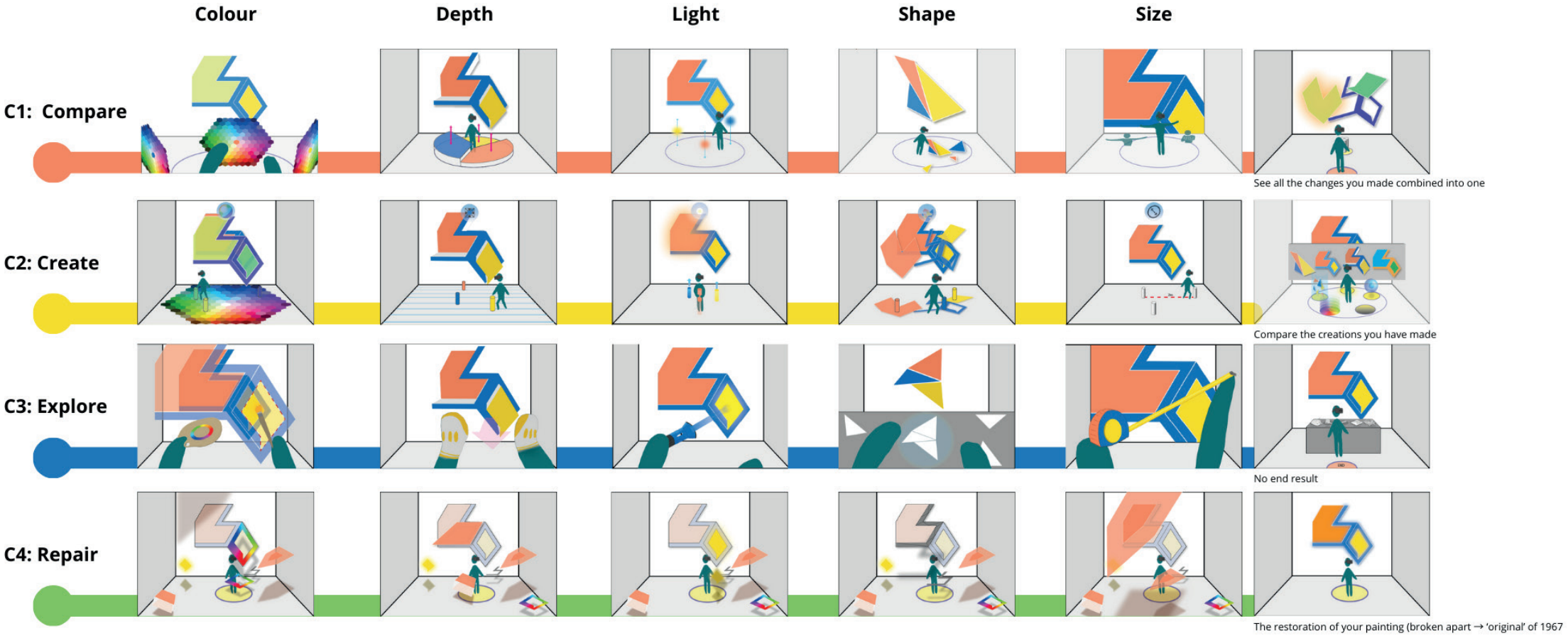


Figure 34: visualization of the concept interactions by visual aspect and ending for each concept

Overarching narrative

The narrative within the 4 concepts is mostly equal. 3 narrative elements are provided
- Temporal change.
- Stella's intentions and modernist principles and.
- 5 visual aspects and their effect on the painting.

The narrative for each concept is provided through a voice-over which provides the narrative and explanation on how to interact.
The full narrative provided (and told in audio elements) with each concept can be found in appendix M.

Figure 35: The voiceover guide provides audible direction and narrative information.

**Links to the p5.js prototypes*

P5.js - Fluorescence
P5.js - Shape
P5.js - Shape 2
P5.js - Depth
P5.js - Size
P5.js - Size with camera

Evaluation

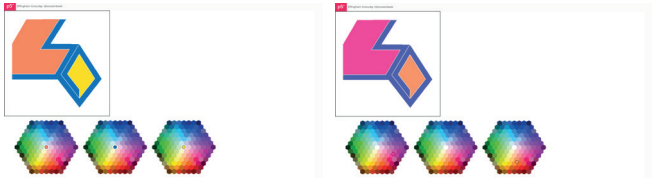
In this chapter the 4 created concepts and their interactive storyboard prototypes are qualitatively evaluated with people from the target group.

The concepts are shown and engaged with through the p5.js prototypes (figure 36) and narrative narration by 4 participants. After each concept a set of questions are asked and after seeing all 4, participants are asked to compare the concepts, give feedback and answer a set of questions.
The procedure and components of this evaluation can be found in appendix L.

Feedback is collected and put together in a collection of positives and negatives per concept.

p5.js prototype parts

Colour

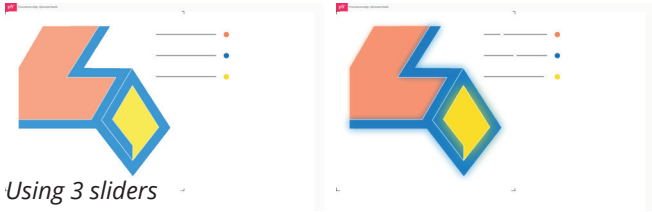


Using 3 colour pickers

Depth

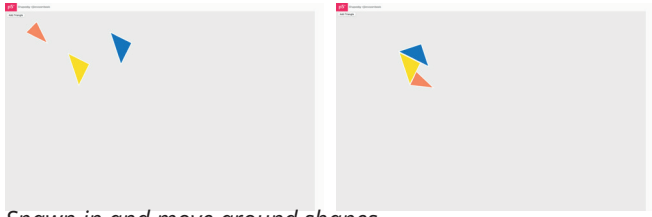
Using slider

Light



Using 3 sliders

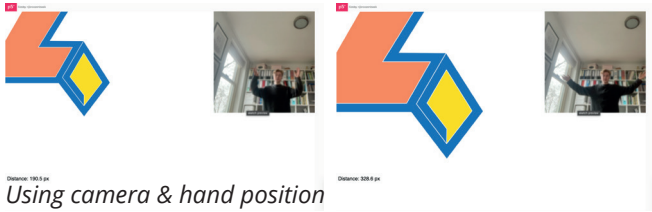
Shape



Spawn in and move around shapes

Create shapes by clicking

Size



Using camera & hand position

Using slider

Figure 36: Screenshots of the P5.js prototypes, before and after changing something

General feedback

Across all four concepts, participants responded positively to the interaction, creativity, and educational value of the AR experiences.

- Concepts 1 and 2 were perceived as more playful and creative, emphasizing experimentation and exploration.
- Concept 3 was most frequently described as clear, educational, and meaningful, achieving a good balance between freedom and structure.
- Concept 4 was appreciated for its informative content but received lower ratings regarding engagement and interactivity.

In terms of comprehensibility, participants found concept 3 the most intuitive, followed by concepts 1 and 2. While concept 4 was clear, its interactions were perceived as less intuitive and less engaging.

Regarding the learning experience, concept 3 stood out, as it encouraged reflection on the artist's choices and the composition of the painting in a clear concrete manner.

Figure 38 shows an overview of the results of the user evaluation, the positives, negatives and figure 37 shows their relation to the defined interaction qualities.

Narrative

Participants seemed to attain the narrative on different levels. Not only did they have varying levels of attention (needed to retain what is being said), but they also interpreted it differently. Although all relate Stella's intentions to the visual aspects and gain an insight in how the painting came to be.

An interaction where you do something as well as being told/shown something is preferred and participants expect to learn more here.

"I learned about the decisions when making the painting. When you see how many choices can be made I have a deeper respect for the think and make process."

"The whole is more than the parts. With the colour you can think "I will change the colour", that is a part of the whole. The next step is another part, in the end you see that all the parts combined create something you did not have in your mind."

"It looks like a simple painting, there were more thoughts behind it than just 3 colours and a shape. Also time has an effect on how the painting looks"

Museum context

According to the participants all concepts (if further developed) could fit in a museum. Museums are quite varied, and all concepts are similar in style. Concept 2 was deemed more playful, towards childish. Which might be a misfit with the serene atmosphere aimed for.

Ease of use & Understanding

Concept 3 was deemed the easiest to understand and use. The objects with their inherent and recognizable affordances allow users to quickly understand and interact.

The clear and simple separation in concept 1 was also found valuable, a clearly defined space where you control the aspects individually in unique ways seems to calm down the experience and make it less overwhelming.

Learning experience

Participants noted that a combination of doing, seeing and listening would work best to attain knowledge. Although concept 4 was seen as educative it does not achieve the idea of 'do, see and listen' that well. In concept 1,2 and 3 the exploration and working with the visual aspects provided a better way to learn about the painting and Stella's intentions.

Interaction qualities	Concept 1	Concept 2	Concept 3	Concept 4	Key takeaways
Contemplative	Moderate Users reflected on the painting but mainly focused on visual effects.	Moderate Some reflective moments, but more focused on playfulness.	Good Participants connected their actions to artistic meaning.	Weak Experience felt more informative than reflective.	Reflection thrives when users interpret outcomes, not just receive info.
Self led	Moderate Users had freedom but sometimes lacked clear direction.	Moderate Users had freedom but sometimes lacked clear direction.	Good Users felt autonomous and confident in their exploration.	Weak Highly guided and linear, little room for self-direction.	Autonomy works best when actions are clear and meaningful.
Discovery	Good Users discovered visual and conceptual changes through interaction.	Good Playful discovery through physical active exploration.	Good Discovery through understanding of artistic choices.	Moderate Users learned facts but not through active discovery.	Discovery emerges through interaction and experimentation.
Freedom	Good Multiple interaction paths, though not always clear in outcome.	Good Users could make and test different choices.	Moderate Freedom within structured choices.	Weak Fixed flow, limited decision-making.	Users enjoy choice but need feedback and clarity about it.
Spatial	Good Spatial engagement in a limited working space	Good Clear use of space and physical activity appreciated by users.	Moderate Some spatial interaction but not central.	Moderate Walking around in the space but interaction itself mostly static	Physical or embodied engagement increases immersion and understanding.

Figure 37: Concepts evaluation on Interaction qualities

	Concept 1		Concept 2		Concept 3		Concept 4	
Topic	**Positive**	**Negative**	**Positive**	**Negative**	**Positive**	**Negative**	**Positive**	**Negative**
Freedom of choice	Lots of possibilities, and freedom in choices		Freedom in what to affect Freedom in the space (walking around)		Freedom in objects selection	Objects guide/limit users in what the possibilities are with the painting		Lack of control, a lot happens but not by the user
Interaction		How to interact with the concept remains unclear, it does not seem intuitive	The use of physical elements is appreciated Active interaction by moving around	Interaction through pillars adds an extra step, interaction becomes less direct	Recognizable objects make the interaction more concrete and easier to understand & use	Recognizable objects feel obvious		Passive, mostly listening with a little walking and collecting Interaction feels forced
Psychological cognition	Activates thoughts about choices made by Stella in his process		The strangely shaped objects could create curiosity		Objects are inviting to grab, they create curiosity Painting comes to life by experimenting			Feels spoon fed, users just have to listen - it does not really come in
Ease of use and understanding		How to use and control the virtual elements remains unclear		Unclarity in when and how to move the pillars	Recognizable objects with inherent affordances make them easier to understand and use		Very easy to interact with	Interaction is too simple, becoming boring
Space	Individual interaction environments for each aspects, more peaceful and direct		Using more of the room by moving around			Danger of touching the actual painting, as interaction takes more place in the real world using 'real' objects		Users do walk around in the space but do not really interact with it.
Engagement	Seen as creative and playful		Feels playful, almost like a game Active	Too playful might become childish	Concrete, direct and playful		Easy to consume	Becomes boring easily
Narrative	The possibilities of Stella's choices becomes apparent. The seemingly simple painting becomes more interesting. What is heard in the narrative affects what is done in interaction			There is no connection between the pillars and the painting or Stella		Connection between object and painting/painter is not clear with every object	Clear focus on Temporal change Clear and educative	Information is provided in a boring manner
The ending	Comparison of users changes in the end provides a moment of reflection		A creation in the end works well and provides something personal			There is not really an ending	Creates clarity on the changes due to time	
Aesthetic		How changes are visualized is still unclear		The form of the interaction pillars	Recognizable objects are appreciated and make possibilities more clear			Creates confusion, how is everything connected?
variation	Variation in how to control every aspect is different		How to use and control the pillars varies per visual aspect	Unclarity in when and how to move the pillars	Interaction with every object is different	Some objects are more fun than others		Repetitive, every interaction is the same

Figure 38: Concept evaluation comparison

Harris profile

A Harris profile based on the design criteria was used to evaluate the strengths and weaknesses of each concept in relation to each other (Van Boeijen et al., 2020). The criteria are a selection of the defined design criteria in chapter Refine. Some criteria are compiled into one, or are left out because the concepts can not yet be tested on these criteria. While the evaluation is based on intuition, it supports a structured reflection on how each concept performs across the identified criteria. The completed profile (Figure 39) suggests that concept 1 performs slightly better overall. However, many criteria received similar scores across concepts, indicating that the differences between them are nuanced.

When reviewing the outcomes on interaction qualities, defined criteria and evaluation scales (Appendix O), Concepts 1 and 3 emerge as the most promising. Both appear to align well with the intended interaction qualities and design objectives, making them valuable starting points for further iteration and refinement.

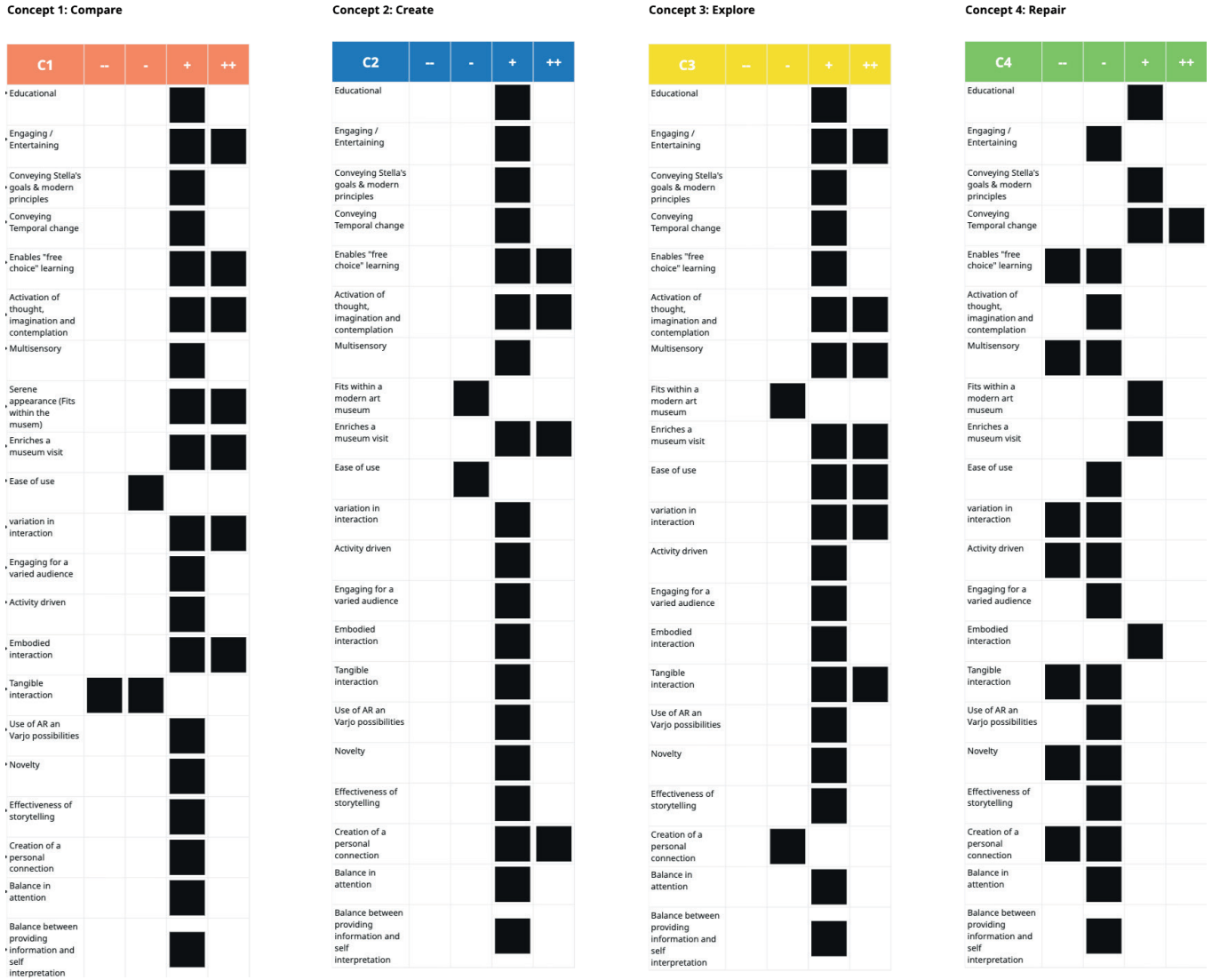


Figure 39: Harris profile comparing the 4 concepts

Discussion

After evaluating the four concepts, no single design emerged as the clear best, each was found to be interesting and valuable in different ways. The findings suggest that a combination of simple physical object with virtual elements would be the most desirable approach. Concept 3 appeared to be slightly preferred, mainly due to its clarity and ease of understanding.

The endings of concepts 1 and 2 were considered particularly engaging, as they provided a visible conclusion of the user's actions and a moment for reflection on the experience.

Although the narrative was partially conveyed, both its content and delivery require further refinement. Additionally, the four modernist principles should be more strongly integrated into the design to communicate them more effectively to users.

Limitations of the evaluation

- After going over one of the 4 concepts, the narrative is already known, instead of handling all concepts individually after seeing one, participants already start to compare.
- The order in which the concepts were presented likely influence how the concepts are evaluated.
- The voiceover elements are difficult to follow at times; this will possibly be better when fully submerged in the experience rather than looking at an idea of it on a screen.

Concept direction

The evaluation of concepts with users and self-evaluation informs the concept direction, leaning in favour of concept 1 and 3.
Concept 1 based on novelty (use of AR capabilities), personal identification, a visual conclusion and clearly separated interactions and interaction environments per visual aspect.
Concept 3 based on the interactions, understandability and use of physical objects in combination with virtual elements.

The concept direction now can be described as:

"An experience where the user utilizes 5 different objects to activate an environment where they can alter Effingham I, actively engage with and learn about 5 visual aspects: colour, depth, Fluorescence, shape and size and their effect on and connection to Frank Stella's painting and intentions.
With this create a personalized outcome in the form of a changed Effingham."

Important design elements

- Variation in interaction
- Clarity of use of virtual elements (on visual and interactive level).
- Concrete and direct interactions.
- Connection between interaction elements and Stella's work.
- Non-overwhelming, avoid a lot happening at once and avoid 'random' things happening.
- Clarity in combination of physical and virtual elements.

Missing elements

With all concepts some desired elements are still missing or lacking. These are:

- Relation between original painting and virtual elements (where and how does the real painting play a role).
- The relation between objects, art history/ preservation and/or the painting or Frank Stella.
- An element of social interaction or connection to the social context.

Concept development

This chapter describes the development of the final concept and prototype. The most important insights and changes in forming the final prototype will be discussed.

The final concept is an experience where tangible objects are used as recognizable and concrete carriers of interactions, where through gestures and embodied interaction changes will be made to a virtual replica of Effingham I.
The concept is developed into an AR prototype using Unreal engine and physical props.

Flowchart of the prototype

To effectively approach the creation of a prototype a flowchart is created, mapping what is happening and how different aspects are activated. This forms a structured base from which the experience is developed.

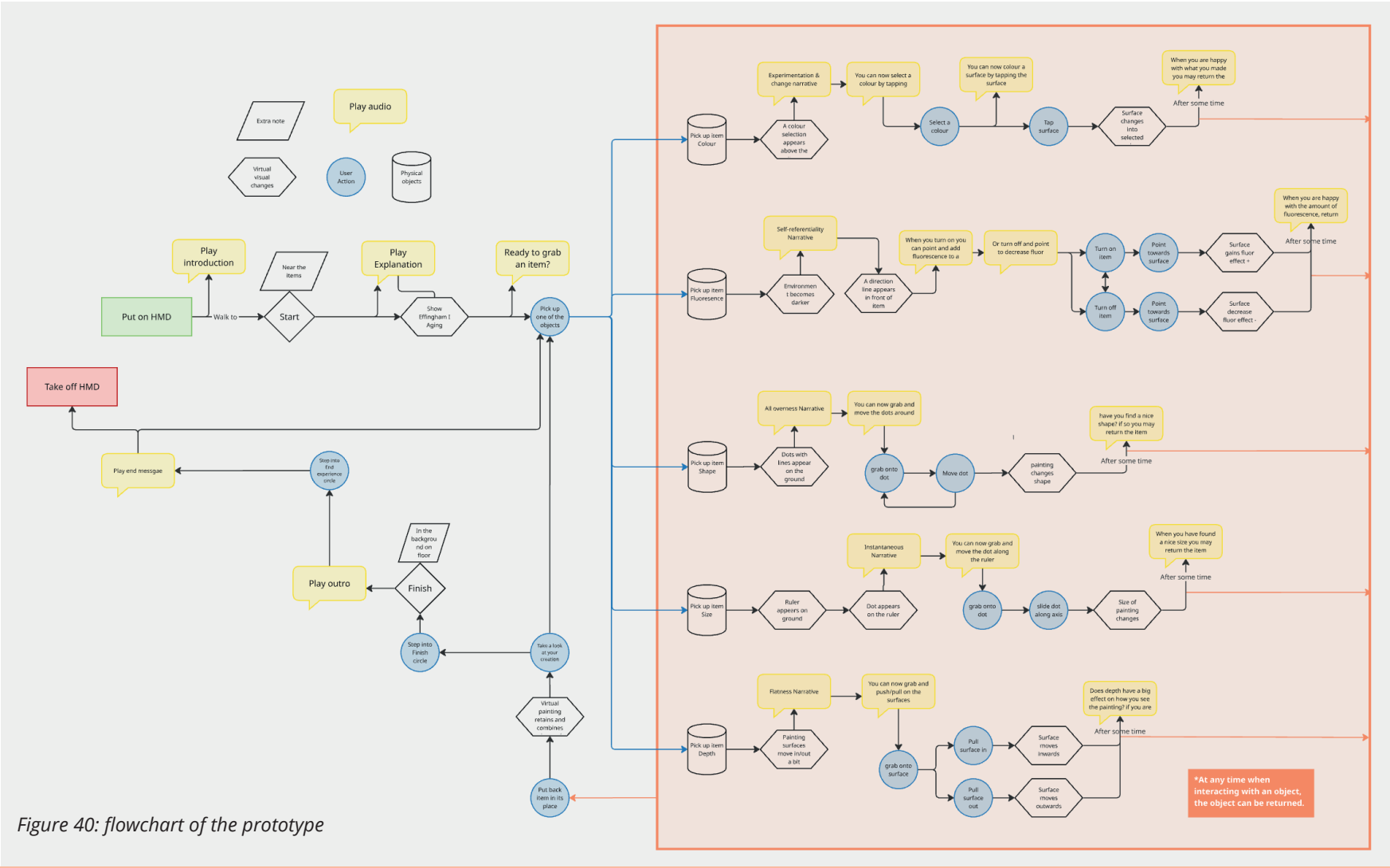


Figure 40: flowchart of the prototype

Elements of the prototype

The concept consists of both virtual elements and physical elements which, by working together, allow the interactions.

Physical elements

The prototype consists of only few physical elements, but these are crucial to the interactions. They form the physical interface and contribute their affordances to make the interactions clearer. With each visual element comes a physical object.
There has been a lot of consideration on the objects to use. The aim was to find objects that represented Frank Stella, provided affordances for the desired interaction and fit the aesthetic of the modern art museum. Figure 44 shows these objects and their iterations during development.

Virtual elements

The virtual part of the experience exists out of the virtual replica of the painting and Interactive user interface (UI) elements, such as navigational squares (see figure 42).

Models of the painting

The virtual replica of the painting is created in 2 ways, a mesh model made using blender and a vector-based model. These models are used to create an interactive 'touchable' painting, as the genuine painting is not to be touched. Which model is used in which place depends on the type of interaction.

Colours

The base colours (figure 41) used in the painting are picked from De Winters research into Illusory depth based on interactions between fluorescent and conventional colours (without a fluorescent effect) (De Winter, 2018).

Interactive elements

In the prototype there is a variation of interactive elements. The virtual replica itself, pinchable dots, a grab-able slider and a colour wheel widget interface. All these elements are controlled through or with one of the physical objects (see figure 57 - 61).

Besides those UI elements there are 3 navigational squares, which allow the user to start, end and step out of the experience. These are kept relatively simple and are only visible when needed.

Virtual replicas of physical objects

During development it became apparent that when virtual elements are loaded, physical objects (or user's body) are in the front of a virtual element, the virtual element will be rendered in over it, the physical body visually disappears. This causes an issue with hand eye coordination. By adding a virtual element onto physical bodies (fingertips, gloves, paintbrush, flashlight, ruler and shape) this problem is solved. The physical body will still visually disappear, but a virtual replica remains visible in front.

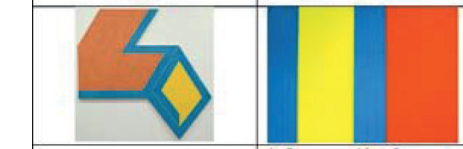
original art work	original	original (conventional variant)
A. Effingham I	design 9	design 13
		
	1: fluorescent blue; 2: fluorescent yellow; 3: fluorescent blue; 4: orange	1: blue; 2: yellow; 3: blue; 4: orange

Figure 41: Approached colours & difference between fluorescent and conventional colours (De winter, 2018)

Figure 42: navigational elements

Figure 43: The tangible bucket (left) with virtual counterpart (right)

Paint bucket and brush - Colour

Connection to context:
Stella used large brushes and wanted his paint to be on the surface as it came straight out of the bucket.

How is it used:
User picks up the bucket and brush, the bucket can either be held or put on the ground. In the bucket a colour wheel widget appears. With the brush, go into the bucket and select a colour by touching the widget at the colour that is wanted.
By touching the surface of the replica with the brush, the shape it is touching will change into the selected colour.

Shape - Shape

Connection to context:
Follows the irregular shape of Effingham I.

How is it used:
User picks up the shape (with left hand), slightly above the shape dots appear, with that lines between the dots and a colour fill between them are visible. The user can pinch the different spheres (with right hand) and drag them to a new location. When a dot is released a reshaped Effingham 'replica' is shown.

Ruler - Size

Connection to context:
Stella used rulers and pencils to draw out the shapes on the canvas.

How is it used:
User picks up and holds the ruler (in left hand). On the ruler there a cylinder is visible. This cylinder can be dragged left and right on the surface of the ruler by pinching it (with right hand). By moving it right the virtual painting will increase in size, moving it to the left will decrease the size.

Glove - Depth

Connection to context:
Gloves are used in art restoration, cultural heritage should be touched with care, highlighting its vulnerability. Do not touch the painting without precautions.

How is it used:
User puts on the glove, walks up to the virtual painting. They can grab onto one of the shape surfaces, which will then move with the users hand. The surface can be dragged out and pushed in.

Flashlight - Fluorescence

Connection to context:
The fluorescent effect is noticeable under Ultra Violet light (UV, the flashlight creates a figurative beam of this UV light.

How is it used:
User grabs the flashlight, a (purple) 'UV light' beam is cast from the front. Moving the beam over the different surfaces will increase a fluorescent effect. When the button on the flashlight is pressed, the beam colour changes to a yellow colour. Now the beam decreases the fluorescent effect when hovered over the virtual painting.

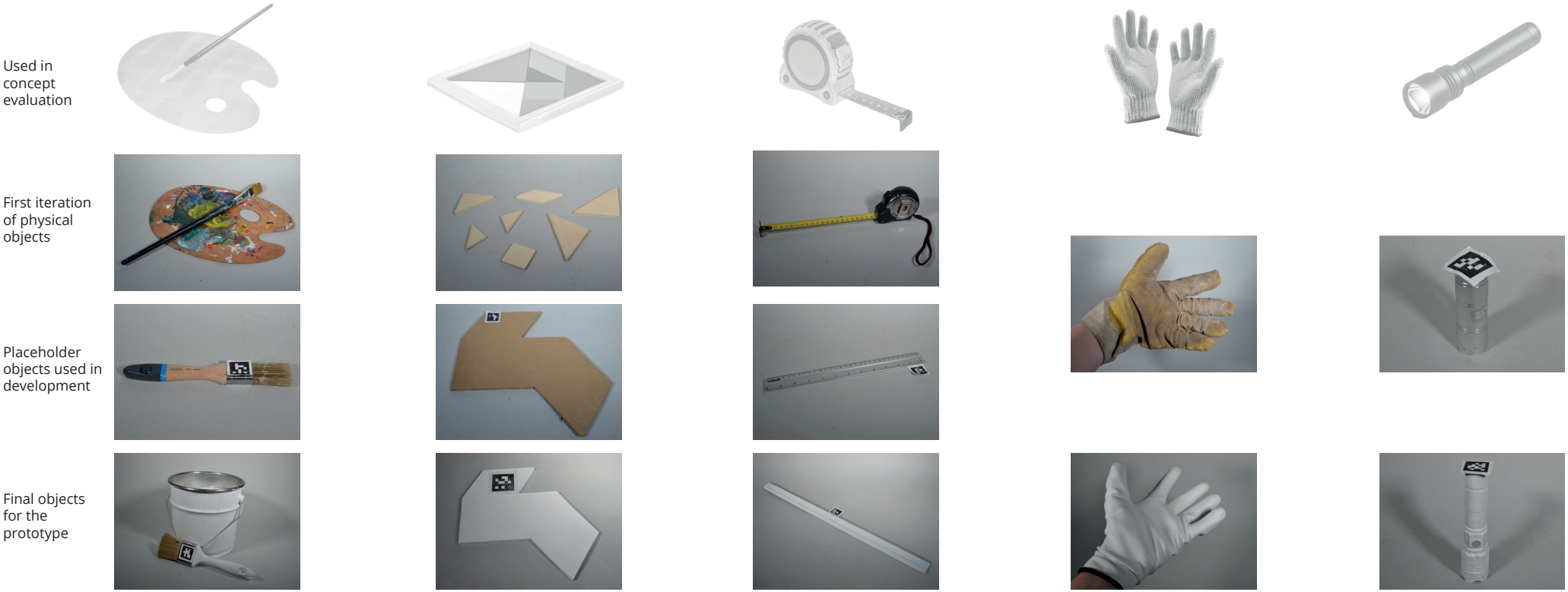
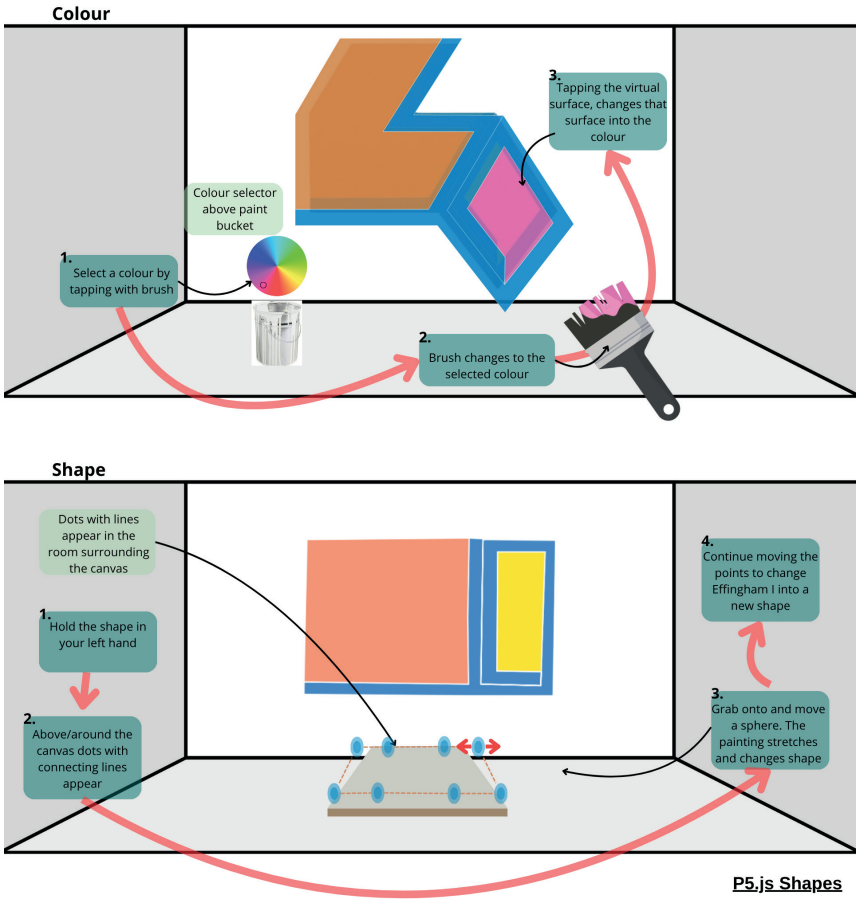


Figure 44: Iteration cycles on physical objects

As described, every object comes with its way of control. To keep every visual aspect interesting and prevent users to get bored doing the same kind of thing over and over. Each interaction is linked to the affordances of the recognizable tangible objects, making it easier to understand and use. Figure 45 describes the interaction for each visual aspect.



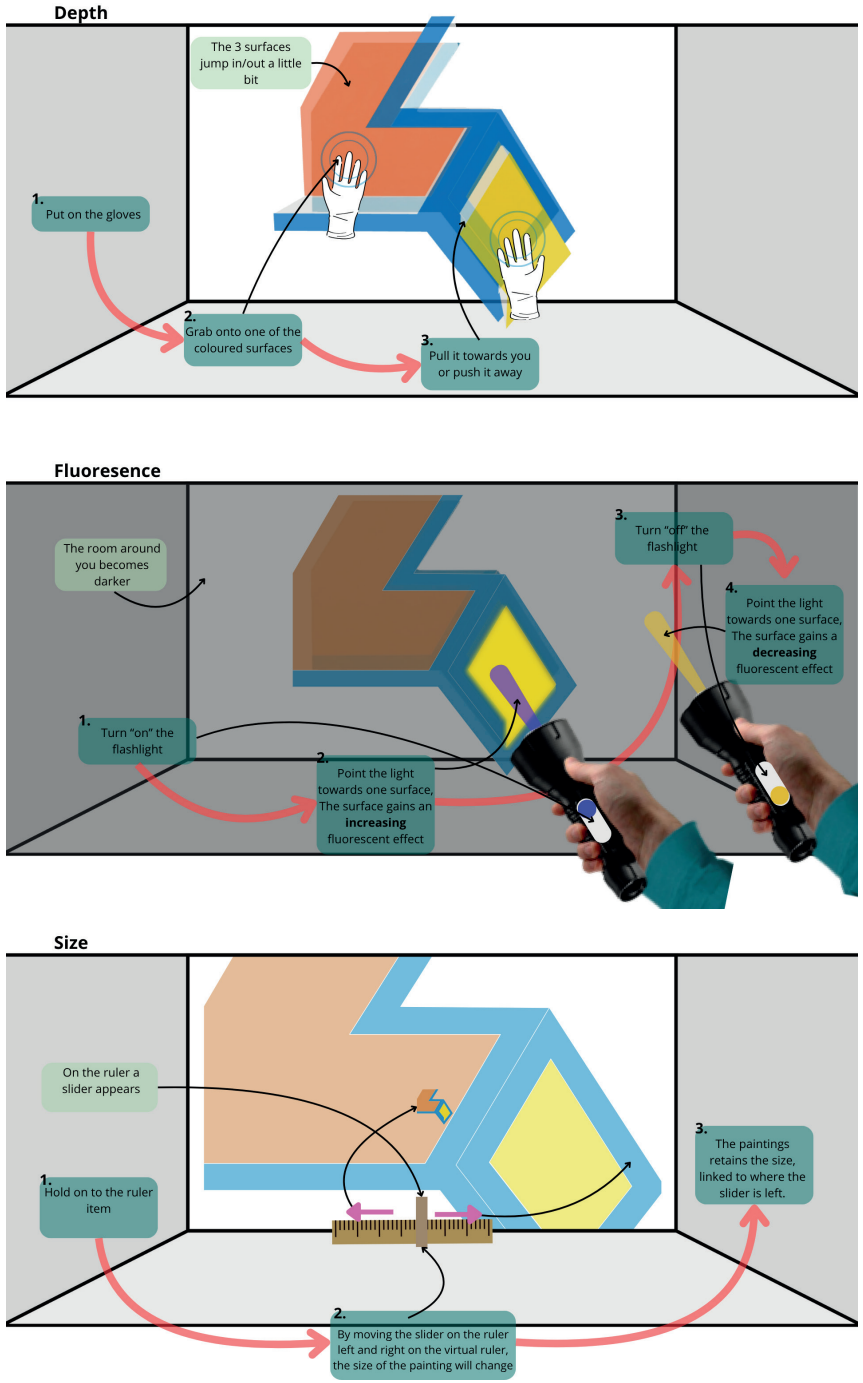


Figure 45: Interaction with the visual elements

Tracking

The prototype makes use of different types of tracking. All tracking is done with Inside out tracking, which means everything is being tracked through the cameras on the HMD. This means that for elements to be interacted with they must be in the view of the HMD.

The interaction makes use of 2 types of tracking, that of the hands and that of Varjo Markers.

Hand tracking

The prototype makes use of hand tracking, using position and grab & pinch gestures. For development purposes the interactions were first made possible using controllers.
To make the interactions feel more embodied and natural it was desired to remove the possibly confusing controllers and make use of the hands exclusively. Tracking and gesturing work relatively well but can be tricky when not tracked correctly. Objects being in the way or colours in the environment as well as the hands being out of visual range can disturb tracking and cause trouble.
Some of the tracking first done through the hands was replaced with Varjo markers, this made interaction more stable in certain cases.

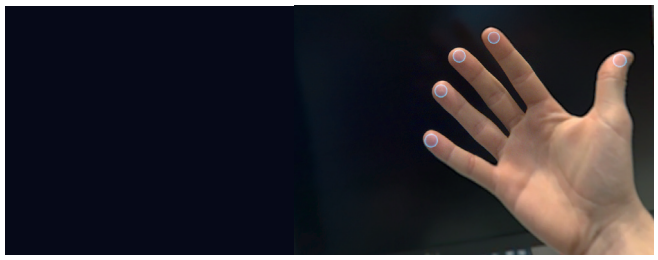


Figure 46: Hand tracking is made visible by blue markers on fingertips

Varjo Markers

One possibility with using the Varjo HMD is the possibility to use Varjo markers (figure 47). These markers are trackable by the HMD and have the possibility to anchor virtual content to them. Varjo markers are placed on the various objects to connect them to virtual content and in this way make them controllers for the interaction.
During the concept development it became clear that placement was an important factor. For the virtual content to be mapped correctly the markers must remain visible, when not some visual glitches might occur. The Markers must be on a flat surface and remain stationary relative to the physical object they are attached to. There are 3 possible sizes of the markers, each size comes with its own traceable distance, the bigger, the further away it can be seen and the more stable the anchored elements will appear.
With some iteration the markers are placed in the best-found way, still some covering of them may happen during interaction.

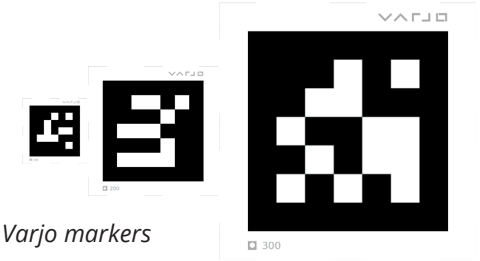


Figure 47: Varjo markers

Figure 48: Addition of social element clusters

Social aspect

To this point one of the contextual aspects was mostly left on the sideline, a social element. During ideation some ideas about this came up but were never further developed.
3 ways of possibly adding a social element have been thought of.
- During the experience - sharing what one sees/ experiences in AR to another who is outside AR
- After the experience - sharing what and how they experienced the AR experience
- Between different users engaging in the experience at different times.

With the creation element in the experience an interesting opportunity appears. Users create something personal, which gives the possibility for that creation to be shared. This can be done either within the experience (A virtual exhibit of user creations) or outside the experience (giving people a copy of what they created, digitally or printed)
For the prototype the 3th option is added in the form of 'The gallery of creations" (see figure 49), giving users the possibility to see some of the creations made by others before them. Allowing them to compare, reflect and react to creations of others.

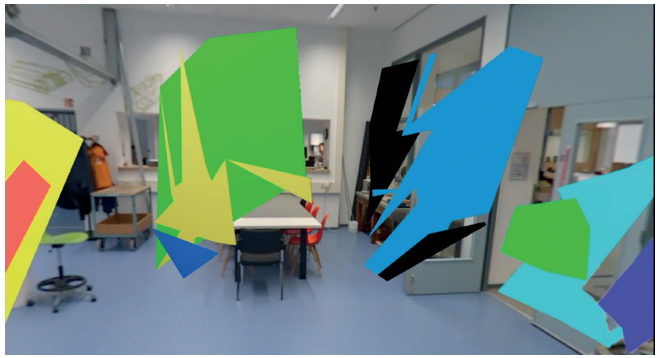


Figure 49: Prototype picture of 'The gallery of creations'

Development cycles

The final prototype went through a multitude of design cycles, through quick testing and reflection with people around at the time the prototype evolved stepwise.

Starting point: p5.js sketches.

Goal: *Create blueprint of the interactions and clarity in how interactions work*
The starting point of the prototype was screen-based using p5.js. Here the 5 different visual aspects are represented and can be interacted with, in a two-dimensional space. These function as the basis and foundation if and how interactions could work.

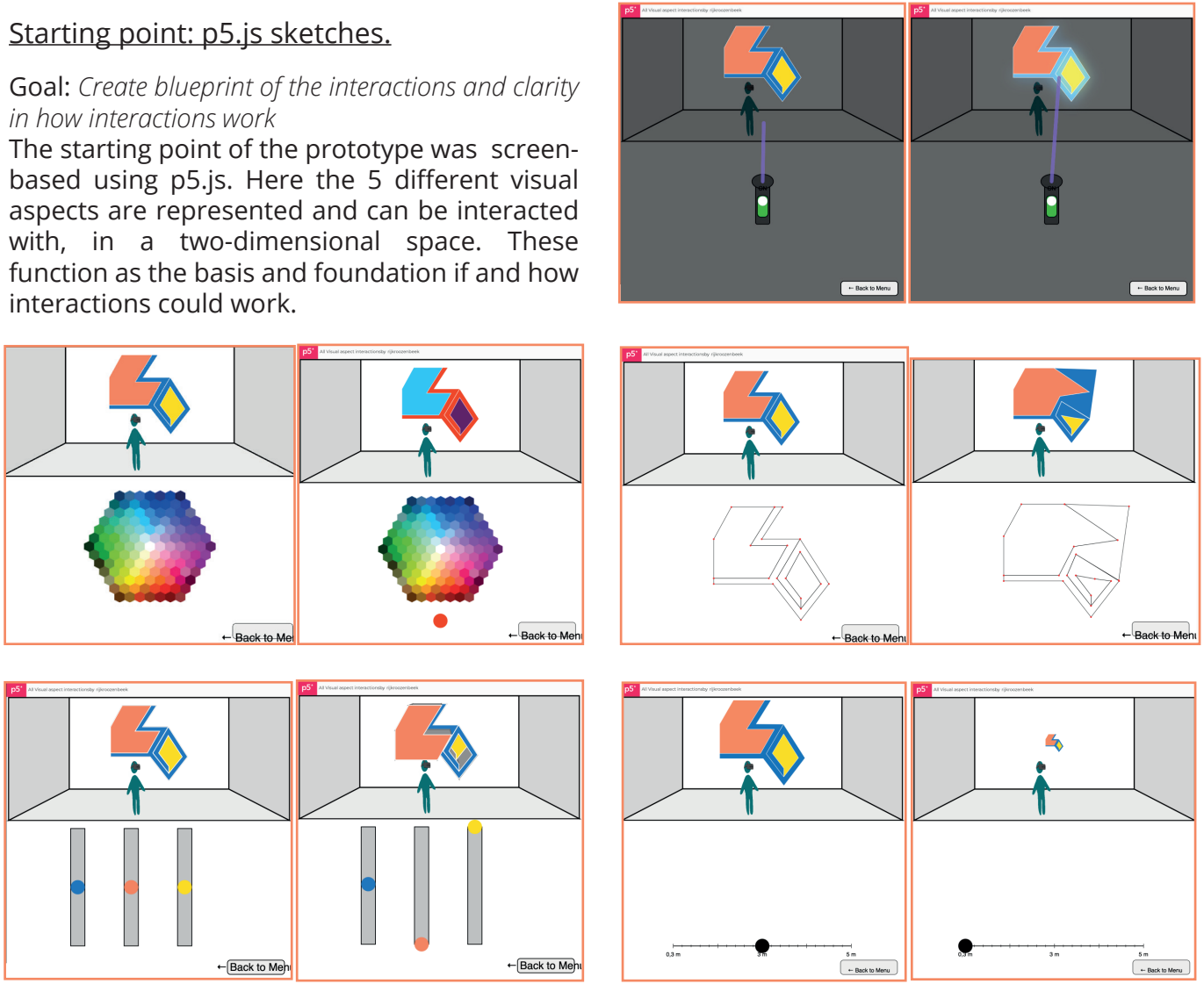


Figure 50: Interactions in screen based P5.js prototype, in order of Colour, Depth, Fluorescence, Shape and Size

The effects to be caused in unreal engine.

Goal:
Showing the 5 visual aspects changing as desired
Improved criteria:
- Users should engage with the 5 visual aspects and get an insight into how the painting is built up.
- The experience should convey the temporal changes Effingham I undergoes
- Elements and information within the experience should feel aesthetically convincing.

With a starting point of the interactions present the development of the AR experience in Unreal started. At the start this meant displaying the desired effects of the interactions passively.

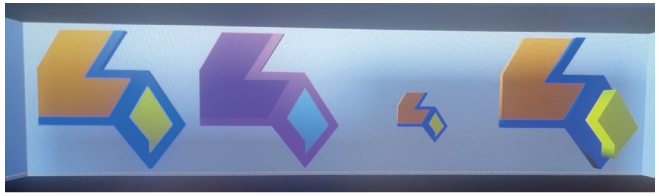


Figure 51: Effects of interaction worked out in Unreal engine

The interactive elements, intractable using Vive-controllers.

Goal:
Make interaction with digital layers possible
Improved criteria:
- The interaction should make use of embodiment, tangibility and spatiality
- The experience makes use of the affordances of AR and Varjo technology

The next step was adding actual interactive elements, being able to control what is happening. At this point handheld-controllers (figure 52) were used as the buttons helped in controlling, grabbing elements and navigating more easily.

Figure 52: Interaction using vive-controllers

The interactions done using hand tracking.

Goal:
Make the interaction more embodied
Improved criteria:
- The interaction should make use of embodiment, tangibility and spatiality
- The experience should be easy to understand and use
- The experience should provide an authentic/novel experience
- The experience makes use of the affordances of AR and Varjo technology

It was desired to avoid the use of controllers; thus, the decision is made to use hand tracking. This did not change the interaction drastically but caused some struggles with accuracy. With the removal of the handheld-controllers it made the interaction feel less like a game and more like interacting in the real world. The controllers acted as a mediating interface between body and effect.

As a way of displaying the hands being tracked, virtual markers are mapped on the user's fingertips (figure 46). This should support users in understanding what is happening and connect them to the virtual environment.

Anchoring the 5 visual aspect interactions on Varjo-Markers and the addition of physical objects, tracked by Varjo markers.

Goal:
Add the tangible experience
Improved criteria:
- The interaction should make use of embodiment, tangibility and spatiality
- The experience should be easy to understand and use
- The activity should activate multiple senses
- The experience makes use of the affordances of AR and Varjo technology

A next and important element is the addition of physical objects, which are tracked using Varjo markers.

It could be noted that the addition of physical 'controllers' could bring back the interface barrier brought by the avoided handheld-controllers. Different than the handheld-controllers these objects felt less like an interface and more like real-world enablers to make the interaction more concrete and easier to understand.
With the Varjo markers it was found that placement is important. During the interaction they should remain visible and thus should be placed in such a way to avoid the user's body from covering them. With some moving around and testing the best (but not perfect) positions were found.

Creating a user interface to control the different scenes.

Goal:
Create control and navigation
Improved criteria:
- Elements and information within the experience should feel aesthetically convincing

As the aim is to make use of some Wizard of Oz control during the evaluation. An on screen User Interface was made (figure 53), containing different buttons to navigate between different scenes and enable/disable the different kinds of interactions.

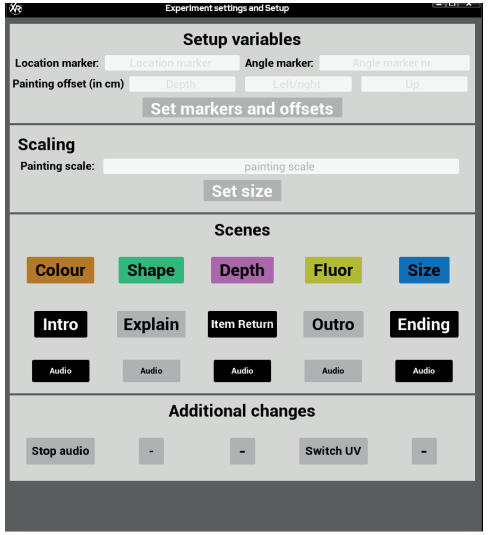


Figure 53: Wizard of OZ on screen interface

Replacing physical object place holders and adding virtual replicas of this object.

Goal:

Increase aesthetic and ease of use

Improved criteria:

- Interactive elements Should be easy to understand and use

- Elements and information within the experience should feel aesthetically convincing

- Users should engage with the 5 visual aspects and get an insight into how the painting is built up.

- Interactive elements should be easy to understand and use

- The interaction should make use of embodiment, tangibility and spatiality

Up to this point a set of very limited props was utilized to generate the virtual experience of the prototype. In this iteration the actual addition of more refined objects have been created. To contain them all in the same aesthetic language and fit them within the museum atmosphere all objects are coloured white. This gives them an equal and serene look while still being recognizable as the object they are.

During development in Unreal engine it was found that virtual elements are rendered in front of real elements, to counter this virtual replicas of the physical objects are added anchored to hands and varjo markers.

Figure 54: Visibility of objects before and after adding virtual replica's

the addition of the narrative elements and user navigation to the experience.

Goal:

Incorporate the narrative elements

Improved criteria:

- The experience should convey the temporal changes Effingham I undergoes

- The experience should convey Frank Stella's 4 modernist principles

- Users should engage with the 5 visual aspects and get an insight into how the painting is built up

- Users should feel like they learned something from the experience

- Within the experience there should be room for contemplation

- The experience should provide a way of personal identification

Alongside developing the prototype, the to be transferred narrative has been selected. For every scene a short script was written and recorded (see Appendix Q).

There was some consideration on using AI generated voices or recording a self-recorded voice. Although AI voices have recently increased in quality, they still felt static, robotic and lacked the feeling aimed for. This led to the decision to record and a slightly edited self-recorded narrative.

The recordings were added to the scenes all with some timing to give users the time to get adjusted and familiar with what is happening before overwhelming them with another sense.

To finish the entire flow of the experience, navigational elements are added so users can move on to the next step by walking onto markers on the ground. When walking in this will activate a new scene and/or narrative.

During the interaction the user is exposed to a combined changed outcome of their doings, which was added in this iteration. By taking elements from every interaction and incorporating those into one virtual "Effingham" creation. This creation can be seen in between picking up the different items and before ending their experience, where they will be asked to take another look at and compare their creation to Stella's Effingham I.

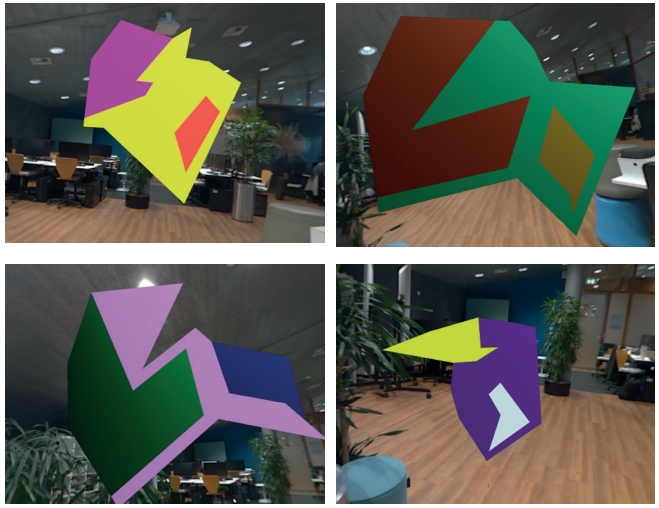


Figure 55: Examples of final creations in the experience

Limitations of prototype

- Hand tracking accuracy

The tracked hands are not always perfectly aligned with actual hands, causing a mismatch with where hands grab/pinch and where the virtual interaction happens. Continuing from that, gestures are not always captured correctly which can cause trouble. It is best to make clear and exaggerated gestures to counter this.

- The virtual painting's material aesthetic in the prototype

The virtual replica is missing the material aesthetic the actual painting has. This is due to the limitation of time and knowledge.
The concept attempts to approximate the original look of Effingham I by using the colour difference over time, based on generated artificially aged fluorescent paint samples investigated by de Winter (n.d.) and conventional colours selected by de Winter (2018)

- Only Right-handed interactions

To make the interactions more stable the decision was made to make the interactions all right-handed. This prevents users from accidentally activating elements with a non-used hand (mainly grabbing and pinching). The downside to this is the level of freedom and accessibility for left-handed people.

- Wizard of Oz

The prototype is missing some technical elements. During the validation this will be countered using a Wizard of Oz method.
This presents itself in the activation of different scenes and sounds, picking up an object and activating its interaction environment.
These elements can all be controlled through an on screen UI.

Final Design

In this chapter the final outcome of this graduation project will be described.
Starting with the general explanation of the experience. Followed by descriptions of the to be transferred narrative, the physical & virtual elements and the interactions.

General explanation

With the developed concept museum visitors are invited to play with modern art. By interacting with Effingham I through AR the experience creates a better understanding of how the painting is build up, the artist's intentions and the effects of change on the painting.

The concept is a relatively free and self exploratory experience, through interaction with physical objects and connected virtual elements. Visitors use a set of recognizable objects to affect, the colour, shape, depth, fluorescence and size of a virtual replica of effingham I. With every visual aspect they are exposed to a narrative element, explaining how Frank Stella approached his art and posing contemplative questions, nudging users to activate thoughts and imagination. Museum visitors create their personal, new painting version based on Effingham as an outcome of their effort. The goal of the experience is to engage visitors with art in a new experiential authentic manner and let them walk away with newly gathered ideas about Frank Stella and his modernist art.

The story

During the experience a visitor is exposed to 3 narrative elements.
1. The temporal change affecting effingham I's look.
2. Stella's intentions with the painting through his modernist principles: Flatness, Self-referentiality, All-overness and Instantaneousness.
3. 5 Visual aspects contributing to how the painting is build up: Colour, Shape, Fluorescence, Depth and Size.

The temporal change is simply shown and explained using a narrator at the start and end of the experience.

Users experience the 5 visual aspects by making changes based on the visual aspect to a virtual Effingham I.

During the interaction with the 5 visual aspects, a voice-over provides information about Stella's principles and how he approached his paintings. The transcript of the narration used in the final prototype can be found in appendix Q.

The experience provides the 2 main goals for a museum, to teach and to provide entertainment. It gives background information to learn something about the painting and provides room for self exploration, the creation of a personal connection and contemplation. A combination of getting real information and creating your own interpretation.

A storyboard walkthrough of the interaction can be found on page 62 to 68.

The environment

The intended environment for the created experience is situated in a modern art museum. To accommodate for this environment the experience itself is made to fit, tangible objects are coloured white and are to be presented on a blanc table. Figure 56 shows how the experience

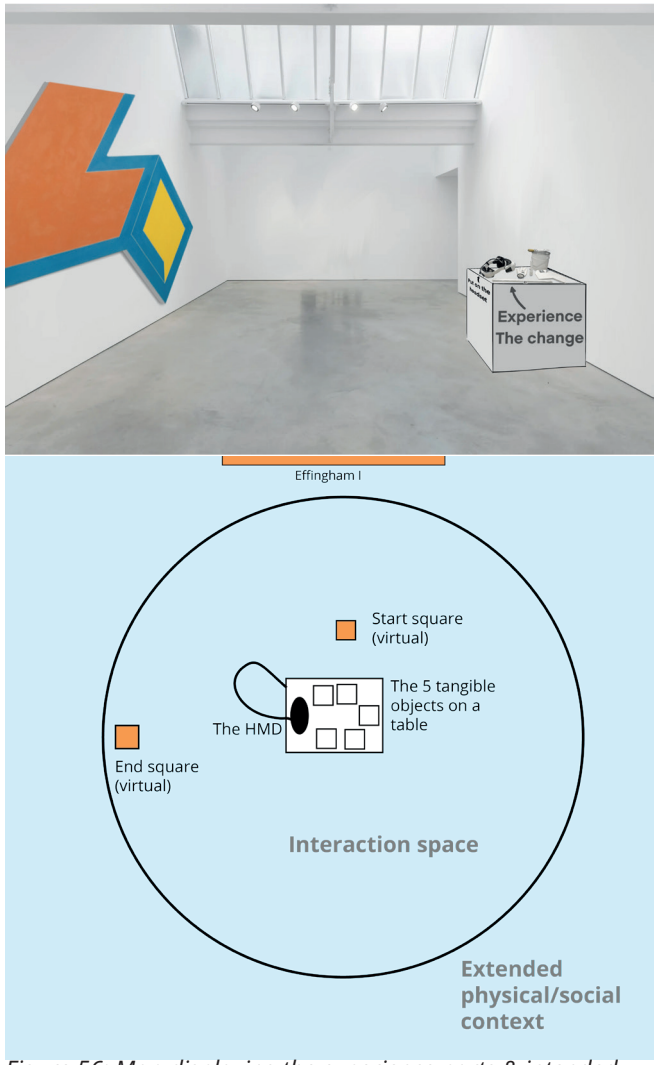


Figure 56: Map displaying the experience parts & intended look in a museum exhibit

Design elements

Tangible objects

The prototypes most notable physical objects are those used in the interaction, these are individually explained in the following sub-chapters. Besides these objects there are a few more. The computer in the room, the HMD, a few varjo markers to position the virtual painting an navigational elements and the real Effingham I.

Virtual elements

All physical objects have a virtual element linked to them, for the intractable object this is explained in the following sub-chapters.
Besides those elements there is:
A virtual replica of effingham I showing temporal change
A virtual intractable replica, for every visual aspect.
A virtual changed Effingham, combining all applied changes during the interaction.
Navigational squares, linked to a Varjo marker, to start/end the interaction.

Colour elements

The object used is a paint bucket combined with a broad brush, made from the actual items painted white.

Bucket

- One medium Varjo marker centered inside of the bucket.
- Virtual widget, with a selectable colour wheel.
- Virtual replica made of cylinders.

Brush

- 2 small Varjo markers, on each side of the brush.
- Virtual rectangle, changing with the picked colour.
- Simplified virtual replica mapped over the brush.

Shape elements

The object used is a cut out effingham shape made of multiplex, painted white.

- A medium Varjo marker placed on the place expected to be touched/covered least.
- 21 Virtual, pinchable dots floating above the physical shape.
- Lines connecting the dots, creating 3 shapes
- Filled in colours between the lines, clarifying the shape to the user.

Figure 57: Bucket, brush and their virtual components

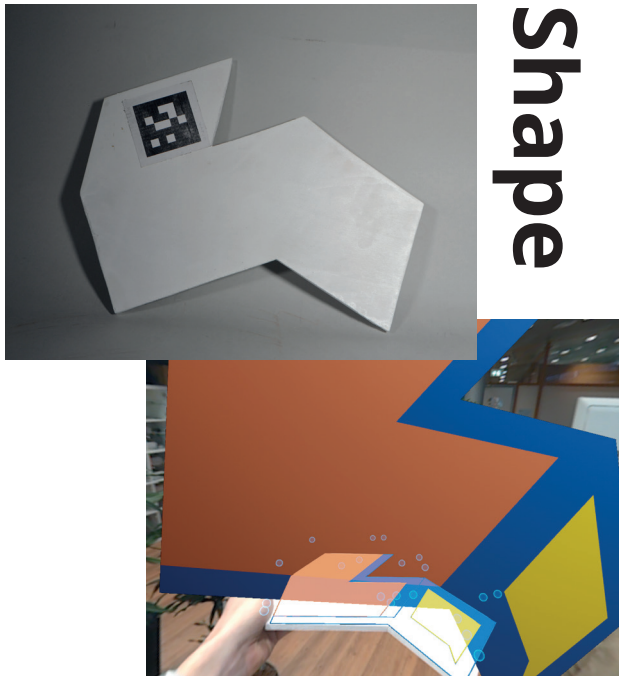


Figure 58: Shape and its virtual components

Depth elements

The object used is a right-handed glove, used to grab onto a surface of the virtual effingham I.

- White glove
- Virtual white hand mapped over user's hand

Fluorescence elements

The object used is a white painted flashlight.

- Small Varjo marker on the bottom, most visible when pointed at painting
- Virtual beam coming from the flashlight, purple coloured (UV) or yellow coloured (normal).
- Virtual representation of flashlight shape
- Button to switch between 'UV' and 'normal' light mode.

Size elements

The object used is a 50cm transparent ruler.

- Small Varjo marker in the centre top of the ruler
- Virtual rectangle following the ruler shape
- Virtual pinchable slider cylinder, slidable along the ruler.

Figure 59: Glove and its virtual components

Figure 61: Ruler and its virtual components

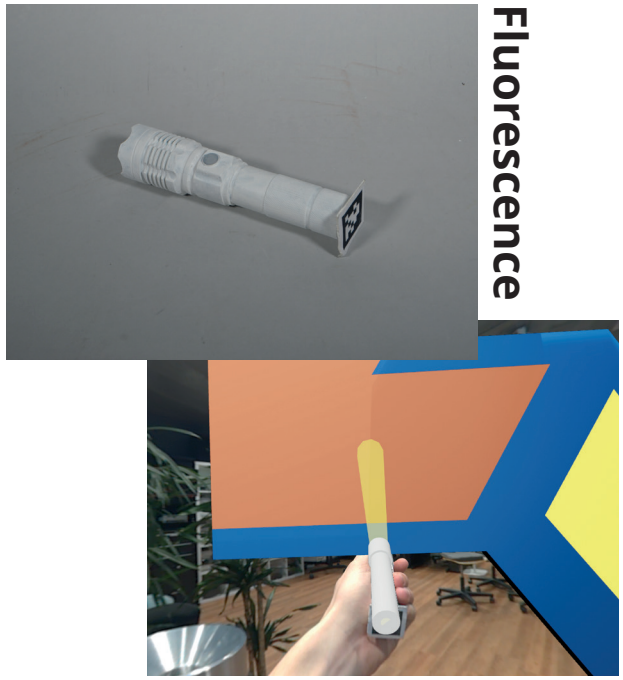
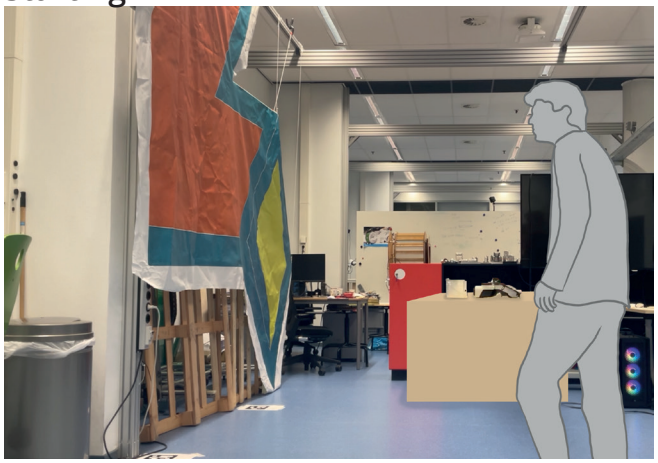


Figure 60: Flashlight and its virtual components

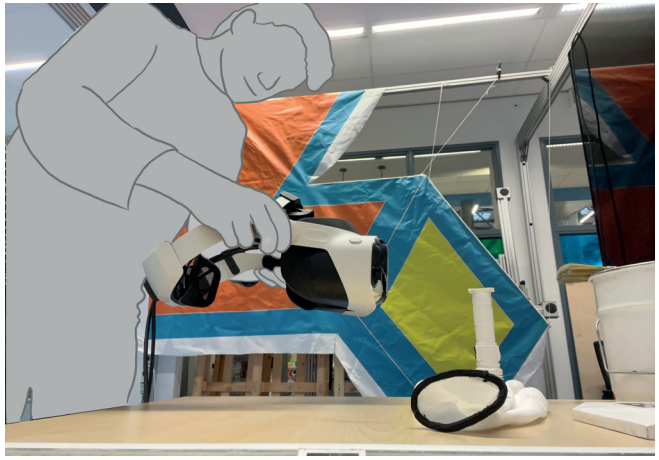
Storyboard

Starting

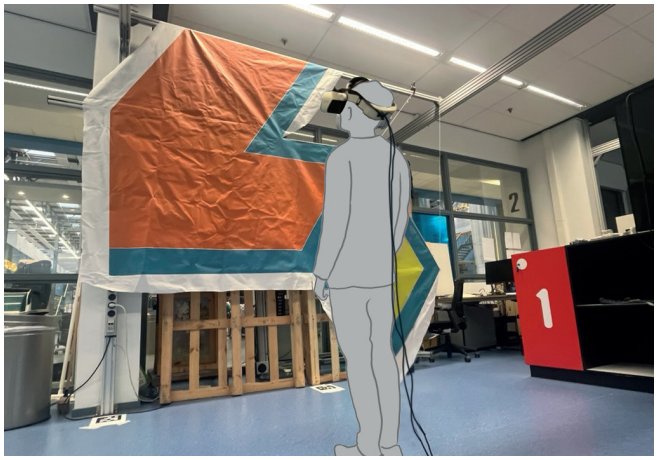


A museum visitor enters the exhibit room. Here they see a painting, 5 white coloured objects and an AR headset.

The visitor approaches the objects out of curiousness and wonders what they are for.

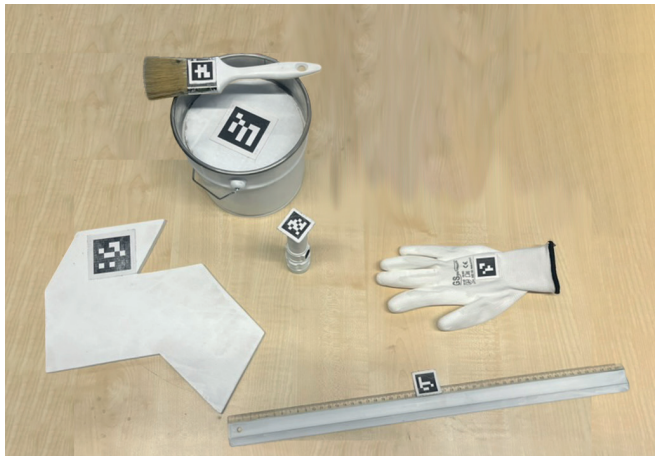


They put on the AR headset to see what they can do. Some time is given to get adjusted to the headset, after a little time an intro narration starts playing.



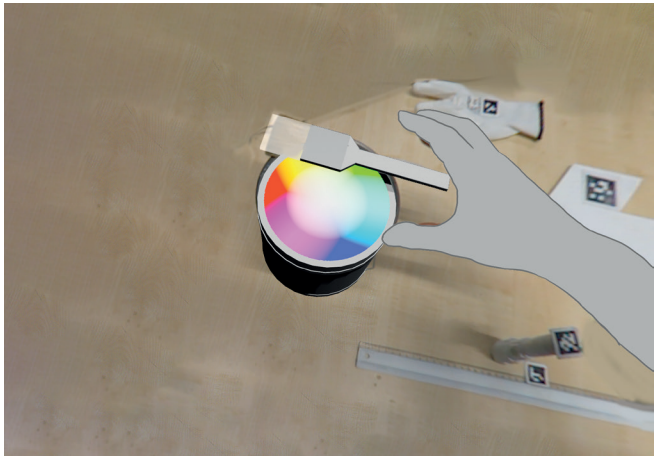
A voice starts playing, explaining some basic information about the painting and nudging them to walk into 'start'.

Over the painting a layer appears, showing how the painting slowly fades away and loses it's vibrancy over time. During this they are being told about the change that happens.

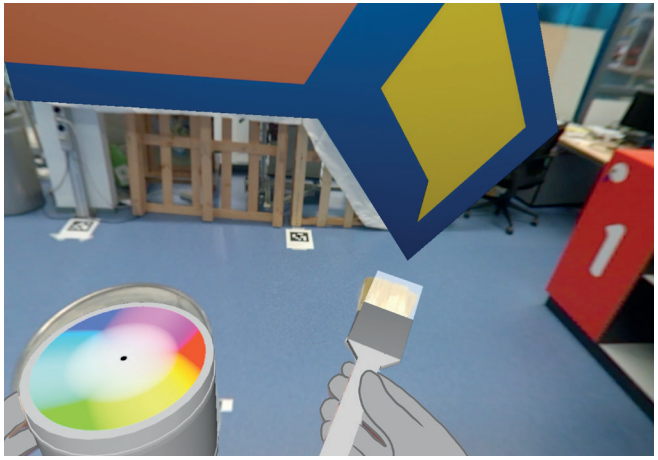


At the end of the message they are told they can pick up one of the items on the table. They walk towards the items and grab one they are curious about.

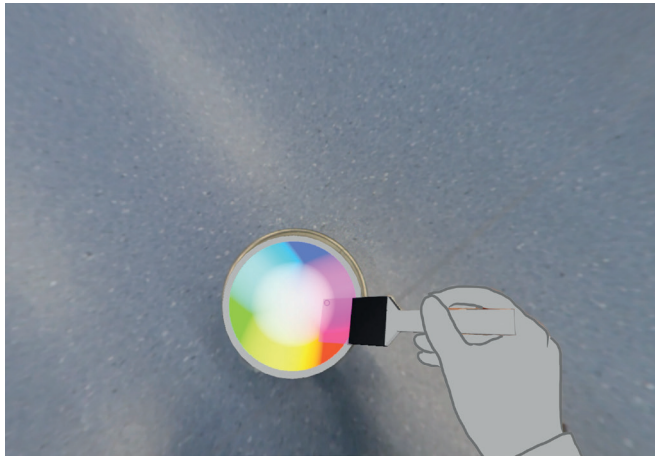
Grabbing the bucket



The visitor grabs the bucket. When touched it gains a virtual layer.

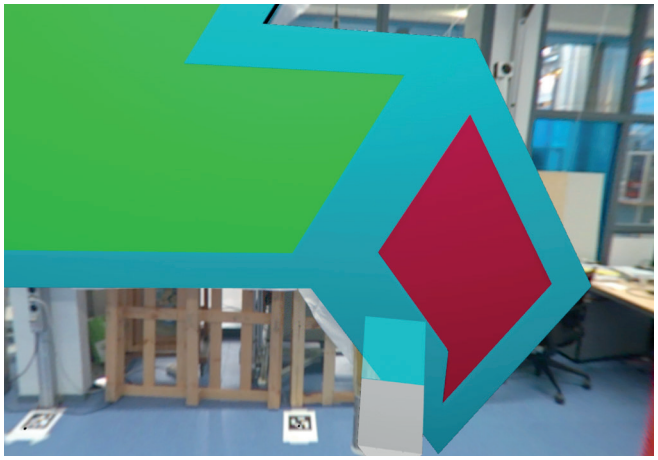


A voice begins to play, explaining about Stella's use of colour and how it affects the painting. It is explained they can apply their own change to the painting.

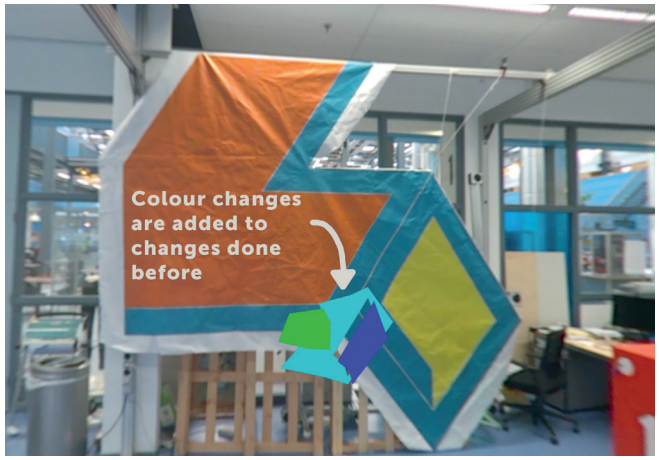


By grabbing a colour from the bucket and applying it by touching the painting with a brush.

They can try out different colours for as long as they like. After applying some changes they are posed with a question "What is the effect of your applied changes on the painting, Its all overness, Self-referentiality, Instanteneousness and Flatness?"

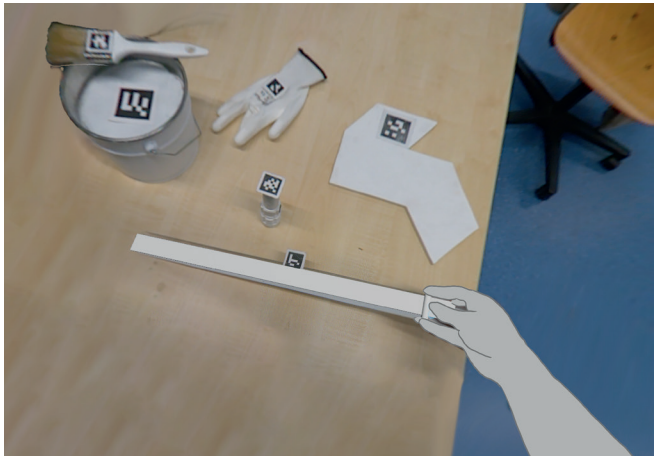


They take some time to think, reflect or try out a little more. When done, they return the item to the table.



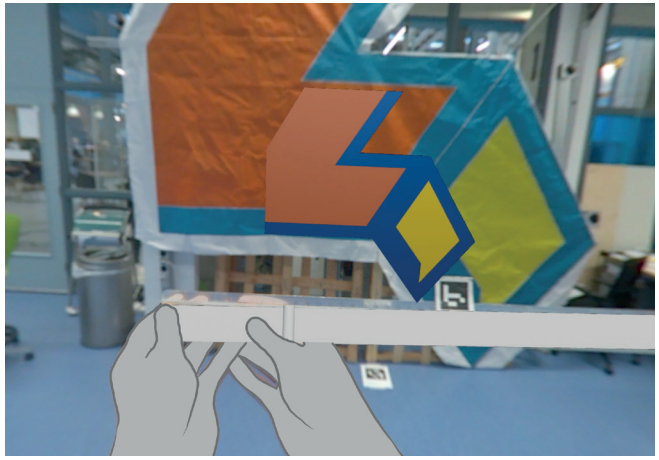
When returning they see their changes combined and applied to the virtual overlay of the painting.

Grabbing the ruler

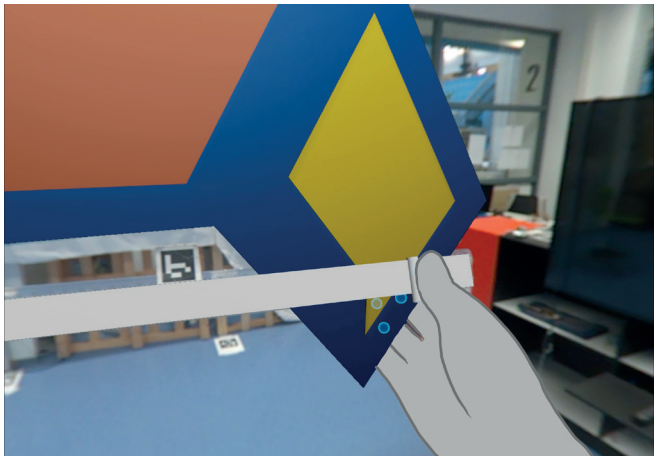


The visitor grabs the ruler. When touched it gains a virtual layer.

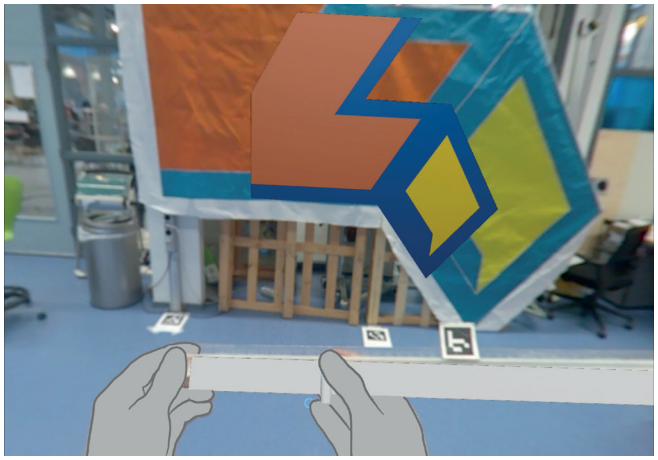
A voice begins to play, explaining about the principle of Instantaneousness and how Stella applied this including the effect of size.
It is explained they can apply their own change to the painting.



By holding the ruler and sliding a bar either left or right the painting changes in size accordingly



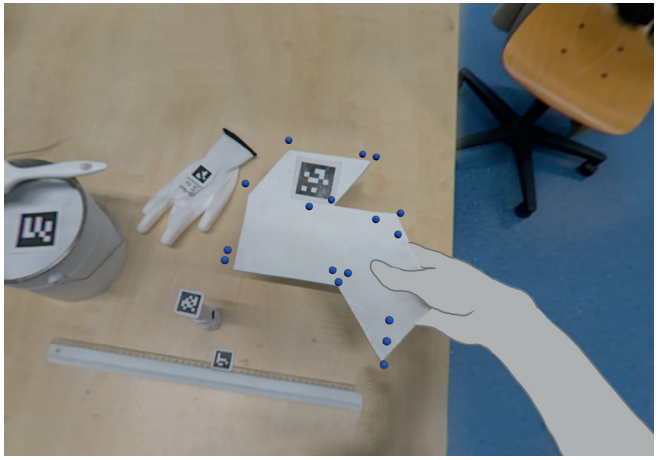
They can try out different sizes for as long as they like. After interacting for a while they are posed with a question “What is the effect of your applied changes on the painting, Its all overness, Self-referentiality, Instanteneousness and Flatness?”



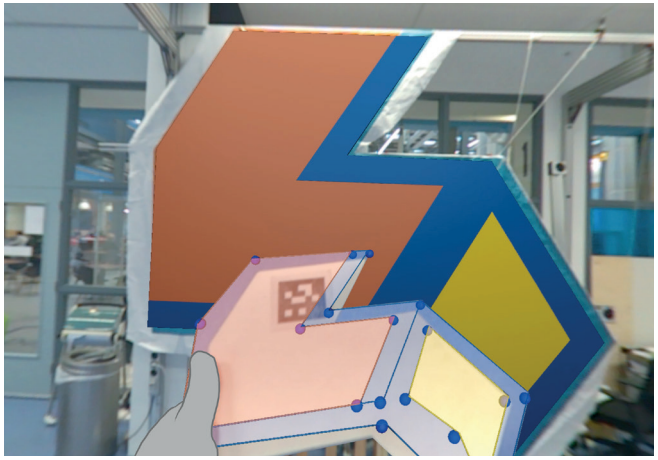
They take some time to think, reflect or try out a little more. When done, they return the item to the table.

When returning they see their changes combined and applied to the virtual overlay of the painting.

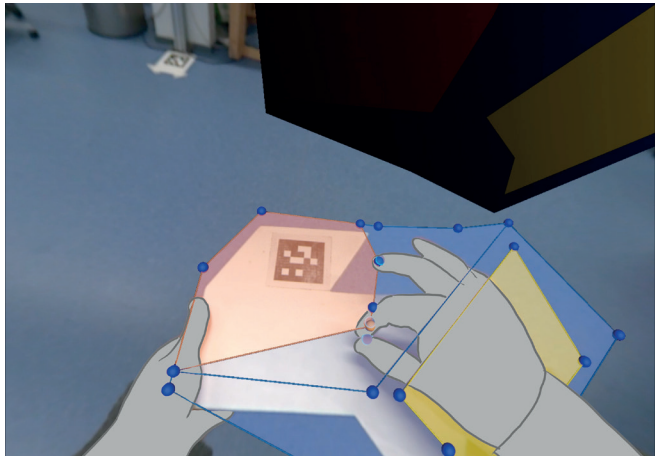
Grabbing the shape



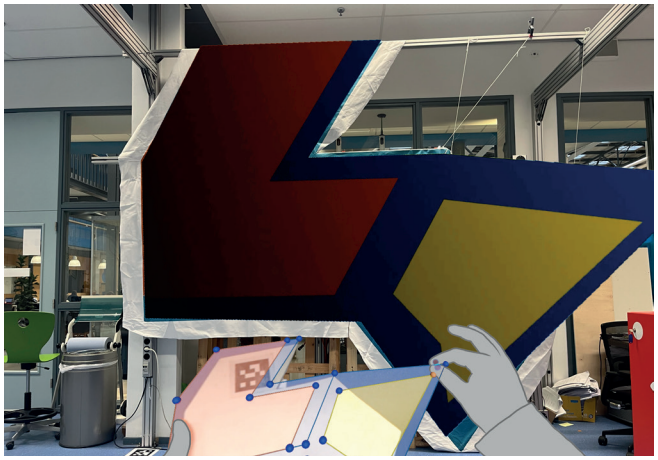
The visitor grabs the strangely shaped board. When touched it gains a virtual layer.



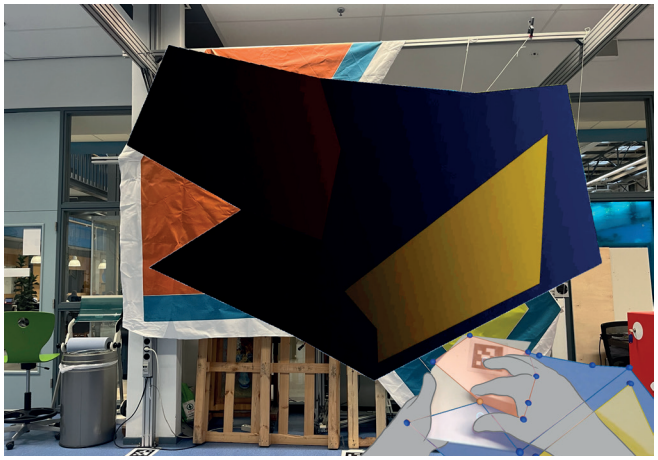
A voice begins to play, explaining about the principle of all-overness explaining how Stella approached this, including the use of irregular shaped canvases.
It is explained they can apply their own change to the painting.



By holding the shape in one hand and with the other hand pinch and move the dots that have appeared above the painting the shape of the painting can be changed.



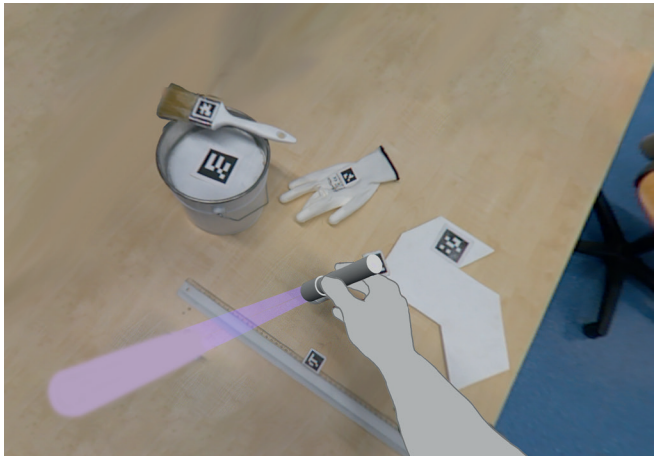
They can try out different shapes for as long as they like. After trying out some shape changes they are posed with a question "What is the effect of your applied changes on the painting, Its all overness, Self-referentiality, Instanteneousness and Flatness?"



They take some time to think, reflect or try out a little more. When done, they return the item to the table.

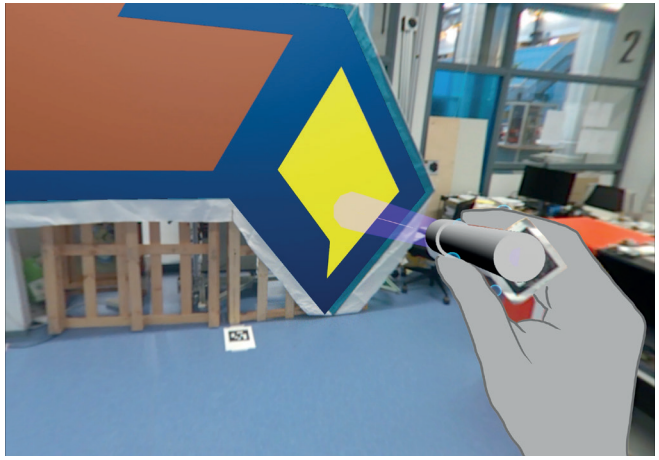
When returning they see their changes combined and applied to the virtual overlay of the painting.

Grabbing the flashlight

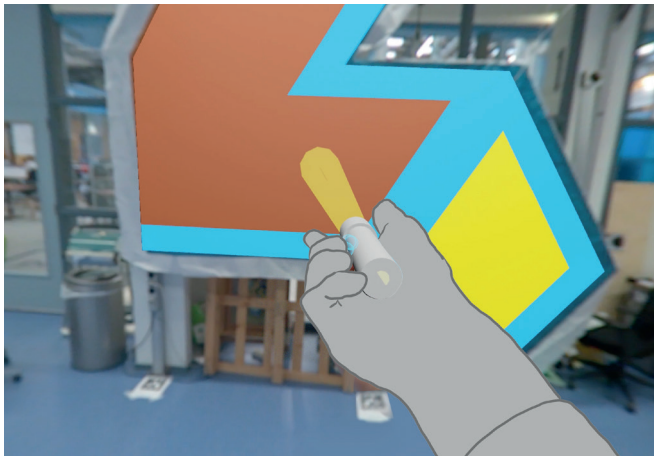


The visitor grabs the flashlight. When touched it gains a virtual layer.

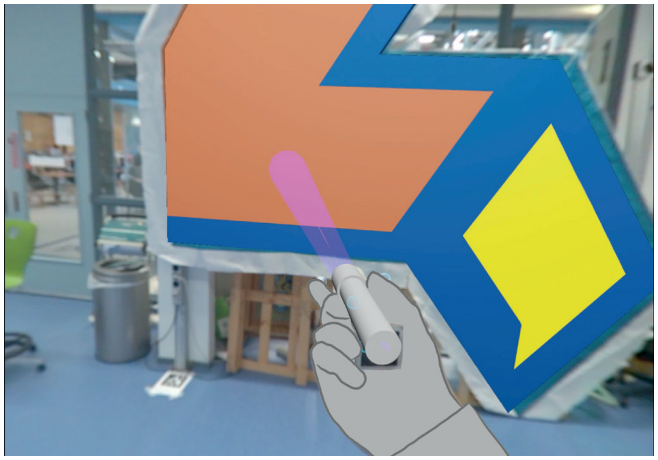
A voice begins to play, explaining about Stella's use of material effects, like fluorescence, how its affects the painting and lines up with the principle of self-referentiality. It is explained they can apply their own change to the painting.



By pointing the flashlight at one of the surfaces, that surface slowly becomes more fluorescent. By clicking the button on the flashlight the mode switches and the surface slowly loses the fluorescent effect.



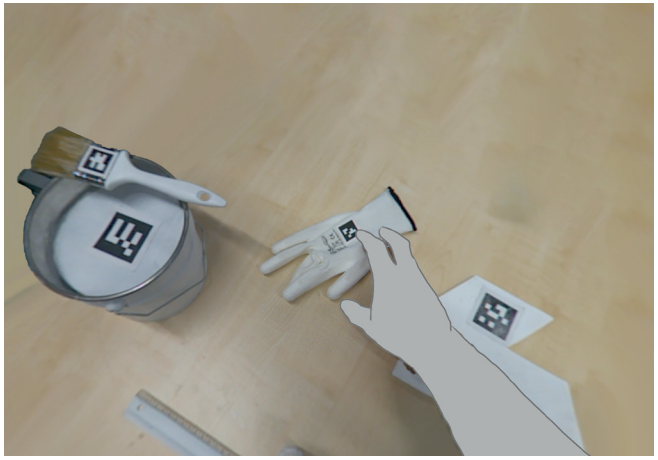
They can explore the effects of fluorescence for as long as they like. After applying some changes they are posed with a question "What is the effect of your applied changes on the painting, Its all overness, Self-referentiality, Instanteneousness and Flatness?"



They take some time to think, reflect or try out a little more. When done, they return the item to the table.

When returning they see their changes combined and applied to the virtual overlay of the painting.

Grabbing the glove

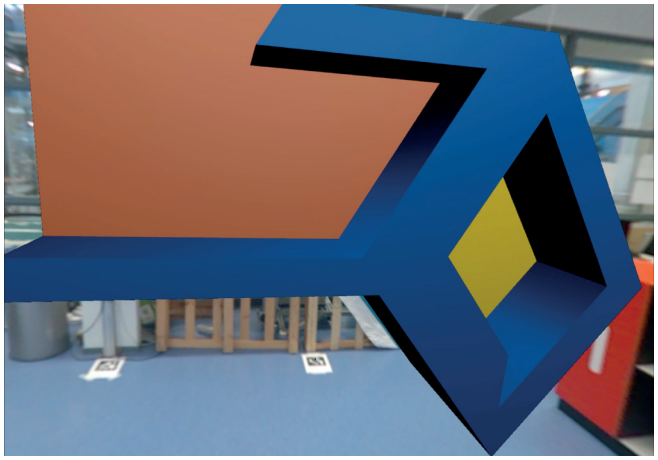


The visitor grabs the glove. When touched it gains a virtual layer.

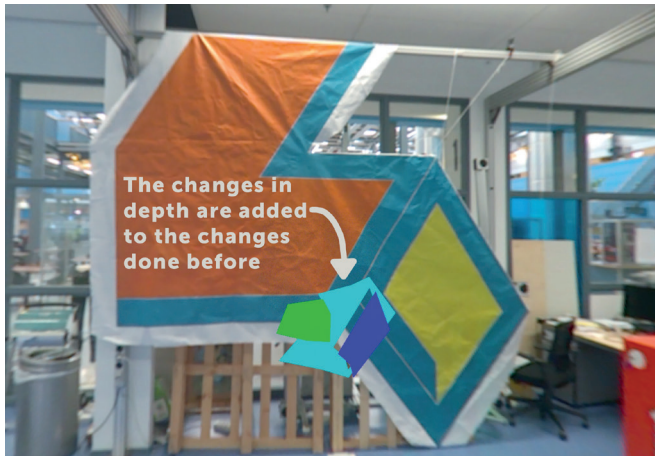
A voice begins to play, explaining about the principle of flatness, how this is visible in the painting and how Stella approached this. It is explained they can apply their own change to the painting.

By putting on the glove they can grab onto the 3 surfaces of the painting, they can drag them out and pull them back in. Giving literal depth to the painting, showing the painting in a changed way.

They can try out different variations in depth for as long as they like. After applying some changes they are posed with a question "What is the effect of your applied changes on the painting, Its all overness, Self-referentiality, Instanteneousness and Flatness?"

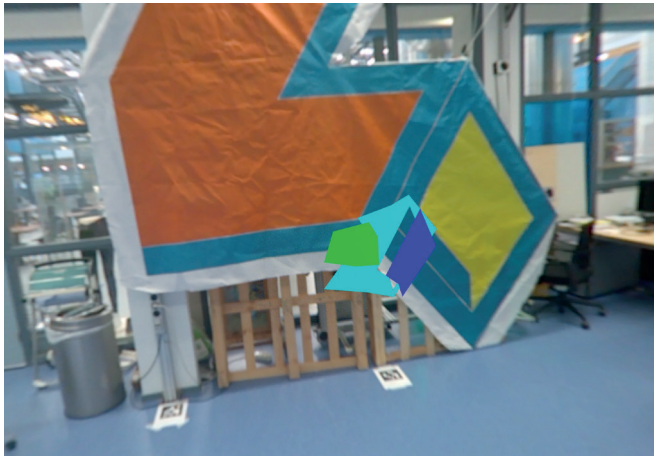


They take some time to think, reflect or try out a little more. When done, they return the item to the table.

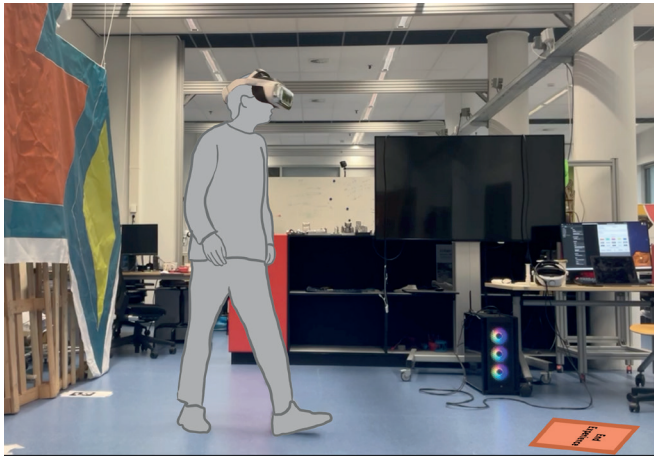


When returning they see their changes combined and applied to the virtual overlay of the painting.

Putting back an item / end of experience



Once used one or multiple of the items the visitor can choose to end their experience or continue making changes. All changes being made are combined in a personal version of Effingham. Which can be compared to the authentic Effingham I.

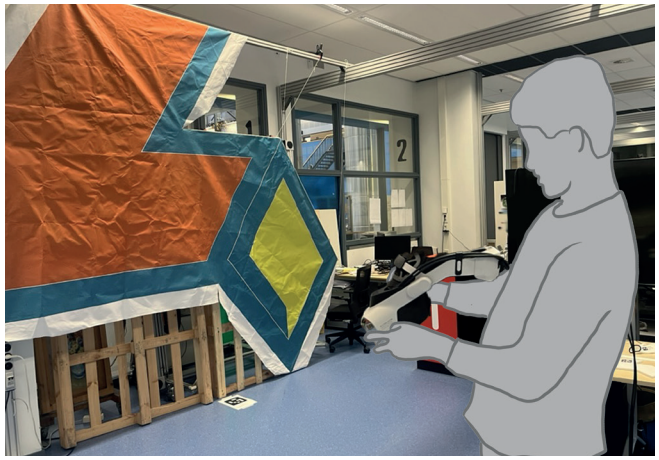


When choosing to be done they walk towards the 'end experience'.Where they will be posed with an ending statement.

Users are told about how change, big or small, affects the painting and that this change affects the effect the painting has on a viewer.

They are asked to compare their creation to the real Effingham I and if they would like to see and compare the creations of others before them.

A set of various creations made by previous users is shown on the wall, creating a gallery of change.



Once the visitor has seen and interacted enough they can take off the headset and return it to the table, ending the experience.

** The full narrative transcription, provided with the experience can be found in appendix Q*

Final evaluation

This chapter describes the evaluation of the final prototype. The prototype was tested with 7 individuals.

Visitor profiles vary in age, self-described visitor profile and amount of museum visits. All had no or very little knowledge of Frank Stella and all but one had no or very little experience with AR or VR, one uses VR regulary.

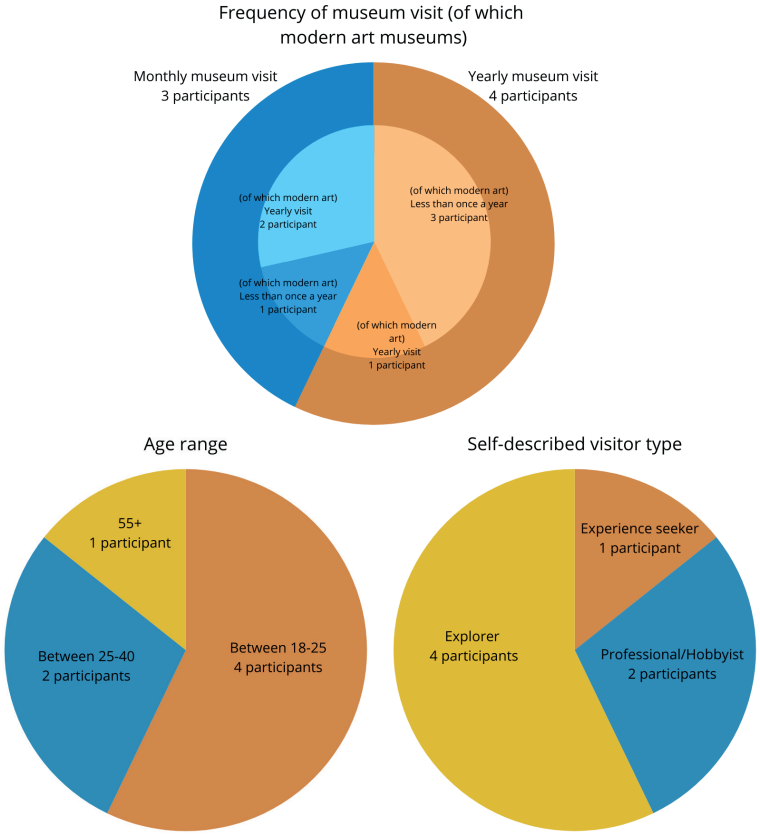


Figure 62: Pie charts of participants museum visit frequency(modern art), age range and described type of visitor.

Method

The evaluation session consisted of the following phases:

1. Explanation of what the session entails, showing images of the desired scene of modern art museums and giving explanation of how the replica differs from the real painting followed by reading and signing a consent form.
2. Starting questions about participant profile.
3. Looking at the physical replica of Effingham I (figure 64), followed by a set of questions.
4. Giving explanation of the HMD and entering & interacting with the AR experience, during which participants are asked to think out loud.
5. Post experience questions and semi structured interview.

During the experience recordings were made, from a distance, participant view from the HMD and audio.

During the experience, participants and environment were observed focussing on:

- Amount of participant movement
- Interactions with painting, objects & environment
- Active participation of participants (excitement, desire to interact)
- Order in which objects are chosen
- Further notable happenings

Questions asked

Pre-experience

- *How often do you visit museums?*
- *How often do you visit a modern art museum?*
- *How would you describe yourself as a museum visitor? (Looking back at your last or a recent visit)*
- *What is your age?*
- *Have you used VR or AR before?*

Post perceiving physical painting (replica)

- *How would you describe the painting in 3 words?*
- *Does the painting activate your thoughts/ imagination? - About what?*
- *Are there questions that arise about the painting?*

Post-experience

- *How would you describe the experience in 3 words?*
- *Is there anything you particularly appreciated or disliked?*
- *Displayed in a museum, would you engage with the experience? - Why/why not?*
- *Does this experience fit within a modern art museum according to you? - Why/why not?*
- *How would you rate the looks/aesthetic of the experience?*
- *How long did the experience feel?*
- *Did the experience bring you something the real one could not?*
- *Did you remain aware of the physical painting during the experience?*
- *Did the experience feel authentic/ meaningful to you? - In what way?*
- *After the AR experience, does the physical painting look different to you now? In what way?*
- *Do you feel that the experience respects the original painting?*
- *How clear was what you could do during the experience to you?*
- *How easy to use were the interactive elements in the experience?*
- *Did you feel spatially free (spatial freedom) in the experience? - Why/why not?*

- *Which interaction stood out most to you?*
- *Did the experience feel guided?*
- *Did you feel like you were free in your choices?*
- *Did the experience feel like a personal experience to you?*
- *How did the experience change your connection to the painting and/or painter?*
- *Did the experience activate your thoughts/ imagination? - About what?*
- *Did and how much did the experience give you a sense of authenticity?*
- *Can you describe one thing you discovered?*
- *Did the experience spark your curiosity? - How/ where?*
- *How engaging was the experience to you?*
- *Which interaction or visual element was most engaging? - Why?*
- *Do you feel like you learned something about the painting or its visual qualities?*
- *Can you name one thing you learned?*

Evaluation set-up

Figure 63, 65 and 66 shows the set up of the evaluation, it shows the intractable and surrounding space, placement of tangible objects, placement of the painting replica camera position and computer position.

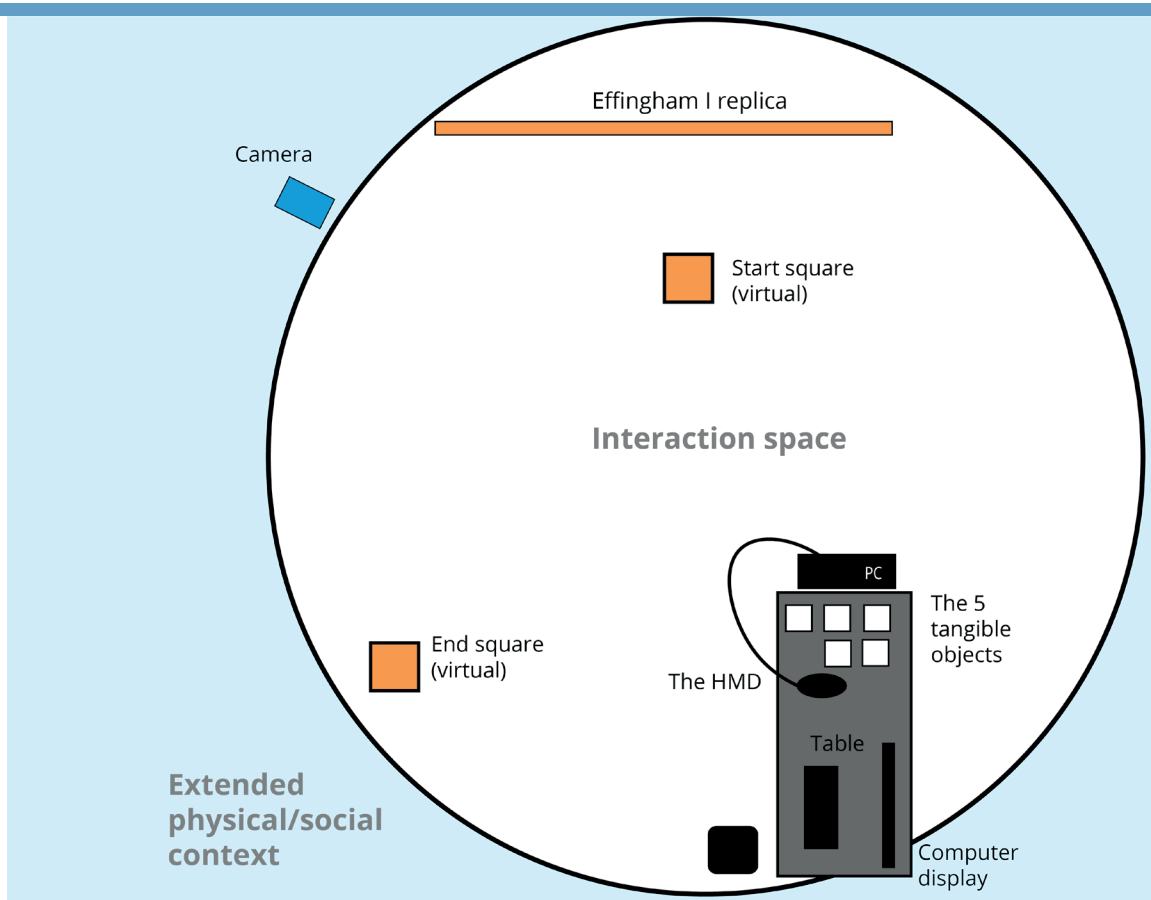


Figure 63: Map of set-up evaluations

Figure 64: The Effingham I replica used for concept development and evaluation

Figure 65: Objects placed on the table

Figure 66: Evaluation set-up picture

Findings

General feedback

Perception of Effingham I (replica)

At the start of the evaluation participants were asked to describe the painting in 3 words. Participants mostly focussed on visual elements of the painting, aligning with the 5 visual aspects present in the experience focussing on Colour, Shape and Size, see figure 67:
This may indicate that there is an interest in these aspects and might thus be a valuable part of the experience.
In addition to the visual elements some words are more descriptive and interpretative, looking for what participants see in the painting or what associations/explanations are made to give the painting meaning. This might indicate that participants are searching for a deeper meaning or reasoning behind the painting.

Figure 67: words used to describe Effingham I when seeing the painting

Reaction to overall experience

When asked to describe the experience with 3 words a variation of answers was given, of which many are in line with the predefined interaction qualities and design criteria.

Figure 68: words used to describe the experience and connections to the defined interaction qualities

Liked

- Being/feeling present in the real space
- The use of bodily movement
- Grabbing onto/pinching virtual elements
- The feeling of becoming part of the painting
- The experience of stepping into the painters' shoes
- The use of physical objects (as tools to interact between real and virtual)

Disliked

- Blurriness of HMD
- Depth estimation
- Accidental grabbing or pinching
- Fiddling around with the objects to get them to work correctly
- Duration of the voice-over elements

Difficulties

- Users interacting from a distance instead of touching the virtual painting
- Virtual painting not always aligning well (in the shape aspect and in-between creation)
- Interaction outside field of view
- Gestures not being captured (pinching and grabbing)

Psychological

Activation of thoughts and imagination

Figure 69 shows an increase in reported activation of thought and imagination among participants. It appears that the experience was able to increase imagination and thoughts compared to the painting alone.

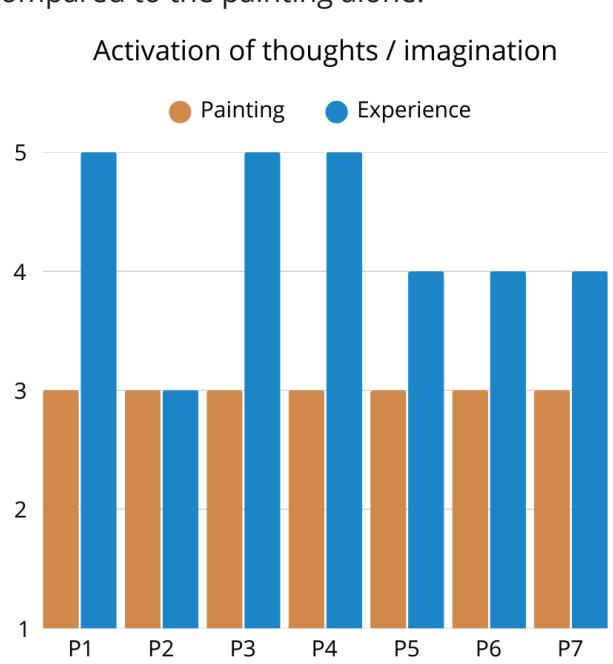


Figure 69: Difference of thought & imagination activation by painting and by experience

What participants were thinking and/or imagining also seems to change. At the start participants mostly seem to wonder what the painting means, why the painter has created the painting or how or what they see in the painting. With the experience participants seem to think more about the impact of the change of visual elements, the possibilities with the painting, and are better able to imagine what changes do to the perception of the painting.

P7 - "By playing with the painting it makes you think more."

P3 - "I found that it became complete after trying out a elements, and that you can see that every aspect brings different things"

P2 - "I thought mostly about AR, not that much about the experience perse"

Engagement

When asked if participants would engage with the interactive exhibition if it was displayed in a museum the consensus appears to be 'yes'. This seems to stem mainly from:

- Curiosity
- General appreciation of interactive exhibits
- More than just looking at art
- The possibility to experiment
- More fun than reading information labels

One participant indicated that they would likely not interact, as they would feel uncomfortable acting in a public space and that too much might be happening around. This is confirmed by another participant who would not interact when a lot of people are present or there were to be a long waiting queue.

P1 - "Out of curiosity what it is. The attributes would really draw me if presented on a table."

P2 - "Doubtful, in a public space with a lot of people no. In a closed off room I would, a lot is happening sometimes a little too much"

P3 - "Personally I always like this kind of things, an experience, something extra. Unless there is a long line or the room is very busy"

P5 - "A lot of fun that you can do more than just watch, you can experience it with multiple senses and movement"

P7 - "I always like to stand still a bit longer at one artwork. Also to hear more about it, just look at it a little longer. I also often put on the headphones, this is a new kind of experience. I always like the experiences in museums."

Looking at the experienced duration, 5 out of 7 participants stated that the time spend felt just right.

- Participants spend ±10 up-to ±25 minutes in the experience, on average ±65% of the time interacting with tangible objects, the other time spend on looking at the virtual paintings or listening to intro/outro audio.
- Participants were in control on how much time they spend with each interaction
- Participant were able to end the experience at any point in time

The two participants who felt that the experience felt a little long noted that this was mainly caused by the duration of the narrative voice, according to them this slows down the experience. There was a greater desire to start active participation instead of having to listen, this was confirmed by the other participants as well, but they felt less restricted and felt free to start interacting anyway and ignore or mentally put the audio in the background.

Overall, the duration of the experience does not appear to be long, users seem to feel to be in control on how much time they want to spend and feel engaged while interacting with the various elements.

P4 - "The text feels too long, I'd rather go and do something more quickly"

P3 - "It took a while for me to connect what was being said to the things I was doing"

P3 - "The audio being there was nice for some extra information, but it made it all a bit slower. I want to interact immediately"

The overall engagement with the experience was rated a 4,4 on a scale from 1-5, this gives an indication that the experience is positively engaging.
Observation showed participants enjoyed interacting, there seemed to be eagerness to try out the different objects and expressed their enjoyment with laughs, "wow's" and mentions like "this is fun", "this looks nice".
The audio narrative was found less engaging, participants expressed that they were waiting for the voice to end, wanted to start interacting immediately and did not actively listen to what was being told and only picked up little of what was said.

P6 - "Ohh, I can see everything together now!"

P6 - "I like that you can see and change one thing en then after see how it all comes together"

Curiosity

All participants expressed they felt a spark of curiosity, before and during the experience. This curiosity could be attributed to a couple of factors mentioned.
At the start three elements were mentioned that spark curiosity.

- The painting itself, as it brings up questions.
- The AR-headset, as this is something novel and exiting for most participants.
- The white objects on the table, as they look mysterious yet recognizable, questioning participants what they are for.

During the interaction participants were mostly curious what each object could change and how this looks. The desire to try out multiple or all objects was expressed. In addition, it was also mentioned that there was curiousness about how every change would come together with the changes made before. One participant also mentioned the curiousness about this experience being applied to other artworks, this may indicate that the experience is interesting for artwork beyond Effingham I.

P3 - "Before I was intrigued by the objects, interested to see what they would do. During I wanted to try multiple things, see what each could change."

P2 - "The props, You wonder what all props do. I think it is good to have a mix of recognizable and harder to recognize objects"

P5 - "I was curious when I would grab a new item. "What would change now" you can only see that if you try it. I was curious to try out all items"

Discovery and learning

When asked what participants discovered during the interaction their answers can be divided into two groups, 1. Discovery about the painting/painter and 2. Discovery about the experience.
All seem to have discovered something through the interaction, which seems based on their own interests.
5 out of 7 participants reported learning something about the visual qualities of the painting. When asked what was learned there were multiple mentions of the difficulty to retain all the specific information. This might indicate that the way in which information is provided does not suffice. Participants do realize and learned

- That there is a lot more behind the painting that can be seen.
- That through experimentation they learned more about what goes behind the creation of a (simple) painting.
- The change of the painting over time.
- How (simple/small) changes can have a big effect on how a painting looks.

It was expected that participants would come with more directed answers pointing towards flatness, all-overness, self referentiality or instantaneous but the answers were more general. The two who reported not learning anything mentioned the difficulty of retaining the amount of information given in a short time and not finding the painting that interesting, the painting still looks the same to them. The amount of information was mentioned by multiple participants as well, indicating that the narrative is not transferred effectively.

P1- "There is a lot behind the painting, remembering things specifically is difficult"

P3 - "You also hear a whole story about the artist and things he thought about. "

P5 - "The painting changes over time and the colours fade. The whole painting has changed"

P7- "Now you experience way more where the artist also played with, these visual aspects. You really go and see what it does. For sure with the colouring, then you think how does this present itself "

P1 - "It shows that change happens and what changes. In the conclusion you think again about the real painting, my self made choices and how this changes the painting"

Authenticity

Added value of AR experience

When asked what the added value of the experience was to the painting, what the experience brought that the painting alone cannot. Participants stated the added value the experience was the ability to play around with the painting, making it your own, experiencing the experimentation the artist also played with and making the painting engaging for a longer time. The AR experience appears to give a deepened understanding of the artists way of working and the various dimensions that make up the painting.

It was mentioned multiple times that the 'real' painting being present would also be valuable and the virtual alone would be less interesting. Participants mentioned that they

- Want to be able to see the actual painting for at least a little bit at the start of the experience, for some users this time is used to create an own opinion about the painting first.
- Use the original painting as a starting point to initiate their interaction of changing
- Feel the painting being present adds to the experienced authenticity, the true own intend of the painting.

This may indicate that the experience as a stand-alone exhibit (without the presence of the real painting) would have a lesser impact and gives a lesser experiential authentic feeling. The other way around, the AR experience also adds value to the painting, providing a deepened insight into the art and artist.

P2 - "I feel like the AR gives more meaning to the painting, it makes it more lively."

P4 - "For me the real painting brings the real own intend of the artist. The virtual makes me step into the shoes of someone and setting it to my own hand, personalize it."

Awareness of the physical painting

4 out of 7 Participants mentioned that they remained aware of the physical painting during the interaction, looking back at it during the experience. 3 participants stated they were not busy with the physical painting at all during the experience, their focus was on what they were making and the virtual replicas of the paintings and paid no attention to the physical painting anymore.

P3 - "The real painting does add something, you cannot leave it away. Imagine you do not see the painting anymore at all, the experience would be less"

P2 - "For me, without the virtual, the painting would be nothing, it only has to be there at the start, then it can go. I would want to see the real painting for a bit but not during the interaction."

P3 - "At the start you get a good look at the real painting and form an opinion, during the experience you can add onto it."

Sense of experiential authenticity

According to 6 out of 7 the experience felt meaningful and/or genuine to them, they felt like they had experienced something authentic and real.

- The immediate action reaction, participants actions could directly be seen
- Creating something personal creates meaning as you make that of the artist your own
- The world around be present and visible, the feeling of being in the real world
- Having an influence on how the experience shapes itself
- The tangible tools added to this feeling as they appear to create the feeling of really using tools to create.

When asked if the experience evoked a sense of authenticity scored this an average of 3,6 on a scale from 1-5. The experience felt like something novel and unique, and the presence of the 'real' paintings seems to contribute to the authentic feeling. The addition of the AR experience did not seem to take away from the genuine authenticity. Both combined appear to contribute to the experiential authenticity.

P6 - "When you are busy it does really feel like you are building. It does not really give meaning as in "it makes my life better"."

P5 - "This is something I have not experienced before"

Respect to the original painting

6 out of 7 participants mentioned that they feel that the experience respects the original painting. According to the participants the experience shows respect through:

- Showing the change that happens to the painting.
- The comparison at the end highlights the difference between original and creation.
- The addition of the whole audible story about the artist and his intentions.
- The return to the original painting, using it as a starting point every time.
- The experience seems to make participants think about the original painting more.

One participant mentioned that they felt like the experience makes too much change to the painting, attacking the original intend. They mentioned that they are not sure if it truly loses value and that creating something yourself was a nice interaction. This attacking of the painters intend was also mentioned by a second participant but stated that by remaining in the artists line of thought and hearing the narrative it still gives respect to the original

P4 - "In Stella's original intend it does. He made the painting with a certain intend, by changing that you attack it a little bit, but by making something yourself you remain in his line of thought."

P5 - "Because every time you return to the original painting. The original is always the centre and starting point."

Changed view on the painting

When asked how the AR experience has changed their view of Effingham I the interactions appear to have guided the participants to think about and envision the different elements that built up the painting. Instead of thinking more about meaning or interpretation. There seems to be more of a focus on what could be rather than what is seen.

Comparing the painting to own creations, realizing the effect of choices made by the artist and by the participant.

Seeing the aspects separated gives new perspectives on the painting.

It seems to be easier to imagine what change looks like, as this is experienced during the session.

One participant mentioned that they did not see the painting differently now and are just not that interested in the artwork.

P4 - "By experimenting yourself creates a new way to relate to the painter"

Enriching to a museum visit

When asked how much the participants thought this experience in a museum would enrich their visit, they scored it an average of 4,1 on a scale from 1-5. This may indicate that the experience has an added value and is enriching to a museum visit.

P4 - "I like it to see what happens if I change things, that normally does not happen in a museum"

P7 - "You are making something yourself, even tough it is virtual. You do not have to touch a real brush or saw but feels a little like it. I would want to do this with other paintings"

Personal experience

The personal feel of the experience was scored a 4 on a scale from 1-5. Participants expressed that the active participation with and personally changing of the painting contributed to this feeling. They could make the painting to their own liking while feeling like stepping into the shoes of the painter. Participants mentioned their connection to the painting and painter changed, they look differently at the painting,

- With a deepened look and better understanding,
- Through reflecting their own choices with those of the painter
- By actually seeing the change happening instead of just having to imagine it

2 participants mentioned that they did not feel a changed connection, for them the art itself was not that interesting and showed no more or less connection to the artwork. This seems to be heavily based on personal interest, but the experience did not manage to activate interest in them either.

P5 - "You can make it very dark or very bright, make it your own"

P5 - "Now it looks a bit faster or something"

P7 - "The bigger the better right!"

The interaction

Understandability

The clarity of use was rated a 3,7 on a scale of 1-5, this suggests that participants were moderately able to understand what to do during the experience. As stated by multiple participants, understandability grew as they progressed in the interactions. Often with the first object grabbed participants showed some confusion but once understanding that the tools are used to apply changes, they were able to do so. Items appear to vary in understandability, the shape stood out as the most confusing object. The limited rotation of dots, the multiple virtual layers shown (Dots, lines, filled in shapes and virtual painting) was a lot and did not follow the movement of the tangible object smoothly. Further insights into the different tangible objects can be found in on page 80.
The recognizability of the objects seemed to support users into knowing how to interact, both on what visual part they could change and on how to use them.

Ease of use

The ease of use was rated a 3,3 on a scale of 1-5. On average this is rated lower than the understandability. There was reasonable clarity on how to use the various objects, but it seems that using them is more difficult. This was again most prominent when using the shape and connected to priorly stated reasons. Overall users seemed to be able to use all objects correctly but sometimes needed a little hint (I.E keeping the Varjo marker in their visual range).

- Smoothness, virtual overlayed objects were jittering at times, preventing users to point to or grab as desired
- Visibility of Varjo markers, attempts to interact with the objects out of visual range or covering with body parts
- Accidental interactions (grabbing and pinching), creates confusion and unclarity in what was happening.

Colour, size and depth elements appeared to be interacted with the most smoothly, there appeared to be some confusion about the distance from which to interact as participants expected to not touch the painting. When realizing this, they showed awe and appeared to appreciate this even more.

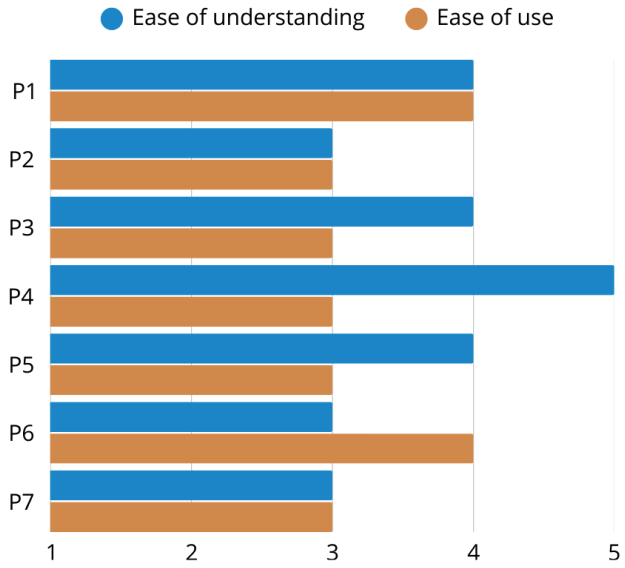


Figure 70: The rated ease of understanding and ease of use per participant

P3 - "Feels very intuitive, I grabbed it (the ruler bar) on accident but this made me understand what I could do"

P7 - "I am not sure if I did it on purpose, but it has become something"

Spatial freedom

All participants stated that they felt spatially free and in control during the experience, they could walk around and move as desired. It was pointed out by almost all participants that there was some fear of tripping over the cable, but this did not happen. 3 participants mentioned blurriness or dizziness due to the headset, but none wanted to take the HMD off during the interaction and mentioned that over time, while being busy this went away.
Participants mentioned trouble with depth perception and uncertainty of distance to the virtual painting, which was also observed when trying to interact with colour and depth.

Most participants interacted from a stationary position (apart when using colour and depth, these activated participants to move). 2 participants moved around more actively, looking at the painting/their creations from different positions.

P6 - "It feels nice, you can move your full body"

P7 - "It (the colouring) does not work, should I really touch it?"

P6 - "You really become part of it or something"

P6 - "Should I really touch it?"

P2 - "Wow, you really have to grab it!"

P7 - "I enjoyed that I could use my hands to move things."

P5 - "Because I had influence on it myself, and it fell together with the real world around me."

Freedom of choice

The level of freedom in choice was rated a 4,7 on a scale from 1-5, this may indicate that when interacting users feel free in what they can do, what they do how far they engage with the experience. Where most participants chose to interact with all objects, two participants did not use all 5 objects provided, this indicates that here they also felt free making that choice.
The observation that some but not all the provided narrative elements were retained by the participants could indicate that only the individually interesting found information was captured, freely choosing what they want to learn. This could also be the effect of the way in which information was provided, not engaging the participants sufficiently.

Users rated their feeling of being guided a 3,9 on a scale from 1-5, this did not appear to limit them. The guidance was seen as something positive, contributing more to the understandability rather than taking away perceived freedom. Participants noted they felt guided but not restricted in their actions.

P4 - "At some point I thought, I'll listen, but I'm going to try something myself"

P6 - "The text felt too long, but you can of course decide yourself how long you want to listen"

P7- "You are being guided by the things you can change. Now I wonder what more I could do with these changes"

Gallery of creations

5 out of 7 participants took some time to look at the creation gallery, comparing the different creations to each other. There were mentions that it was fun to see what more was possible. Overall, not much attention was paid to this element of the experience. 2 participants showed no interest and were ready to end the experience. 1 participant mentioned the idea to get a copy (physical card) of their creation to take home. This as a way to remember and share what they did.

Activity driven

From observations it appeared participants were engaging with the interactions. There did not appear to be a focus on creating a final result, the combined creation in between interactions. Participants did take some time to look at what the combined creation looked like but did not seem to keep this in mind while interacting with the individual aspects, this might indicate interaction is activity driven, participants are busy with what they are doing in the moment and do not attempt to reach a certain goal.

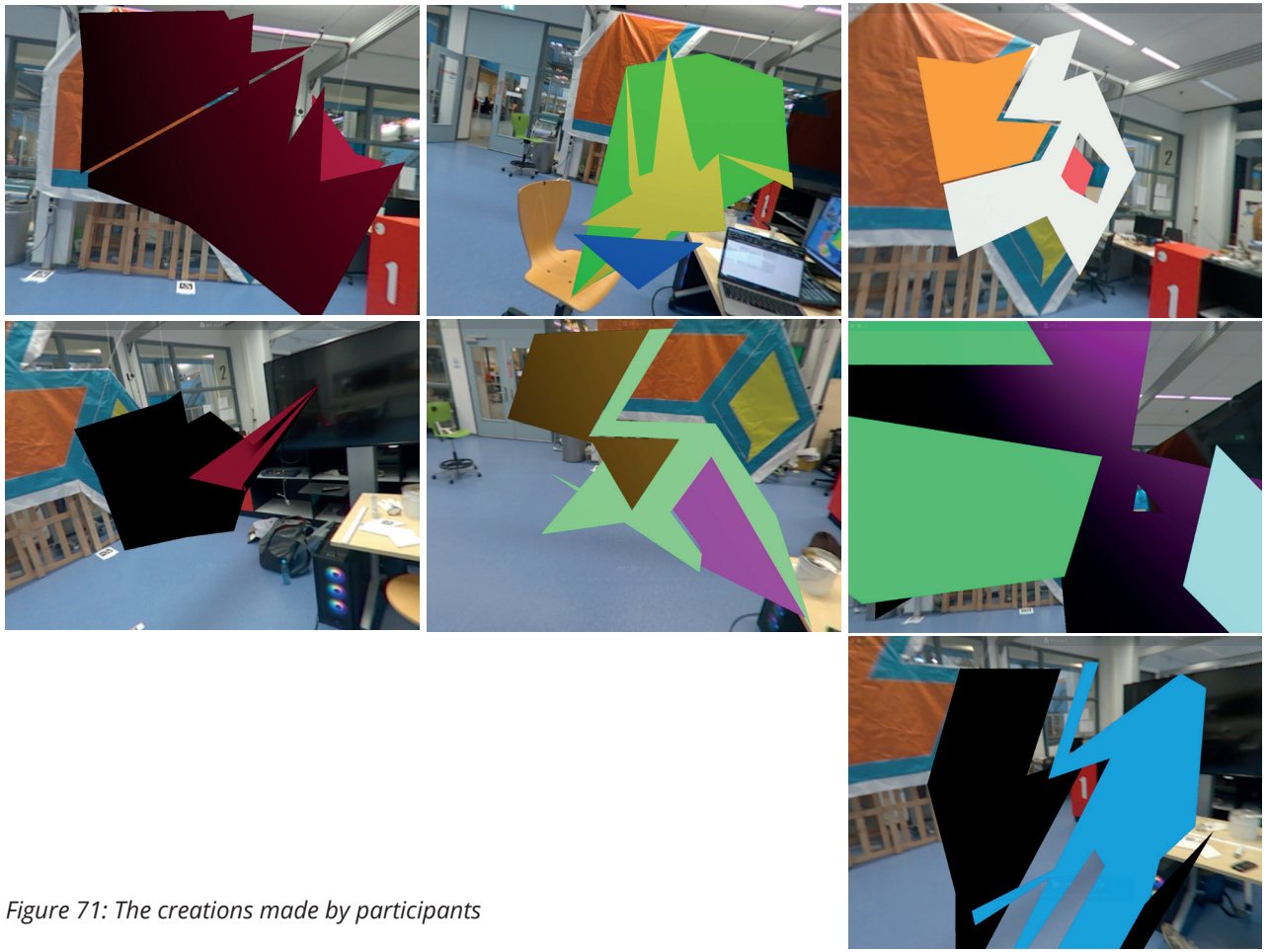


Figure 71: The creations made by participants

Context

Fitting in a modern art museum

All but one participant indicated that the experience would fit within a modern art museum (similar to museums presented to them with a set of images, Appendix R). According to the participants it would fit well because of:

- The minimalistic look
- The white and clean appearance of the objects
- Them being able to do something to retain attention better
- The novelty, fitting with something modern
- The addition of a 'new' experience (indicated as a reason to visit a museum)

One participant pointed out that the experience might be too playful to be exhibited in a room with multiple works of art, it may disturb other visitors, clash with the serious and quiet atmosphere and too much might be happening at once. They mentioned they could see it fit if presented in a separate room.

P1 - "I can see it in front of me, a big white room with white walls"

P4 - "I am not sure if this would be the vibe in between more art. If it is separated in a room then it could work. Maybe it is a bit too playful for a serious, quiet museum"

P5 - "Something interactive with AR would fit with modern art, something novel. I think that is why people would go to such museums, to gain new experiences."

Aesthetic

The aesthetic look of the physical and virtual elements was rated an average of 3,7 on a scale from 1-5. It was generally appreciated and not much could be said about it.

Some shortcomings in the virtual version of the painting were pointed out, for example the missing white lines on the virtual replicas. This however did not seem to bother the participants. It was also pointed out that the aesthetic difference between the virtual and the physical painting help to distinguish the authentic from the created experience, it may draw a clearer separation between real and intervention.

P1 - "Why art the white lines missing in the digital version?"

P2 - "It can become overwhelming, I feel like I should listen but I also want to interact but with everything happening this feels like too much"

Social context

From observation of the space around the interaction, various people in the room appeared to show interest, looking at participant interacting and some approaching and looking at the screen (showing the view of the participant). This may indicate signs of created curiosity and how the social context plays a role.

In between evaluations 2 children accompanied by a parent approached and asked if they could try out the HMD.

- They switched the HMD between them after each object.
- Asked about each object and what they could do.
- Wanted to try out all objects.
- Used the object (especially colour multiple times)
- When one was interacting the other watched the screen.
- Spoke out loud what they were doing/trying out to the other

Although these observations were contextual observations and not a full evaluation it appears to show the curiosity about the HMD and objects, engagement with changing the painting through the tangible objects and gives a look on a social interplay between interaction users and bystanders.

The physical objects

The interactions with colour and depth were appreciated most, followed by size, then fluorescence and least shape. The factors that played a role in the enjoyment of the interactions were:

- Intuitiveness
- Simplicity, non-overwhelming
- Big, immediate effects
- Requirement to touch the (virtual) painting
- Use of body and movement
- Smoothness
- Variation

An interesting mention was that objects from a distance felt more like remote controls (Fluorescence, Shape, Size) and the interactions where touching was required felt more special. This is one of the more unique affordances of AR, it might indicate that this could be utilized even more. On the other hand, the variation in ways of interaction was also appreciated, the touching might have stood out because not every interaction was similar.

P3 - "I like this one (colour) as well, because it is so big, a big effect"

P4 - "I liked it that I could use physical objects . Hand tracking worked surprisingly well."

P5 - "I liked the variation in what to do and how to do it, very interesting. I liked the different movements and the search on how to make it work."

P6 - "When you have something in your hand you immediately want to do something with it"

Duration of the interactions

Figure 72 shows the order of the objects used and time spend interacting with each object per participant. The time spend is measured from picking up the item till putting it back on the table. (The graph only shows time with objects in hand and not the entire time spend in the experience.)

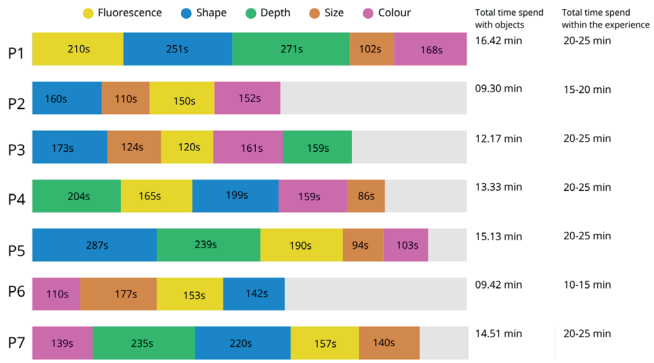


Figure 72: Order of objects used and time spend with each object + time spend interacting and time spend in the AR experience

There does not appear to be a specific order in which objects are picked up. This may indicate the absence of strong desirability between objects but the glove was not used by 2 participants, which might indicate a lesser interest for this object. No reason was given for not interacting, apart from having seen enough.

It appears that shape has been interacted with the longest, which can possibly be related to the difficulty in use, participants required much effort to get this object to work correctly.

Followed by depth, which appeared to be easy to be used by participants. Them spending a longer amount of time might relate to a positive engagement with this aspect.

3th most time spend on is fluorescence, this could be connected to the time it takes for change to actually become visible on the virtual painting. Other from the other interactions, the fluorescence was increased or decreased over time instead of user input. Participant noted to find the flashlight interesting but the effect minimal.

Colour was used the second shortest amount of time, which is surprising because participants expressed enjoying this a lot. The ease of use and understanding and the speed in which participants could interact may contribute to the lesser time spend.

Size was the least amount of time interacted with. This could be connected to the ease of use and simplicity of this object. Change happens on a one dimensional scale and there is not a lot to change. Participants did express a likeability of this object, due to its smoothness of use and immediate visual effect.

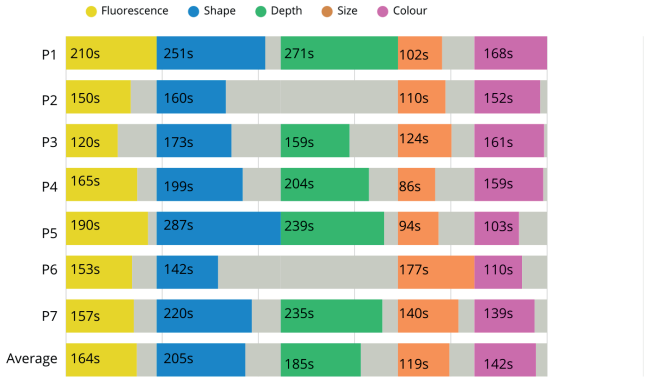


Figure 73: Time spend per object and average time spend per object

P3 - "It was nice that I had the time and I could keep going for as long as I would want"

Paint Bucket

- Easy to understand and use
- Strong and direct effect
- Smooth interaction
- No extra instructions were needed
- Clear connection between form and interaction
- Use of movement and touching was appreciated
- Some confusion about interaction distance (having to touch the virtual painting)
- Found highly engaging

Glove

- Easy to understand and use
- Strong effect
- Smooth in use
- Few extra instructions were needed
- Glove blocking hand-tracking at times
- Use of movement and touching was appreciated
- Fear of touching the physical painting
- Some confusion about interaction distance (having to touch the virtual painting)
- Found highly engaging

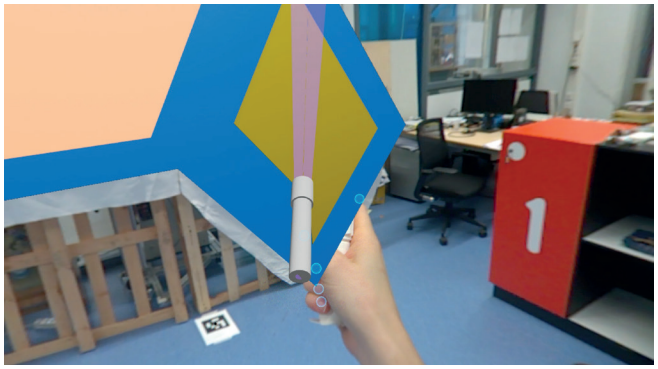


Figure 74: Misalignment of virtual objects, mainly caused by Varjo markers being covered

Ruler

- Easy to understand and use
- Clear and strong effect
- Smooth interaction
- Very simple
- No extra instructions were needed
- Found medium engaging

Flashlight

- Easy to use and understand
- Mediocre effect
- Difficulties keeping Varjo marker in sight
- Jittering of light beam, thus accuracy of pointing
- Few extra instructions were needed
- Found medium engaging

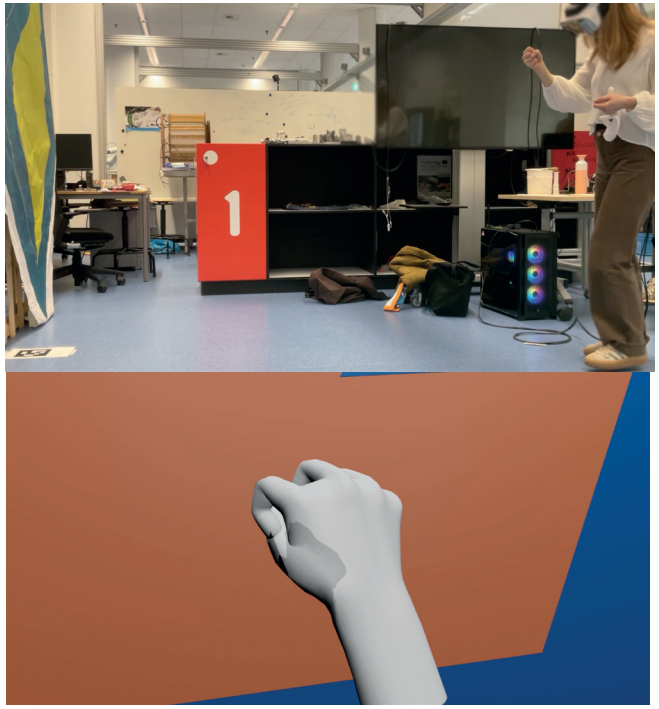


Figure 75: Participant attempting to change depth but grabs from a distance, instead of into the virtual painting

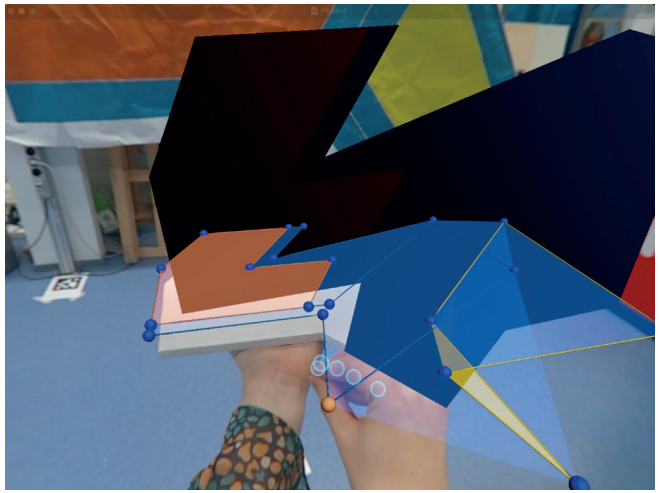


Figure 76: Picture of interacting with shape. Visually overloading and accidental grabbing of dots.

Shape

- Difficult to understand and use
- Strong effect
- Difficulty to interact as desired
- A lot of extra instructions were needed
- Messed with the total creation
- Many accidental interactions (pinching dots)
- Misplacement of overlay of virtual painting
- Found least engaging

Best **Medium** **Least**

Limitations of evaluation

The evaluation of the prototype encountered a set of limitations, which possibly affect the experience with the prototype in the evaluation setting.

The museum environment setting

Evaluation of the prototype was performed in a semi publicly accessible lab environment, not representing the desired setting for the experience. Surrounding objects and people moving around possibly create (visual) background noise. The non-representative setting could:
- Possibly distract participants
- Require imagination of the setting by participants.
- Affects spatial awareness and aesthetic of the experience.

Small participant sample

The experience is evaluated by 7 participants, too small of a sample to draw definite conclusions. The outcome of the evaluation merely highlights indications of trends and hints towards insights.

Lack of social context

As the evaluation is done with individual participants there is a lack of social interaction. Participants do not experience how the prototype works in a social setting. The appearance of bystanders in and around the test environment provided some insights but this can not be translated to how the social context would appear in actuality.

Possible influence of invited evaluation and posed questions.

Insights are gathered on participants feelings and or thoughts during the interaction. It is possible that by posing directed questions participants are nudged to think and talk about elements they would not mention by themselves. This likely could have an influence on how participants perceive the experience. An observation of 'random' museum visitors who are not explicitly invited to participate, engaging with the experience could give better insights on how the experience is actually used, and perceived by museum visitors.

Bugs with, and limitations of the prototype

The experience is evaluated using a prototype where elements were missing or underdeveloped. Most notable are:
- Button on the flashlight, being controlled by participant voicing to press and the researcher clicking a button.
- Activating visible and audible elements through researcher pressing buttons on a on screen UI.
- Aesthetic and materiality of the virtual painting.

These limitations possibly interfere with the flow and perception of the experience.

Conclusion

This chapter concludes the design project. It includes a reflection on the design goal, interaction qualities and design criteria, discusses the outcome of the project, provides recommendations for further research/ development, an overall conclusion of the project, how this project contributes to the field of interaction design and gives a personal reflection on the process.

Discussion

This part discusses the predefined interaction qualities and design criteria and indicates whether they appear to be reached or not based on user evaluation. With every quality or criteria it is described how the experience fulfils or does not fulfil the desired goal.

The overall goal to '**Create an interactive AR museum experience, showing the effects of changes in visual elements and their effects on the perception of Effingham I'** appears to be achieved with certain elements requiring further development and research.
Participants seem to positively engage with the prototyped experience and reported learning and enjoyment. The voice-over elements seem to require the most improvement as this was indicated to be too long and/or too much, causing participants to not retain information effectively. The use of tangible objects and the use of bodily movement was especially appreciated. The experience provided participants with a sense of stepping into the shoes of the painter. Learning about and experiencing the choices that can be made creating and the effect of change on a painting.

Interaction qualities

Contemplative:
Appears present.
Participants showed and noted their activation of thoughts and the experience affected what participants were thinking about.

Discovery:
Appears present.
Participants appeared to retain at least some of the information provided through the experience. Most discovery is done by active interaction. The most prominent discovery seems to be the thoughts of the artist behind the painting and how choices or (small) changes affect a painting.

Self-led:
Appears present.
Participants noted their feeling of control in the experience, objects seem to be chosen in random orders and participants interact with and change to their own desire. The experience was felt like a personal experience, where they were in control.

Freedom
Appears present.
It was noted by the participants they felt free during the experience. Participants decided whether to listen or start interaction, whether to test out all objects and how long they wanted to interact. It was noted that participants felt guided but this was seen as something positive, giving them more of a direction/explanation. The experience could even provide more guidance to explain how to interact clear quicker.

Spatial:
Appears present.
Mostly notable in the use of the colour and depth objects, as users were required to move to interact. Participants noted spatial freedom, the awareness of the physical painting and being present in the (physical) environment.

Design criteria

The experience should convey the temporal changes Effingham I undergoes.
- Satisfactory.
Multiple participants noted that the painting changes and looses how it looked before.

The experience should convey Frank Stella's 4 modernist principles: Self-referentiality, Flatness, All-overness and Instantaneousness.
- Not Satisfactory.
Participants did mention the 'story behind the painting' and 'the original intend behind the painting' but in general were unable to name the principles or their meaning. The inability to retain the information is most likely linked to the duration and manner of providing the voice-over narrative.

Users engage with the 5 visual aspects and give an insight into how the painting is built up.
- Satisfactory.
There appears to be a realization by most participants that paintings are made up of different aspects and that change in these aspects has an effect on how the painting looks and how they are perceived.

Interactive elements are easy to understand and use.
- Semi Satisfactory, varying.
Due to the variation of use of interactive elements ease of understanding and use differs. Almost all interactive elements appeared to be easily usable, with the exception of the flashlight, needing a little more instruction due to the missing button in the prototype. And the shape, which was difficult to use and many accidental interactions happening. The elements required participants to fiddle around and find out how to interact, before it was explained by the narrative voice (which sometimes was missed) this fiddling was liked by some but disliked by others.

The interaction makes use of embodiment, tangibility and spatiality.
- Satisfactory.

The use of physical objects as a means of interaction seems to be appreciated, they provided hints and direction in how to interact, as well as creating curiosity before engaging with the design. Participants appeared to appreciate the use of their bodies as a means of control, walking, grabbing, 'touching' appears to actively engage and excite them. This is especially appreciated in the colour and depth aspect, where movement and 'touching' the painting was required. This movement towards, into and away from the painting. This movement contributes to the spatial feeling of the experience, where users seemed to make use of the space around them. For the other visual aspect this spatiality could be further improved, nudging them to move around and use the space around them even more.

The experience engages multiple senses.
- Satisfactory.

Participants use touch, hearing and vision to interact with the experience. The audio elements seem to be found least engaging and could be further improved, looking at how narrative elements could be delivered better.

Makes use of the 'unique' possibilities of AR an the Varjo HMD.
- Satisfactory.

The experience uses multiple elements that AR and the Varjo technology allow for. See through, Varjo markers, Hand tracking are all prominently used in the experience.
The placement and use of Varjo markers could be further improved to prevent blocking of them, making interactions more smooth.

The experience is engaging for a varied audience.
- Appears Satisfactory, requires further research.

With the small participant group the engagement for various museum visitors is under-investigated. The participants did vary in type and appeared to show different interests into the experience (focus on technology, focus on self doing and focus on the painting), which might indicate that the experience is indeed interesting for multiple types of museum visitors.

The experience respects the original painting.
- Satisfactory

Satisfactory indicated that the experience still respects the original painting. Contributive to this, is the painting is used as a starting point of the interaction and returned to multiple times, as well as the background information being given while interacting. The respect for the original painting could be attacked due to the experience making users completely change the painting, but this is also seen as a way to interact with the way the painter experimented and created.

The experience gives recognition to changes & intervention.
- Satisfactory.

For participants there seems to be a clear distinction between what is real and what is created. The visible difference between the real painting and simplified virtual version seems to contribute to this.

Context, painting and technology are present on an balanced level.
- Semi Satisfactory but requires further research in more representative setting.

Participants noted being aware of the space around them, and appeared to look around multiple times, this is most likely due to background noises. The awareness and presence in a real environment was appreciated by participants. About half of the participants noted to remain aware of the physical painting while interacting, possibly indicating that the Virtual interaction draws most of the attention. Because the evaluation is performed in a less representative setting without the actual painting this aspect requires further investigation.

It would be desirable if the experience provides an element of social interaction.
- Not Satisfactory, under developed

The gallery of creations seems to be appreciated but not much attention is paid to it. No real social interaction seems to happen here. Observation of the environment around the interaction showed multiple people looking at what was happening, showing curiosity but if this would be similar in am museum setting remains to be seen. A pair of two children started to interact simultaneously with aspects of the experience, indicating that there could be active social interaction but this requires further investigation.

Users feel like they learned something from the experience.
- Satisfactory.

Not all the teachable information seems to be transferred to participants, this would be desirable but not expected. Participants noted having learned something from the experience, showing self reported learning. What is learned seems to differ person to person.

Within the experience there is room for contemplation.
- Satisfactory.

Participants noted an increase of thoughts/imagination due to the interaction. Active engagement with the experience appears to increase this.

The experience enables users to engage in "free choice" learning.
- Satisfactory.

It seems that participants showed interest in different parts of the experience, into technology, the painting or own creations. It appears participants engage with elements that sparked individual curiosity.
The experience appears to somewhat guide the participants into learning about the 5 visual aspects, which is to be expected as this is where the experience mostly focusses on. Still there seems to be enough

variation in what participants retain and engage with. This is supported by the variation in duration of interacting with each visual aspect, possibly indicating their interest in particular visual elements.

The experience should stimulate imagination.
- Satisfactory
Participants imagination about the painting and possibilities with the painting seem to increase. Participants noted an increase of imagining what could be done with the painting. By having seen changes happening they seem to be able to imagine further and other change.

The interaction should provide a way of personal identification.
- Satisfactory
To most participants the experience felt personal, The creation of something that is their own and to their own liking creates a deeper connection between them and the painting and painter. It was noted that participants felt like 'stepping into the shoes of the painter'. Getting a feeling of experiencing the painting as if they were the creator and through this understand the decisions the painter could make.

For the duration of the experience, the user should feel engaged.
- Satisfactory.
Participants found the overall experience satisfactory engaging. This is mostly due to doing themselves, most notable in the interactions with colour and depth. The voice-over narrative was found less engaging, the presence was appreciated but participants rather start interacting themselves and the duration of voice-elements felt too long at times.

The experience should provide an authentic/novel experience.
- Satisfactory
For most participants the experience seems to feel like an authentic and new experience. Them not interacting with AR often possibly contributes to this for a huge part. The possibility to personally affect the painting instead of just looking at it appears to be a new and interesting interaction with art for the participants, which they would like to experience with other art in museums.

The experience creates a sense of curiousness.
- Satisfactory.
Both before and during the interaction curiosity appears to be sparked. The white, recognizable objects create interest and participants seem to wonder what they are and what to do with them. During the experience this wonder remains, participants appear to be curious about the effect every object enables. Observation of the environment also seems to capture a sense of curiosity of bystanders, showing interested in what is happening when a participant is interacting. The surprise interaction of two kids supported this as well, as they showed curiosity to interact and ask questions about and try out every interactive object.

The experience feels enriching to a museum visit.
- Satisfactory.
Participants noted the added value of the experience to a museum. Interacting with art seems to increase the interest in art and the duration spend with art. Whether this is specific to this experience or if it can be said about interactive exhibits in general remains unclear, but according to the participants this experience would add to their museum experience.

The experience has a serene appearance, fitting with a modern art museum.
- Satisfactory.
Although further refinement of physical and virtual elements is desired, participants expressed that the general appearance would fits with an art museum setting. The white objects were found to be fitting in the given context. The minimalistic, white and clean appearance were found to fit with the art and a modern art museum setting

Elements and information within the experience are aesthetically convincing.
- Semi Satisfactory but requires further refinement.
During evaluation some visual glitches appeared, Virtual elements were in the wrong place and jittering of tracked objects happened. This did not appear to bother participants too much. It seems the general aesthetic was found convincing, with participants being aware of the experience being a prototype, open for further refinement.

Recommendations

Based on the insights and feedback gathered from the user evaluation various recommendations can be made to further develop the experience.

Narrative delivery.
Further investigation is needed on how to deliver the intended narrative more effectively. This could be done by partitioning the narrative in more graspable pieces, being provided more stepwise the longer users interact, instead of providing an overload of information at the start of each intractable element.

Amount of content.
The prototype experience attempts to deliver a lot of content. Further research should be done to see if all content should be present in one experience or if it could/should be more selective.

Shape object and/or interaction.
Out of the tangible objects, the shape object requires the most refinement. This object was the only one that did not represent an everyday tool but was more abstract representative. Interaction with the object was difficult due to the overwhelming amount of visuals (dots, shapes, virtual painting) which did not appear or worked smoothly. Either the entire shape object should be revisited or the interaction should be simplified.

Reset navigation.
The addition of a reset or undo option could help users when accidentally doing unintended. A undesired interaction can mess with the whole experience, most notable in the shape interaction. Providing a way to restart or redo the individual parts could help to resolve this.

Refinement of physical objects.
Move Varjo Markers or explore other ways of tracking to prevent users from covering them and distort tracking.

Visual explanation/animation of how to interact with objects.
To increase the ease of understanding, enable users to more quickly start interacting and to not loose explanation in the voice-over narrative further research is required in delivering explanation. A simple animation of how to interact or a 'hologram' person showing what the user can do could help. With awareness needs to be remained as the addition of more elements could cause for more overload and decrease the serene aesthetic.

Unreal Engine code.
As the AR experience is created by a inexperienced designer the code should be improved further. This would most likely increase the smoothness of the interactions

A varied audience.
As the experience prototype is tested with a limited amount of participants further research is needed to find out if the experience offers engagement and learning to the varied museum audience.

Social context.
The designed prototype takes the social context too little into account. The elements designed to provide social interaction are underdeveloped and little evaluated as the focus was more on creating an individual experience. More research into the social context and interaction should be done as this is likely an important factor when displayed in a museum.

Aesthetic of virtual painting.
The presented virtual paintings appeared to be sufficient during user evaluation but do not yet represent the actual look of the painting. To further increase the authenticity and honesty of the experience the material appearance and model of the painting requires further refinement.

The experience with other paintings.
To further explore the possibilities if the experience it would be valuable to investigate if and how it can be applied on other paintings.

Conclusion

The goal of this project was to ***create an interactive AR museum experience, showing the effects that changes in visual elements have on the perception of Effingham I.*** This has resulted in the form of an AR prototype, encouraging museum visitors to actively engage and interact with changes in Effingham I, whilst learning something about it's background.

This graduation project set out to explore how AR could support meaningful engagement with abstract modern art in a museum context. It investigates how to revive and add on to decaying abstract modernist artworks.

Material change over time, such as the degradation of pigments in Effingham I complicates how such artworks are meant to be experienced and are experienced with a changed look. This project investigated how interaction could be used not to explain or replace the artwork, but to invite visitors into an active, reflective encounter with visual change, perception, and interpretation.

Through a research-through-design process, the project combined theoretical research with explorative design experiments and iterative prototyping. Insights from literature on museum experience design, human–computer interaction, authenticity, and art perception informed the design approach centred on embodied, tangible, and spatial interaction. Rather than relying on text-based interpretation or screen-focused interfaces, the design emphasised bodily engagement, openness of interaction, and a clear distinction between the physical artwork and digital augmentation. This approach allowed interaction to function as a tool for exploration over providing instruction.

The final delivery offers a prototype of an interactive AR museum experience that allows visitors to engage with a virtual representation of Effingham I, in cooperation with the physical painting in the same space. By manipulating visual aspects such as colour, shape, depth, fluorescence, and size through bodily movement and tangible interaction, visitors are encouraged to reflect on how changes in the artwork influence their own perception of the artwork. The experience brings together three interconnected narratives: the temporal change of the artwork due to material degradation, the modernist principles underlying Frank Stella's practice: self-referentiality, all-overness, instantaneousness and flatness, and the visitor's personal exploration of visual change and perception.

Evaluation of the concept through iterative prototyping and user testing suggests that the created experience could support reflective engagement without disrupting the contemplative atmosphere of the modern art museum. Participants were able to interact freely with the experience, using exploration and comparison to develop their own understanding of the artists way of working and the artwork and its visual qualities. While the prototype is not ready to be implemented as a final museum installation, the evaluation indicates that AR could be used as a non-invasive interpretative layer that complements, rather than competes with, the physical artwork.

The project highlights several limitations and opportunities for future work. The experience was designed for individual engagement and relies on head-mounted AR technology, which raises questions about scalability, accessibility, and social interaction in museum settings. Future explorations could investigate multi-user or shared AR experiences or applications of this approach to other abstract or non-representational art. The evaluation pointed out the value of embodiment and tangible interaction using recognizable objects as mediators to interact but the currently designed objects could use further research and refinement. Additionally, further collaboration with conservators and curators could help to explore what information should be shared and how to relay this in an effective and engaging manner.

In conclusion, this graduation project demonstrates that AR interaction could play a meaningful role in shaping how abstract modern art is experienced in museums, demonstrating how AR can function as a reversible, non-invasive interpretive layer that supports experiential authenticity in modern art museums. By foregrounding exploration, perception, and embodied engagement, the project suggests that interactive technologies can enrich encounters with art without diminishing its autonomy or authenticity. As such, it contributes to ongoing discussions on the role of interaction design in cultural contexts and offers directions for future design research at the intersection of art, technology, and museum experience.

Significance

This project demonstrates a possible way to interact with abstract modern art through AR. The project explores how embodied, tangible and spatial interaction can support meaning-making in encounters with abstract modern art within a museum context. Through design and prototyping of an interactive AR experience centred on Effingham I this work demonstrates how interaction design can mediate between artworks, novel technology and visitor experience without undermining the experienced authenticity of original artworks.

From an interaction design perspective, this project contributes by showing how interaction can function as a reflective, exploratory activity rather than a task-oriented or goal-driven process. Instead of optimising for efficiency or information transfer, the experience is designed to encourage contemplation, experimentation, and personal interpretation. This places interaction as a means to think with an artwork rather than just learn about it.
By treating space, body, and physical artefacts as integral parts of the interface, this work contributes an example of activity-driven interaction design in a cultural context, extending traditional HCI approaches that are often screen-based or instruction-led.

By treating space, body, and physical artefacts as integral parts of the interface, this work contributes a concrete example of activity-driven interaction design in a cultural context, extending traditional HCI approaches that are often screen-based or instruction-led.

Within the field of museum interaction design, this project contributes by exploring how AR technologies could be integrated into the “white cube” environment without separating interaction from the artwork itself. Unlike many interactive museum installations that are physically detached from exhibited objects, this experience remains visually and spatially connected to the original painting.

Collectively, this project contributes a design-led example showing how interaction design can:

- Mediate relationships between authenticity, technology, and interpretation.
- Support deeper engagement with abstract art through embodied exploration rather than explanation.
- Expand the role of AR in museums from informational enhancement to meaning-making through interaction.

As such, the project offers insights and design strategies not only relevant to interaction designers, but also for museum professionals, curators, and researchers working at the intersection of art, technology, and visitor experience.

Personal reflection

To conclude this report, I would like to reflect on my own development during this graduation project. The process came with its ups and downs, and although it did not follow a linear and always-clear path, I am overall satisfied with what I have achieved.

This project allowed me to develop new skills, particularly in working with XR, which was new to me at the start of the project. Learning to work with these technologies expanded my technical capabilities and my understanding of how interactive experiences can be designed beyond screen-based interaction.

The project was largely done individually, which helped me grow more confident in directing my own work and taking responsibility for design decisions. At the same time, I became aware that I did not always seek external input when it could have strengthened the project. Insecurity and indecisiveness sometimes held me back from reaching out to others, even when I recognised the value of doing so. Towards the end of the project, I noticed an increase in confidence, making it easier to ask for feedback and move forward.

I also gained insight into my own design approach. I tend to work intuitively, which supports exploration but can result in an unclear design path and make it difficult to articulate decisions made. Learning to better structure and communicate my process is an important takeaway for future projects.

Overall, I am satisfied with the outcome of this project. While there are aspects I would approach differently with more time, the evaluation showed that the prototype was engaging, inspiring, and had the potential to support learning. I hope my work in some way can contribute to the creation of more exciting interactions with modern art.

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Appendix

Appendix A: Project brief

DESIGN FOR our future

TU Delft

Personal Project Brief – IDE Master Graduation Project

Name student Rijk Roozenbeek **Student number** 5,058,201

PROJECT TITLE, INTRODUCTION, PROBLEM DEFINITION and ASSIGNMENT
Complete all fields, keep information clear, specific and concise

Project title Designing interactive reconstructions of Color Field paintings with Augmented Reality

Please state the title of your graduation project (above). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

Introduction

Describe the context of your project here; What is the domain in which your project takes place? Who are the main stakeholders and what interests are at stake? Describe the opportunities (and limitations) in this domain to better serve the stakeholder interests. (max 250 words)

The context of this project is within a field of art history, conservation of art, and interaction design. It is conducted in collaboration with Stefanie de Winter, an art historian exploring aging in Color Field painting as an art historical problem. With her current project Interdisciplinary Reconstruction of Art project (IRECONA) she is investigating a new type of conservation method using Augmented Reality.

In the 1960s, artists like Frank Stella began experimenting with fluorescent pigments. These materials, while visually striking, are chemically unstable and highly affected by light degradation. As a result, many of these works no longer resemble their original state (see figure 1), and conventional conservation methods struggle to restore or preserve the original/intended visual experience. (de Winter, 2010)

This project focuses on *Frank Stella's Effingham I (1967)*, a painting where color degradation is both visible and significant. The opportunity lies in using Augmented Reality to digitally revive and concereve the painting's original vibrancy, allowing audiences to engage with the artist's intentions. This approach addresses conservation limitations but also introduces new possibilities to interpret and interact with the paintings. A question that arises is wheter the digital enhances the analog or takes away it's story and intent.

Stakeholders include artists, art critics, and the general public. Each has their interest in preserving, understanding, and experiencing the aesthetic and history of the paintings. The challenge lies in balancing the historical story with technological enhancements, raising questions about authenticity, interpretation, and user experience.

Winter, Stefanie De. (2010) Conservation problems with paintings containing fluorescent layers of paint. CeROArt. https://doi.org/10.4000/ceroart.1659

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introduction (continued): space for images

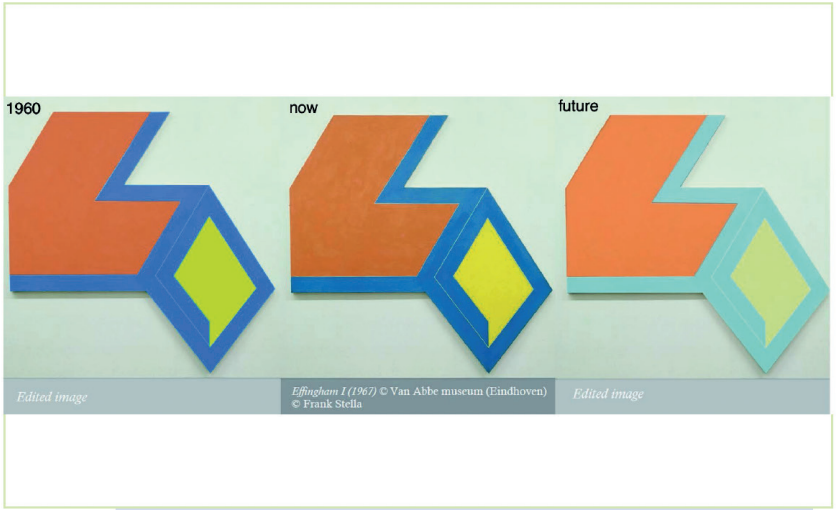


image / figure 1 Change of Color Field Paintings over time (Effingham I, Frank Stella)

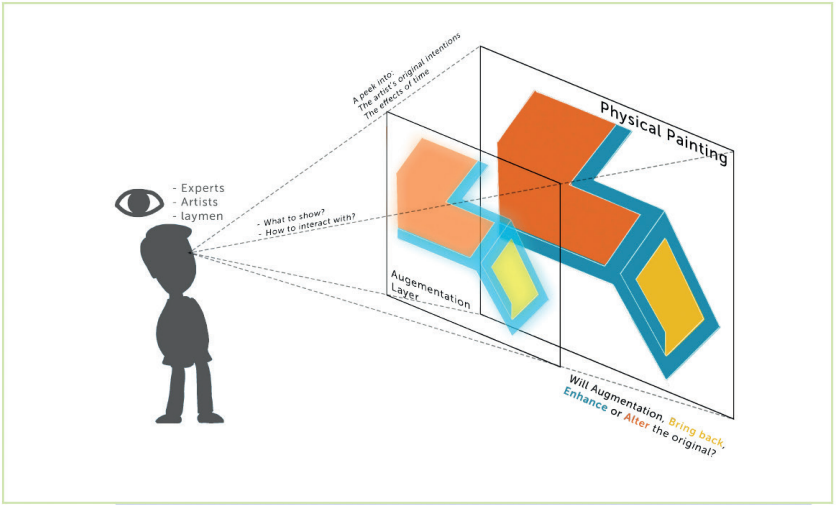


image / figure 2 View on the project and its outcome at the start

DESIGN FOR our future

TU Delft

Personal Project Brief – IDE Master Graduation Project

Problem Definition

What problem do you want to solve in the context described in the introduction, and within the available time frame of 100 working days? (= Master Graduation Project of 30 EC). What opportunities do you see to create added value for the described stakeholders? Substantiate your choice.
(max 200 words)

Fluorescent pigments used in Color Field paintings from the 1960s, such as Frank Stella's *Effingham I (1967)*, degrade rapidly over time. As a result, these artworks possibly no longer convey the effects originally created by the artist, such as enhanced depth perception caused by fluorescent color contrasts (de Winter et al., 2018).
Currently, there are no good sustainable methods to restore or convey these visual effects without compromising the artwork's integrity. This creates a problem with both public experience and research regarding the original impact of these paintings. This project aims to address this problem by exploring Augmented Reality as a (preventive) conservation and/or reconstruction tool.

During the project I will design and prototype an interactive AR experience with *Effingham I*, enabling viewers to experience its original visual impact while also learning about the decay and artistic context.
This approach creates value for multiple stakeholders: artists, art critics, and the general public, by preserving artistic intent, facilitating further analysis, and enhancing the experience surrounding the painting.

De Winter, S., Moors, P., Van Gelder, H., & Wagemans, J. (2018). Illusory Depth Based on Interactions Between Fluorescent and Conventional Colours: A Case Study on Frank Stella's Irregular Polygons Paintings. *Art & Perception*, *6*(2-3), 116-150. https://doi.org/10.1163/22134913-20181093
Winter, Stefanie De. (2010) Conservation problems with paintings containing fluorescent layers of paint. CeROArt. https://doi.org/10.4000/ceroart.1659

Assignment

This is the most important part of the project brief because it will give a clear direction of what you are heading for. Formulate an assignment to yourself regarding what you expect to deliver as result at the end of your project. (1 sentence) As you graduate as an industrial design engineer, your assignment will start with a verb (Design/Investigate/Validate/Create), and you may use the green text format:

Design a Virtual Reality experience to show and inform about degradation of color field paintings using fluorescent colors for museum visitors in a museum environment

Then explain your project approach to carrying out your graduation project and what research and design methods you plan to use to generate your design solution (max 150 words)

This project explores how Augmented Reality (AR) can be used to digitally preserve and experience fluorescent Color Field paintings, focusing on *Frank Stella's Effingham I (1967)*. The aim is to design an AR experience that allows users to interact with the artwork while revealing insights into the artist's intent, material aging, and historical context.

The project will begin with literature review on Color Field painting, art-historical backgrounds, and AR. I will also conduct interviews and surveys with stakeholders and museum visitors to uncover user needs and desires.
Using an iterative design approach, I will develop and test a series of (AR) prototypes that explore different modes of interaction and storytelling. The project will conclude with a final (prototype) AR experience and eventually evaluated in a simulated museum setting to assess its impact on interaction with, perception of and understanding of the artwork.

Project planning and key moments

*To make visible how you plan to spend your time, you must make a planning for the full project. You are advised to use a Gantt chart format to show the different phases of your project, deliverables you have in mind, meetings and in-between deadlines. Keep in mind that all activities should fit within the given run time of 100 working days. Your planning should include a **kick-off meeting**, **mid-term evaluation meeting**, **green light meeting** and **graduation ceremony**. Please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any (for instance because of holidays or parallel course activities).*

Make sure to attach the full plan to this project brief.
The four key moment dates must be filled in below

Kick off meeting	6 juni 2025
Mid-term evaluation	1 sept 2025
Green light meeting	6 nov 2025
Graduation ceremony	11 dec 2025

In exceptional cases (part of) the Graduation Project may need to be scheduled part-time. Indicate here if such applies to your project

Part of project scheduled part-time	✓
For how many project weeks	20
Number of project days per week	4,0

Comments:

Motivation and personal ambitions

Explain why you wish to start this project, what competencies you want to prove or develop (e.g. competencies acquired in your MSc programme, electives, extra-curricular activities or other).

Optionally, describe whether you have some personal learning ambitions which you explicitly want to address in this project, on top of the learning objectives of the Graduation Project itself. You might think of e.g. acquiring in depth knowledge on a specific subject, broadening your competencies or experimenting with a specific tool or methodology. Personal learning ambitions are limited to a maximum number of five.
(200 words max)

My main goal is to show myself that I am ready to step into the world as a design professional, this is my opportunity to show my skills and knowledge and apply them in a real world context.
During my DFI journey I have struggled to find my identity as a designer. I enjoy a wide variety of topics but at the same time find it hard to feel what I am really passionate about. Looking back at previous projects I found that my interest lies in creating experiences through form and senses, telling stories in an abstract manner. I feel this project perfectly aligns with this direction and hope to put a lot of passion into it.

With this project I like how the analog and digital worlds are combined and used to strengthen each other. I hope to create an experience that shows people a different story beyond what they would normally see.

During my studies I have learned a lot of different design methods. With this project everything now comes together. I want to apply all that I have learned and further sharpen these skills.

My personal learning ambitions:

1. Experiencing more of the real world of design and working in a more real context.
2. I am very keen on learning new skills (e.g. Augmented reality) and finding ways to apply them.
3. Taking control of a project and doing it all myself.
4. Creating an experience that brings joy, inspires and teaches something to people

Appendix B: Explorative experiments

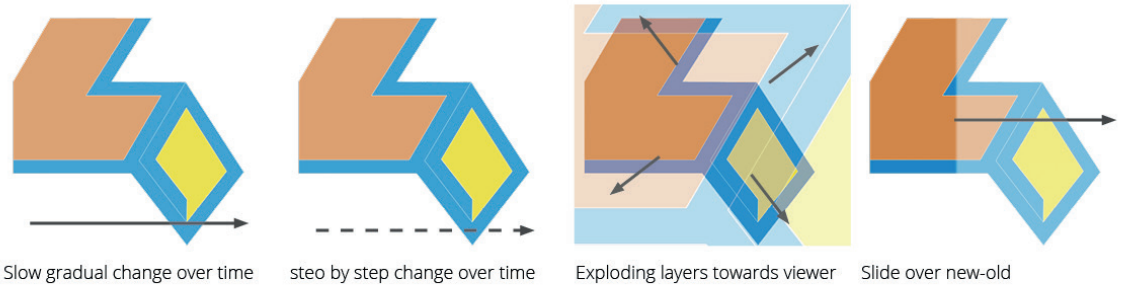
The following appendices document several explorative experiments performed in the Explore phase and at the beginning of ideation. These experiments were informal and open-ended, aimed at sparking ideas and uncovering early insights. While not rigorous studies, they provided valuable input that informed later design choices.

B1. Temporal transitions

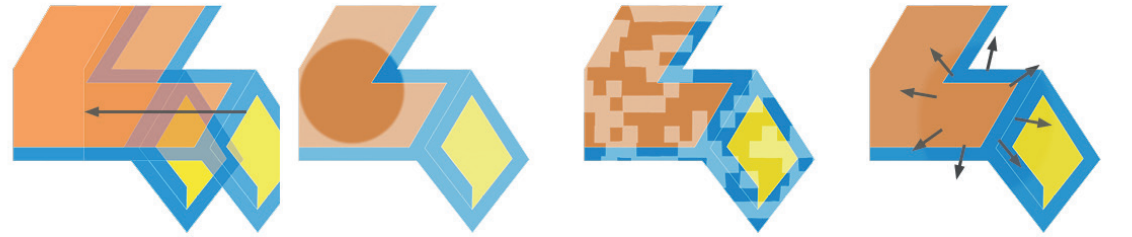
A few animations were generated to investigate possible transitions from how the painting looked to how it looks and how it will possibly look in the future.

The Animations show different forms of change, from simple to more playful. All show the transition from what was to what is.

A group of 5 people were asked to respond to these transitions. They were asked what they were being shown, how the transitions made them feel and which version felt best tot them. The results are gathered in the form insights, which can e used in further development



Slow gradual change over time | steo by step change over time | Exploding layers towards viewer | Slide over new-old



Slide in layers | Search light | Building up/ breaking down blocks | Gradual change from center, layer by layer

Insights

The ‘slow gradual change over time’ and the ‘slide over new-old’ were seen as best

- Change should be calm and gradual, most clear and feels smooth.
- Change should not be too quick, as this provides too little time to absorb what is happening
- Change should not be shown too slow as the change will not be clearly visible.
- Prevent too playful movements as it does not convey decay very well.
- A calm transition would fit best with the intended goal of showing how the painting changes over time
- Just showing a visual change did not convey the story of a decaying painting, more context seems to be needed.

B2. Semi-transparent mirror

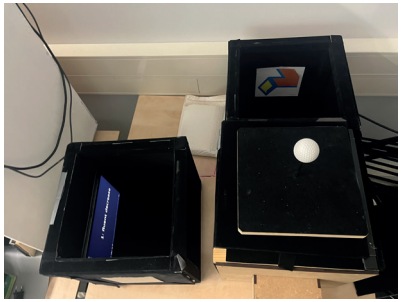
With the intend to investigate other forms of augmenting reality, an experiment was carried out using a set-up with a half transparent mirror.

The goal was to investigate if another form of augmentation could work instead of using the computer AR.

With the intend to investigate other forms of augmenting reality, an experiment was carried out using a set-up with a half transparent mirror.

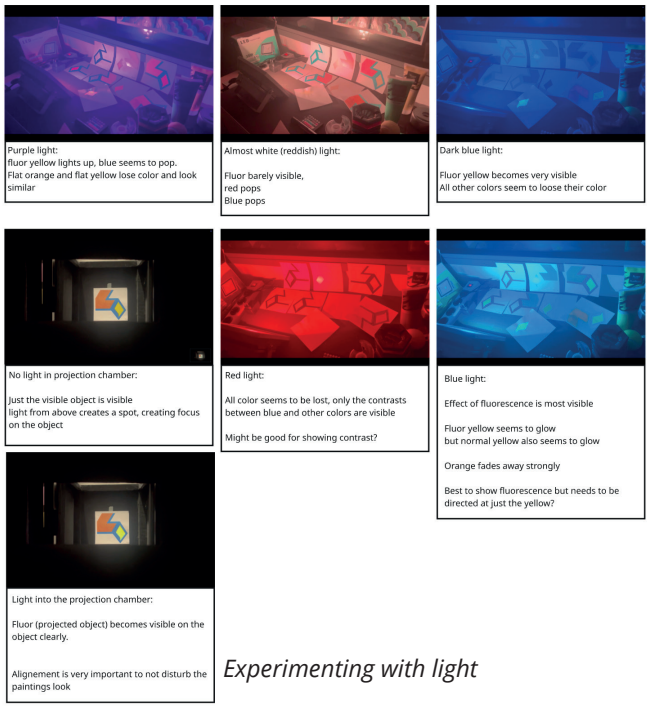
The goal was to investigate if another form of augmentation could work instead of using the computer AR. The experiment was set up in 2 ways.
1. In a closed off box with a small replica of the painting.
2. A replica of the painting on a wall a bit further away, to investigate if this could be used to “project” things over the real painting.

With both set-ups different settings were tested, changing amount and type of light, animation shown and overlays projected.

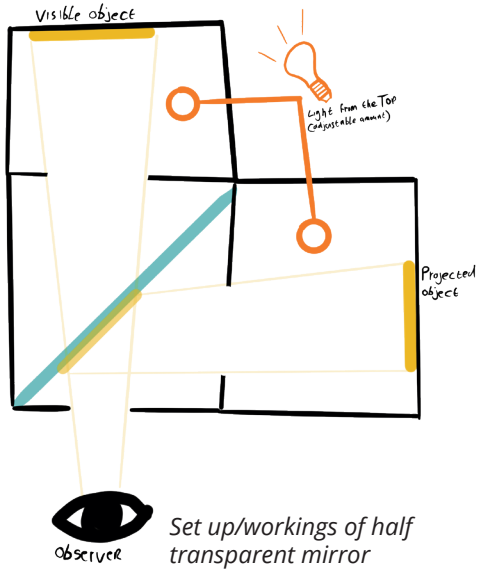


Set-up 1

Set-up 2



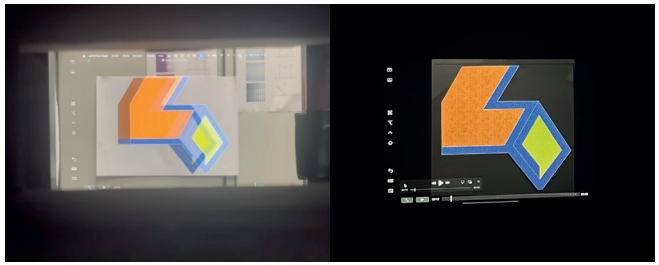
Experimenting with light



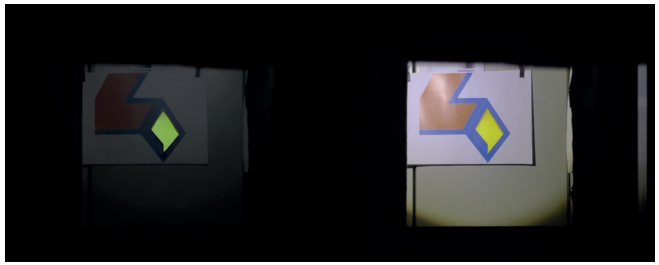
Set up/workings of half transparent mirror

Insights

- Calibration of projection over object is tedious and hard to align correctly, required to sit very still and look from one position.
- Interactions (possibilities) are very static
- Closed off experience, as all your focus is guided through a box
- The idea of looking at the painting through different lenses and seeing different things seems interesting
- Gives a more ‘real’ experience, not looking through screens or having an HMD on. Feels more like actually being there, more grounded in reality



Calibration difficulties *Projection of materiality*

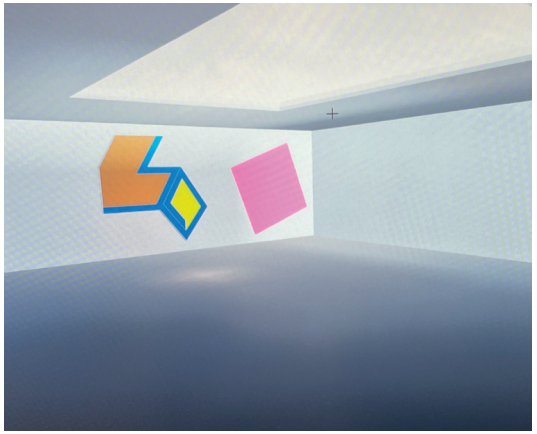


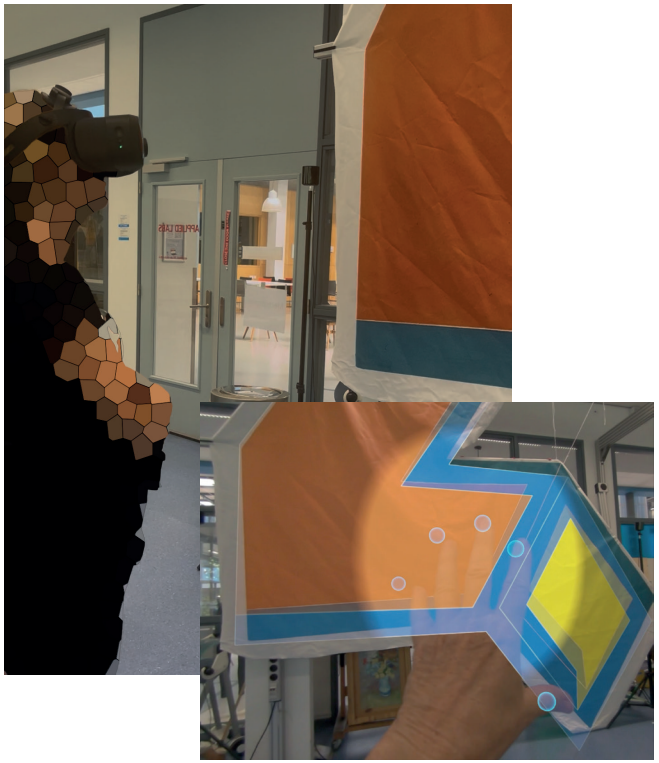
Fluorescence in a dark environment *Fluorescence in a lit environment*

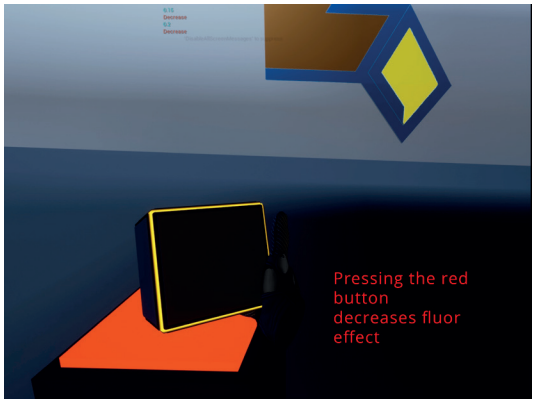
B3. VR experimentation

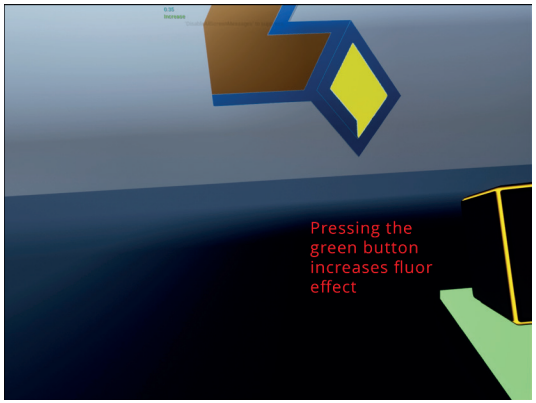
As I was new to Unreal engine and using VR or AR, I took some time to experiment creating and using the technology.

I created a simple VR room where I tested a few things. During my experimentation I invited some people over to experience what I was working on and share their thoughts.
From this experimentation I myself gained some insights and some insights were provided by the people visiting me.









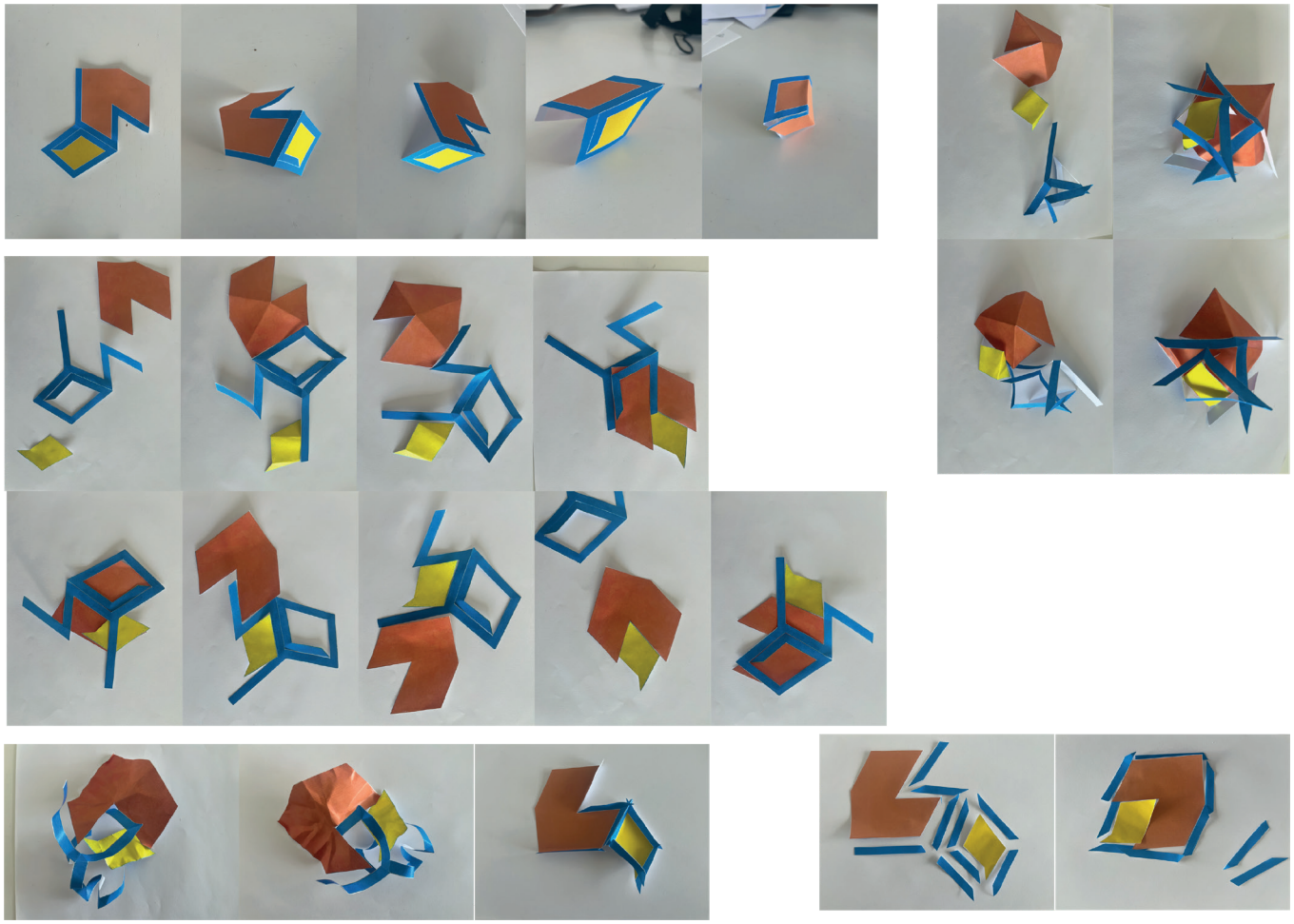
Insights

- Interactions should be more than pushing virtual buttons, AR allows for more exciting forms of interaction.
- Making use of space, embodiment or tangibility could be interesting
- Some time is needed to get adjusted to being in VR/AR
- Not too much should be happening at once, AR can be easily overwhelming
- The connected cable can cause some hazard and limits movement
- Change based on moving around feels weird, every perspective will be different on 2 dimensions – amount of decay and point of view
- Have enough space/time within the experience to just watch and observe
- Having only virtual objects (like a pillar) can cause confusion between what is real and not real. Walking through a virtual block was avoided and there was an attempt to lean on a virtual lock (which can be a hazard)
- Holding an object as a means of controlling the interaction feels more intuitive than just using the body
- Handheld controllers can be confusing for inexperienced users, interactions enabled through them should be simple (using few buttons)
- Control should be easy an uncomplicated

B4. Reshaping Effingham I

As a playful exploration on the shape and form of effingham I a few printed copies of the shape were made. These copies are folded and cut to explore the possibilities with the shape and how to possibly de/reform it.

Experimenting by doing different things to the painting was a fun activity. It allowed to look at the painting differently and seek out what parts of the painting could do or could be. This also meant looking back at the original painting and looking at that differently.
There was no grounded reason in what was done but rather a free exploration on shape.



Insights

- Restructuring the painting created a space for reflection and contemplation, reflecting on (parts of) the painting
- There are many possible ways to play with shape and form
- Even when completely restructuring the shapes, due to the elements retaining some of the visual look (I.E. colour or basic shape) Effingham I was still recognizable. It is not an entire new creation but an 'evolution' on the painting.

Appendix C: Peoples perception of Effingham I

To get a quick idea on what people see and think when being confronted with the painting 10 people where asked to look at a picture of Effingham I and share their first impression. No information about the painting was given, the goal was to get a quick response allowing the people who were asked to form their own opinion and ideas with the painting.

The question asked

Hi there, can I get a short moment of your time? I am interested in seeing what you think of this painting?
- What do you think of this painting?
- What are your thoughts looking at it?
- What would you like to know about the painting?
- Are there questions that the painting arises?

I would appreciate if you could share your opinion, it can just be a short response and is meant to give me a quick impression of what you think with the painting.

(Translated from Dutch to English)

Picture of Effingham I shown

Notes of the responses

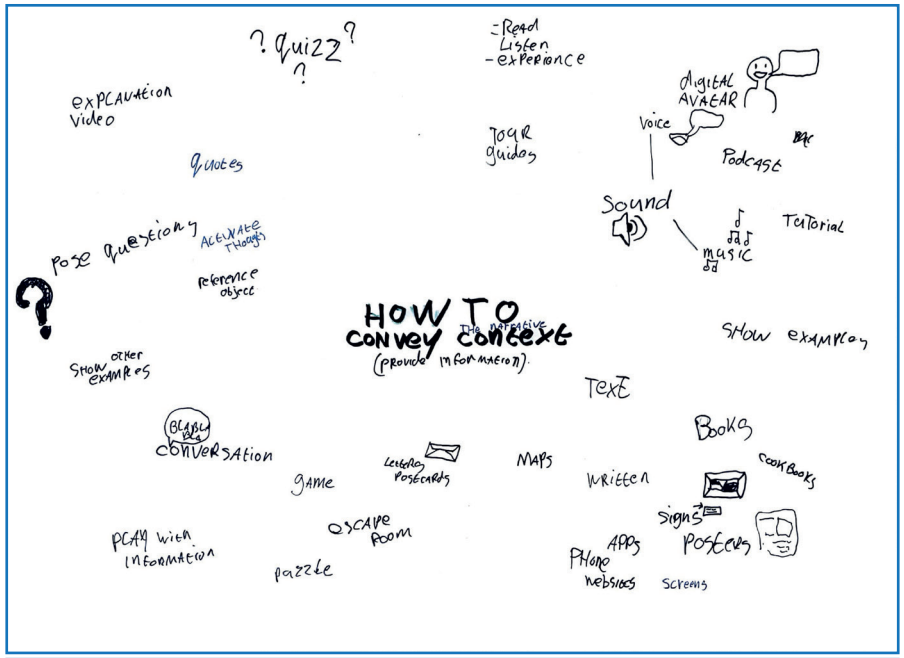
Insights

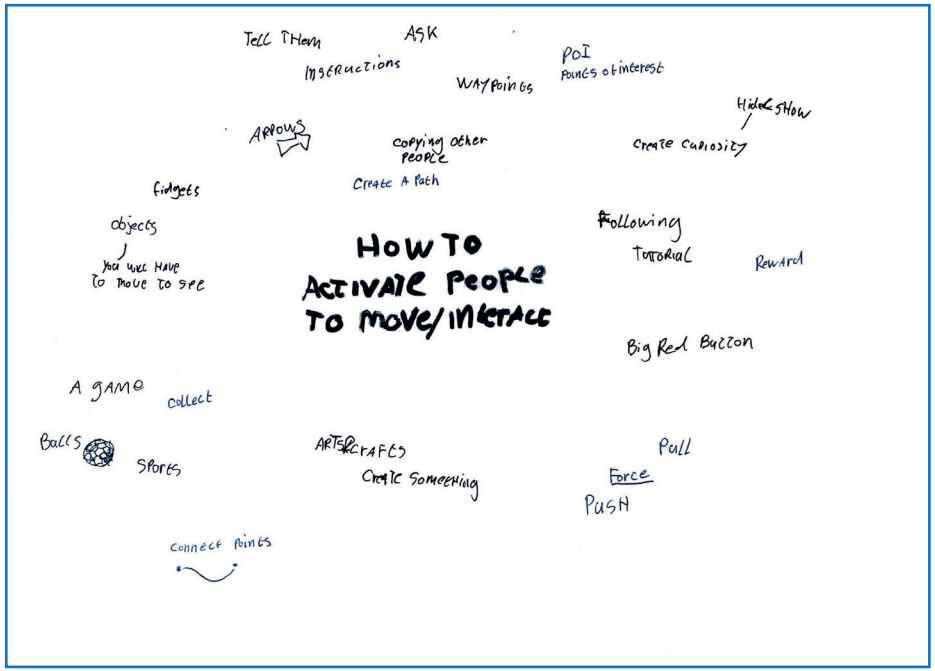
- Associating the painting to things they know
- Analysing shape, colour and meaning
- Interested in the painters goal with the painting
- Mentions of an interplay of 2D and 3D

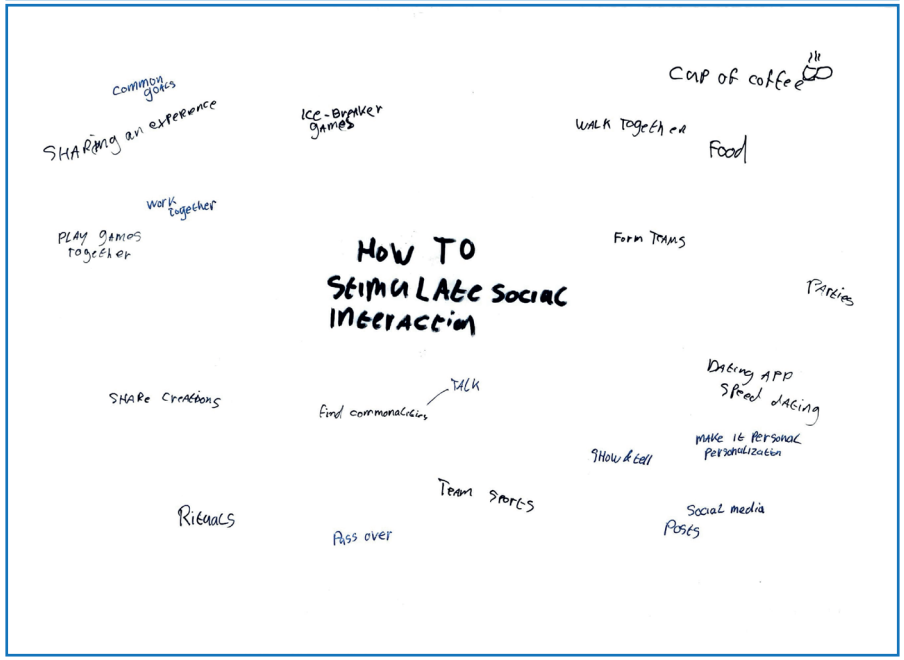
Appendix D: Mood-board of aesthetic experience

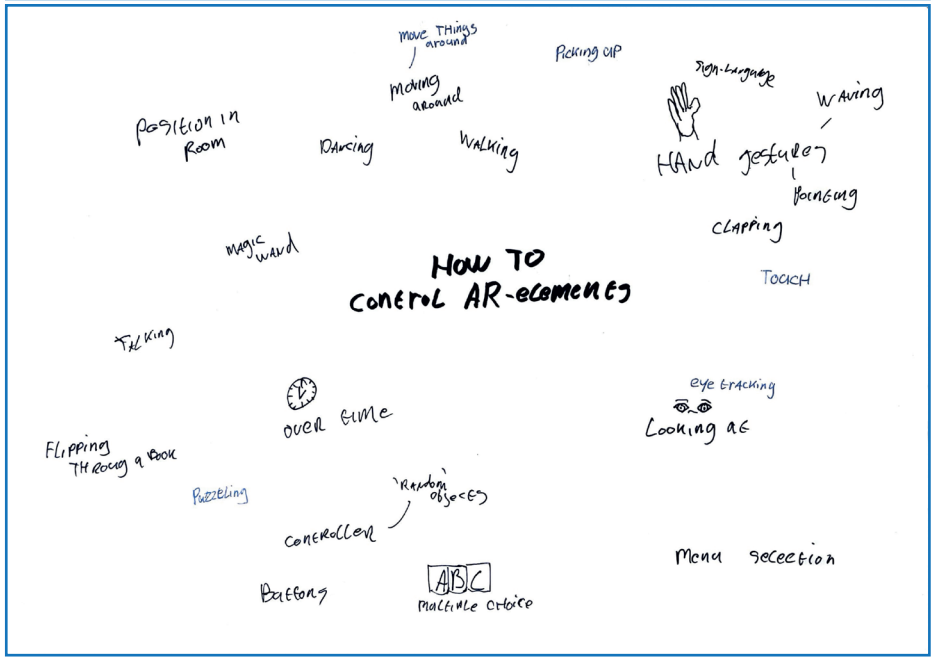
- Serene
- Calm
- White
- Effingham I accents
- Straight-lines

Appendix E: How-to's

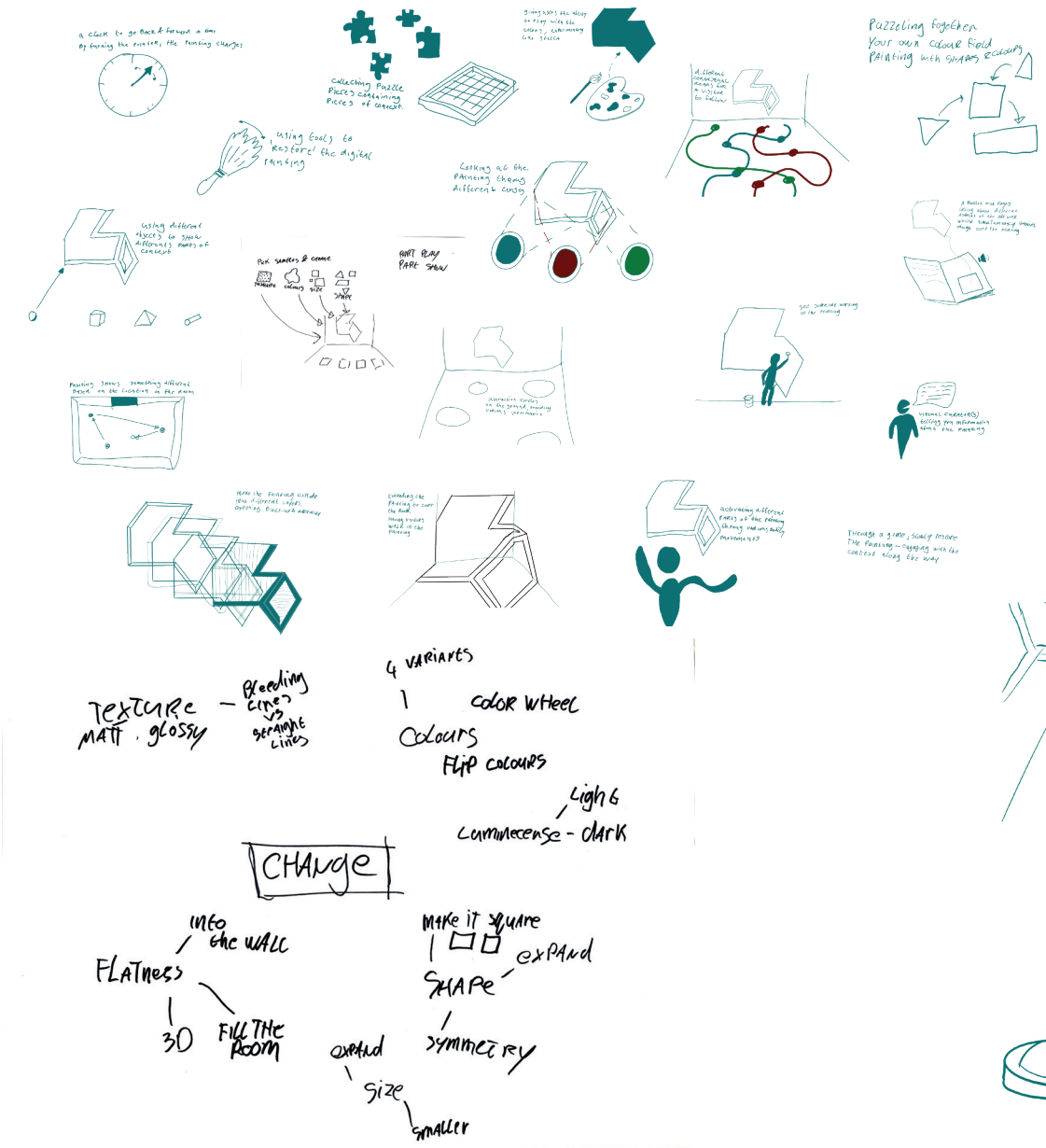


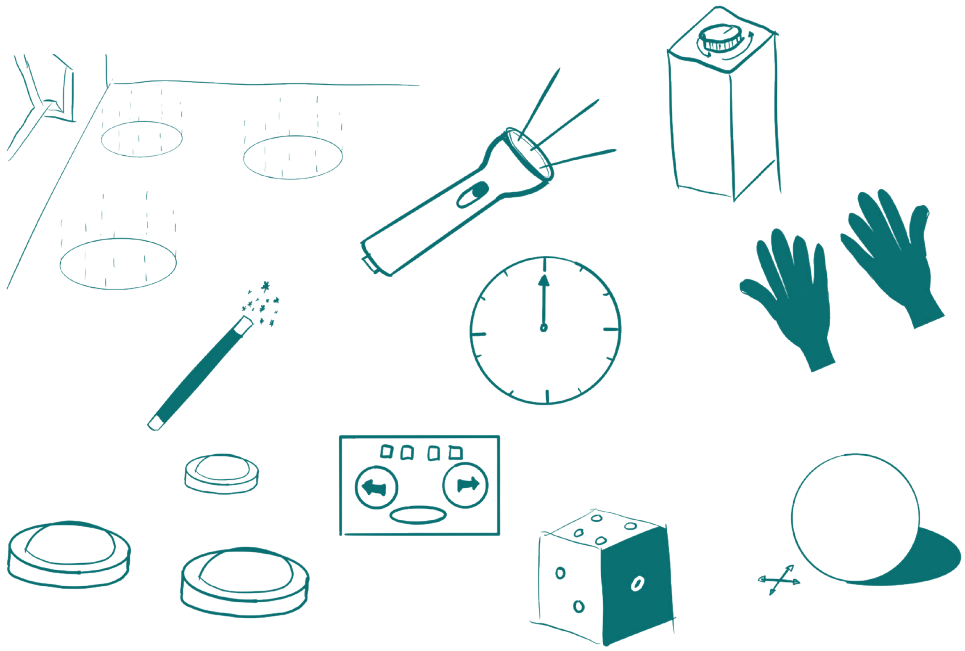






Appendix F: Brainstorming





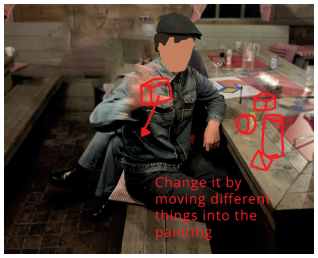
Appendix G: Bodystorming 1

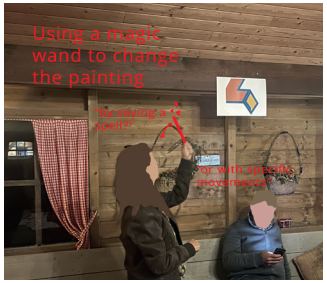
Method:
First, the project was introduced, talking about AR and explaining the goal of the project. Participants were asked to sign a informed consent form to participate.
A small copy of the painting was hung up on the wall, and the participants were asked different prompts to react to: I.E. ” what if we want to change the colour, how could we do this?”
Then someone steps forward and tells/shows how they imagine doing this.

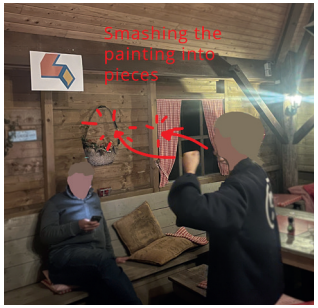
Prompts asked:
How would you change colour
How would you change flatness/depth
How would you change shape?
How would you change size?
How would you change luminescence?

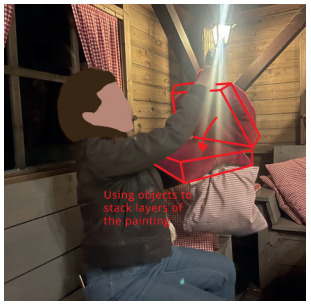
These prompt let to further ideas and discussion

Using this method provided with some interesting results. Still the exercise went very chaotic. Most of the discussion was about what could be seen within the painting. A lot of associations where made, a lot spoken of what could be seen within the painting and what could happen with it. It still seemed difficult to put this into real action & bodily movement, translating it into interactions or ideas.









Notes taken

General:
I see letters - maybe make/ find words
I see a leg - make it move/run like a leg
I see a chair
It makes me thing of tangram
Opening the yellow part as. a door, revealing something new
Talk with the painting, make it come alive
Depending on where people are in the room things change - so the room is your selection board
Placing objects around the room, depending on where they stand, they give off an effect
References were made to various objects that can be used to show certain parts (flood lights, painters’ palette)

Colour
Mix the colours together by moving your hands, washing it together
Pick up a part of the painting (yellow) and use it as a lens to look at the painting differently
Colours change based on the mood of the room (Music, or movement, or facial expression)
Painting can rotate around an axle, every rotation the painting undergoes a change
Use a brush to apply new colours
Tap the painting to change the colour
Jump and the painting changes colours

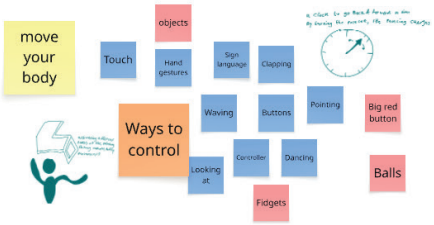
Depth/flatness:
Push and pull on the painting to bring elements forward and backwards
Fold it into a cube

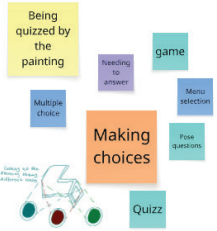
Shape
Find the “missing” pieces to make the painting rectangular again.
Pull forward the yellow part to make it “right” again
Pull on the sides to change the shape
Break apart by pulling on the white line like a string that holds everything together
Puzzle together the painting from loose pieces in the room
Grab and roll out the blue part

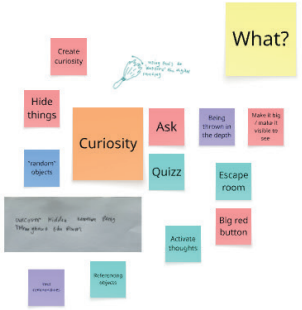
Size
Open and close arms to increase and decrease size
Move from left to right to change size
Open and close your mouth to change size
Pull on the sides of the painting

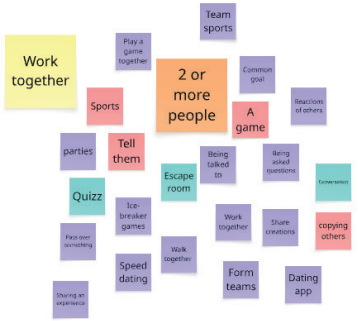
Luminescence
A floodlight on the ground, which you can point towards the painting, changing the colour of luminescence
Make the painting light up by screaming or making noise.

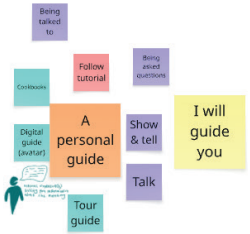
Appendix H: Clustering

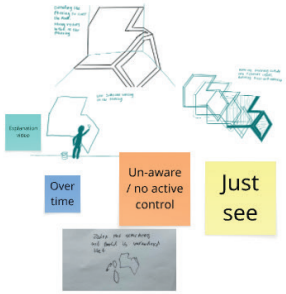


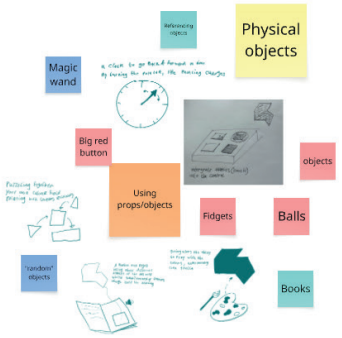


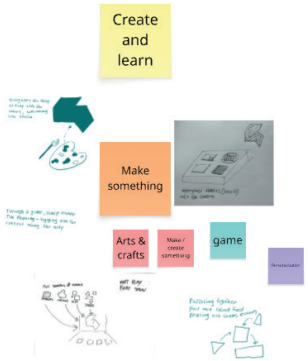


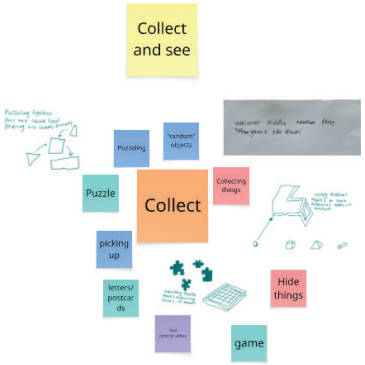


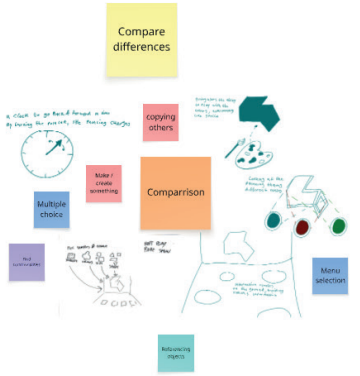












Appendix I: Starting point of 4 concepts

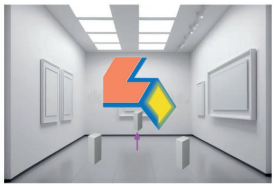
Create
The room as selection board

Room = selection board

There are 3 objects, each connected to one part of the painting - Blue, orange and yellow.

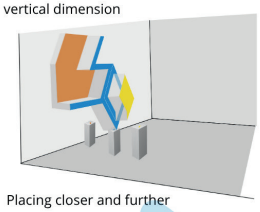
By locating the object in the room or doing an action with it they affect that part of the painting.

You select one visual aspect, which changes the room.
Depending on where you (or others) place these objects, the painting changes



Lifting higher - vertical dimension

Moving around on a field



Placing closer and further

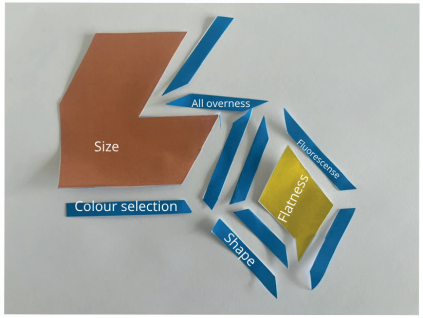
Short introduction, explaining temporal change → User selects an element to change and instructions on what to do with the objects is given → User moves around object in the room, selecting what sort of change happens → User can move around and see the effect of each element → In the end have created your own revisioned Effingham

Collect
Collecting puzzle pieces

Puzzle

Throughout the room pieces different 'puzzle' pieces of the painting are spread. By collecting these pieces and bringing them together the painting is slowly rebuild. With each piece collected the painting becomes whole again. Connected to each piece is a part of narrative slowly reviving the paintings vibrancy, colour and fluorescent effect

Painting is broken apart (by pulling the white string?) - pieces spread over the room - interaction = collecting the pieces



Short introduction, explaining temporal change, showing the painting in its current and future state → Painting falls apart into pieces through the room → Users return the pieces to a central point → With every piece collected another piece of narrative is told, slowly repairing the painting towards the original → All pieces collected fully repair the painting, showing it as it once was

Explore
Perceptual objects

Perceptual objects

Connect a visual element to an object, interacting with these objects affect their connected visual element.

User pick up one of the object and with these objects they can control a certain element in the painting

Depth: To push and pull (parts of) the painting back and forth

Luminosity: To make parts of the painting light up more or less

Colour: To select and apply colours to the painting

Size: To expand or size-down the painting

Shape: Puzzle a shape together to alter the shape of the painting

Texture: To select and apply a certain texture/material to the painting

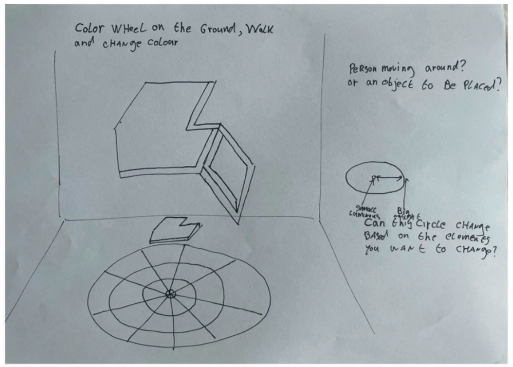
User is shown the temporal changes with the painting → User is asked tu pick up an object → Each object is used to control visual aspects in their own way → Painting changes by the things user does → Your creation and original painting are shown and can be compared

Compare
Comparison of 4

Compare 4

In front of the painting is a circle. This circle functions as a control panel. Depending on where you position yourself on this circle the painting undergoes changes.

Circle would be actual object on the ground but interactive control is only visible in AR. Creating a performance space



Scales: Bright <-> dimmed or Gloss <-> matt
Selection board: All kinds of materials to stand on

User enters a Circle and is being shown/told the effects of change → User selects an element to change and the circle changes to make a selection → User picks a spot in this circle which changes one aspect of the painting → Choice is locked in A next element is selected repeat 4 times → Ending up with 4 paintings, in which one element is changed every time → Compare the 4

Appendix J: Bodystorming 2

The second bodystorming session was performed with 2 participants.

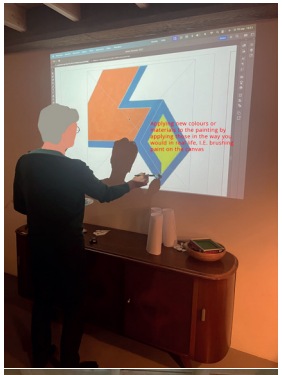
The goal of this session was to test a first iteration on the generated concepts and to generate ideas about how to interact with these concepts.

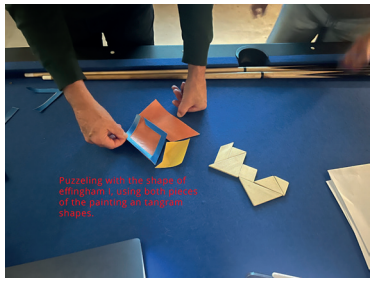
The start of 4 concept directions is used to give guidance during the bodystorm.

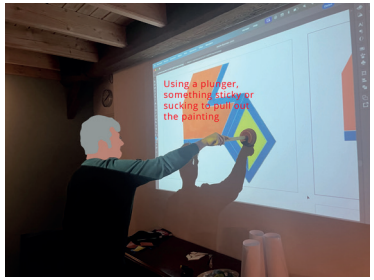
During the session the participants were explained each concept one by one. Participants were asked to share their thoughts and ideas through bodily movements.

In an open bodystorm participants could use their body and objects around them to clarify and how interaction could work. To allow them to use objects a few props were collected and created but they were free to find more.

During the session, notes & pictures were taken.

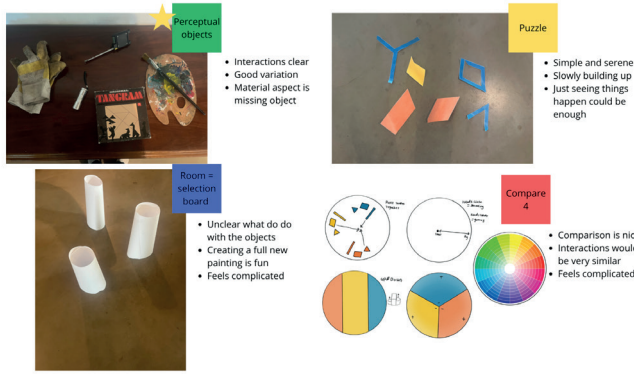






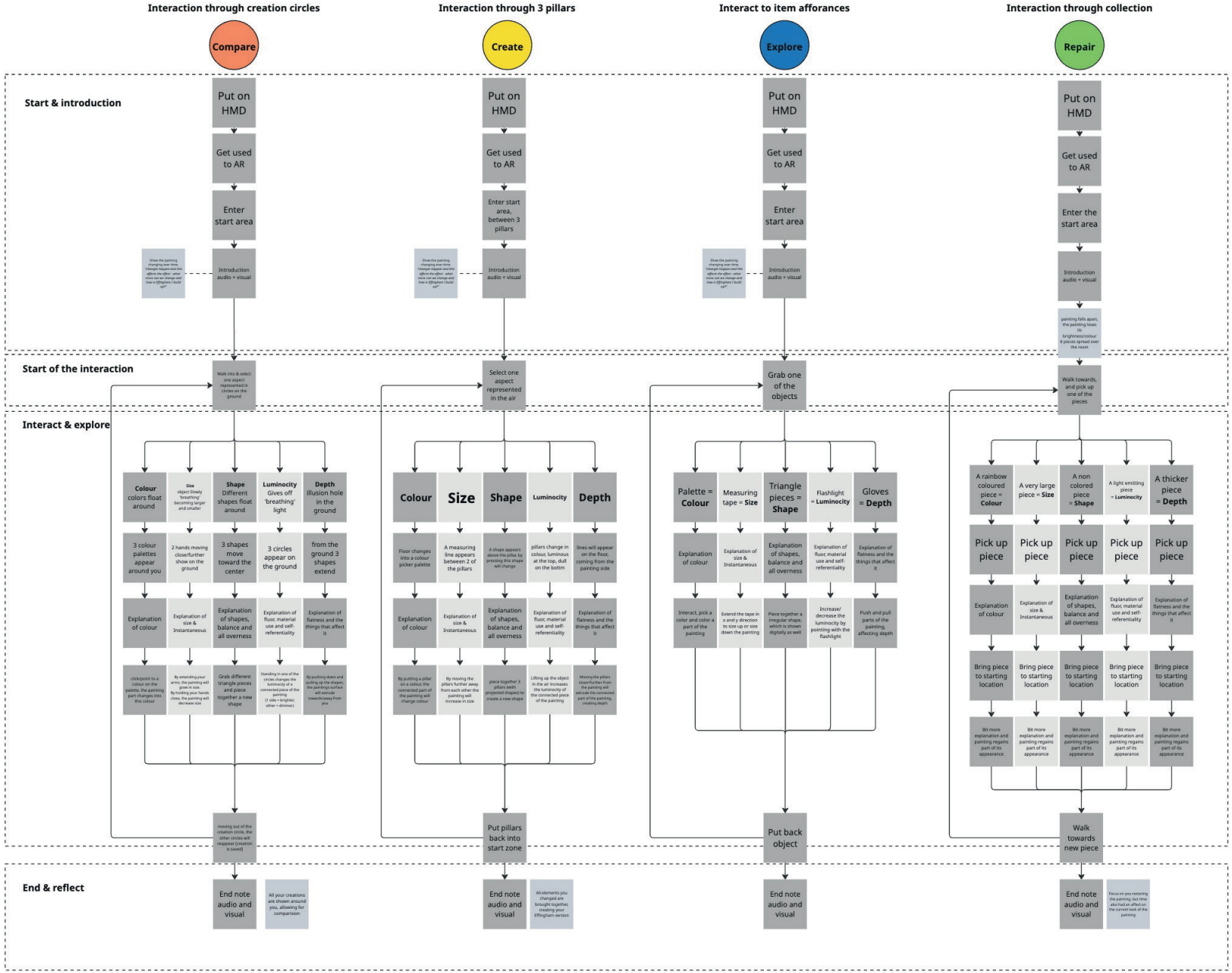
Pages used to explain concepts

Insights



- Interaction through objects seems to contribute to ease of use and directness in interaction.
- Playing around with physical elements is easier to understand than just playing with virtual elements (limited in this bodystorm).
- Having interactions both close by and further away from the painting create variation in how you see the painting.
- During the bodystorm it was unclear how the painting would change.
- There is value in recognizing the painting in the elements that are used to interact (I.E. Effingham shapes seem to work better than Tangram shapes)
- Movements that take too much work (jumping, ducking, running) are not desirable
- There is a danger in touching the real painting when interacting (especially when using physical objects)
- Making use of a combination of using body and objects looks like an interesting direction

Appendix K: Flow of the 4 concepts



Appendix L: Evaluation plan 4 concepts

Test plan – evaluatie 4 concepten

Onderdelen van evaluatie:
Canva slides: https://www.canva.com/design/DAGz0OYdz3E/h7U6SLx7hL-sXkXlkq_mBQ/edit?utm_content=DAGz0OYdz3E&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton

Geluidsopnames pers slide: Vind uitgeschreven teksten onderaan (in het engels)

Videofragmenten: zichtbaar in Canva slides

P5.js digitale prototypes op scherm per visueel aspect:
Kleur:
https://editor.p5js.org/rijkroozenbeek/full/VrYH9xfzO
Diepte:
https://editor.p5js.org/rijkroozenbeek/full/QQNM7_GTb
Licht/fluorescentie:
https://editor.p5js.org/rijkroozenbeek/full/XxS06AE7R
https://editor.p5js.org/rijkroozenbeek/full/p6oVsp3nP
Vorm:
https://editor.p5js.org/rijkroozenbeek/full/R34KQIMh8
https://editor.p5js.org/rijkroozenbeek/full/AZB2ibHNN
https://editor.p5js.org/rijkroozenbeek/full/vTMEyWvX6
Grootte:
https://editor.p5js.org/rijkroozenbeek/full/BluEOPN-U
https://editor.p5js.org/rijkroozenbeek/full/ySBB8u_Un

Uitleg project:
Voor mijn afstuderen ben ik bezig met het maken van een interactieve ervaring met een schilderij in Augmented Reality (AR).

AR voegt digitale elementen toe aan de fysieke wereld, om deze digitale elementen te zien krijg je een Headset/bril op en kijk je door een scherm naar de echte wereld. In AR kun je interacteren met digitale elementen, hierin bouw ik een ervaring rond een schilderij.

Het schilderij is Effingham I, ik vertel hier nog niet te veel over, als het goed is kom je hierover tijdens het zien en ervaren van de concepten meer over te weten.

De ervaring die ik aan het maken ben zal plaats vinden in een modern kunstmuseum, waar ook het fysieke schilderij hangt. Deze afbeeldingen geven een impressie van de (museum) omgeving.

[Lezen + ondertekenen consent form]

Uitleg over wat we gaan doen:

Ik wil je graag meenemen door 4 concepten voor een AR interactie met Effingham I.

Deze concepten zijn nu weer gegeven op verschillende digitale slides maar het is het idee dat dit verder ontwikkeld wordt naar een AR ervaring. Ik wil je vragen om voor te stellen dat deze interacties in AR in een museum plaats vinden.
Na elk concept hoor ik graag je feedback en gedachtes en heb ik een paar vragen.
Na alle concepten te hebben gezien hoor ik graag nogmaals wat je denkt en heb ik een aantal vragen om de 4 concepten te vergelijken.

Elk concept bestaat uit een aantal tekeningen met tekst om het concept uit te leggen, enkele geluidsopnames, die een bijbehorend verhaal vertellen en interactieve digitale prototypes op het scherm om een beter idee te krijgen over wat er met het schilderij gebeurt tijdens de interactie.
Als je tijdens het zien/ervaren van de concepten vragen en/of opmerkingen hebt hoor ik ze graag.

Concepten doorlopen/ervaren:

[Neem deelnemers mee door alle 4 concepten in verschillende volgorde, als er tijdens het doorlopen vragen komen worden deze beantwoord]

De slides leiden zich vrijwel vanzelf, de concepten bestaan uit afbeeldingen met uitleg tekst. Enkele afbeelding hebben een geluidsfragment, door hier op play te drukken krijg je een verhaal te horen, ook hebben enkele pagina's videofragmenten, welke vanzelf zullen afspelen. Op de slides staan enkele knoppen waarop geklikt kan worden, deze zullen je door de concepten begeleiden.

Concept 1:
We beginnen hier in een ruimte in het museum, waar het schilderij aanwezig is, er een zichtbare cirkel op de grond is en de AR-Headset aanwezig is.

De rest van de interactie leidt zich vanzelf door middel van de tekst onder de afbeeldingen, klikbare elementen en video & geluidsfragmenten.

Concept 2:
We beginnen hier in een ruimte in het museum, waar het schilderij aanwezig is, er 3 fysieke pilaren voor het schilderij staan en de AR-Headset aanwezig is.

De rest van de interactie leidt zich vanzelf door middel van de tekst onder de afbeeldingen, klikbare elementen en video & geluidsfragmenten.

Concept 3:
We beginnen hier in een ruimte in het museum, waar het schilderij aanwezig is, er een tafel met daarop 5 wit gekleurde objecten staat en de AR-Headset aanwezig is.

De rest van de interactie leidt zich vanzelf door middel van de tekst onder de afbeeldingen, klikbare elementen en video & geluidsfragmenten.

Concept 4:
We beginnen hier in een ruimte in het museum, waar het schilderij aanwezig is en de AR-Headset aanwezig is.

De rest van de interactie leidt zich vanzelf door middel van de tekst onder de afbeeldingen, klikbare elementen en video & geluidsfragmenten.

Uitleg/begeleiding geven waar nodig

Feedback:

[Na elk concept vragen stellen + feedback]

1. Wat vond je van dit concept?
2. Zijn er dingen die je onduidelijk vindt/vond?
3. Zijn er dingen die je goed/leuk of juist niet goed/leuk aan dit concept?
4. Heb je het idee dat dit concept je iets heeft geleerd?
    a. Wat heb je geleerd?
5. Kun je (je gevoel bij) dit concept beschrijven in 3 woorden
6. Zorgde dit concept dat je ergens over ging nadenken?
    a. Waarover?

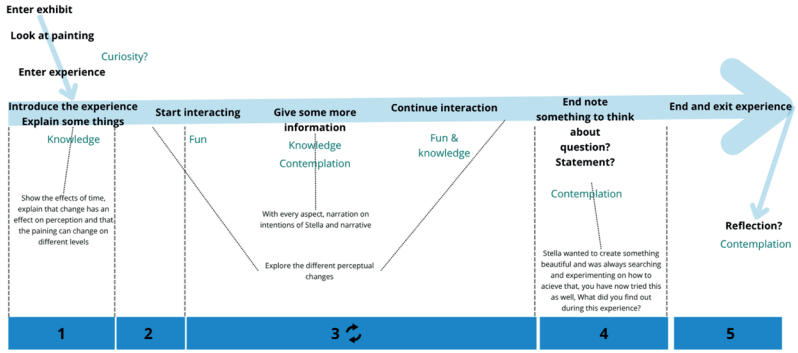
Verdere bespreking van het concept

[Na doorlopen van alle 4 concepten – vragen + algemene feedback]

1. Zou je de 4 verschillende concepten aan mij willen beschrijven?
    a. Wat doe je, wat is het doel, wat maakt het uniek?
2. Als je de keuze zou maken om 1 van de 4 in het echt te ervaren, welke zou dat dan zijn?
    a. en waarom?
3. Na het zien van deze concepten, wat kun je me vertellen over het schilderij?
4. Zijn er dingen die je graag had willen weten over het schilderij die je nu gemist hebt?
5. Welk concept past volgens jou het best in een modern kunst museum?
    a. En waarom?
6. Van welk concept denk je dat je het best iets leert?
    a. Waarom?
7. In welk concept zijn de volgens jou de interacties het meest boeiend?
    a. Waarom?
8. Wat vond je het meest unieke aan elk concept?
9. Welk van de 5 aspecten vond je het meest interessant?
    a. Waarom?
10. Welk einde is volgens jou het meest interessant?
    a. Het maken van een nieuwe versie van Effingham I
    b. Het vergelijken van je creaties op elk aspect?
    c. Het gewoon onderzoeken/ondervinden van elk aspect?
    d. Het repareren van het schilderij?
11. Welk concept maakte je het meest nieuwsgierig?
    a. Waarom?
12. Welk concept geeft jou de meeste (of gewenste hoeveelheid) vrijheid?
    a. Waarom?
13. Welk concept lijkt jou het makkelijkst om te begrijpen?
14. Welk concept lijkt jou het makkelijkst om te gebruiken?

Verdere bespreking van de concepten

Basis flow van elk concept:



Narrative text (Dutch)

Video Fragmenten – Narratief uitgetypt:

1: Start of the experience

C1

Welcome to this experience, here we are going to explore the painting Effingham I, made by Frank Stella in 1967.
Effingham I is part of Stella's Irregular polygon series, where he created paintings on irregular asymmetrical canvases composed of bold lines and colorful geometric forms.
Stella created his paintings with a goal of anti illusionism, which you will get more familiar with through this experience.

Let's **step into the circle** when you are ready to start

C2

Welcome to this experience, here we are going to explore the painting Effingham I, made by Frank Stella in 1967.
Effingham I is part of Stella's Irregular polygon series, where he created paintings on irregular asymmetrical canvases composed of bold lines and colorful geometric forms.
Stella created his paintings with a goal of anti illusionism, which you will get more familiar with through this experience.

Let's **step towards the 3 pillars** standing in the room when you are ready to start

C3

Welcome to this experience, here we are going to explore the painting Effingham I, made by Frank Stella in 1967.
Effingham I is part of Stella's Irregular polygon series, where he created paintings on irregular asymmetrical canvases composed of bold lines and colorful geometric forms.
Stella created his paintings with a goal of anti illusionism, which you will get more familiar with through this experience.

Let's **step towards the items** you see in front of you.

C4

Welcome to this experience, here we are going to explore the painting Effingham I, made by Frank Stella in 1967.
Effingham I is part of Stella's Irregular polygon series, where he created paintings on irregular asymmetrical canvases composed of bold lines and colorful geometric forms.
Stella created his paintings with a goal of anti illusionism, which you will get more familiar with through this experience.

Let's **step into the circle** when you are ready to start.

Show and talk about:
basic information about the painting - Painter, Time, Series, The goal
Entice to start the experience

2: Introduction to interaction

C1

Over time Effingham I changed. The paints that Stella used deteriorate quickly and the painting loses the vibrancy it once had.
This of course changes the look of the painting, but does it also change the effect the painting has on you?

During this experience you are invited to explore the painting. Frank Stella's intentions and experiment with a variation of aspects that make up the painting.

We are going to dissect the painting into 5 aspects, which you are free to explore in, when you are ready **step into one of the circles to get to know more.**

C2

Over time Effingham I changed. The paints that Stella used deteriorate quickly and the painting loses the vibrancy it once had.
This of course changes the look of the painting, but does it also change the effect the painting has on you?

During this experience you are invited to explore the painting. Frank Stella's intentions and experiment with a variation of aspects that make up the painting.

We are going to dissect the painting into 5 aspects, which you are free to explore in, when you are ready **grab onto one of the spheres to get to know more.**

C3

Over time Effingham I changed. The paints that Stella used deteriorate quickly and the painting loses the vibrancy it once had.
This of course changes the look of the painting, but does it also change the effect the painting has on you?

During this experience you are invited to explore the painting. Frank Stella's intentions and experiment with a variation of aspects, that make up the painting. **These aspects are connected to the items in front of you**

We are going to dissect the painting into 5 aspects, which you are free to explore in, when you are ready **grab onto one of the items** to get to explore and get to know more.

C4

During this experience you are invited to discover the painting, Frank Stella's intentions and experience a variation of aspects that make up the painting.

What happens if the painting loses visual elements? [painting falls apart] and does not look like what it was supposed to look like?

As you see the painting fell apart into 5 pieces, all with their own unique change. Walk towards and collect a piece then bring it back and see what happens

Tell and show about the changing of Effingham I due to time degradation.
Introduce 5 visual aspects that can also change

Tell and show degradation in a more dramatic form (not introducing degradation due to time)
intorudce 5 visual aspects that can also change

3a: Selected colour *[When selected the colour element]*

C1

You selected to explore the colours in Effingham I.

With his irregular polygon series Stella used vibrant colours. He did not have a real plan selecting those colours, he chose them seemingly arbitrary, on intuition.
He used the paint that was easily available to him, applied them in a way that seemed best to him and learned from what he did. He created every irregular polygon shape in 4-fold, using a different combination of colours every time. Do you think other colours would fit this painting?

Now it is your turn to pick some colours, which colours do you think create a good looking Effingham? **Select a colour on the palletes around you.**

C2

You selected to explore the colours in effingham I.

With his irregular polygon series Stella used vibrant colours. He did not have a real plan selecting those colours, he chose them seemingly arbitrary, on intuition.
He used the paint that was easily available to him, applied them what to him seemed best and learned from what he did. He created every irregular polygon shape in 4-fold, using a different combination of colours every time. Do you think other colours would fit this painting?

Now it is your turn to pick some colours, which colours do you think create a good looking Effingham? **place the pillars onto acolour and tap the top of the pillar to change the surface into that colour.**

C3

You **selected the palette**, lets explore the colours in effingham I.

With his irregular polygon series Stella used vibrant colours. He did not have a real plan selecting those colours, he chose them seemingly arbitrary, on intuition.
He used the paint that was easily available to him, applied them what to him seemed best and learned from what he did. He created every irregular polygon shape in 4-fold, using a different combination of colours every time. Do you think other colours would fit this painting?

Now it is your turn to pick some colours, which colours do you think create a good looking Effingham? **Grab a colour onto your pencil and apply it to the the painting** to see the surface change.

C4

You grabbed the colour of Effingham I.

With his irregular polygon series Stella used vibrant colours. He did not have a real plan selecting those colours, he chose them seemingly arbitrary, on intuition.
He used the paint that was easily available to him, applied them what to him seemed best and learned from what he did. He created every irregular polygon shape in 4-fold, using a different combination of colours every time. Do you think other colours would fit this painting?

As you see you stared to repair the painting a little bit, it has regained some of it's look.

Talk about and show the effects of colour.
Stella's arbitrary and on intuition approach
Creating multiple of the same and testing/experimenting

Play with (or show) the colour by changing the colours of the surfaces

3b: Selected depth *[When selected the depth element]*

C1

You chose to explore the element of depth.

An element that played a role in the creation of Stella's anti illusionist paintings was the aesthetic experience of flatness. A flat depiction on a flat surface, with no depth or illusion.
Effingham I along with the other paintings in the irregular polygon series started to confront Stella's emphasis on flatness and start play with illusion. Overlapping shapes, colours and fluorescence started to create visual illusions, wether intended or not.

What happens when the painting truly gains depth, going from 2D to 3D?
Does flatness really make a difference on the aesthetic experience and creating something that feels beautiful?

You can **grab onto and push & pull the elements rising from the ground** and see what happens.

C2

You chose to explore the element of depth.

An element that played a role in the creation of Stella's anti illusionist paintings was the aesthetic experience of flatness. A flat depiction on a flat surface, with no depth or illusion.
Effingham I along with the other paintings in the irregular polygon series started to confront Stella's emphasis on flatness and start play with illusion. Overlapping shapes, colours and fluorescence started to create visual illusions, wether intended or not.

What happens when the painting truly gains depth, going from 2D to 3D?
Does flatness really make a difference on the aesthetic experience and creating something that feels beautiful?

Place the pillars towards or further away from the painting to extrude or inset the surface of the painting and see what happens to your experience.

C3

You chose the **gloves** with which we are exploring the element of depth.

An element that played a role in the creation of Stella's anti illusionist paintings was the aesthetic experience of flatness. A flat depiction on a flat surface, with no depth or illusion.
Effingham I along with the other paintings in the irregular polygon series started to confront Stella's emphasis on flatness and start play with illusion. Overlapping shapes, colours and fluorescence started to create visual illusions, wether intended or not.

What happens when the painting truly gains depth, going from 2D to 3D?

Using the gloves, grab onto a surface of the painting and pull it out, or push onto a surface to pull it back inwards. What does this do to your experience?

Does flatness really make a difference on the aesthetic experience and creating something that feels beautiful?

C4

You collected the depth element of Effingham I

An element that played a role in the creation of Stella's anti illusionist paintings was the aesthetic experience of flatness. A flat depiction on a flat surface, with no depth or illusion.
Effingham I along with the other paintings in the irregular polygon series started to confront Stella's emphasis on flatness and start play with illusion. Overlapping shapes, colours and fluorescence started to create visual illusions, wether intended or not.

What happens when the painting truly gains depth, going from 2D to 3D?
Does flatness really make a difference on the aesthetic experience and creating something that feels beautiful?

As you see you stared to repair the painting a little bit, it has regained some of it's look.

Talk about and show the effects of depth.
Introduce the concept of flatness
talk about how in the irregular polygon series flatness is confronted (link to colour, shapes and fluorescence)

Play with (or show) the element of depth by pushing out/pulling in the coloured surfaces

3c: Selected Fluorescence *[When selected the light element]*

C1

Lets learn about the light in Effingham I, or better said: the fluorescence.

In Effingham I Stella used so-called DayGlo fluorescent paints. A paint that reflects non-visible light, making it look like the paint is glowing. He chose this paint not for this effect but because it was mainly known for its utility usage. To him these materials spoke for themselves, they are what they are.
Stella wanted to use non-artistic industrial materials. He had a certain respect for the materials he used and wanted to show this.

He was deliberate in the use of his material, as they spoke for themselves and thus only refer to themselves. The material should show you what they are and with that do not refer to anything else.

Not only the materials should refer to themselves but also the painting itself. the painting is an object and nothing else.

He specifically likes the transparent quality of the DayGlo paints showing the material underneath, but the fluorescence has more effects, wether this was intended or not.

What does this illuminating effect have on you and on the painting?

Lets try and see what happens when the painting starts to emit light, **lift up one of the spheres around you to increase the fluorescence.**

C2

Lets learn about the light in Effingham I, or better said: the fluorescence.

In Effingham I Stella used so-called DayGlo fluorescent paints. A paint that reflects non-visible light, making it look like the paint is glowing. He chose this paint not for this effect but because it was mainly known for its utility usage. To him these materials spoke for themselves, they are what they are.
Stella wanted to use non-artistic industrial materials. He had a certain respect for the materials he used and wanted to show this.

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Not only the materials should refer to themselves but also the painting itself. the painting is an object and nothing else.

He specifically likes the transparent quality of the DayGlo paints showing the material underneath, but the fluorescence has more effects, wether this was intended or not.

What does this illuminating effect have on you and on the painting?

Lets try and see what happens when the painting starts to emit light, **lift up one of the pillars to to increase the fluorescence of the coloured surfaces.**

C3

Lets learn about the light in Effingham I or better said: the fluorescence. using the **flashlight.**

In Effingham I Stella used so-called DayGlo fluorescent paints. A paint that reflects non-visible light, making it look like the paint is glowing. He chose this paint not for this effect but because it was mainly known for its utility usage. To him these materials spoke for themselves, they are what they are.
Stella wanted to use non-artistic industrial materials. He had a certain respect for the materials he used and wanted to show this.

He was deliberate in the use of his material, as they spoke for themselves and thus only refer to themselves. The material should show you what they are and with that do not refer to anything else.

Not only the materials should refer to themselves but also the painting itself. the painting is an object and nothing else.

He specifically likes the transparent quality of the DayGlo paints showing the material underneath, but the fluorescence has more effects, wether this was intended or not.

What does this illuminating effect have on you and on the painting?

Lets try and see what happens when the painting starts to emit light, **turn on the flashlight and point it towards a coloured surface to add fluorescence to the surface. Is it glowing to much? turn it off and point it again to decrease the effect.**

C4

You grabbed the fluorescent part of Effigham I, lets talk about Stella's material use.

In Effingham I Stella used so-called DayGlo fluorescent paints. A paint that reflects non-visible light, making it look like the paint is glowing. He chose this paint not for this effect but because it was mainly known for its utility usage. To him these materials spoke for themselves, they are what they are.
Stella wanted to use non-artistic industrial materials. He had a certain respect for the materials he used and wanted to show this.

He was deliberate in the use of his material, as they spoke for themselves and thus only refer to themselves. The material should show you what they are and with that do not refer to anything else.

Not only the materials should refer to themselves but also the painting itself. the painting is an object and nothing else.

He specifically likes the transparent quality of the DayGlo paints showing the material underneath, but the fluorescence has more effects, wether this was intended or not.

What do you think this illuminating effect have on you and on the painting?

As you see you stared to repair the painting a little bit, it has regained some of it's look.

Talk about and show the effects of fluorescence .
Introduce the concept of self-referentiality
Stella's interest in materiality
Unintended effects of material properties

Play with (or show) the element of fluorescence by lighting up the coloured surfaces

3d: Selected shape *[When selected the shape element]*

C1

Lets explore the shape and composition of Effingham I.

Stella build up his paintings combining different shapes and putting these together, forming an irregular shape.

With the intertwining shapes there's a kind of visual tension in which the two forms come together and appear to be spring loaded, creating some form of illusion, which he especially in previous work tried to avoid.

What was an aspect in his anti-illusionism is the idea of all-overness, the idea that ther is not one singular area of focus, but the eye is freely wandering around the work. there is a balance between, shape, colour and composition which guides you to experience the entiety of the painting instead of having a single point of focus.

Do you experience the painting in this way?

Are you able to create a shape which is able to create all-overness?

Lets **play around with shapes,** are you able to find a simple, balanced yet interesting shape where every part of the whole is equally important?

C2

Lets explore the shape and composition of Effingham I.

Stella build up his paintings combining different shapes and putting these together, forming an irregular shape.

With the intertwining shapes there's a kind of visual tension in which the two forms come together and appear to be spring loaded, creating some form of illusion, which he especially in previous work tried to avoid.

What was an aspect in his anti-illusionism is the idea of all-overness, the idea that ther is not one singular area of focus, but the eye is freely wandering around the work. there is a balance between, shape, colour and composition which guides you to experience the entiety of the painting instead of having a single point of focus.

Do you experience the painting in this way?

Lets investigate the balance between the different shapes?

Lets play around with shape, **move around the pillars to create a collage with the shapes,** do you experience the balance Stella aimed to create?

C3

You selected the **triangle shapes**, with that lets explore the shape and composition of Effingham I.

Stella build up his paintings combining different shapes and putting these together, forming an irregular shape.

With the intertwining shapes there's a kind of visual tension in which the two forms come together and appear to be spring loaded, creating some form of illusion, which he especially in previous work tried to avoid.

What was an aspect in his anti-illusionism is the idea of all-overness, the idea that ther is not one singular area of focus, but the eye is freely wandering around the work. there is a balance between, shape, colour and composition which guides you to experience the entiety of the painting instead of having a single point of focus.

Do you experience the painting in this way?

Lets investigate the balance between the different shapes?

Lets play around with shape, **move around the pieces to create a new form,** do you experience the balance Stella aimed to create? are you able to create a nice, balanced and all-over shape?

C4

You picked up the part made up of different triangle shapes, lets talk about the shape of the painting

Stella build up his paintings combining different shapes and putting these together, forming an irregular shape.

With the intertwining shapes there's a kind of visual tension in which the two forms come together and appear to be spring loaded, creating some form of illusion, which he especially in previous work tried to avoid.

What was an aspect in his anti-illusionism is the idea of all-overness, the idea that there is not one singular area of focus, but the eye is freely wandering around the work. there is a balance between, shape, colour and composition which guides you to experience the entiety of the painting instead of having a single point of focus.

Do you experience the painting in this way?

What do you think of the shape and composition Stella crafted? does it look balanced and beautiful to you? and do you see the whole painting or have a focus on a certain aspect?

As you see you stared to repair the painting a little bit, it has regained some of it's look.

Talk about and show the effects of shape and composition .
Introduce the concept of all-overness

Play with (or show) the element of shape by moving different shapes to create a new one

3e: Selected size *[When selected the size element]*

C1

Let's take a look what the size of the canvas does to the painting.

As part of Stella's anti-illusionism he wanted his paintings to be instantaneous.

This idea means the that a painting is grasped all at once, without the need for reading or interpretation.

With this size plays a big role, Stella decided to build his paintings on this scale. This should play a role in presenting the painting without illusion or metaphor. They present themselves directly as objects, aligning with his anti-illusionist goals.

But what happens when we change the size? does it change the effect the painting has on you? and what size feels just right for you?

hold your hands close together to make the painting smaller or hold your hand further from each other to make the painting grow

C2

Let's take a look what the size of the canvas does to the painting.

As part of Stella's anti-illusionism he wanted his paintings to be instantaneous.

This idea means the that a painting is grasped all at once, without the need for reading or interpretation.

With this size plays a big role, Stella decided to build his paintings on this scale. This should play a role in presenting the painting without illusion or metaphor. They present themselves directly as objects, aligning with his anti-illusionist goals.

But what happens when we change the size? does it change the effect the painting has on you? and what size feels just right for you?

Lets play with the size of the canvas, **2 of the pillars have changed, move these pillars towards or away from each other to change the size** and see what this does to your experience of the painting.

C3

Let's take a look what the size does to the painting using the **measuring tape**

As part of Stella's anti-illusionism he wanted his paintings to be instantaneous.

This idea means the that a painting is grasped all at once, without the need for reading or interpretation.

With this size plays a big role, Stella decided to build his paintings on this scale. This should play a role in presenting the painting without illusion or metaphor. They present themselves directly as objects, aligning with his anti-illusionist goals.

But what happens when we change the size? does it change the effect the painting has on you? and what size feels just right for you?

Lets play with the size of the canvas, **pull out the tape from the measuring tape** and and see what this does to your experience of the painting.

C4

You collected the growing/shrinking piece of the painting, let talk about Effingham I's size.

As part of Stella's anti-illusionism he wanted his paintings to be instantaneous.

This idea means the that a painting is grasped all at once, without the need for reading or interpretation.

With this size plays a big role, Stella decided to build his paintings on this scale. This should play a role in presenting the painting without illusion or metaphor. They present themselves directly as objects, aligning with his anti-illusionist goals.

But what happens if the size changed? would it change the effect the painting has on you?

As you see you stared to repair the painting a little bit, it has regained some of it's look.

Talk about and show the effects of size.
Introduce the concept of Instanteneousness

Play with (or show) the element of size by expanding and decreasing the size of the virtual painting

4: Done with interaction *[When not wanting to go further, someway end experience or if all aspects are gone through]*

C1

Are you done exploring the aspects? If you are done **step outside the circle and lets compare the aspects you played with.**

As you see, you c**reated your variations based on Effingham** I, all make the painting look different. maybe you like them better or maybe they look worse?

All elements play a role in the creation of something beautiful, which in the end was Frank Stella's goal.

You can **change one aspect and the whole painting and its effect changes**, unfortunately **time has also changed the painting from what it once was and thus maybe the effect on you as a viewer has also changed.**

C2

Are you done exploring the aspects? If you are done lets see what you created by changing the aspects.

As you see, **you created your version of Effingham,** Does it look nice and beautiful or very strange? All aspects play a role in making the painting look beautiful.

Frank **Stella's ultimate goal was to create something beautiful, but did not always get there. Sometimes you're happy you get close, and sometimes you make something that you feel is beautiful and you hope that you can share that with others."**

Even if Stella had created something beautiful still change happens. Unfortunately **time has done this, also changing the painting from what it once was and thus maybe the effect on you as a viewer has also changed.**

C3

Are you done exploring the aspects?

As you maybe have experienced every elements play a role in the creation of something beautiful, which in the end was Frank Stella's goal.

Frank Stella's ultimate goal was to create something beautiful, but did not always get there. Sometimes you're happy you get close, and sometimes you make something that you feel is beautiful and you hope that you can share that with others."

Altough the ultimate goal was to create something beautiful, Stella's aim was **anti illusionism, reached through: Flatness, All-overness, instantaneousnes and self-referentiality.**

Even if Stella had created something beautiful still change happens. Unfortunately **time has done this, also changing the painting from what it once was and thus maybe the intended effects of the paintings disappeared and the effect on you as a viewer has also changed.**

C4

Are you done exploring the aspects?

You collected and explored multiple aspects that build up Effingham I, aiding in it restoration

All elements play a role in the creation of something beautiful, which in the end was Frank Stella's goal. A change of one aspect can change the look of the painting and the effect it has on you.

Although the ultimate goal was to create something beautiful, Stella's aim was **anti illusionism, reached through: Flatness, All-overness, instantaneousnes and self-referentiality.**

You can change one aspect and the whole painting and its effect changes, unfortunately the painting still does not look like it once did. Other than these dramatic visual elements time has also changed the painting and thus maybe the effect on you as a viewer has also changed.

End the experience with some added information
Repeat the goals and intentions of stella
Tell about the effect of visual elements
Tell about the effect of temporal changes

5: Ending of the interaction *[When exiting (to be determined how) the experience]*

C1

With this experience you hopefully learned a little more about Effingham I and Frank Stella's intentions. The painting might look simple but looking beyond the surface there is more thought and intention behind what you see.

Stella aimed to create painting where "What you see is what you see" but maybe that is not as easy as he thought. And maybe there is more to see than what you see

C2

With this experience you hopefully learned a little more about Effingham I and Frank Stella's intentions. The painting might look simple but looking beyond the surface there is more thought and intention behind what you see.

Stella aimed to create painting where "What you see is what you see" but maybe that is not as easy as he thought. And maybe there is more to see than what you see

C3

With this experience you hopefully learned a little more about Effingham I and Frank Stella's intentions. The painting might look simple but looking beyond the surface there is more thought and intention behind what you see.

Stella aimed to create painting where "What you see is what you see" but maybe that is not as easy as he thought. And maybe there is more to see than what you see

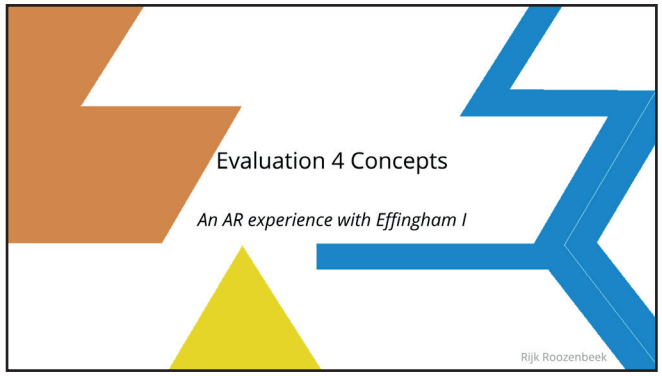
C4

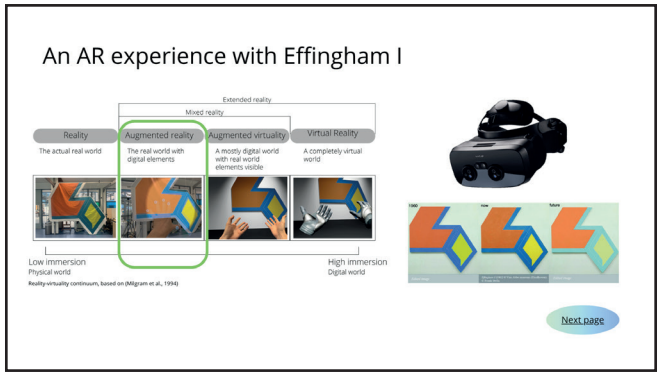
With this experience you hopefully learned a little more about Effingham I and Frank Stella's intentions. The painting might look simple but looking beyond the surface there is more thought and intention behind what you see.

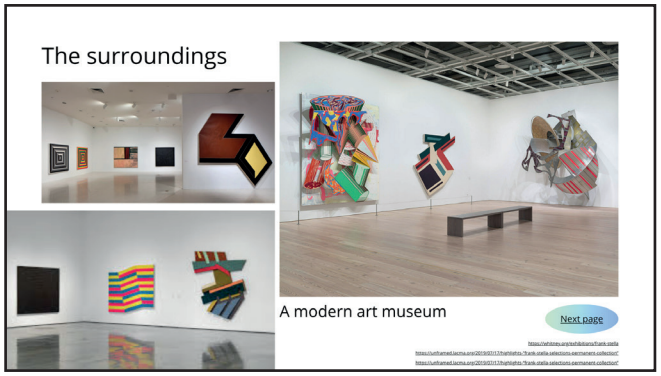
Stella aimed to create painting where "What you see is what you see" but maybe that is not as easy as he thought. And maybe there is more to see than what you see

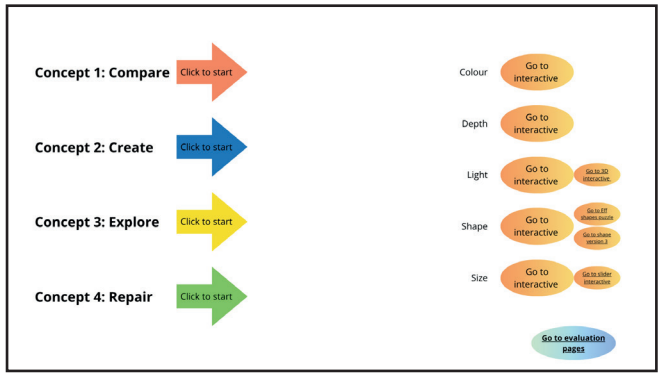
End note
Give something to think about

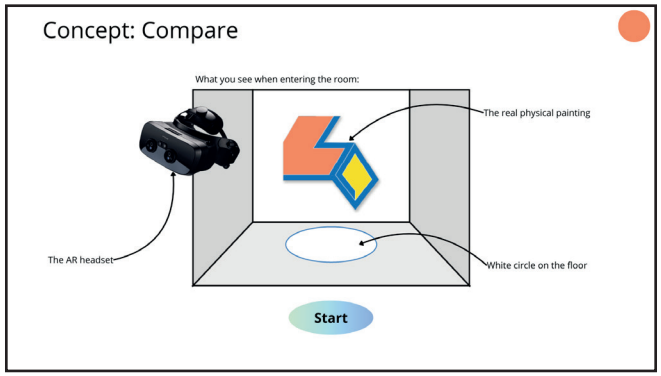
Appendix M: 4 Concepts Storyboards

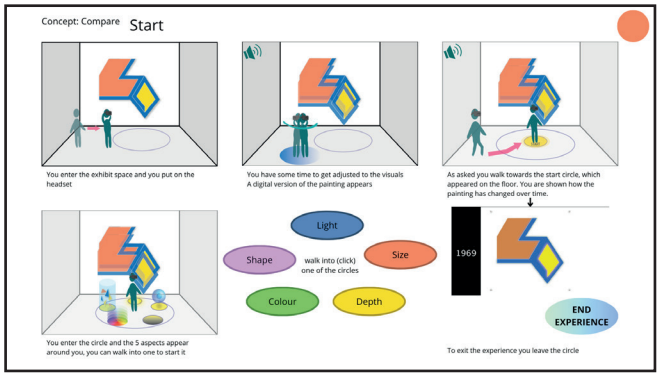


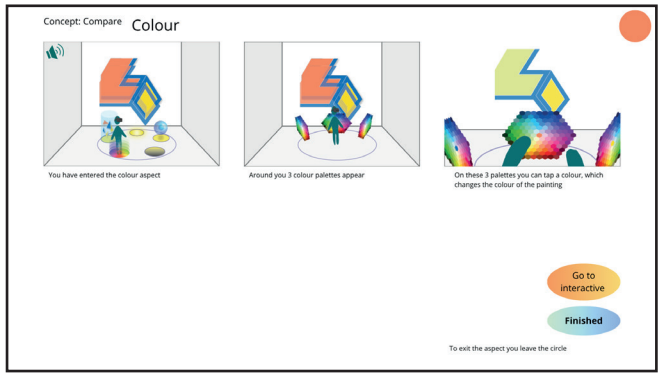


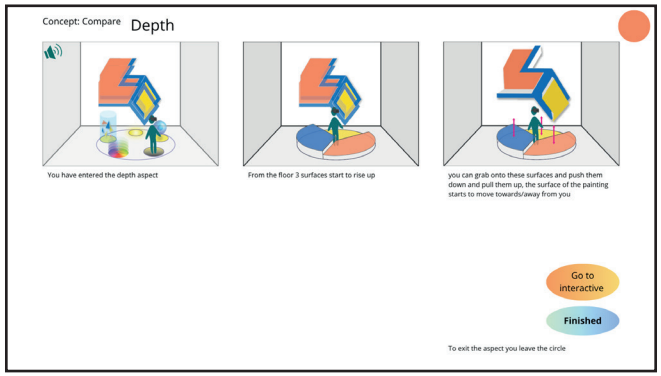


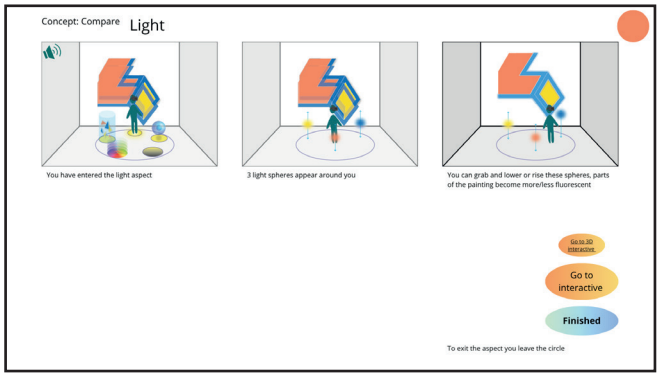








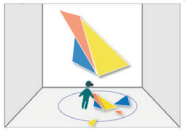




Concept: Compare **Shape**

You have entered the shape aspect

Triangle shapes appear on the ground



You can start to grab and move the triangles, creating a new shape

Go to interactive

Finished

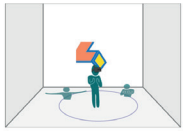
To exit the aspect you leave the circle

Concept: Compare **Size**

You have entered the size aspect

2 projections of arms wide and arms close show up

When you open your arms the painting starts to grow



When you hold your hands close together the painting starts to shrink

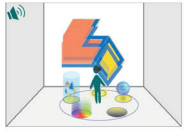
Go to interactive

Go to slider interactive

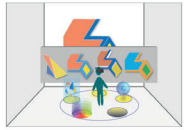
Finished

To exit the aspect you leave the circle

Concept: Compare **Exit**



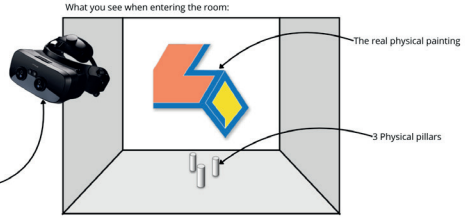
You have had enough of the experience, you walk out of the circle



Once out, the creations you made appear along the real painting

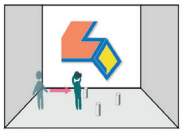
Return to start

Concept: Create

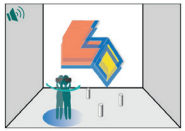


Start

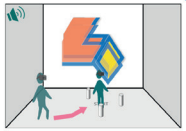
Concept: Create **Start**



You enter the exhibit space and you put on the headset, you see 3 pillars standing in the room



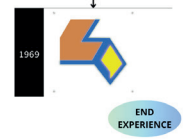
You have some time to get adjusted to the visuals
A digital version of the painting appears



As asked you walk towards the 3 pillars on the ground into start, which appeared on the floor. You are shown how the painting has changed over time.

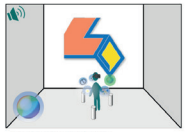
Once at the start, 5 spheres appear above the pillars, you can grab one to select it

Click one of the spheres

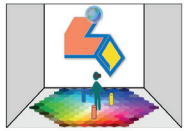


END EXPERIENCE

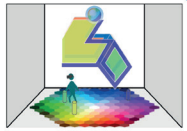
Concept: Create **Colour**



You grabbed the colour sphere



The floor changes into a big colour field, the pillars change into the colours of the painting



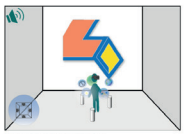
You can place the pillars on the colours, changing the part of the painting into the colour

Go to interactive

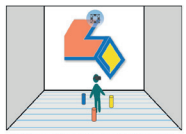
Finished

To exit the aspect you put the objects connected to each other

Concept: Create **Depth**



You grabbed the depth sphere



On the ground lines appear, the pillars change into the painting colours

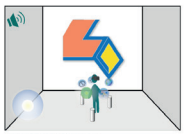
You can place the pillars anywhere in the room, based on the location, the painting will extrude

Go to interactive

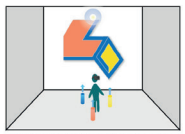
Finished

To exit the aspect you put the objects connected to each other

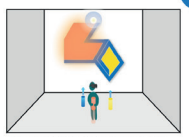
Concept: Create **Light**



You grabbed the light sphere



The 3 pillars change colour, going from dimmed at the bottom to giving of light at the top



You can lift up the pillars higher, which makes the part of the painting more fluorescent

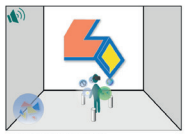
Go to interactive

Go to 3D interactive

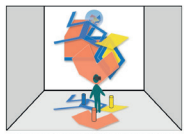
Finished

To exit the aspect you put the objects connected to each other

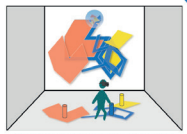
Concept: Create **Shape**



You grabbed the shape sphere



Underneath the pillars the 3 shapes of Effingham I appear



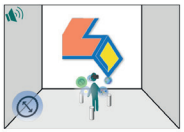
You can reposition and rotate the pillars to create a new collage of the Effingham I parts

Go to interactive

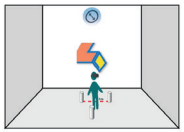
Finished

To exit the aspect you put the objects connected to each other

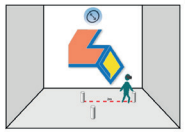
Concept: Create **Size**



You grabbed the size sphere



2 pillars light change colour, between them a line appears with a distance above it



You can move the pillars further/closer from eachother which changes the size of the painting

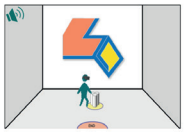
Go to interactive

Go to slider interactive

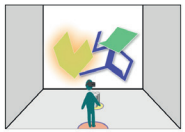
Finished

To exit the aspect you put the objects connected to each other

Concept: Create **Exit**



You placed the pillars back in the center and walk towards the exit circle

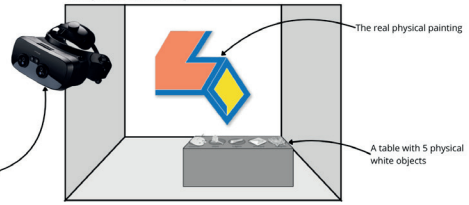


On the wall all changes combined (colour, depth, shape, light and size) appear as your version of Effingham

Return to start

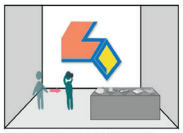
Concept: Explore

What you see when entering the room:

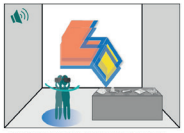


Start

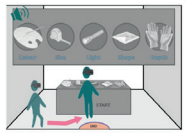
Concept: Explore **Start**



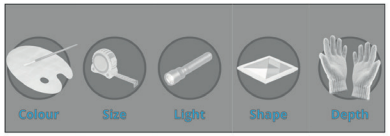
You enter the exhibit space and you put on the headset, you see 5 white objects on a table



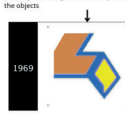
You have some time to get adjusted to the visuals
A digital version of the painting appears



You walk towards the table. You are shown how the painting has changed over time. you can grab one of the objects

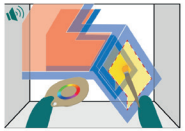


Each object is linked to an aspect, you can pick one up, (click on one to select)



END EXPERIENCE

Concept: Explore **Colour**



You picked up the palette and brush, colors appear on the painters palette.

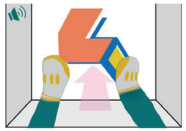
You can grab a colour on the pencil and with a tap fill the surface of the painting

Go to interactive

Finished

To exit the aspect you put the item back on the table

Concept: Explore **Depth**



You picked up and put on the gloves

You can now pull parts of the digital painting inwards

And you can grab onto parts of the digital painting to pull them outwards

Go to interactive

Finished

To exit the aspect you put the item back on the table

Concept: Explore **Light**

You picked up the Flashlight, by turning it on and pointing it towards a part of the painting this parts starts to become more fluorescent

turning it of and pointing it will make the painting less fluorescent

Go to interactive

Finished

To exit the aspect you put the item back on the table

Concept: Explore **Shape**

You picked up the triangle pieces.

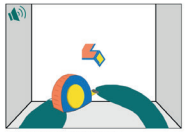
You can now put them into a new shape, which will reform the digital painting

Go to interactive

Finished

To exit the aspect you put the items back on the table

Concept: Explore **Size**



You picked up the measuring tape

the painting becomes very small.

The further you extend the tape, the bigger the painting becomes

Go to interactive

Go to slider interactive

Finished

To exit the aspect you put the item back on the table

Concept: Explore

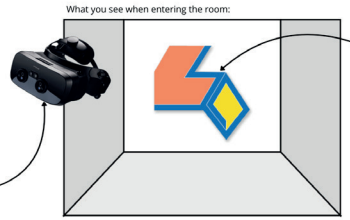
Exit

Once you are done you enter the end circle

Return to start

Concept: Repair

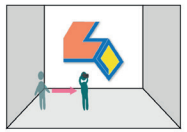
What you see when entering the room:



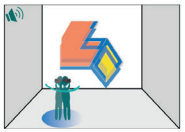
Start

Concept: Repair

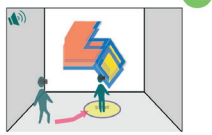
Start



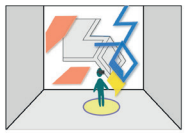
You enter the exhibit space and you put on the headset



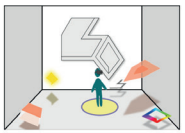
You have some time to get adjusted to the visuals
A digital version of the painting appears



As asked you walk towards the start circle, which appeared on the floor



The painting falls apart into 5 pieces, the digital painting completely loses all colour



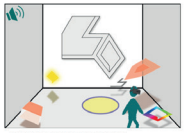
The pieces all change an aspect about them, now you can start walking towards and collecting the pieces

Select a piece you walked towards by clicing on it

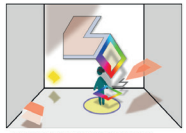
END EXPERIENCE

Concept: Repair

Colour



You walkt towards the colored piece



You pick up and return the piece to the circle.

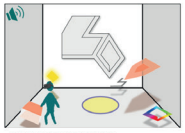
The collected piece will appear on the painting, and the not yet collected parts slowly regain some colour

A 3D animation like this will be played during the voice

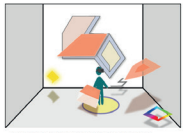
Finished

Concept: Repair

Depth



You walk towards the Depth piece



You pick up and return the piece to the circle.

The collected piece will appear on the painting, and the not yet collected parts slowly regain some colour

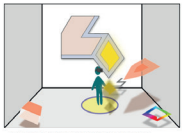
A 3D animation like this will be played during the voice

Finished

Concept: Repair

Light

You walk towards the light emiting piece



You pick up and return the piece to the circle.

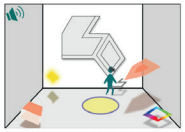
The collected piece will appear on the painting, and the not yet collected parts slowly regain some colour

A 3D animation like this will be played during the voice

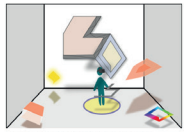
Finished

Concept: Repair

Shape



You walkt towards the piece divided into smaller shapes



You pick up and return the piece to the circle.

The collected piece will appear on the painting, and the not yet collected parts slowly regain some colour

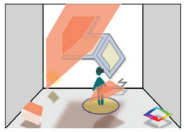
A 3D animation like this will be played during the voice

Finished

Concept: Repair

Size

You walk towards the large sized piece



You pick up and return the piece to the circle.

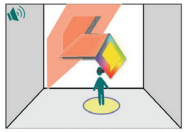
The collected piece will appear on the painting, and the not yet collected parts slowly regain some colour

A 3D animation like this will be played during the voice

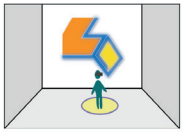
Finished

Concept: Repair

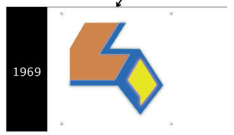
Exit



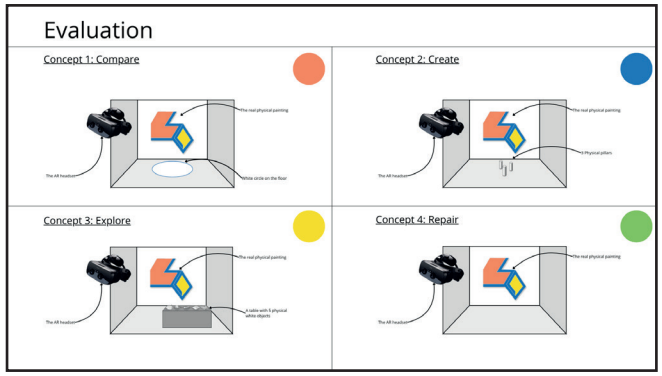
You have collected all (or some) of the pieces and are done, a very weird painting is shown

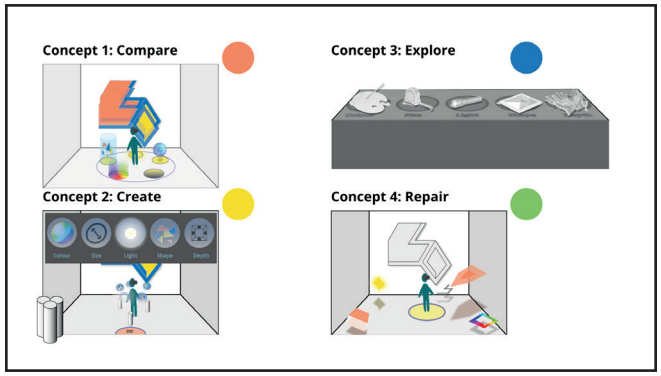


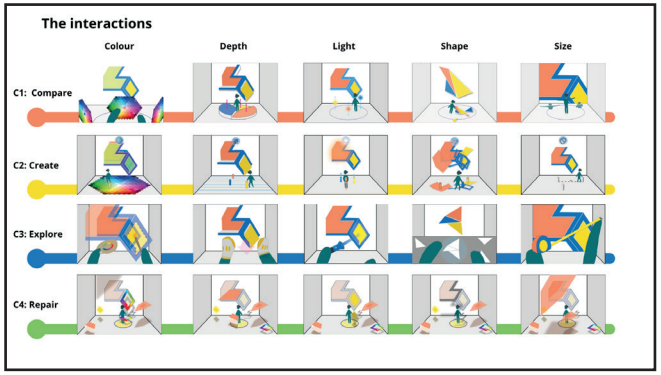
Once done the painting turns into what it used to look like before affected by time

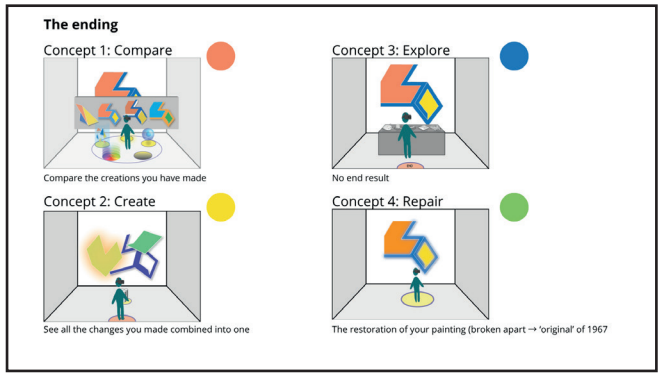


Return to start

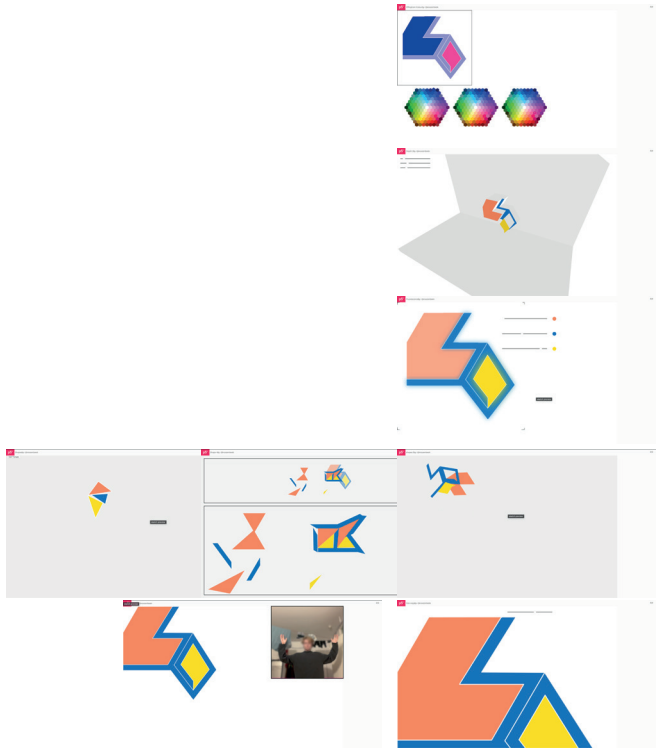








Links to P5.js screen interactives



Colour:

https://editor.p5js.org/rijkroozenbeek/full/VrYH9xfzO

Depth:

https://editor.p5js.org/rijkroozenbeek/full/QQNM7_GTb

Fluorescence:

https://editor.p5js.org/rijkroozenbeek/full/XxS06AE7R

Shape:

https://editor.p5js.org/rijkroozenbeek/full/R34KQIMh8
https://editor.p5js.org/rijkroozenbeek/full/vTMEyWvX6
https://editor.p5js.org/rijkroozenbeek/full/AZB2ibHNN

Size:

https://editor.p5js.org/rijkroozenbeek/full/BluEOPN-U
https://editor.p5js.org/rijkroozenbeek/full/ySBB8u_Un

Appendix N: User Evaluation Notes

Vragen	Participant 1 Evaluation order: C1-C2-C3-C4	Participant 2 Evaluation order: C1-C2-C3-C4	Participant 3 Evaluation order: C4-C3-C2-C1	Participant 4 Evaluation order: C3-C2-C4-C1
Concept 1				
1. Wat vond je van dit concept?	Leuk, meer dan kijken naar het schilderij. Leuk dat je aan het eind de vergelijkingen kuntzien.	Wel gewoon veel variatie in mogelijkheden, wat je met het kunstwerk kan doen en hoe je het kan vervormen. Hoe je het een beetje eigen kan maken	Lijkt een beetje op concept 2, alleen zitten de keuzes hierop de vloer Deze is ook abstracter, je doet niet iets met het schilderij maar met de vloer.	Lijkt erg op concept 3, krijg de neiging om deze te combineren met concept 3. De objecten om je heen hebben is beter dan naast elkaar op tafel Het einde, de creaties naast elkaar vind ik een leuke. Verandering van omgeving bij aspect geeft meer nadruk op het aspect
2. Zijn er dingen die je onduidelijk vindt/vond?	omhoog trekken elementen is vaag, weet niet of ik op de vlakken ga staan Usecases zijn niet helemaal duidelijk. Digitale elementen die bewegen nodigen wel/niet uit. Hoogteverschillen bepalen deels je keuze?	Interacted met virtuele elementen is lastig om in te beelden, hoe vormen verplaatsen etc.	Hoe ga je weer terug naar de start Deze vind ik ook een beetje ingewikkeld Staan de namen van de onderdelen ook bij de cirkels?	Depth, de hele vloer veranderd, dat zou je ook in het kleine cirkeltje kunnen die. Toch?
3. Zijn er dingen die je goed/leuk of juist niet goed/leuk aan dit concept?	Leuk dat het iets nieuws is dat je niet alleen kijkten doet Dat je iets ziet veranderen leuk Nieuwe manier van eigen interpretatie van het schilderij, iedereen kijkt op z'n eigen manier naar een schilderij. Hierdoor is het nog meer individueel en je acties weer effect hebben op het schilderij, nodigt uit tot creatief denken Fijn dat het in losse stukjes is opgebroken, anders gebeurt er te veel	Leuk dat je bij ieder element op een andere manier in beweging benten je eigen lichaam gebruikt. Dat je actief bezig bent ipv alleen maar in je hoofd bedenkt	Dit concept is een beetje ingewikkeld, ik denk dat als je in de ruimte komt, je moet keuzes maken uit dingen die op elkaar lijken. Er komt veel informatie op je af en het is minder beeldend, ik denk dat ik in de warzou raken. (Ook in concept 2)	Het is leuk dat je hele werkomgeving verandert om te werken met zo'n aspect
4. Heb je het idee dat dit concept je iets heeft geleerd?	het effect van het schilderij op jou veranderd Leren vind ik moeilijk om te zeggen, denk dat het wel het effect van het schilderij op jou verandert	Je hoort aan de voice overiets over de aspecten, daar pas je je interactie als toeschouwer op aan.	Nietiets anders dan de andere concepten.	Niet anders dan concept 3
5. Kun je (je gevoel bij) dit concept beschrijven in 3 woorden	Interactief, creatief, speels, wollig, inspiratie, positief	Interactief, creatief, veel mogelijkheden	Ingewikkeld, spelen, abstract	Virtueel, direct, speels
6. Zorgde dit concept dat je ergens over ging nadenken?	Overde keuzes van het maken van het schilderij van Stella, als je ziet hoeveel keuzes er gemaakt kunnen worden Meer respect voor de denkproces en maakproces	Dat je met een kunstwerk zoveel kan doen, het staat niet vast hoe het ergens hangt, je kan er nog steeds veel dingen aan veranderen.	Nietiets anders dan de andere 3 concepten	Overde begrippen van Frank Stella en hoe hij die beweert te hanteren.
verdere opmerkingen	Nee ja gewoon leuk	Depth, niet verder de muur in alleen naar je toe? Colour gradient veld ipv colour swatches, meer variatie en perfect vinden		
Concept 2				
1. Wat vond je van dit concept?	Ook leuk, wel leuk dat je ook fysiek iets doet en pakt, meer connectie met de echte wereld dat je echt iets pakt.	Fijn dat je iets kan voelen en oppakt ipv dat het allemaal maar in het niets is. Vorm van de pilaren, meer in verband met het schilderij? Einde dat je een creatie ziet van alles gecombineerd is leuk	Iets ingewikkelder dan c3 en c4. Omdat de link met wat je doet en het schilderij complexeris. Ik denk iets abstracter. Als je concreet een palette pakt is anders dan iets aantikken. Veel stappen	Als ik het vergelijk met concept 3 zijn de acties die je doet minder direct, de pionnen zorgen dat er een soort stap tussen zit, het maakt het ingewikkelder, wel wat actiever. Het begint meer op een spelletje te lijken, wat voor mij niet perse goed is.
2. Zijn er dingen die je onduidelijk vindt/vond?	Hoe die bubbels werken, hoe je keuzes maakt.	Niet perse	Als je klaar bent met een onderdeel ga je dan weer terug naar de basis, terug naar de 5 bollen om een keuze te maken. het is iets lastig ervoor te stellen. Iets ingewikkelder, moeilijk om er nu een voorstelling bij te maken	Best duidelijk Niet duidelijk dat je kiest voor 1 finished uitkomst per aspect
3. Zijn er dingen die je goed/leuk of juist niet goed/leuk aan dit concept?	Leuk dat het meer fysiek is Minder dat de digitale elementen controllernog onduidelijk is Hoe maak je duidelijk dat die cilinders opgetild en verplaatst kunnen worden? Niet heel duidelijk wanneer en dat de paaltjes verplaatst kunnen worden Gevaar van kinderen die met de paaltjes gaan spelen of mensen in een	Fysiek iets vasthouden/oppakken is fijn Gecombineerd eindwerk is leuk Kegelvormen minder goed/leuk	Ik zou voor de kolommen eerder pionnen kiezen (mens ergerje niet pionnen) voelt eerder als iets waarje mee kunt spelen Het is wat abstracter/ingewikkelder	Leuk dat het een spelvorm kan zijn, past bij een doelgroep - kinderen Je zou het ook met pionnen kunnen doen maar ook met 3 mensen in de ervaring
4. Heb je het idee dat dit concept je iets heeft geleerd?	Zelfde als c1	Vergelijkbaar met C1	Het geheel is meer dan de onderdelen. Je kunt denken bij de kleur, ik verander de kleur, dat is een onderdeel van het geheel. Volgende stap is weer 1 onderdeel. In het eind resultaat zie je dat alle onderdelen samen zorgen voor een geheel dat je niet in je hoofd had.	Niet perse iets nieuws Eigenlijk hetzelfde als in concept 3
5. Kun je (je gevoel bij) dit concept beschrijven in 3 woorden	Zelfde als c1 iets meer verwarring op dit moment, duidelijkere	Speels, creatief, actief	Abstract, resultaat, spelen	Spel gevoel (leuk om te spelen), actief, afleidend
6. Zorgde dit concept dat je ergens over ging nadenken?	Zoveel keuzes in elementen, effect van elke keuze heeft effect op eind resultaat. Resulteerd in totaal andere ervaring	Dat er zoveel dimensies in zo'n kunstwerk zitten, dat daarmee ook een heel ander beeld kan creëren door maar 1 dimensie aan te passen.	Een beetje van wat moet ik doen, hoe interactie is niet gelijk duidelijk Niet perse dieper over het schilderij of Stella	Misschien als je actief verbent dat de ideeen beter doordringen.
verdere opmerkingen	Einde: Iets gedaan gesplitst zien is leuk, manieris anders, miss iets verrassend Iets meer kijk wat ik zelf heb gemaakt		Je werktlos aan alle elementen en dan komt er aan het eind een verrassend resultaat uit. Dat vind ik wel verrassend	Hier gaat het meer op een spelletje lijken, moet direct aan een kinderspel denken Ik vraag me af of als je uiteindelijk alles combineert alles dichtloopt, als je bijv veel met de vorm verandert heeft en je het origineel niet meer

Vragen	Participant 1 Evaluation order: C1-C2-C3-C4	Participant 2 Evaluation order: C1-C2-C3-C4	Participant 3 Evaluation order: C4-C3-C2-C1	Participant 4 Evaluation order: C3-C2-C4-C1
Concept 3				
1. Wat vond je van dit concept?	Leuk, iets uitnodigender om te gebruiken Affordances duidelijk, je weet gelijk ik kan het pakken en gebruiken. Denk dat ik voor de volle ervaring zou gaan omdat het meer uitnodigend is per element.	Leuk, hierwat concretere dingen bij de verschillende dimensies. Het voelt ook erg simpel, voor de hand liggend Terwijl er met AR veel meer bij kt te kunnen. Vind het ook wel weer goed dat er concrete objecten hebt, daardoor is het logischer wat je aan het doen bent	Divers in wat je kan doen, al die verschillende tools zijn divers, andere beleving. De ene wijs je ergens naar, je puzzelt, je pakt. De interacties/bewegingen zijn verschillend en hebben een ander effect.	Wel leuk om met dat schilderij te experimenteren. Omdat het daardoor een beetje tot leven komt Een statische compositie door een paaringetepen heel anders kan worden maar in essentie toch hetzelfde blijft. Geeft een extra dimensie aan het kunstwerk
2. Zijn er dingen die je onduidelijk vindt/vond?	Weinig twijfel en onduidelijk Depth alleen miss nog onduidelijk Kleurlijkt me leukervan een afstand, met een aanwijzer/laser	Verbinding van objecten naar schilderij Meer het gevoel dat mensen het echte schilderij perongeluk aanraken wat bij de anderen minderwas	Nee niet echt Het ene object is leuker om te gebruiken dan de ander	Het begrip all overmess is lastig te bevatten De andere begrippen zijn wel eigens te interpreteren
3. Zijn er dingen die je goed/leuk of juist niet goed/leuk aan dit concept?	Interacties zijn van zelfsprekend en gaan vanzelf. Ik denk dat het heel duidelijk is en mensen alles wel willen proberen Leuk dat je fysiek bezig ben net als bij de pilaren	Leuk dat je verschillende dingen doet bij verschillende aspecten.	Kleur, vorm en diepte spreken me het meeste aan. Size is een beetje saai qua beleving en het meetlint is ook een beetje vaag	Kleuren veranderen heel leuk want het is heel direct en je veel kunt variëren Shape ook veel doen en variëren Anderen is een beetje eenzijdig
4. Heb je het idee dat dit concept je iets heeft geleerd?	Zelfde als vorige 2, keuzes die ik omen kijken bij het schilderij maken	Niet anders dan c1 & c2	Dat het leuk is om te spelen met het schilderij Dat er een keuze gemaakt moet worden in kleur etc. Stella heeft daarin een afweging gemaakt. Hij heeft gezien voor deze vorm maar je hebt 100duizenden mogelijkheden.	Het wordt duidelijker wat de principes die Stella hanteerde inhouden
5. Kun je (je gevoel bij) dit concept beschrijven in 3 woorden	Zelfde als de andere weer, Concreet, satisfying	Concreet, speels, creatief	Spelen, creatie, diversiteit	Spannend, leerzaam, leuk
6. Zorgde dit concept dat je ergens over ging nadenken?		/ niet anders dan andere concepten	meer gaat nadenken over. Als er iets is lijkt het iets logisch, het is niet logisch dat deze vormen en kleuren zijn ontstaan. Het zijn keuzes van Stella	Overde begrippen die Stella hanteert, zijn op meerdere manieren uit te leggen. De begrippen zijn geen formule maar zijn op meerdere manieren te gebruiken
verdere opmerkingen	Een vergelijking aan het eind zou hier ook wel leuk zijn	Waarom handschoenen Hoe zorg je dat mensen niet het echte schilderij aanraken/pakken. Meetlint is beetje vreemd dat het schilderij klein begint en niet z'n ware grootte		Die flatness, die diepte zou ik iets anders verwachten. Er zit een soort perspectief in en die wil je dan ook werkelijkheid maken, het gele vlak omvouwen
Concept 4				
1. Wat vond je van dit concept?	Je hoeft hier niet zoveel te doen, zoeken wel leuk. Je doet niet echt iets, het is iets passiever Ik vraag me af of het echt binnen komt bij mensen	Het meest vaag, huh wat gebeurd er, het valt uit elkaar en wat dan? Minder controle, je weet niet echt een keuze eigens op gebaseerd, je brengt het naar een plek en het gaat vanzelf. Steeds dezelfde actie. Je hebt het gemaakt maar dan verandert het weer terug Gaat vooral over de informatie krijgen, je kan het niet echt naar je eigen wensen veranderen. Miss gaat het daar ook om, op tijd hebje ook geen grip. Maar minder leuk om te doen	Ik ben benieuwd hoe het echt is, ik heb eral zin in om echt in de ruimte te staan en te beleven. Wat in mij opkomt is: tijd heeft imvloed gehad op de kleur. Tijd heeft ook imvloed op hoe je dingen ziet, dit schilderij voelt nu niet experimenteel maar in 1967 is dit heel anders en wordt het schilderij waarschijnlijk anders beleeft.	Ook een leuk concept alleen vraagt weinig actie van de bezoeker. Is wel heel educatief omdat je het echt haal verteld krijgt. Het interactieve aspect is wat minder
2. Zijn er dingen die je onduidelijk vindt/vond?	Denk het niet	Wat elk element doet, je doet willekeurig iets/keuzes	Hoe de veranderingen en overgangen er precies uitzien	De vorm heeft niet perse iets te maken met het element waarover verteld wordt? Het is een beetje gezocht om aan de hand van de stukken dan dat onderdeel van het verhaal te vertellen Onderdelen hadden ook op het oppervlak kunnen blijven zitten
3. Zijn er dingen die je goed/leuk of juist niet goed/leuk aan dit concept?	Minder dat het meer voor je wordt gedaan ipv dat je hetzelfde doet.	Leuk dat je over iedere dimensie iets kan leren Herhalen van dezelfde saaie actie niet leuk. Minder controle hebben is minder leuk maar past ergens wel bij het verhaal van het schilderij	Heel duidelijk, stemlogt uit wat je moet doen en wat gebeurd	Het verhaal wordt je een beetje voorgekauwd, je hoeft niet veel te doen het is makkelijk consumeren Het is weinig interactief Het interactieve deel is een beetje geforceerd/erbij gehaald
4. Heb je het idee dat dit concept je iets heeft geleerd?	Denkt dat je minder goed leert dan bij de anderen, komt minder binnen en dringt minder door Minder uniek als ik het vergelijk met andere museum ervaringen Lijkt op een audiotour in een museum	De tijd heeft imvloed op hoe een schilderij verandert en dat je daarzelf geen imvloed op hebt	Het doet iets met de belevenis van het schilderij. Als je voor de eerste keer het schilderij ziet denk je wat is dit, hoezo. Als je het in onderdelen benadert zie je dat het iets met je beleving doet. Waardoor er meer begrip komt van: het schilderij is meer dan een schilderij het is ook een beleving	Hierwordt je iets verteld wat je tot je neemt, bij de vorige moet je meerzelf bedenken wat je geleerd hebt. Interacted met de stof is interessanter ook om te leren, het verhaal bekijft dat beter
5. Kun je (je gevoel bij) dit concept beschrijven in 3 woorden	Interessant, passief, minder bijzonder	Willekeurig, informatief,	Ruimte, beleving, verandering	Passief, traditioneel, leerzaam
6. Zorgde dit concept dat je ergens over ging nadenken?	Ligt meer focus op de temporal change. Ipv verandering van visuele elementen	Zelfde als wat ik heb geleerd Vraag 4	Wat veranderd er allemaal in de tijd, niet alleen de kleur vervaagd. Context en de wereld veranderd	Jawel maar minder dan de eerdere, omdat je het zo voorgekauwd krijgt. Het is gewoon aannemen niet ervaren Erwalt minder te ontdekken
verdere opmerkingen	Idee: fysieke puzzelstukjes i.p.v. volledig digitaal			

Vragen	Participant 1 Evaluation order: C1-C2-C3-C4	Participant 2 Evaluation order: C1-C2-C3-C4	Participant 3 Evaluation order: C4-C3-C2-C1	Participant 4 Evaluation order: C3-C2-C4-C1
Alle 4				
1. Zou je de 4 verschillende concepten aan mij willen beschrijven?				
C1	1. Kijken hoe het schilderij is opgebouwd en de gedachte van de kunstenaar erachter. En hoe jij het als je de kunstenaar was anders had gedaan	1. Leer je over de verschillende dimensies van het schilderij en kun je met bewegingen en AR aanpassen op het schilderij.	1. Abstracter, je beweegt in de ruimte om veranderingen aan te brengen, helemaal virtueel	1. worden 5 begrippen van Stella geprojecteerd op de grond, staan in deze cirkels veranderd de omgeving en krijg je de kans om dat aspect uit te testen en te kijken wat dat resulteerde in het schilderij
C2	2. Met huidige schilderij een nieuwe versie maken	2. Kegels gebruiken om verschillende dimensies in het schilderij aan te passen en het zo te vervormen in je eigen schilderij	2. bstracter, je beweegt in de ruimte om veranderingen aan te brengen, je beweegt concreet een voorwerp	2. worden de 5 begrippen gevisualiseerd in 5 bollen, je kiest een bol. Vervolgens kun je met 3 fysieke de verschillende begrippen onderzoeken.
C3	3. Je doet iets en er gebeurt iets, oorzaak gevolg, actie reactie. Je speelt met de intentie van het schilderij is actief met fysieke objecten en concreter.	3. Je kunt fysieke objecten gebruiken om het schilderij te laten veranderen	3. Concreter, je pakt een attribuut en je brengt een verandering aan in het schilderij	3. Worden de 5 begrippen uitgebeeld door objecten, ieder object vertegenwoordigd een begrip. Je kiest een object bvb een palette bij het aspect kleur. Dmv AR krijgt het palette kleur, hiermee kun je het schilderij anders kleuren
C4	4. Focus ligt oud vergeleken met nu en niet perse op intenties van Stella met het schilderij	4. Door verschillende stukken van het schilderij te pakken kun je iets over het schilderij leren en zo zien dat er meer dingen invloed hebben hoe het schilderij eruit zet dan alleen jij zelf.	4. Concreter, je bekijkt per onderdeel en je komt meer te weten over de afzonderlijke onderdelen	4. Zweeft er een aantal digitale objecten die onderdelen lijken van het schilderij. Door de objecten te pakken en op het schilderij te plaatsen wordt een educatieve film afgedraaid met informatie over dat begrip.
2. Als je de keuze zou maken om 1 van de 4 in het echt te ervaren, welke zou dat dan zijn? – en waarom?	Concept 3 I, ik houd van fysieke en concrete objecten dus dat zou ik willen doen. Denk dat ik hierde hele ervaring zou willen onderzoeken	Concept 2, leuk dat je een soort fysieke elementen hebt, niet alleen AR. En dat je een eind creatie ziet	Ik denk 3, het is leuk dat je een object kunt pakken waarvan duidelijk is dat je er iets mee kan, doordat te gebruiken gebeurt er iets	Concept 1: die maakt het meest gebruikt van de virtuele ruimte en is heel direct in het onderzoeken van de begrippen
3. Na het zien van deze concepten, wat kun je me vertellen over het schilderij?	Zwaalde veel af bij de opnames, ligt ook aan de setting, als het echt in een AR ervaring is, is dat denk ik anders	Het lijkt een simpel schilderij maar er is wel meer over nagedacht dan alleen 3 kleuren en een vorm en dat lijkt ook invloed heeft op hoe het schilderij eruit ziet.	Lastig want in het Engels Wat ik bij Stella bedenk, hij wil het overbrengen als het is wat het is maar hierdoor realiseer je dat het niets anders had kunnen zijn. Dat versterkt zijn idee maar tegelijkertijd kom je ook niet zomaar op iets. Intuïtie, het is wat het is maar het had ook anders kunnen zijn.	Het is een schilderij van Frank Stella uit 1967, hij werkte volgens een aantal principes. Dit principes zijn gebaseerd op het kleurgebruik dat random, zonder bepaalde bedoeling is gekozen. Heeft te maken met de maat maar wat daarover gezegd kanis me ontscholen. Hij maakte gebruik van fluoriserend verf, ik weet niet meer waarom.
4. Zijn er dingen die je graag had willen weten over het schilderij die je nu gemist hebt?	//	Ben benieuwd wat de kunstenaar vond van de verandering door tijd in het schilderij.	Wat ik intrigerend vind is is: waarom is hij beroemt geworden, waarom maakte dit zo. Indruk, en in wat voor tijd was dat. Gemaakt in de goeie tijd past bij de tijdsgeest, kreeg waardering en herkenning. Is hij een inspiratiebron voor anderen of ontwikkeling in de kunst geweest	Ben wel benieuwd naar de andere schilderijen van rond die tijd. Het is vgm een ontwikkeling in een proces van Stella, ditbedenk je niet zomaar. De schilderijen ervoor en erna
5. Welk concept past volgens jou het best in een modern kunstmuseum?	Ligt aan het type modern kunstmuseum, ligt er aan wat er staat. Alle 4 zouden wel kunnen passen	Allemaal wel, zie het wel gewoon voorme. Is het in een aparte ruimte of ook met andere kunst. Het is allemaal wel modern met AR.	Allemaal wel een beetje maar vooral 3 of 4 Het moet niet te ingewikkeld zijn, makkelijk toegankelijk. Het speel effect is leuk voor kinderen. Het moet niet te abstracten digitaal zijn	Concept 1: omdat ik denk dat dit echt wat toevoegd aan het schilderij aan de muur
6. Van welk concept denk je dat je het best iets leert?	Concept 1,2,3 beter omdat het minder passief is en je echt wat doet met de elementen	Bij explore wordt het wel het meest speels. Leidt sneller af. Bij kegels is het nog de vraag "wat is dit" dan ga je er meer open in, het is nog wat meer een verassing, wat ik wel vind passen bij kunst. 1,2,3 het duidelijkst, 4 het vaagst- pas aan het eind wordt het duidelijk Eerste 3 allemaal wel duidelijk, kun je het ook echt zien.	Hoofd handen hart -denken doen en voelen in 3 zie je wel heel duidelijk, het schilderij heeft verschillende aspecten	Concept 1: het meest interactief en direct, het leidt niet af en is geen spielatje De virtuele omgeving staat direct ter dienste aan wat je als bezoeker wilt onderzoeken
7. In welk concept zijn de volgens jou de interacties het meest boeiend?	Concept 3, concreet, fysieke onderdelen	Concept 2 of 3, ook wel 1. bij elke dimensie een andere actie doen. 3 duidelijkst, 1 en 2 moet je dat meer uitzoeken of instructie krijgen	Concept 3, heel duidelijk een keuze maken, je kun tiets pakken, het is concreet	Concept 1: Combinatie van 1 en 3 lijkt me dan het leukst
8. Wat vond je het meest unieke aan elk concept?	1. Zittussen actief en passief in (ergens tussen 2 en 4 in) 2. Combinatie van fysiek en zweverig 3. Meer fysieke concrete objecten 4. Focus op verval van schilderij door de jaren heen	1. De interactie in combinatie met AR 2. Eind resultaat, eigen creatie 3. combinatie van echte objecten/wereld met virtueel 4. Verassing seffecten, niet echt een keuze hebben. Je doet iets maar je weet niet wat er gebeurt, aan het eind wordt het pas duidelijk.	1. Je kunt de resultaten naast elkaar zien. 2. Je kunt schuiven en balans zoeken door de pilaren te verplaatsten 3. Concrete attributen 4. Rondzwevende stukken die je moet grijpen, waardoor je midden in het schilderij zit	1. De totale virtuele omgeving, die steeds verandert 2. De verplaatsbare pionnen 3. De attributen 4. De film
9. Welk van de 5 aspecten vond je het meest interessant? zowel om over te leren als de interactie	Colour, kleur veranderen is gwn leuk Diepte, wordt ineens een hele andere vorm/associatie	Shape of kleur, zijn de meeste mogelijkheden voor verandering mee.	Kleur want: kleuren combinaties zorgen gelijk voor een groot visueel effect. Heb je in het dagelijks leven ook veel meer mee te maken	Kleur, meest sprekend en heel eenvoudig te bewerken
10. Welk einde lijkt jou het meest interessant?	1 en 2 want 1, Je ziet het verschil bij alle stappen en het effect daarvan, reflectie 2, verassings element, cadeautje	Concept 2, je creeert een geheel van alle veranderde dimensies samen.	3, het gaat niet om iets nieuws maken maar na elke exploratie weer terug naar dit is het	Concept 1: hierin kun je de verschillende aspecten nog eens zien maar dan naast elkaar, als een soort reflectie.

Vragen	Participant 1 Evaluation order: C1-C2-C3-C4	Participant 2 Evaluation order: C1-C2-C3-C4	Participant 3 Evaluation order: C4-C3-C2-C1	Participant 4 Evaluation order: C3-C2-C4-C1
11. Welk concept maakte je het meest nieuwsgierig?	Concept 4 nieuwsgierigheid vanuit leeg schilderij Concept 2 afvragen wat die paaltjes daar doen Concept 1 lege cirkel wekt nieuwsgierigheid op Concept 3 effect van herkenbaar object op schilderij maar houdt het wel Concept 4 het minst, meer vooggekauwd Concept 2 het meest vrij, omdat je de palen kan plaatsten waar je wilt	1 of 2 omdat dat in het begin wat vaag is als je in de ervaring zit Aan het begin 2, wat moet je met die kegels, wat kun je daar mee doen?	3, hier denk je ik ga iets doen bij het zien van de objecten: dan komt de vraag: "wat is dat?"	Vind ik moeilijk om te zeggen. Concept 3 omdat je daar al iets ziet. Zodra je de bril hebt is dat weer anders Concept 1 en 3 genoeg variatie
12. Welk concept geeft jou de meeste (of gewenste hoeveelheid) vrijheid?	Maar iets minder duidelijk wat je kan doen 1 en 3 voelen meer als een route/stappen die je moet volgen	concept 2, je kan de elementen combineren. Terug gaan naar elementen om dingen te veranderen	Is afhankelijk van of je na elk onderdeel aanpassen terug naar de basis gaat. Denk concept 2 omdat je iets creëert, steeds stukjes kan veranderen.	4 kun je hooguit de volgorde veranderen 1,2 en 3 zijn daarin gelijk, je kunt eindeloos onderzoeken
13. Welk concept lijkt jou het makkelijkst om te begrijpen?	Concept 3, je herkent de objecten, usecues zijn duidelijk	3, concrete objecten duidelijk	Concept 3 en 4, 3 duidelijke objecten 4 je hoeft niet zoveel te doen	Concept 3: je herkend te objecten en wat je daarmee zou kunnen doen. Refereert naar de traditionele attributen
14. Welk concept lijkt jou het makkelijkst om te gebruiken?	Concept 3, je herkent de objecten, usecues zijn duidelijk Balans van temporal change en Stella's intenties beter uitvogelen	3, concrete objecten duidelijk	Beetje Hetzelfde als v13 Bij 3 moet je meer gebruiken, maar items zijn wel snel duidelijk in gebruik	C1: simpele interacties, weinig uiteg nodig, direct act en affect
verdere opmerkingen				

Appendix O: Concept Individual Evaluation

Evaluation on Interaction qualities

Interaction qualites	Concept 1	Concept 2
Contemplative	Moderate Users reflected on the painting but mainly focused on visual effects.	Moderate Some reflective moments, but more focused on playfulness.
Self-led	Moderate Users had freedom but sometimes lacked clear direction.	Moderate Users had freedom but sometimes lacked clear direction.
Discovery	Good Users discovered visual and conceptual changes through interaction.	Good Playful discovery through physical active exploration.
Freedom of choice	Good Multiple interaction paths, though not always clear in outcome.	Good Users could make and test different choices.
Spatial	Good Spatial engagement in a limited working space	Good Clear use of space and physical activity appreciated by users.

Interaction qualites	Concept 3	Concept 4	Key takeaways
Contemplative	Good Participants connected their actions to artistic meaning.	Weak Experience felt more informative than reflective.	Reflection thrives when users interpret outcomes, not just receive info.
Self-led	Good Users felt autonomous and confident in their exploration.	Weak Highly guided and linear, little room for self-direction.	Autonomy works best when actions are clear and meaningful.
Discovery	Good Discovery through understanding of artistic choices.	Moderate Users learned facts but not through active discovery.	Discovery emerges through interaction and experimentation.
Freedom of choice	Moderate Freedom within structured choices.	Weak Fixed flow, limited decision-making.	Users enjoy choice but need feedback and clarity about it.
Spatial	Moderate Some spatial interaction but not central.	Moderate Walking around in the space but interaction itself mostly static	Physical or embodied engagement increases immersion and understanding.

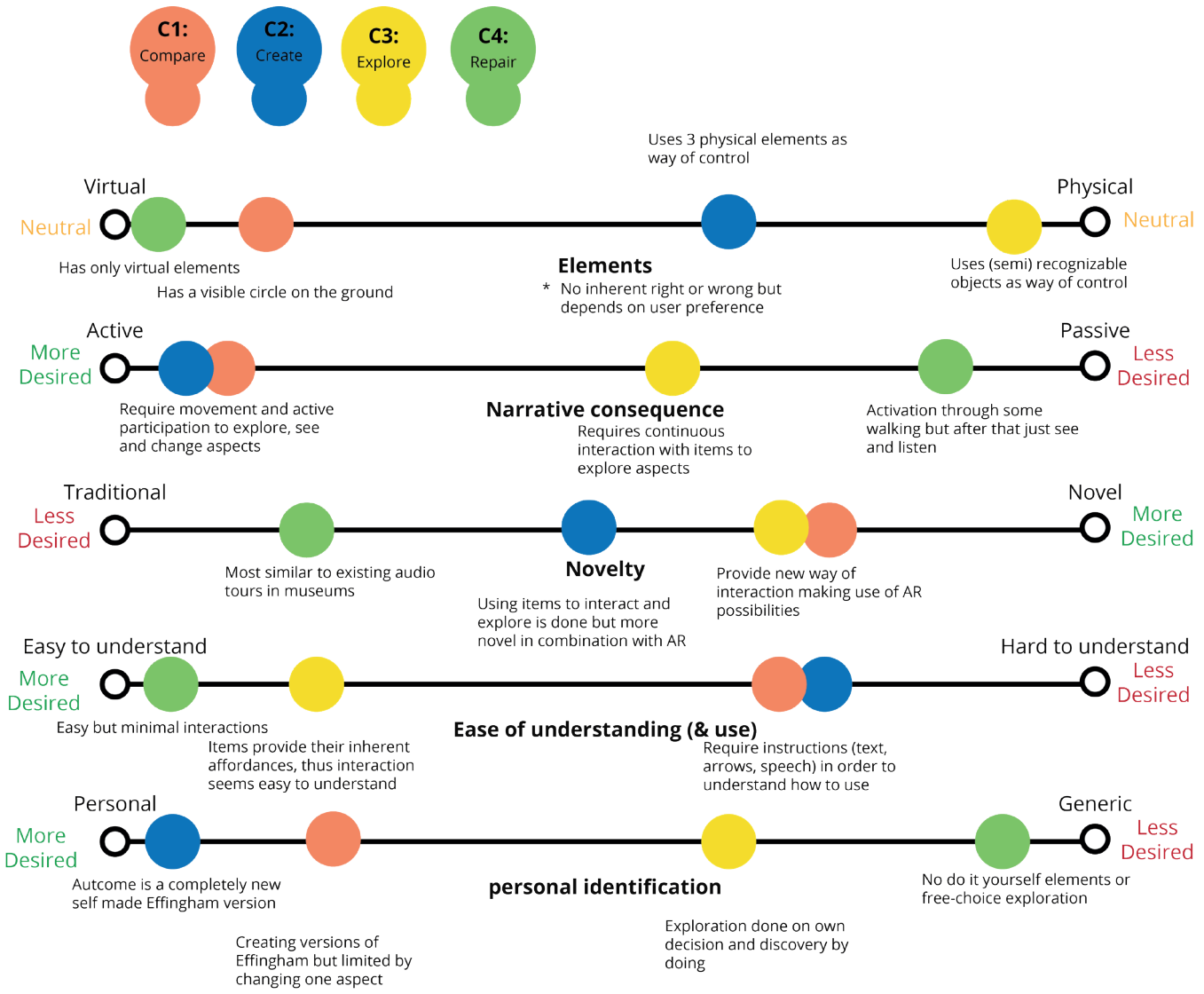
Design criteria evaluation

As they were defined up to this point of the design process

	C1: Compare	C2: Create	C3: Explore	C4: Repair
The story				
- The experience should convey the temporal changes of Effingham I	YES	YES	YES	BEST
- The experience should convey the 4 non-illusionist principles of Frank Stella: Self-referentiality, Flatness, All overness and Instantaneousness.	YES, but	YES, but	YES, but	YES, but
- The experience should keep the user engaged	BEST	YES	BEST	LEAST
- The experience teaches something	YES	YES	YES	YES, but
- The experience should effectively transfer the intended narrative				
- Provides the narrative through multiple senses	YES	YES	BEST	YES, but
Feeling				
- The experience has a serene appearance	BEST	YES, but	YES, but	YES, but
- Elements within the experience are convincing	YES, but	LEAST	YES, but	LEAST
- Within the experience there is room for contemplation	YES	YES	YES	YES, but
- The experience creates a sense of curiousness	BEST	YES, but	BEST	YES, but
Authenticity				
- The experience should provide an authentic / novel experience.	BEST	YES	YES, but	LEAST
- The experience respects the original painting	TBD	TBD	TBD	TBD
- The experience gives recognition to changes & intervention	TBD	TBD	TBD	TBD
- The interaction should provide a way of personal identification	YES	BEST	YES, but	NOT
- The experience should stimulate imagination	YES	YES	YES	NOT
Interaction				
- The interaction makes use of embodiment and spatiality	YES	YES	YES, but	YES, but
- The experience allows for "free choice" learning	YES	YES	YES	LEAST
- The experience is easy to use	YES, but	YES, but	YES	YES
- The experience is activity driven (not goal driven)	YES	YES	YES	NOT
- Context, painting and technology are present on an equal level	TBD	TBD	TBD	TBD
- The experience should provide an element of social interaction	NOT	NOT	NOT	NOT
- Interaction with the 5 visual aspects (colour, shape, size, fluorescence and depth) give insight into how the painting is built up.	YES	YES	YES	YES
- Users can change the colours in the painting	YES	YES	YES	LEAST
- Users can change the size of the painting	YES	YES	YES	LEAST
- Users can change flatness/depth in the painting surface	YES	YES	YES	LEAST
- Users can affect the shape/form of the painting	YES	YES	YES	LEAST
- Users can change the amount of light/fluorescence of the colours in the painting.	YES	YES	YES	LEAST

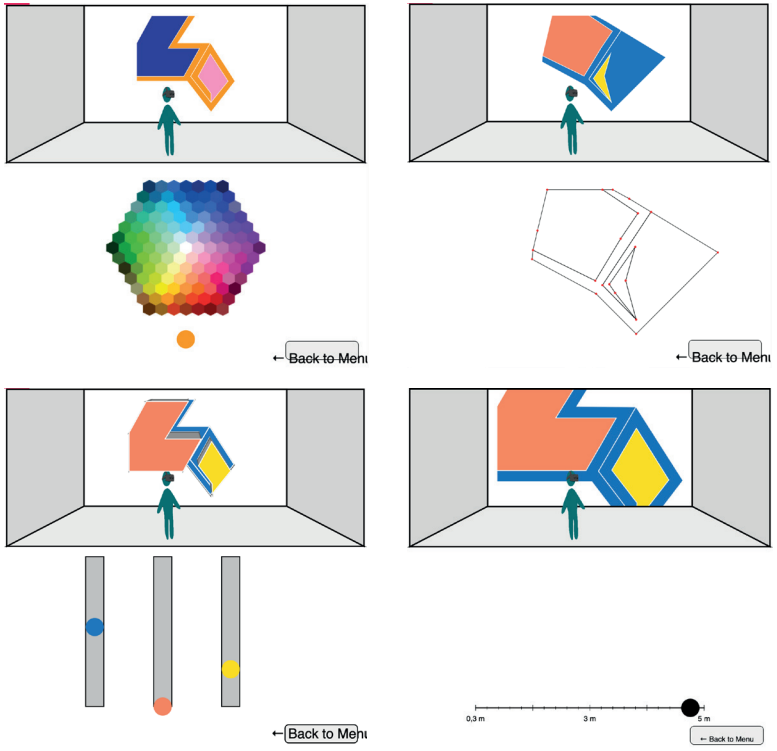
Comparing scales

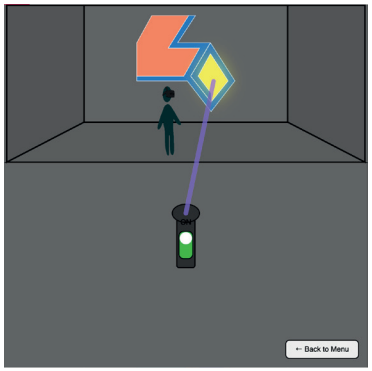
To explore these nuances further, a set of evaluation scales was developed, linking specific aspects of the interactions to the underlying design criteria. These scales should be interpreted relatively, providing an overview of perceived strengths and weaknesses rather than definitive measurements. This comparative approach offers direction rather than closure, serving as a tool for design reasoning rather than validation.



Appendix P: p5.js prototypes concept development

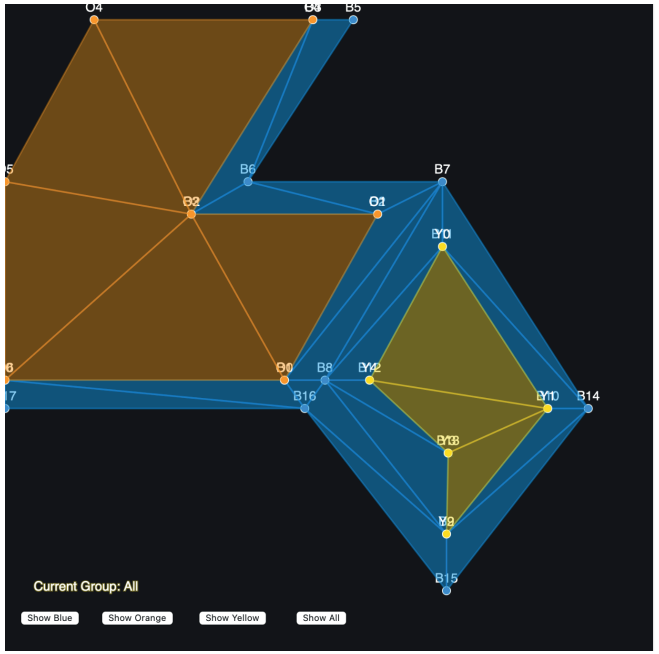
Interactions with the 5 visual aspects in on screen based prototype.





https://editor.p5js.org/ri-jkroozenbeek/full/ZNX89MlVk

Used to create the vector based shape to be used in Unreal Engine



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Appendix Q: Narrative final prototype

Introduction:
Welcome to this experience, take some time to get used to this semi-virtual environment while I tell you about the painting we will explore. Today you are visiting Effingham I made by Frank Stella in 1967.
Effingham I is part of Sella's Irregular irregular polygon series, where he created paintings on irregular asymmetrical canvases composed of bold lines and colourful geometric forms, exploring the interplay of colour, form and space.
Stella created his paintings with a certain goal; in previous work this was a goal of anti-illusionism but with this series moving towards abstract illusionism.
He attempted to achieve this by applying 4 principles: Flatness, Instantaneousness, All overness and Self referentiality. You will get more familiar with these principles through this experience.

When you are ready to start, please step towards the "start" square and we will dive deeper into Effingham I.

Explanation:
Before we can start exploring the painting there are a few things you should now.
Over time Effingham I has changed, similar to what you see happening on the painting now. Due to the materials Stella used the painting deteriorates relatively quickly and it is losing the vibrancy it once had. This changes how the painting looks, but... Does this also change the effect the painting has on you?

During this experience you are invited to make further changes to Effingham I, Explore Frank Stella's intentions and experiment through a set of 5 visual aspects that contribute in building up the painting. During this experience you can see and feel what the change of these visual aspects does with the effect the painting has on you.

When you are ready to really start interacting, please grab onto one of the objects and we will continue.

Colour:
You selected to explore the colours in Effingham I.

With his irregular polygon series Stella used vibrant colours. He did not have a real plan selecting these colours. He said he chose them arbitrarily, on intuition.
He used the paint that was easily available to him, applied them in a way that seemed best to him and learned from what he did, through experimentation.
He created every irregular polygon shape in 4-fold, using a different combination of colours every time.

Now it is your turn to pick some colours, which colours do you think work well together? Pick up the brush, grab a colour from the bucket and apply it to one of the surfaces by brushing over it in the virtual replica.

Take a look at your applied changes, does a change in colour have an influence on Stella's 4 principles of: Flatness, All-overness, Self referentiality and Instantaneousness?

Depth:
You chose to explore one of the spatial elements, the element of depth.

One of the four principles that played a role in the creation of Stella's anti illusionist paintings was the aesthetic experience of flatness. Creating a flat depiction on a flat surface, with no depth or illusion. With his move towards abstract illusionism, Effingham I along with the other paintings in the irregular polygon series started to confront Stella's emphasis on flatness and start playing with abstract illusion. Overlapping shapes, colours and fluorescence started to create visual illusions, whether intended or not.

What happens when the painting truly gains depth instead of creating it with colour, shape or material properties, going from 2D to 3D?
Does flatness really make a difference on your aesthetic experience?

Put on the glove and grab onto one of the 3 surfaces, push & pull them towards and away from you and experience what happens.

This literal change in depth, has an obvious effect on the principle of flatness but does it also affect its Self-referentiality, all-overness or instantaneousness?

Size:
Let's take a look how the size of the canvas can change how you see the painting.

As part of Stella's goal for anti- and abstract illusionism, he wanted his paintings to be instantaneous.
The idea that a painting is grasped all at once, without the need for reading or interpretation.

With this size plays a role, Stella decided to build his paintings on a relatively large scale. This plays a role in presenting the painting without illusion or metaphor. They present themselves directly as objects, aligning with his goal.

But what happens when we change the size? Does it change the effect the painting has on you?

Let's play around with the size, on the ruler you can see a bar, when you move this left or right the painting changes accordingly.

Does the size of the painting affect how you perceive the painting?
Does it Increase or decrease the painting's Flatness, Instantaneousness, Self referentiality or all-overness?

Fluorescence:
Let's explore one of the material properties in Effingham I: Fluorescence

In Effingham I Stella used 2 fluorescent paints for his blue and yellow surfaces. A paint that reflects non-visible light into the visible spectrum, making it look like the paint is glowing.
He chose this paint not for this effect but because it was mainly known for its known utility use like in signal panels and outdoor billboards.
To him these sorts of materials spoke for themselves, they are what they are.
Stella aimed to use non-artistic industrial materials, as they spoke for themselves and are clear in what they are – they are self-referential, one of his 4 modernist principles. Removing himself as the painter and creating a painting that is an object by itself.

According to his principles, not only the materials should refer to themselves but also the painting, the painting is just that, a painting, an object and nothing else.

Let's see If the effect of fluorescence changes the painting. Point the flashlight towards the painting and see the effect increase. By pressing the button you can switch modes, decreasing the effect when pointed at the surfaces. Does the effect affect the paintings Self-referentiality, its Flatness, It's all over effect or instantaneousness?

Shape:
Let's look at the shape of Effingham I.
The irregular shaped canvases truly make Stella's paintings stand out compared to usual rectangular shaped artworks.
Stella builds up these paintings combining different shapes and putting these together, forming an irregular shape.

With the intertwining shapes there's a kind of visual tension in which the two forms come together and appear to be spring loaded, creating some form of abstract illusion, which he especially in previous work tried to avoid.

One of his principles was the idea of all-overness, the idea that there is not one singular area of focus, but the eye is freely wandering around the work. There is a balance between, shape, colour and composition which guides you to experience the entirety of the painting instead of having a single point of focus.

Do you experience the painting in this way?

Let's investigate how a change in shapes can affect it's all over effect.

Let's play around with shape, move around the pieces to create a new form.
On the shape you have in your hand you can see a lot of dots appear, pinch one of these dots with you right hand and drag them towards a new location, stretching out and reshaping the canvas.

Besides the effect of all overness, does a change in shape also influence how you perceive its flatness, its instantaneousness or its self-referentiality?

After using the object for a while:
When you are happy with the changes you made you may return the item and pick a new one.
The changes you made will be added to a personal version of the painting which can be seen in between using the tools and at the end of your experience

Returning an item:
I hope you enjoyed exploring and experimenting, as you can see, we added your changes to a replica of the painting, have a look at it.
If you want to know more and change more, feel free to pick up another item.
If you are done exploring, please step into the "End Experience" rectangle

Outro:
All done?
As you maybe have experienced a lot of elements can play a role in the creation of a relatively simple looking painting, a lot can be changed and every change affect how the painting affects you.

In his painting Stella's aim was that of abstract illusionism, reached through: Flatness, All-overness, instantaneousness and self-referentiality.

Even if Stella had created something that at one point in time truly conveyed these principles still change happens. Unfortunately, time has done this, changing the painting from what it once was. And thus, maybe the intended effects of the paintings disappeared or changed and the effect on you as a viewer has also changed.

To finish the experience, please step into the end experience rectangle.

Ending:
With this experience you hopefully learned a little more about Effingham I and Frank Stella's intentions. The painting might look simplistic but looking beyond the surface there is more thought and intention behind what you see.

Stella aimed to create paintings where "What you see is what you see" but maybe that is not as easy as he thought. Maybe there is more to see than what you see and what you see changes over time.

Feel free to take another look at your creation and compare it to Effingham I. And take a look at what others have changed and created before you.

When you are done feel free to take of the headset and return it.

Appendix R: Evauation plan final prototype

Evaluation Plan — Final Prototype
An Augmented Reality Museum Experience with Effingham I (Frank Stella)

1. Purpose of the Evaluation
The goal of this evaluation is to assess how visitors experience the AR experience designed for Effingham I.

The evaluation combines qualitative and quantitative data using a think-aloud AR walkthrough, a semi-structured interview, and behavioural observation.

2. Participants
- 5–10 adult participants
- Mixed museum familiarity levels
- Some with and some without prior AR/VR experience

3. Procedure Overview
The evaluation consists of four phases:

1. Pre-experience questions
2. Baseline perception of the physical painting (replica)
3. AR experience walkthrough (think-aloud)
4. Post-experience semi-structured interview + short quantitative ratings
5. Researcher observation throughout

Total duration: 30–60 minutes

4. Procedure
4.1 Pre-Experience Interview
Purpose: understand background, expectations, and prior museum/AR experience.

"Welcome to my user test, today I would like you to give your thoughts and opinions on the AR experience I created.
I would like you to pretend we are visiting a modern art museum together, describe what you think and tell me like we are experiencing the museum together. We are visiting an exhibition, displaying Effingham I by Frank Stella
Before we start in Augmented Reality, first I have a few things I want to tell and ask you."

Questions:
1. How often do you visit museums?
More than once a month – monthly – yearly – rarely – other
2. How often do you visit a modern art museum?
More than once a month – monthly – yearly – rarely – other
3. How would you describe yourself as a museum visitor? (Looking back at your last or a recent visit)
o Explorer o Facilitator o Experience seeker o Professional / hobbyist o Recharger
4. What is your age?
o 18–25 - 25-40 - 40-55 - 55+
5. Are you Familiar with Frank Stella?
Yes/No
6. Have you used VR or AR before?
o Never – Once or twice - Often

Researcher prompt:
"As I said, I want us to pretend like we are in a modern art museum, visiting an exhibition where Effingham I is displayed. Here is an example of what such an environment could look like. [Show image collection of modern art museums]"

4.2 Baseline Perception of the Physical Painting (Replica)
Purpose: establish a reference point for later comparison.
Questions:
1. How would you describe the painting in 3 words?
2. How much does the painting activate your thoughts or imagination?
o1-5
2.1. About what?
3. Are there any questions that arise about the painting?

4.3 AR Experience Walkthrough (Think-Aloud)
Participants put on the HMD.
Instructions:
"Please describe what you see, think, and feel throughout the experience. There is no right or wrong way to experience this. If anything is unclear, uncomfortable, or confusing, please tell me immediately."
"As you see, the headset is connected to a cable, please be aware of this, furthermore you are free to move around and go where you want."

Tasks:
- Approach this experience as if you were visiting a museum
- Engage as long/short as you want and in the way you want

- Describe the thoughts you have during the experience, try to talk out loud.

(During the experience the researcher observes and takes notes of things that stand out I.E. look at:

- How much they move around (standing in one location – just moving between objects and painting – moving more than required)
- The time they spend on each interaction
- Interaction with painting, objects & environment (looking back at original painting while interacting, looking around)
- How active their participation is (excitement, desire to interact)
- The order in which the objects are chosen?
- Did they interact with every object?
- Do they grab an object more than once?

4.4 Post-Experience Semi-Structured Interview

A. Overall Experience
1. How would you describe your experience in 3 words?
2. Is there anything you particularly appreciated or disliked?
3. If displayed in a museum, would you engage with the experience?
o Why/why not?
4. Does this experience fit within a modern art museum according to you?
o Why/why not?
5. How would you rate the looks/aesthetic of the experience?
o 1-5

B. Authenticity & Relationship with the Real Painting
1.1. Did the experience bring you something the painting alone could not?
2.Did you remain aware of the physical painting during the experience?
o Yes/no
3. Did the experience feel genuine or meaningful to you?
o In what way?
4. How much would the experience enrich your museum visit?
o 1-5
5. After the AR experience, does the physical painting look different to you now?
o How?
6. Do you feel that the experience respects the original painting?
o Yes/no

C. Interaction, Clarity & Tangibility
1. How clear was what you could do during the experience to you?
o 1-5
2. How easy to use were the interactive elements in the experience?
o 1-5
3. Did you feel spatial freedom in the experience? In what way?
4. Which interaction moment stood out most? Why?

D. Personal Experience
1. Did you feel guided during the experience
o 1-5
2. Did you feel like you were free in your choices?
o 1-5
3. Did the experience feel like a personal experience to you?
o 1-5
4. How did the experience change your connection to the painting and/or painting?

E. Contemplation, Discovery & Curiosity
1. Did the experience activate your thoughts or imagination?
o 1-5
o About what?
2. Did and how much did the experience give you a sense of authenticity??
o1-5
2.1. Can you describe one thing you discovered?
3. Did something in the experience spark your curiosity?
o How and where?

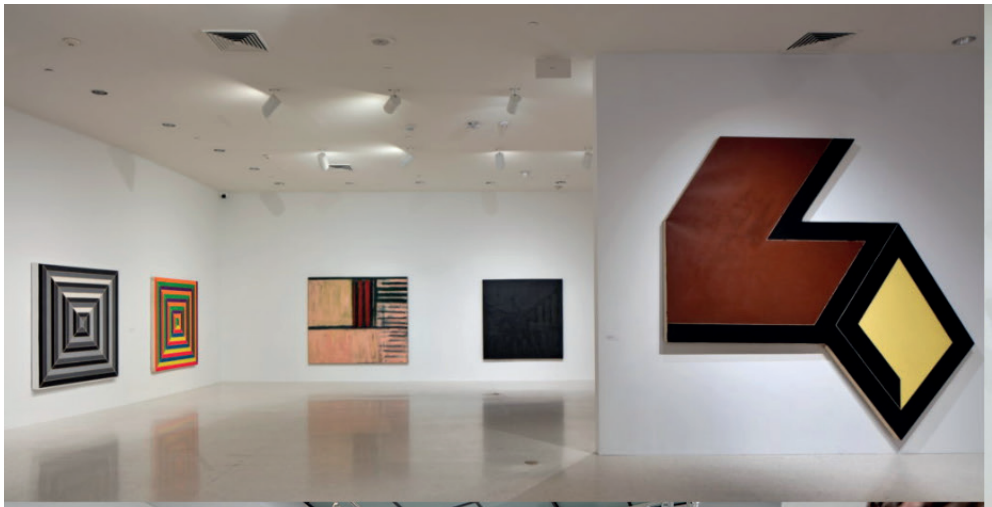
F. Engagement & Learning
1. How engaging was the experience to you?
o 1-5
2. Which interaction or visual element was most engaging?
o Colour – Shape – Depth – Fluorescence - Size
o Why?

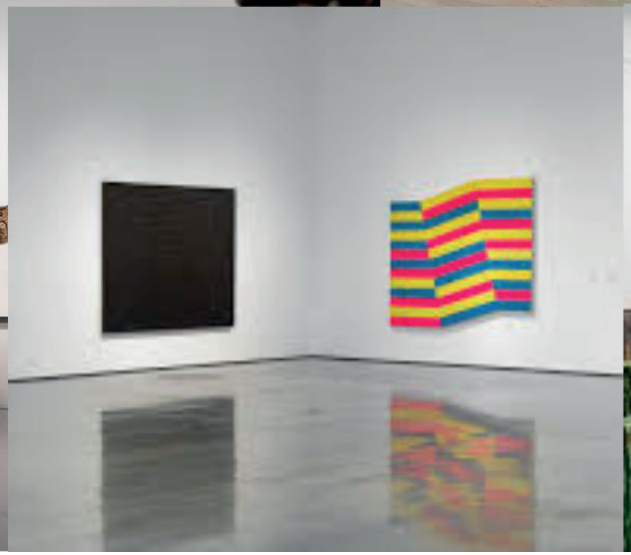
3. Do you feel like you learned something about the painting or its visual qualities?
o Can you name one thing?

9. Materials

- Replica of Effingham I
- Varjo XR HMD + PC
- Tangible interaction objects
- Video camera
- Audio recorder (optional)

The collection of images shown to make sure participants have the right idea of the intended context of a modern art museum





Appendix S: Notes Evaluation of final prototype

								P1	P2	P3	P4	P5	P6	P7
Pre-Experience														
1.How often do you visit museums?		More than once a month	Monthly	Yearly	Less than once a year			Monthly	Yearly	Yearly	Yearly	Monthly	Yearly	Monthly
2. How often do you visit a modern art museum?		More than once a month	Monthly	Yearly	Less than once a year			Less than once a year	Yearly	Less than once a year	Less than once a year	Yearly	Less than once a year	Yearly
3. How would you describe yourself as a museum visitor? (looking at your last or a recent visit)		Explorer	Facilitator	Experience seeker	Professional/Hobbyist	Recharger		Experience seeker	Professional/Hobbyist	Explorer	Professional/Hobbyist	Explorer	Explorer	Explorer
4. What is your age?		18-25	25-40	40-55	55+			18-25	18-25	18-25	18-25	25-40	25-40	55+
5. Are you familiar with Frank Stella?		Yes	A little bit	No				A little bit	No	No	No	A little bit	No	No
6. Do you have prior experience with VR or AR?		Never used	Used once or	Use it regulary				Used once or twice	Used once or twice	Used once or twice	Use it regulary	Never used	Used once or twice	Never used
Questions with physical painting														
1. How would you describe the painting in 3 words?							1	large	Bright	Large	Road	abstract	Colorful	Large
							2	Colorful	sharp	Colorful	Open / Closed	Unfinished	Bordered (white lines)	Nice colors
							3	Simplistic/simple	Bold	Very big	Geometric	Big	Colorcombination	abstract - (roofwindow, attic, something in a building)
2. Does the painting activate your thoughts/imagination?		1	2	3	4	5		3	3	3	3	3	3	3
2a. About what?								When walking by first then you think "quite simple shapes" if I look a little linger I see more details and question why the shape is as it is.	The colours make me think of a superhero, It looks like a lightningbold. I feel like something is missing on that (the left) side.	Why the shapes like that? Why does the blue flow that way? Basic colours.	I look at it and try to see what is meant with it from my own interpretation	If the painting means something? How the painter came to creating this work	It gives me the feeling that the painting puts me in a loop or something like that.	Something like passthroughs, that you can go outside or upwards, whats behind that? Yes, the world. Much more i don't think.
3. Are there questions that arise about the painting?								Why does the blue line stop? Why is the shape like that? Why the white lines?	Is there more? Like it is part of a bigger whole	Not necessarily, I am not that interested in art/this painting	Not that much, for me it is more what I see in it, not that much that I would have questions about it.	If the painting means something? How did the painter get to this work?	How did the painter came up with this? What is the purpose of the painting? Why are these colours chosen? Why are not more colurs used?	are the ideas? Why did the artist make this? From which period is this? Is it from the time of Mondriaan? (I think later?) With whom could I compare it? Is it from a certain movement? It makes me think a bit of escher, in some ways it is not right, it looks like something is p[emomg but upwards it does not. Should i see it flat or 3Dimensional? How the surfaces are arranged brings up many questions.
Post experience questions														
Overall experience														
1. How would you describe the experience in 3 words?							1	Inspiring	Surprising	Nice	Experiment	Make it your own	Special	Play
							2	Active	Playful	Interesting	Own(personal))	Active	Chaotic	Explore
							3	Educational	Lively	Cool	Step into the shoes of..	Experiment / Experimental	Explorative	Colours / Space / Figures /
2. Is there anything you particularly appreciated or disliked?								I liked the colouring and the changing of depth. I found the narration difficult in english and the volume was a bit too low	dislike: Screen feels a bit blurry, due to the pixels. Estimating the depth is difficult, this makes walking a bit scary. Like: Interacting in the real world	Some elements were more fun than others, size was cool, realy in your face, Shape was difficult to use which quickly messes up the creation and making it weird. It was nice that I had the time and I could keep going for as long as i would want	objects . Hand tracking worked surprisingly well. What I liked less was that I had to fiddle quite a bit to get things to work, with more experience I could get this to work but someone with less experience would have more trouble, somekind of cue could help?	At first I did not notice that in between all changes are put together. The changing of depth worked really well. I liked the variation in what to do and how to do it, very interesting. I liked the different movements and the search on how to make it work.	I liked the flashlight and that I could change the brightness.	I enjoyed that I could use my hands to move things. Especially the experience that the painting consists of different aspects, Shape, colour, depth. You became more part of the painting
3. displayed in a museum, would you engage with the experience?		yes	no					yes	no	yes	yes	yes	yes	yes
3a. Why/why not?								Out of curiosity what it is. The attributes would really draw me if presented on a table.	Doubtful, in a public space with a lot of people no. In a closed off room I would, a lot is happening sometimes a little too much	Personally I always like this kind of things, an experience, something extra. Unless there is a long line or the room is very busy	As a hobbyist I like experimenting with things. If I can only watch I like it less. Way more fun than reading signs. Nice to fiddle around.	A lot of fun that you can do more than just watch, you can experience it with multiple senses and movement	If I would know more what I would get into, I want more of a purpose. combination with the real painting	at one artwork. Also to hear more about it, just look at it a little longer. I also often put on the headphones, this is a new kind of experience. I always like the experiences in museums.
4. Does this experience fit within a modern art museum according to		yes	no					yes	yes	no	yes	yes	yes	yes

4a. Why/why not?								Minimalistic, I can see it in front of me, a big white room with white walls.	Empty, white, clean	I am not sure if this would be the vibe in between more art. If it is seperated in a room then it would work. Maybe it is a bit too playful for a serious, quiet museum	I like the gamification of art, really do something. It is somethimes hard to keep attention, not out of disinterest but by doing something it becomes more exciting	Something interactive with AR would fit with modern art, something novel. I think that is why people would go to such museums, to gain new experiences.	I think so, with the right marketing "create your own version"	Especially, because it is a modern artwork
5. How would you rate the looks/aesthetic of the experience?		1	2	3	4	5		5	4	4	3	3	3	4
6. how long did the experience feel?		Too short	A little	Just right	A little	Too long		Just right	A little long	Just right	A little long	A little long	Just right	Just right
Authenticity														
1. Did the experience bring you something the real one could not?								It brings the actual paining more to life, it makes it engaging for longer. The real painting should still be there, it has added value that there is something physical.	For me, without the virtual the painting would be nothing, it only has to be there at the start, then it can go. I would want to see the real painting for a bit but not during the interaction.	Yes at the start you get a good look at the real painting and form an opinion, During the experience you can add onto it.	The virtual brings: stepping into the shoes of someone and setting it to your own hand, personalize it. THe physical brings: The true own intend of the artist, the virtual breaks this a little bit	The virtual brings the different seperated dimensions, and something active. You can make the painting like your own taste	Digitally you can play around with the painting, this gives a new dimension, you sort of become the artist.	I think so, now you experience way more where the artist also played with, these visual aspects. You really go and see what it does. For sure with the coloring, then you think how does this present itself
2.Did you remain aware of the physical painting during the experience?		Yes	No					no	yes	no	yes	yes	yes	no
3. Did the experience feel genuine/ meaningful to you?		Yes	No					yes	yes	no	yes	yes	yes	yes
3a. In what way?								Action reaction, it brought up a happy emotion	The interactions did feel genuine/real, the painting not really	Not more or less than usually with art	Could be meaningful because you make your own creation, you make that of the artist your own	Because I had influence on it myself, and it fell together with the real world around me.	When you are busy it does really feel like you are building. It does not really give meaning as in "it makes my life better"	You are making something yourself, even tough it is virtual. You do not have to touch a real brush or saw but feels a little like it. I would want to do this with other paintings
4. Would the experience enrich your museum visit?		1	2	3	4	5		5	3	4	5	4	4	4
5. After the AR experience, does the physical painting look different to you now? In what way?								I compare it to my own doings/ creations. Why were these choices made while I made different choices.	No, not really	Yes, I think so. More seeing all aspects separate, you look differently at the painting.	What stood out to me is that when you yourself are busy you can not really make anything of it, nothing meaningful or recognizable.	I look at it and what could all be different. You see the orange now as orange but just experienced it a different colour, different shaped and with different depth. I can now imagine this because i just experienced/saw this.	Yes, I look at it as if I could do more with it, it becomes more playful.	Yes, I now see it as 3things where you can do all kinds of things with. I now see the whole more dynamic, I can let my imagination loose. It makes you think what more you could make of it.
6. Do you feel that the experience respects the original painting?		Yes	No					yes	yes	yes	yes	yes	no	yes
								It shows that change happens and what changes. In the conclusion you think again about the real painting , my self made choises and how this changes the painting	I feel like the AR gives more meaning to the painting, it makes it more lively.	Because you also hear a whole story about the artist and things he thought about.	In Stella's original intend it does. He made the painting with a certain intend, by changing that you attack it a little bit, but because by making something yourself you remain in his line of thought.	Because everytime you return to the original painting. The original is always the centre and starting point	You can make anything out of it, i don't know if it loses value but it is very nice you can make your own version.	From what i heard, the painting is just what it is, but by playing with it it makes you think more. It nudges you to think.
Interaction & clarity														
1. How clear was what you could do during the experience to you?		1	2	3	4	5		4	3	4	5	4	3	3
2. How easy to use were the interactive elements in the experience?		1	2	3	4	5		4	3	3	3	3	4	3
3. Did you feel spatial freedom in the experience?		Yes	No					yes	yes	yes	yes	yes	yes	yes
3a. In what way?								I was a bit scared of the cable at some times. The feeling of depth with the virtual painting felt strange, the distance to reach it.	It takes a little time getting used to AR. The cable was a bit in the way. After getting used to both it felt fine.	Just going backwards, because of the cable and possible things in the way	not feel like I would walk into somethings. I did feel like I had to dodge the 3D shapes, but that is part of it i think.	Only the canle, somethimes I did not know how close I was to the physical canvas, a bit afraid I would walk into it.	I had the feeling like I was in control myself.	At the start I was a bit dizzy and felt i had to watch out for the paiting, once i was busy doing that went away.
4. Which interaction stood out most to you?								Size & Colour, Most intuitive and most easy to use by how it is to be used.	Colour, Clear, simple non-overwhelming.	Ruler, One of the first I interacted with, with a big effect. The most exciting was painting and pulling, this felt very interactive because you really had to go to the painting and do things physically. Other items felt more like remote-controls	I am doubting beyween 3 of them, Flashlight, shape and glove. If the Flashlight has more effect I like that one the most I think, the effects now felt very subtle. The depth worked very well and felt smooth, direct effect. Changing the shape had I think the biggest impact, it became a totally different thing.	Gloves,Here you could use your body the most. The others was mostly pointing and clicking, very simple.	The colours, I could make the painting more rough imediatly.	forward and backward. I would have wanted to push and pull in more ways, diagonally, flap open. But just pushing and pulling also showed that you could really use the 3D space. I also liked this in the shape but there you just had a surface with a lot of spheres in your hand. The glove really made you push and pull, go into the painting.
Personal experience														
1. Did the experience feel guided?		1	2	3	4	5		4	2	4	5	4	4	4
2. Did you feel like you were free in your choices?		1	2	3	4	5		5	4	5	4	5	5	5
3. Did the experience feel like a personal experience to you?		1	2	3	4	5		5	2	4	4	4	4	5

4. How did the experience change your connection to the painting and/or painter?								I now look differently at the painting, a more deepend look.	No, I did not listen that well, a lot was happening, I was eager to interact myself.	Yes, I still don't remember the painters name. I know a lot more about the painting, I have a little connection with it now.	You get a painting from someone else and look at it with "how would I do this" you get more of an insight into the choices the painter made.	yes, Because I also made my own version	No, it did not	Yes I think so, it feels like that you create something with what the painter has creaded. The painting is the bedrock on which you continue. If you stand in front of a painting you can imagine a lot, this connects more because you also really see the change.
Contemplation, Discovery & Curiosity													
1. Did the experience activate your thoughts/imagination?		1	2	3	4	5		5	3	5	5	4	4	4
1a. About what?								About all the parts that build up the painting.	Mostly about AR, not that much aout the experience perse	About what the impact is of all the different visual elements and how you perceive them.	Because I like being creative myself and can try out things, even though the result might not be beautiful, it is still nice to see.	About all the possible things that you can do with such a visual	The painting is not just what you see, it changes and you can make your own creation of it.	More aimed at the things I could change, less about other things. You are being guided by the tings you can change. Now I wonder what more I could do with these changes
2. Did and how much did the experience give you a sense of authenticity?		1	2	3	4	5		4	2	4	4	4	3	4
2a. Can you describe one thing you discovered?								The ideas of the artist, That he really thought about it	The difference between AR and screen interaction. Not much about the painting, other than it does not have a real meaning.	That the artist thought about all the things he did, there is more behind it. With a few different choices it could be very different.	The original intend behind the painting, I understood that better by being busy with the painting myself.	It is fun being busy with art in a different way. I mostly know art as something to only look at, now you can do something with it yourself.	You can make it as wild as you want jourself, weird shapes, rough colours, "a breeding ground for creativity"	the use of flourescence, I dont think I ever realised that. That you do not just pick a colour but that there is more.
3. Did the experience spark your curiosity?		yes	No					yes	yes	yes	yes	yes	yes	yes
3a. How/where?								With every change/step, the visible change	The props, You wonder what all props do. I think it is good to have a mix of recognizable and harder to recognize objects	Before I was intrigued by the objects, interested to see what they would do. During I wanted to try multiple things, see what each could change	It would be nice if this were in a museum, especially when further worked out, even with 1 or 2 objectss already	I was curious when I would grab a new item. "what would change now" you can only see that if you try it. I was curious to try out all items	It was nice to see that I could change the different parts, I found that interesting	Yes, just about the painter already. Also what you could do with this technique with other artworkds, you put on a certain pair of glasses to look differently at the artwork.
Engagement & learning														
1. How engaging was the experience to you?		1	2	3	4	5		5	4	5	4	5	4	4
2. Which interaction or visual element was most engaging?		Colour	Shape	Depth	Fluorescence	Size		Depth	Colour	Colour	Depth	Depth	Colour	Depth
2a. Why?								It did not remain just a paintg but it created a new meaning	From that point on I got the geste, how it worked, that I could walk towards and touch the painting.	That you had to move physically and had to touch it	get to see it from a different perspective, giving an extra dimension to the painting. Maybe this is also because it worked soo smoothly compared to some of the others	Using your body the most, it felt like a big change. I liked you really had to use your bodily movement	Gives the most life, direct change	That you really become part of it. When moved look around and see, what can I do differently now?
3. Do you feel like you learned something about the painting or its visual qualities?		yes	no					yes	no	yes	yes	yes	no	yes
3a. Can you name one thing you learned?								There is a lot behind the painting, remembering things specificly is difficult	Hard to take in all the information.	There is more behind the painting than what it is.	By experimenting yourself creates a new way to relate to the painter	The painting changes over time and the colours fade. The whole painting has changed	I still look the same at the painting , like it is. I do not find it particularry interesting	painting, I also missed some things. You only hear it once and can not capture everything. That it should be abstract and does not mean anything but that that is a difficult objective